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SUMMER EPHEMEROPTERA, PLECOPTERA, AND TRICHOPTERA (EPT) SPECIES RICHNESS AND COMMUNITY STRUCTURE IN THE LOWER ILLINOIS RIVER BASIN OF ILLINOIS

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ABSTRACT

Ephemeroptera, Plecoptera, and Trichoptera (EPT) species richness is useful for monitoring stream health, but no published studies in Illinois quantitatively document EPT richness or assemblage structure. The objectives of this study were to characterize adult EPT richness and structure and relate these to relative water quality at eight stream sites (160–69,300 km^3 area) in the lower Illinois River basin. Adults were ultra-violet light trapped in June, July, and August 1997. Nutrient enrichment by nitrate and nitrite nitrogen was strongly evident, especially in smaller drainages, while critical loss of stable habitat was observed in larger water bodies. Seventy EPT species were identified from 17,889 specimens. Trichoptera were by far the most speciose (41 species), followed by Ephemeroptera (26), and Plecoptera (3). Caddisflies also dominated species richness across sites, contributing 18.0 of the average 28.9 total EPT species collected. Site EPT richness varied significantly ($F = 5.51$, $p = 0.003$, $df = 7$), with smaller drainages supporting greater richness, generally. Differences were also evident for months ($F = 21.7$, $p = 0.0001$, $df = 2$), with June being lower (11.8 average) than either July (20.6) or August (18.1) values. Hilsenhoff biotic index (HBI) scores did not vary significantly across sites ($F = 0.7$, $p = 0.7$, $df = 7$), but were different across months ($F = 5.4$, $p = 0.02$, $df = 2$). June (4.23) and July (4.53) means were not different, but both were lower (of better quality) than August (5.33) scores. The relationship of EPT to HBI scores was not investigated statistically due to problems of sample size and interdependance of monthly samples, but graphical analysis suggested no consistent relationship. This suggested a decoupling of the HBI from the EPT and implied that the gain in taxonomic resolution achieved by using adults outstripped the resolution of the HBI. Use of the HBI to characterize adult aquatic insect communities is discouraged. New state records and range extensions for Ephemeroptera and Trichoptera are presented and possible loss of sensitive Plecoptera in the drainage is discussed.

Aquatic macroinvertebrates are an effective tool for monitoring stream health (Plafkin et al. 1989). Due to the great efforts necessary in working with entire communities of macroinvertebrates, aquatic scientists have sought subsets of this community that yielded information quickly and with

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less expense (Barbour et al. 1992). One such subset uses the sum of Ephemeroptera + Plecoptera + Trichoptera (mayflies, stoneflies, caddisflies, or combined as EPT) species richness per unit effort. Lenat and Penrose (1996) summarized the history and usefulness of the EPT index, and others (Wallace et al. 1996, Lenat 1988, and Barbour et al. 1992) confirmed its suitability as an index of stream health.

The state of Illinois, through the efforts of Illinois Natural History Survey (INHS) researchers Burks (1953), Frison (1935), and Ross (1944) set the stage to use EPT species as a effective biomonitoring tool. Despite published identification manuals, no published studies exist that document the spatial or temporal variability of EPT species richness or community structure in Illinois streams.

Aquatic biologists using EPT species as indicators of stream health typically rely on immature stages (Lenat 1988). However, many EPT species are known solely as adults, the immatures often being identifiable only to the generic level. Use of immatures can lead to underestimates of assemblage richness, to an over simplification of community structural characteristics, and to a loss of the ability to associate ecological conditions with species requirements (Resh and Unzicker 1975). Use of adults permits species level identification in most cases. Additionally, recent studies suggest that many adults of EPT species fly only relatively short distances from their parent stream, and that the probability of encountering them greatly diminishes with increasing lateral distance (Griffith et al. 1998, J. Morse pers. comm.). These studies suggest that greater use of adult EPT for assessing stream health is appropriate.

