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Abstract

Nearly 150,000 caddisfly specimens representing 238 species were analyzed from 166 5–15m wide streams within Michigan and Minnesota to determine the characteristic indicator species of 5 previously-established regions of caddisfly biological diversity. Based on a combination of relative frequency and abundance, 35 of these species indicated a particular region or regions. Indicator species in forested regions constituted a balance of trophic functional groups, whereas indicator species from agricultural regions were dominated by filtering collectors. While it was difficult to determine if species were indicating natural habitat type or differences in anthropogenic disturbance, establishing indicator species now will render potential future changes to the fauna easier to evaluate.

Indicator species are those that define particular ecosystems or habitat types. Indicator values for species are determined by combining their relative frequency in an ecosystem with their relative abundance in that ecosystem into an overall indicator value (Dufrêne and Legendre 1997). Knowing indicator species is important for biological assessment because information about an ecosystem can be inferred from the species that are indicative of it, and because changes in indicator species populations will likely reflect changes in the ecosystem that might otherwise be difficult to detect.

This note determines indicator values for caddisflies (Trichoptera) in the determined caddisfly regions of Michigan and Minnesota. Caddisflies are taxonomically abundant and ecologically diverse in nearly all types of freshwater ecosystems (Mackay and Wiggins 1979). These traits, coupled with their differing tolerances to various types of ecological disturbances, render caddisflies important in biological water quality monitoring (Dohet 2002).

Michigan and Minnesota have both been rigorously sampled for adult caddisflies during the last 15 years using light traps (Houghton 2015). This technique consists of an 8 watt ultraviolet light placed over a white pan filled with ethanol and set near an aquatic habitat for 2 hours starting at dusk. While not intended to be an exhaustive technique, maintaining consistent bulb wattage, pan size, weather conditions, and time interval allows for quantitative comparisons between samples of the nocturnally active species (Wright et al. 2013).

Based on 79 samples from Michigan and 87 from Minnesota, mid-order (5–15 m wide) streams of both states were previously ordinated into 5 distinct regions of caddisfly biological diversity, with latitude, stream gradient, and relative upstream habitat disturbance determined as the most important variables affecting overall caddisfly assemblages (Fig. 1) (Houghton 2015). These regions have higher value at partitioning the caddisfly fauna into distinct groups than do traditional landscape delineations such as watershed or biotic province and, thus, are the appropriate sampling units for caddisflies in the two states (Houghton

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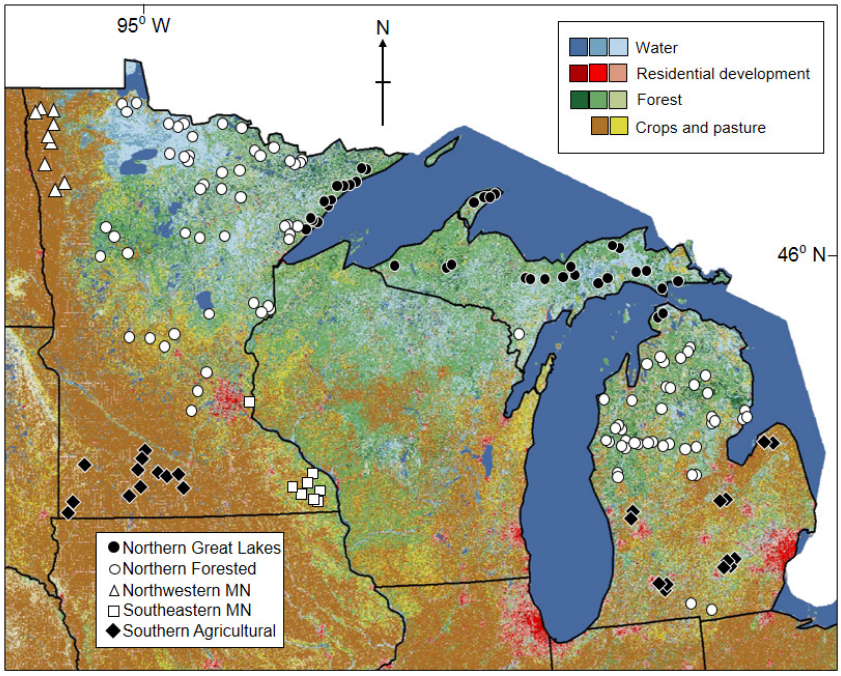

Figure 1. The 5 caddisfly regions of Michigan and Minnesota as determined by Houghton (2015) relative to geographic location and land use. Land use data from the 2006 USGS National Land Cover Database (www.mrlc.gov).

2003). The purpose of this note was to determine indicator values for the individual species that indicated these particular established regions. Michigan specimens were collected from 2009–2013 and are stored in the Hillsdale College Insect Collection. Minnesota specimens were collected from 1999–2001 and are stored in the University of Minnesota Insect Museum.

Species were tested for their value as indicator species using Dufrêne and Legendre's (1997) indicator species technique using the program PC-ORD for Windows (McCune and Medford 2006). This method determines a species' indicator value based on a combination of the percentage of streams within a region that contain a particular species, and the average abundance of that species within each region divided by the average abundance of that species in all regions. Combining these frequency and abundance values yields an overall indicator value, which is expressed as a percentage of perfect indication. Thus, in order to be a significant indicator, a species needs to be common and abundant in some ecosystems but not in others. A monte carlo test determines the significance of determined indicator values (McCune and Medford 2006).

