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Caddisflies (Insecta: Trichoptera) of fringing wetlands of the Laurentian Great Lakes

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Introduction

Fringing wetlands of the Laurentian Great Lakes are subject to natural processes, such as water-level fluctuation and wave-induced erosion, and to human alterations. In order to evaluate the quality of these wetlands over space and time, biological communities are often examined. Ideally, the groups of organisms selected for these evaluations should be resident in the wetlands themselves. Fish are often sampled, but many species are not truly resident, visiting wetlands on an occasional basis to feed or on a seasonal basis to breed. Aquatic vascular plants are perhaps the most common group selected for evaluation. However, in some cases, aquatic plants give a false impression by providing photosynthetic capabilities and structural infrastructure but having greatly diminished herbivore and carnivore communities.

Aquatic insect communities are key components of healthy wetlands. Whereas much research has been published on fish, birds, and algae in the Laurentian Great Lakes, there is relatively little information on the community composition, population dynamics, secondary productivity, and trophic relationships of aquatic insects (KRIEGER 1992). We can assume, based on studies in other habitats and geographic locations, that they are important processors of aquatic vegetation and serve as food for a number of carnivores and detritivores. Aquatic insects generally cannot escape natural or human perturbations; thus, they make good indicators of changes in water and habitat quality. SHUEY (1985) indicated that wetland biological communities contain many of the rarest and most interesting plant and animal species native to the Laurentian Great Lakes' region. Certainly this is true of caddisflies (Insecta: Trichoptera), a major component of aquatic insect communities in wetlands.

Because more than 70% of caddisfly taxa have not had their larval and adult stages associated, the true diversity of a given wetland is often underestimated when immatures are collected. The adult stage is, therefore, more desirable for creating species lists, estimating species richness, and developing biotic indices. This paper reports on the use of adult caddisflies to evaluate fringing wetlands of Lake Huron, Lake Michigan, and Lake Superior.

Methods

Fringing wetlands of Lake Superior (n = 6), Lake Huron (n = 4), and Lake Michigan (n = 7) were evaluated during 1993, 1994, and 1995, respectively. The Lake Superior sites (Allouez Bay, Bark Bay, Bibbon Lake, Fish Creek, Hog Island, and Siskewit Bay) are located in Bayfield and Douglas Counties, Wisconsin and are protected from Lake Superior by barrier beaches. Aquatic vegetation is very diverse in at least four of the wetlands. The Lake Huron sites (Almeda Beach, Vanderbilt Park, Wigwam Bay, and Wildfowl Bay) are located on the west, southeast, and northeast sides of Saginaw Bay. These are primarily *Scirpus*-dominated wetlands. The Lake Michigan sites (Arcadia Lake, Betsie River, Lincoln Lake, Little Manistee River, Pentwater Marsh, Pere Marquette River-private, and Pere Marquette-public) are all drowned river-mouth wetlands containing a diversity of aquatic plant species.

Adult caddisflies were collected employing ultraviolet light traps consisting of an Eveready 5470 flashlight with an F6T5-BLB black light tube over a 2.4 cm × 3.6 cm plastic pan filled with 85% ethanol. The pan and light were placed down amongst the wetland vegetation and, in general, did not serve as a beacon for adult insects from a distance. The ultraviolet bulb has very low luminance. The light traps were placed around dusk and picked up the next morning. Only one sample was taken in August 1993 for the Lake Superior sites, whereas two samples were collected in July and September for the Lake Huron (1994) and Lake Michigan (1995) sites. Additional caddisflies were collected in each wetland by hand sweeping the vegetation with a terrestrial insect net.