The objectives of this study are to document the temporal and spatial variation in summer adult EPT species richness and assemblage structure for eight sites in the lower Illinois River basin of central Illinois. Additionally, EPT richness will be related to general water quality in the basin using Hilsenhoff's (1987) biotic index (HBI). The HBI has not been used on a subset of the aquatic community and certainly not with the adult stage. This study provides an opportunity to test the HBI's usefulness under both circumstances. The present study complements a basin-wide assessment of water quality currently being conducted by the National Water Quality Assessment Program (NAWQA) of the United States Geological Survey (USGS).

METHODS AND MATERIALS

Physical habitat and water chemistry. Water chemistry investigations followed standardized NAWQA methods as outlined by Shelton (1994). Dissolved oxygen (DO), pH, conductivity, total Kjeldahl nitrogen, nitrogen as dissolved NO_2^- and NO_3^-, and total phosphorus were monitored at least monthly at each of eight stream sites from 1 May through 31 August, 1997. Nitrogen-to-phosphorus ratios (N:P) were calculated from the sum of total Kjeldahl nitrogen and NO_2^- and NO_3^- concentrations divided by the total phosphorus concentration for each date. The potential for hypoxic conditions at four of the eight sites was monitored using Hydrolab™ recorders over 48-hr periods during August 1997. Year around water chemistry, discharge, and contaminant data for the 1997 water year are available in United States Geological Survey (1998).

Physical habitat descriptions followed Meador et al. (1993). Habitat parameters were measured at low flow, in September 1996 or 1997 from six transects in each of the eight study reaches. A Geographic Information System provided general land use and land cover categories at 1:250,000 scale (Anderson et al. 1976, United States Geological Survey 1990).

EPT sampling. Adult EPT were collected using a Bioquip™ 12-vt, ultraviolet DC light source. The trap was run for 1 hr immediately after sunset on a single evening in each of June, July, and August 1997. It was placed 1 m above the stream bank, so that an unobstructed viewing arc of at least 90° was maintained across the stream. This was accepted as adequate for attracting local EPT species. A vertical white sheet reflected this light and provided a surface for hand picking of adults. Two 20 cm × 30 cm white trays, filled with 80% ethanol, trapped insects that fell from the sheet. Mayfly subimagoes were picked directly from the sheet and allowed to transform before preservation. Stonefly males were also hand picked and prepared for examination according to Stark (1989).

Most specimens, except females of some taxa, were identified to species. Species richness was tallied for each month and as a "total" for each site. Percentages of the top five numerically dominant taxa, tallied across the entire sample period, demonstrated which species were most abundant at each site. Literature records and searches of electronic databases at the INHS provided historical records at or near each sampling location. Specimens of all species have been deposited in the INHS insect collection.

The HBI is a measure of the overall tolerance of the aquatic macroinvertebrate community to organic pollution, but also is sensitive to general watershed disturbance (Hilsenhoff 1998). It has never been applied to an assemblage of adult aquatic insects, nor has it been applied to insects alone. Here it is applied to adult EPT in order to have a second measure of stream health. Both EPT and HBI scores were subjected to a repeated measures analysis of variance (ANOVA) to examine mean differences across months and sites (Cody and Smith 1997). A second iteration of this approach was conducted including total EPT and HBI values as a fourth "month" to facilitate a discussion of which months were most similar to totals. Following the ANOVA, Duncan's multiple range test (MRT, $\alpha = 0.05$) defined any significant differences. The relationship of EPT richness to HBI scores was investigated graphically. The potential problem of interdependence of monthly values at a site and the small sample size within months necessitated this approach.

Lower Illinois River Basin Description

The lower Illinois River basin drains much of the Grand Prairie Division of Illinois (Schwegman et al. 1973). This region, once an extensive tall-grass prairie, accounts for approximately 30% of the state's landmass. Few areas of the country have experienced the degree of modification evident in this region. Corn and soybean agriculture now account for >90% land use in all rural counties. Additionally, the tiling of fields for drainage, straightening of channels, and the removal of most natural riparian vegetation has transformed the division's meandering perennial streams into straight agricultural drainage ditches, often with critically low flows during summer months (Page 1991).