A total of 148,238 specimens were analyzed in both states combined. Of the 238 species tested, 35 had significant indicator values for a particular region (Table 1). Several species indicated >1 region. Indicator species of streams in the Northern Great Lakes and Northern Forested regions were of a mix of trophic functional groups. This pattern was expected by the river continuum concept (Vannote et al. 1980), which predicts a balanced assemblage of trophic functional groups in mid-order streams. Conversely, indicator species were >80% filtering

Table 1. Overall indicator values (IV) and associated *P* values for the 35 significant indicators of medium streams within the five caddisfly regions (NGL: Northern Great Lakes, NF: Northern Forested, NM: Northwestern Minnesota, SA: Southern Agricultural, SM: Southeastern Minnesota) (Figure 1). Numbers below regions denote the percentage of perfect indication based on a combination of species relative abundance and relative frequency in a particular region. Species are arranged in approximate descending IV value for each region, although some overlap exists for species indicating multiple regions. Trophic functional groups: AP: algal piercer, FC: filtering collector, GC: gathering collector, Sc: scraper, Sh: shredder, Pr: predator.

Species	**Group**	**IV**	***P***	**NGL**	**NF**	**NM**	**SA**	**SM**
Dolophilodes distinctus (Walker)	FC	51.7	0.000	52	3	0	0	0
Hydropsyche sparna Ross	AP	39.8	0.002	40	13	0	0	3
Hydroptila valhalla Denning	AP	35.0	0.002	35	3	0	0	0
Molanna blenda Sibley	Sc	32.1	0.002	32	4	0	0	0
Rhyacophila fuscula (Walker)	Pr	31.4	0.002	31	0	0	0	0
Hydropsyche walkeri Betten and Mosely	FC	26.8	0.004	27	0	0	0	0
Cheumatopsyche gracilis (Banks)	FC	26.1	0.014	26	5	0	0	5
Polycentropus centralis Banks	Pr	25.2	0.028	25	0	0	0	0
Hydroptila antennopedia Sykora and Harris	AP	21.6	0.009	22	0	0	0	0
Agrypnia improba (Hagen)	Sh	22.5	0.026	22	7	0	0	0
Hydroptila ampoda Ross	AP	19.6	0.015	20	0	0	0	0
Limnhephilus ornatus Banks	Sh	18.5	0.038	18	5	0	0	0
Limnephilus moestus Banks	Sh	39.0	0.001	39	15	0	2	0
Lepidostoma togatum (Hagen)	Sh	34.4	0.000	34	19	0	0	3
Banksiola crotchi (Banks)	Sh	29.9	0.010	30	29	1	1	0
Glossosoma nigrior Banks	Sc	20.8	0.048	21	10	0	0	0
Hydroptila jackmanni Blickle	AP	22.6	0.042	12	10	0	0	1
Oxyethira forcipata Mosely	AP	26.9	0.002	4	27	0	2	1
Hydroptila wyomyia Denning	AP	20.9	0.022	10	21	0	0	0
Oxyethira rivicola Blickle and Morse	AP	20.7	0.028	2	21	0	0	0
Cheumatopsyche speciosa Banks	FC	92.9	0.000	0	0	93	0	0
Ceraclea flava (Banks)	GC	54.4	0.000	0	1	54	0	0
Hydropsyche confusa Walker	FC	37.5	0.000	0	0	38	0	0
Potamyia flava (Hagen)	FC	62.1	0.000	0	0	62	32	0
Hydropsyche bidens Ross	FC	60.2	0.000	0	0	60	10	0
Hydropsyche simulans Ross	FC	56.9	0.000	0	0	57	25	0
Hydroptila ajax Ross	AP	20.7	0.006	0	0	0	21	0
Cheumatopsyche campyla Ross	FC	18.4	0.047	0	3	2	18	0
Hydropsyche placoda Ross	FC	18.1	0.018	0	1	0	18	0
Brachycentrus americanus (Banks)	FC	50.5	0.000	3	4	0	0	51
Glossosoma intermedium Banks	Sc	49.7	0.000	0	0	0	0	50
Micrasema gelidum McLachlan	FC	44.4	0.000	0	0	0	0	44
Hydropsyche alhedra Ross	FC	39.1	0.000	1	1	0	1	39
Hydropsyche slossonae (Banks)	FC	36.1	0.002	13	7	0	0	36
Hydroptila consimilis Morton	AP	23.3	0.032	7	3	0	5	23

collectors in the Southern Agricultural and Northwestern Minnesota regions, and 67% in the Southeastern Minnesota region. Agricultural disturbance is higher in these regions than it is in the Northern Great Lakes and Northern Forested regions (Fig. 1) (see Houghton 2007 for an in-depth discussion of land use in these regions).

In the absence of historical data, it is difficult to determine if species in this note are indicating natural habitat type or differences in anthropogenic disturbance. While I suspect both factors have an important influence on caddisfly assemblages, indication of anthropogenic disturbance may be the more important use of these indicator species data going forward. In both prairie and forested habitats, a caddisfly assemblage characterized by filtering collectors has been shown to reflect agricultural disturbance of the surrounding watershed (Whiles et al. 2000, Gage et al., 2004, Houghton 2007). More specifically, streams of northwestern Minnesota changed during the increase in agricultural land use of 1950–1985 from those containing a balance of functional groups to those dominated by filtering collectors (Houghton and Holzenthal 2010). Now that characteristic indicator species have been determined for the 5 caddisfly regions of Michigan and Minnesota, any future changes to the assemblages would likely reflect changes in watershed integrity. Thus, by establishing the characteristic caddisfly indicator species of these regions now, any future changes to the fauna and associated watersheds can be evaluated with greater precision and confidence.

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