Each sample was sieved and flooded with fresh alcohol. Following picking and sorting, the individ-

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ual taxa were identified to species and the data entered into an electronic spreadsheet for preliminary data analysis. A relatively few species known to have come from flowing-water habitats, and not wetlands, were eliminated from the data set. Samples from Lake Superior were counted by taxa for numbers of individuals and for numbers of males and females. This was done to compare statistical results from count data versus presence/absence data. Jaccard similarity coefficients among sites in each lake and among all sites combined were calculated for the presence/absence data matrix. Euclidean distance was calculated for the count data. The sequential, agglomerative, hierarchical, and nested clustering methods (SAHN) of SNEATH & SOKAL (1973) were used to generate the tree matrices and cluster diagrams. The presence/absence similarity matrices were further analyzed employing principal coordinate analysis. First, the matrices were transformed using a double center technique to convert to scalar product forms so that eigenvectors and eigenvalues could be calculated. Minimum spanning trees were also generated for all matrices. The eigenvectors were then plotted using the first two principal coordinate axes for each data matrix, and the minimum spanning trees were superimposed. The use of minimum spanning trees assists in detecting relationships among sample sites when all dimensions are considered, but which might not be apparent when only plotting the first two. All analyses were performed using NTSYS version 1.70.

Results and discussion

Eight families of caddisflies were collected over all sites. Table 1 presents the number of taxa for each family and lake, as well as total taxa for each lake and for each family. Also indicated in Table 1 are the numbers of species for each family and lake which are considered rare, based on the published literature and over 17 years of collecting and identifying caddisflies from this ecoregion. The number of species collected and identified from Lake Huron was considerably lower compared to Lake Superior and Lake Michigan wetlands. Similarly, the number of rare species was lowest in the Lake Huron sites. Lake Superior had a comparable number of species to Lake Michigan but greatly exceeded Lake Michigan in the number of rare taxa collected and identified. The relatively high number of species collected in the Lake Superior sites was all the more remarkable because it was derived from one collection date per site. The dominant families found in all of these sets of fringing wetlands include (in order of species richness) the Leptoceridae, Hydroptilidae, Limnephilidae, Polycentropodidae, and Phryganeidae. The greatest number of rare species was found in the Hydroptilidae (microcaddisflies). Some very interesting geographic disjuncts were discovered during the course of this work, all of which will be reported in other publications.

Evaluation of the Lake Superior samples based on numbers of individuals and further separation by sex revealed no explainable pattern or inference. The wetland (Hog Island) with the lowest number of species (n = 5) consistently paired up with the second-most species-rich wetland (Allouez Bay, n = 24), which is in relatively close proximity. Further, it has been observed by the first author that there can be considerable fluctuations in numbers of

Table 1. Numbers of species identified from wetlands in Lake Huron, Lake Michigan, and Lake Superior by caddisfly family. Numbers of rare species identified are contained in parentheses.

Caddisfly Family	Lake Huron	Lake Michigan	Lake Superior	Totals
Hydropsychidae	1	2	2	3
Hydroptilidae	7	14 (3)	5 (4)	18 (5)
Lepidostomatidae	0	0	2	2
Leptoceridae	12	19	17 (3)	27 (3)
Limnephilidae	3	8	10 (2)	15 (2)
Molannidae	1	1	2	2
Phryganeidae	3	7	5	8
Polycentropodidae	4 (1)	7	8 (2)	13 (3)
Totals	31 (1)	58 (3)	51 (10)	88 (13)

individuals and in the ratio of the sexes from one sampling date to another, even day to day. Thus, species counts and sex ratios do not provide reliable information in this context.

A plot of eigenvectors for all wetland sites combined (n = 17) is presented in Fig. 1. The combined plot (Fig. 1) reflects a mixture of within-lake and among-lake relationships. The Lake Superior wetlands grouped together to the left. Similarly, the Lake Huron wetlands grouped together in the upper right quadrant. For the Lake Michigan wetlands, we have a division of association. The Arcadia Lake and Little Manistee River sites, which were most unlike the other Lake Michigan wetlands based on similarity coefficients, associated with the Lake Huron wetlands. The remaining five Lake Michigan wetlands grouped together in the lower right quadrant. There are several explanations, in addition to wetland quality, which can be brought to bear to explain this plot. First, the Lake Superior wetlands are further north in latitude and have a somewhat different community composition. Second, the Lake Huron wetlands are dominated by *Scirpus*, and whereas other taxa, including islands of *Typha angustifolia*, are present, they are infrequent in occurrence. The two Michigan wetlands that have associated with the Lake Huron wetlands in Fig. 1, and ultimately with the Lake Superior wetlands, also have two of the lowest species richness values for all the Michigan sites. No other explanation is apparent for this association.