The Illinois River can be divided into upper and lower basins due to an abrupt change in the river profile (United States Army Corps of Engineers 1974) occurring near Starved Rock State Park (site 1 of Fig. 1). The upper basin has the steepest gradient and, concomitantly, the greatest flow rate. The present study focuses on the lower basin that drains a 46,550 km^2 area of central and western Illinois. Major rivers here include 390 km of the Illinois River mainstem, the Vermilion (3,450 km^2 drainage area), Mackinaw

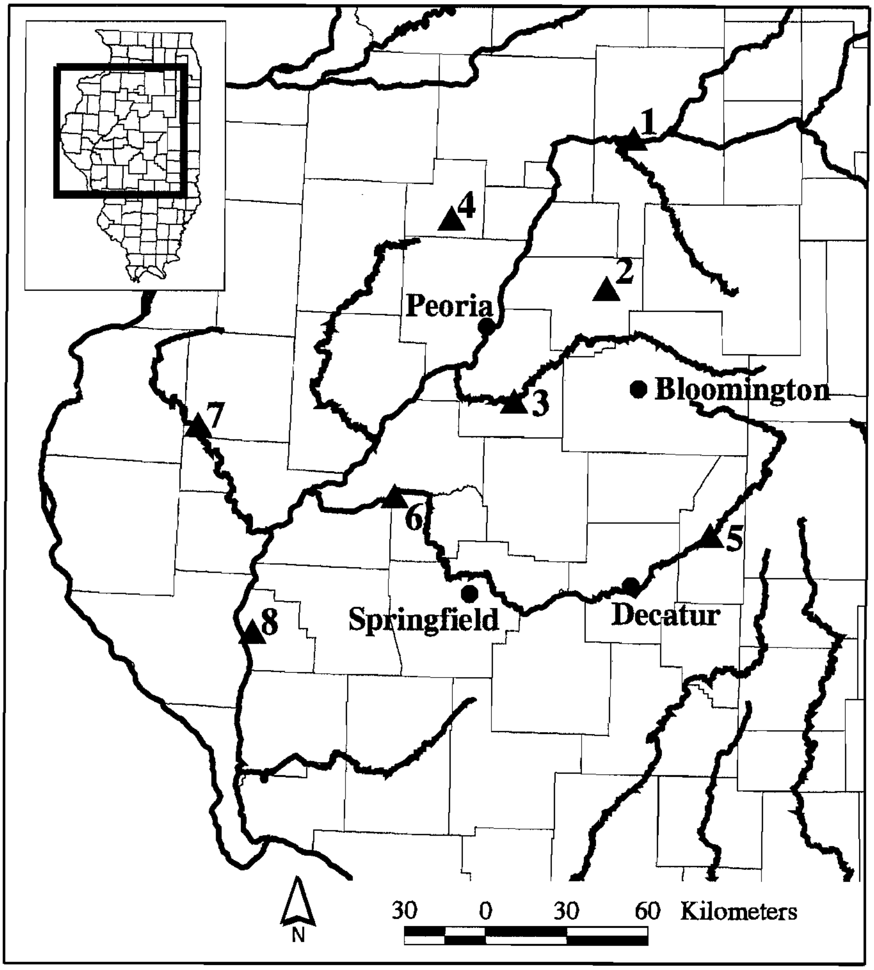

Figure 1. EPT collection sites in the lower Illinois River basin, summer 1997. ▲Indicates sample locations. 1 = Illinois River, Starved Rock State Park, 2 = Panther Creek, 3 = Mackinaw River, 4 = Indian Creek, 5 = Sangamon River, Monticello, 6 = Sangamon River, Oakford, 7 = La Moine River, 8 = Illinois River, Florence.

(2,950 km^2), Spoon (4,820 km^2), Sangamon (14,050 km^2), and La Moine (3,500 km^2) rivers. Figure 1 depicts the location of the eight sites studied.

Agriculture averaged 91.1% land use coverage in the basins studied (Table 1). These streams varied widely in basin size, channel width and depth, and in average discharge. The four smallest streams had bottom substrates of fine sand and gravel, abundant bank and snag habitat, and largely

Table 1. Physical characteristics of eight stream sites in the lower Illinois River basin, 1 May through 31 August 1997. Width and depth parameters represent the average of six measures. Discharge n is indicated in that column.

Site	Drainage Area (km^3)	% Agriculture	Mean Discharge (m^3/sec)	Mean Width (m)	Mean Maximum Depth (m)
Illinois River, Starved Rock	28,750	75.0	290.0 (9)	200.0	4.5
Panther Creek	240	99.0	1.1 (5)	8.5	0.7
Mackinaw River	2,750	95.0	12.0 (5)	28.0	1.3
Indian Creek	160	97.0	1.1 (5)	10.0	0.8
Sangamon River, Monticello	1,426	96.0	10.6 (18)	20.0	1.8
Sangamon River, Oakford	13,200	94.0	61.7 (5)	74.0	1.6
La Moine River	1,700	90.0	12.0 (18)	20.0	1.9
Illinois River, Florence	69,300	83.0	610.0 (9)	156.0	4.9

shaded stream banks. The Mackinaw, a small river, differed from the other small drainages in having coarse mineral substrates. Two large river sites, the Illinois River at Florence and the Sangamon River at Oakford, had a mostly shifting sand bottom with little available snag habitat. The Illinois River at Starved Rock State Park, another large river site, had abundant bank and snag habitat and varied bottom substrates and current velocities.

RESULTS

Water chemistry. Dissolved oxygen concentrations varied most within streams (Table 2). The Sangamon River at Oakford experienced pronounced super-saturation during daylight hours. The Illinois River at Florence was the only site with relatively low daytime DO concentrations. However, 48-hr continuous monitoring of DO revealed that Panther and Indian Creeks, two of the smaller drainages, declined to near or below 5 mg/l during predawn hours (Fig. 2).

Nutrient enrichment was evident in all stream reaches, but dissolved NO_2^- and NO_3^- concentrations were highest in the smallest streams (Table 2). Consequently, N:P ratios were highest and most variable for these streams. Larger rivers showed neither the magnitude, nor the variability, in nutrient parameters found in the smaller drainages.

EPT richness and community structure. A total of 17,889 adult EPT were examined for an average of 2,236 specimens per stream (Table 3). Seventy-two EPT taxa were identified overall. Caddisflies provided 41 (58.6%), mayflies provided 26 (37.1%), and stoneflies added another 5 (6.9%) EPT species identified (Table 3). Caddisflies also dominated species richness across sites, contributing 18.0 of the average 29.1 total EPT species collected. Mayflies contributed 9.8 species, while stoneflies contributed only 1.4.

Total richness separated into three groupings by general stream size (Table 3). Large rivers (Illinois River reaches and the Sangamon River at Oakford) averaged 24.0, small rivers (Mackinaw, La Moine, and Sangamon (Monticello) Rivers) yielded 30.7, and small streams (Panther and Indian Creeks) were the richest at 34.5 EPT species.

Species richness of EPT varied significantly across sites ($F = 5.9$, $p = 0.002$, $df = 7$). A complex relationship developed from three overlapping groupings of sites. Indian Creek, a small, EPT-rich stream (22.0 average), had a greater richness than all large river sites (11.0 to 15.7 averages) and the La Moine (16.0 average), a small river. None of the other small streams or small rivers (Panther, Mackinaw, Sangamon at Monticello, and La Moine, 16.0 to 20.7 averages) were significantly different from each other. Significant differences were also found for EPT across months ($F = 22.7$, $p = 0.0001$, $df = 2$). June EPT richness (11.9 average) was significantly lower than that for July (20.9) or August (18.1) values. July and August values were not significantly different from each other. Caddisflies drove this monthly trend, with low June richness that increased dramatically in July (Table 4). Conversely, mayfly richness showed a continuous increase throughout the summer. Stoneflies were of such low diversity that no trend was noticeable for them. When total richness was added as a fourth "month", significant differences strengthened ($F = 53.9$, $p = 0.0001$, $df = 3$). Total EPT richness formed a third grouping with a mean of 29.1 EPT, but relationships among the other sites were unchanged.