Plots of the eigenvectors for each Laurentian Great Lake are presented in Figs. 2–4. The plot for Lake Huron indicates a divergence between Wigwam Bay and the other three sites. Wigwam Bay samples contained 22 species whereas the other three sites contained 14–15 species. The plot for the seven drowned river-mouth wetlands in Lake Michigan reflects the differences inherent in these sites. All of the Lake Michigan wetland sites were reasonably diverse (19–34 species), with Lincoln Lake being the most species-rich (n = 34) of all the wetlands for any Laurentian Great Lake. The central position of Lincoln Lake on the eigenvector plot, with the minimum spanning tree lines radiating out from it to the other groups of sites, reflects both the more inclusive number of species for this site and its relatedness to the other sites. We do not see a similar pattern for Wigwam Bay in Lake Huron because, although it is the most species-rich site studied in Lake Huron, it had a larger number of peculiar species not shared with the other Lake Huron sites. The plot for the Lake Superior wetlands reveals the similarity among the higher quality sites (Allouez, Bark, Bibbon, and Siskewit) and the divergence of the lower quality sites (Hog Island and Fish Creek), the latter two also have the lowest species diversity. With one exception, the rare species from the Lake Superior wetlands came from the four higher quality sites

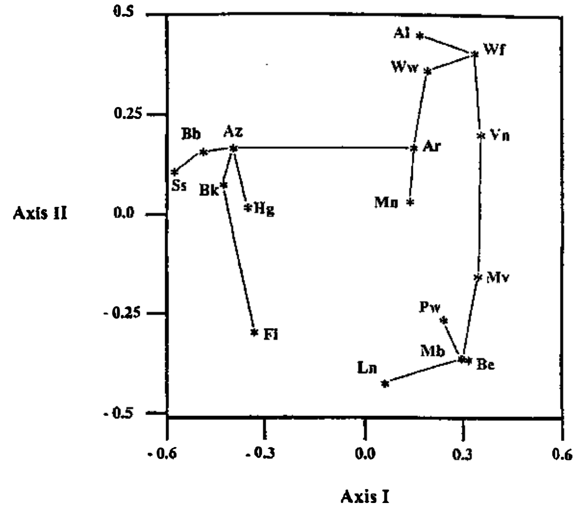

Fig. 1. Plot of eigenvector coordinates for all Laurentian Great Lakes' wetland sites on first two principal coordinate axes, based on Jaccard similarity coefficients with minimum spanning tree superimposed. (Lake Huron wetlands: Al, Almeda Beach; Vn, Vanderbilt Park; Wg, Wigwam Bay; Wf, Waterfowl Bay. Lake Michigan wetlands: Ar, Arcadia Lake; Be, Betsie River; Ln, Lincoln Lake; Mn, Little Manistee River; Pw, Pentwater Marsh; Mv, Pere Marquette-private; Mb, Pere Marquette-public. Lake Superior wetlands: Az, Allouez Bay; Bb, Bibbon Lake; Bk, Bark Bay; Fi, Fish Creek; Hg, Hog Island; Ss, Siskewit Bay).