Large river sites (Fig. 3a) concentrated an average of 92.7% of their abundance across the five most dominant taxa. The small rivers (Fig. 3b) supported only 83.4% of their entire catch among the five dominant taxa,

Table 2. Mean, range, and number of measures for water chemistry parameters from the Illinois river basin collected 1 May 1997 through 31 August 1997. All units in mg/l unless otherwise noted.

Site	Dissolved Oxygen	pH	Conductivity (uS/cm)	Dissolved NO_2/NO_3 N	Total Kjeldahl N	Total P	N:P Ratio
Illinois River, Starved Rock	9.7	8	652	4.2	1.2	0.39	14
	(7.9–12.1)	(7.5–8.3)	(495–859)	(2.3–8.7)	(0.8–1.6)	(0.32–0.51)	(7–31)
	9	9	9	9	9	9	9
Panther Creek	9.1	8.1	763	7.9	1.2	0.17	387
	(7.0–13.1)	(7.7–8.5)	(569–969)	(0.3–16.0)	(0.4–2.2)	(0.01–0.29)	(9–1201)
	5	5	5	6	6	6	6
Mackinaw River	11.4	8.3	629	5.0	1.0	0.13	69
	(9.5–14.3)	(8.2–8.5)	(603–671)	(0.3–10.0)	(0.7–1.6)	(0.07–0.28)	(7–157)
	5	5	5	6	6	6	6
Indian Creek	10.1	8.2	648	6.3	0.8	0.15	83
	(7.5–13.4)	(8.0–8.6)	(548–720)	(2.2–9.7)	(0.5–1.5)	(0.04–0.42)	(19–236)
	5	5	5	6	6	6	6
Sangamon River, Monticello	8.0	7.9	614	7.9	0.9	0.17	73
	(6.2–9.8)	(7.4–8.1)	(208–1100)	(0.6–17.0)	(0.3–1.3)	(0.04–0.47)	(5–264)
	18	18	18	17	17	17	15
Sangamon River, Oakford	12.0	8.3	672	3.5	1.5	0.44	13
	(7.2–21.0)	(8.0–8.8)	(519–909)	(0.1–7.0)	(0.9–1.8)	(0.25–0.68)	(4–24)
	5	5	5	4	4	4	5
LaMoine River	7.9	7.8	625	5.0	1.2	0.35	37
	(5.6–11.5)	(7.3–8.3)	(204–2320)	(0.5–9.4)	(0.3–4.4)	(0.06–1.7)	(4–131)
	19	18	19	18	18	18	16
Illinois River, Florence	6.7	8.0	707	3.8	1.2	0.4	16
	(4.9–9.5)	(7.4–8.2)	(512–1070)	(1.6–6.7)	(0.5–1.9)	(0.11–0.58)	(6–62)
	9	9	9	9	9	9	8

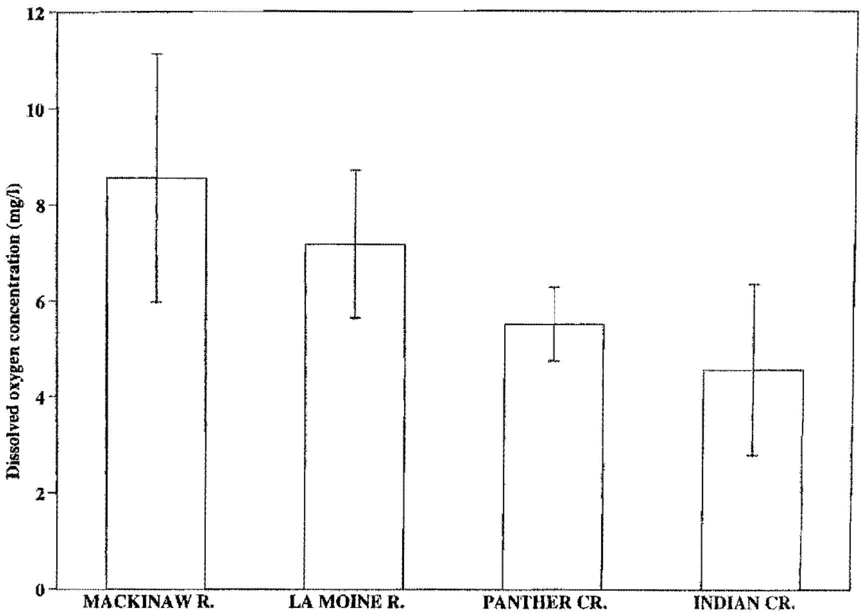

Figure 2. Mean and standard deviation of dissolved oxygen concentrations (mg/l) measured at four lower Illinois River basin sites. Values represent continuously monitored conditions over 48 hr periods in August 1997.

while small creeks supported only 66.4% of their catch among the five dominants. The latter had a fauna singularly different from either the large or small rivers. The single, most dominant taxon averaged 44.3% (33.4–54.9) of the total catch in large rivers, only 30.0% (26.7–32.1) for small rivers, and 26.6% (26.1–27.1) for small creeks.

Three caddisfly species, *Potamyia flava* (Hagen), *Hydropsyche bidens* Ross, and *Cheumatopsyche pettiti* (Banks) dominated the three large rivers (Fig. 3a). Only six other taxa were considered dominant, and no overlap existed among them. The three small rivers (Fig. 3b) shared two dominant taxa. These were the caddisflies *C. pettiti* and *Ceraclea tarsipunctata* (Vorhies). Small creeks shared the dominant caddisflies *Nectopsyche* sp. (probably *N. diarina* Ross) and *Ceratopsyche bronta* (Ross). They shared few dominant taxa with either the small or large river sites.

Hilsenhoff Biotic Index scores. Monthly HBI scores did not vary significantly across sites ($F = 0.7$, $p = 0.7$, $df = 7$) (Fig. 4), but were different across months ($F = 5.4$, $p = 0.02$, $df = 2$). The June (4.23) and July (4.53) means were not different from each other, but both were significantly different from the August (5.33) mean. When total HBI scores (4.78 average) were added to the model, differences in months strengthened ($F = 5.2$, $p = 0.008$, $df = 3$), and a complex relationship developed between the months. Total HBI occurred in two groupings, with August in one group and June and July in the other.

Table 3. EPT species contributions (%), taxon richness, abundance, and ordinal abundance (%) from eight lower Illinois River basin sites, summer 1997.

SPECIES/SITES—->	1	2	3	4	5	6	7	8
EPHEMEROPTERA								
BAETIDAE								
Acentrella ampla		P		P	0.1			
Baetis intercalaris		P	0.1					
Callibaetis fluctuans						*		
Fallceon quilleri			0.1	0.2				
Labiobaetis propinquus			P					
Paracloeodes minutus			0.3					
CAENIDAE								
Caenis amica			0.1	5.4	0.4		0.1	
Caenis hilaris	3.9		5.5		2.8	0.2	0.4	0.4
Caenis latipennis	0.3	1.3	P	1.5	32.1	0.1	0.5	P
EPHEMERIDAE								
Hexagenia bilineata	0.5		0.18		*	*		P
Hexagenia limbata	0.2	0.9			0.6*	P*		P
Hexagenia rigida					*			
Pentagenia vittigera	P							
HEPTAGENIIDAE								
Heptagenia diabasia		4.3	0.4	0.1	*			
Heptagenia flavescens								
Leucrocuta aphrodite		2.4						
Leucrocuta maculipennis	0.5		0.3	0.2	*			
Leucrocuta sp.			0.1					0.1
Nixe inconspicua		3.6		0.9				
Stenacron interpunctatum	0.4*	1.6			0.1*	0.3	0.4	
Stenacron sp.					P			
Stenonema femoratum					*			
Stenonema luteum	P		P	P	0.4*		0.1	
Stenonema mexicanum	0.3				*	0.4		
Stenonema pulchellum								P
Stenonema terminatum	0.2		0.1		P		0.1	0.6
Stenonema sp.	0.6		P		0.3	0.2	0.3	
Heptageniidae spp.	8.8		0.6	0.5			0.1	