The use of adult caddisflies identified to species provides a basis for evaluating wetland quality. For the Lake Superior sites, adult caddisflies proved to be the best measure of wet-

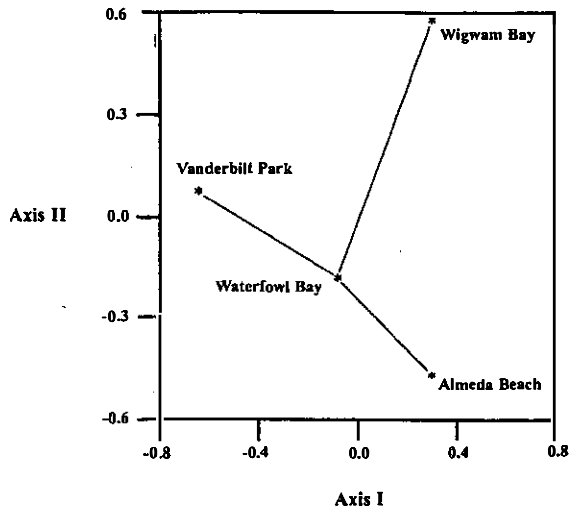

Fig. 2. Plot of eigenvector coordinates for Lake Huron wetland sites on first two principal coordinate axes, based on Jaccard similarity coefficients with minimum spanning tree superimposed.

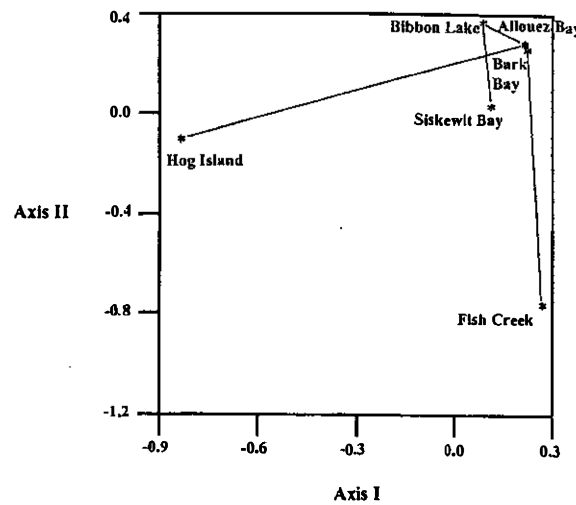

Fig. 4. Plot of eigenvector coordinates for Lake Superior wetland sites on first two principal coordinate axes, based on Jaccard similarity coefficients with minimum spanning tree superimposed.

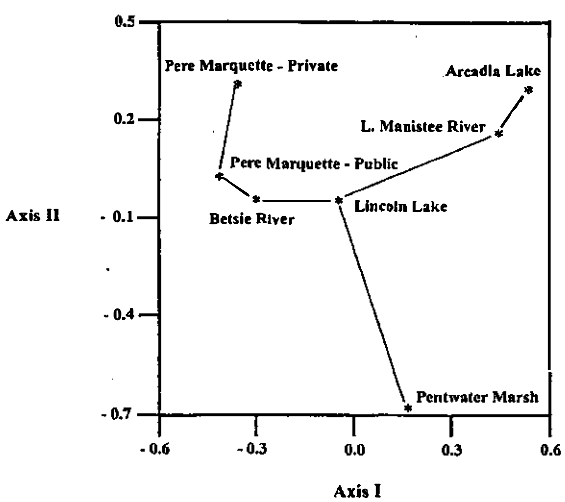

Fig. 3. Plot of eigenvector coordinates for Lake Michigan wetland sites on first two principal coordinate axes, based on Jaccard similarity coefficients with minimum spanning tree superimposed.

land quality among many biological and physical parameters. Whereas final analyses of Lake Huron and Lake Michigan sites are ongoing, preliminary indications are that adult caddisflies will provide useful insights concerning the wetlands in these areas. Certainly, employing presence/absence data and multivariate statistical methods, as presented herein, discriminates among sites and provides indications of relatedness. The total number of taxa, the number of rare species, and the diversity within families of caddisflies are other parameters that should prove useful in comparing wetlands and in monitoring the recovery of restored wetlands. The combined eigenvector plot suggests that wetlands within each Laurentian Great Lake tend to group together. This suggests that this methodology could be appropriate within a Great Lake but might lack sufficient robustness for statistical inference when wetlands throughout the Laurentian Great Lakes are combined. Additional sampling and analyses are required.

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