SPECIES/SITES—->	1	2	3	4	5	6	7	8
ISONYCHIIDAE								
Isonychia rufa	P	4.9	0.1		0.3*	0.24	0.3	
Isonychia sp.	P	0.1	0.6	P		3.2	0.5	0.1
POLYMITARCYIDAE								
Ephoron album			0.1					
Ephoron leukon			0.1		0.1*			
Ephoron sp.						0.3		
POTAMANTHIDAE								
Anthopotamus myops				P	P*			
PLECOPTERA								
PERLIDAE								
Acroneuria abnormis								*
Acroneuria frisoni					*			
Acroneuria internata	*							
Agnetina capitata	*				*			*
Neoperla clymene		*						*
Perlesta decipiens	P*	*	*		P*	0.5	0.2*	
Perlesta golconda					P			
Perlesta lagoi					0.7			
Perlinella drymo					P			
PERLODIDAE								
Isoperla bilineata	P		P		*	P		1.3
Isoperla sp.		*						
TRICHOPTERA								
BRACHYCENTRIDAE								
Brachycentrus numerosus					*			
GLOSSOSOMATIDAE								
Protoptila maculata					*			
HELICOPSYCHIDAE								
Helicopsyche borealis							0.1	
HYDROPSYCHIDAE								
Ceratopsyche bronta		5.4		2.4				
Cheumatopsyche campyla	5.5*	0.1	0.7	P	0.1*	3.0	1.7	0.2*

Continued

Table 3. EPT species contributions (%), taxon richness, abundance, and ordinal abundance (%) from eight lower Illinois River basin sites, summer 1997 (Continued).

SPECIES/SITES—>	1	2	3	4	5	6	7	8
Cheumatopsyche lasia		0.4	5.5	1.9			0.2	
Cheumatopsyche pettiti	*	16.3		1.6	0.4*	5.0	5.7	0.7
Hydropsyche arinale	*							
Hydropsyche betteni	*	2.8		0.6	P			
Hydropsyche bidens	23.2		3.4	0.2	2.3	8.1	7.1	21.3
Hydropsyche incommoda					*			
Hydropsyche orris								*
Hydropsyche placoda	*							
Hydropsyche simulans				0.9				
Potamyia flava	16.2		29.7	2.0	2.2*	54.9	8.1	33.4*
HYDROPTILIDAE								
Hydroptila ajax	P	3.4	3.8	27.1	0.8		2.1	P
Hydroptila albicornis					P			
Hydroptila angusta	0.8*	4.9	4.7	1.4	0.8		1.2	P
Hydroptila consimilis				0.4				
Hydroptila perdita	2.6	0.8	2.2	0.2	0.4			
Hydroptila waubesiana	0.1	0.4	0.3		0.6*			P
Mayatrichia ayama	*							0.3
Ochrotrichia tarsalis					*			
Orthotrichia cristata			P	0.6				
Oxyethira pallida	P	P	0.2	1.0	0.2			
Stactobiella palmata					*			
LEPTOCERIDAE								
Ceraclea cancellata	*				*			
Ceraclea flava						*		
Ceraclea punctata						P		
Ceraclea tarsipunctata	1.6*	0.7	10.0	1.7	11.0	15.8*	17.9	1.5
Ceraclea transversa	1.3*	5.8	1.4	0.2	11.8*	0.6	2.3	0.2
Leptocerus americanus	P			1.1				
Nectopsyche candida	0.9	0.4	1.9	0.5	18.9	1.8	27.3	1.5
Nectopsyche diarina		2.2		0.5				0.2
Nectopsyche pavida					0.5			
Nectopsyche sp.	P	10.3		15.0				
Oecetis avara	P							P

SPECIES/SITES—>	1	2	3	4	5	6	7	8
Oecetis cinerascens		0.1		0.3		*	0.6	
Oecetis ditissa		0.2			0.9			
Cheumatopsyche sp.	38.9	9.7	26.2	28.0	8.2	4.0	18.8	4.6
Oecetis inconspicua	0.1*	4.3	0.1	1.7	1.3*	P*	1.7	2.2
Oecetis nocturna		P					0.2	
Oecetis persimilis					0.4			
Triaenodes melacus		2.0						
Triaenodes tardus				0.2	0.1			
Triaenodes sp.		0.2		1.0				
LIMNEPHILIDAE								
Anabolia consocia				P				
PHILOPOTAMIDAE								
Chimarra obscura			P	P				
Chimarra sp.		0.2						
PHRYGANEIDAE								
Phryganea sayi					0.1			
Ptilostomis semifasciata	P	0.2						
POLYCENTROPODIDAE								
Cyrnellus fraternus	1.3		0.7	P	0.3	1.1*	1.1*	31.5
Neureclipsis crepuscularis		0.4			*			*
Paranyctiophylax affinis				0.2			1.2	
Paranyctiophylax moestus						*		
Paranyctiophylax sp.				P				
Polycentropus sp.				P				
Mayfly species	11	9	15	10	11	7	7	8
Stonefly species	2	0	1	0	4	2	1	1
Caddisfly species	16	22	16	28	21	10	16	15
Total EPT	29	31	32	38	36	19	24	24
Abundance	1259	1420	2772	2439	1913	2967	1104	2038
% abundance mayflies	7.10	23.6	8.96	8.50	36.95	4.99	2.62	1.48
% abundance stoneflies	0.10	0.00	0.04	0.00	1.04	0.51	0.18	1.32
% abundance caddisflies	92.80	76.40	91.00	91.50	62.00	94.50	97.20	97.20

* Indicates historical record from literature or INHS databases.
P = present at <0.1%.
1 = Illinois River, Starved Rock
2 = Panther Creek
3 = Mackinaw River
4 = Indian Creek
5 = Sangamon River, Monticello
6 = Sangamon River, Oakford
7 = La Moine River
8 = Illinois River, Florence

Table 4. EPT species richness for June, July, and August from eight lower Illinois River basin sites, summer 1997. MF = mayfly, SF = stonefly, CF = caddisfly, Total = all EPT for month.

	JUNE				JULY				AUG			
SITES	MF	SF	CF	Total	MF	SF	CF	Total	MF	SF	CF	Total
Illinois R., Starved Rock	1	1	8	10	8	1	14	23	6	0	8	14
Panther Cr.	4	0	8	12	7	0	15	22	5	0	16	21
Mackinaw R.	3	1	10	14	11	0	13	24	10	0	14	24
Indian Cr.	4	0	10	14	3	0	25	28	6	0	18	24
Sangamon R., Monticello	3	0	8	11	5	4	15	22	8	0	14	22
Sangamon R., Oakford	2	1	6	9	2	1	8	11	7	0	6	13
La Moine R.	3	0	10	13	4	1	15	20	6	0	9	15
Illinois R., Florence	2	1	8	11	4	1	10	15	3	0	9	12
Means	2.8	0.5	8.5	11.8	5.5	1	14.4	20.8	6.4	0	11.8	18.1

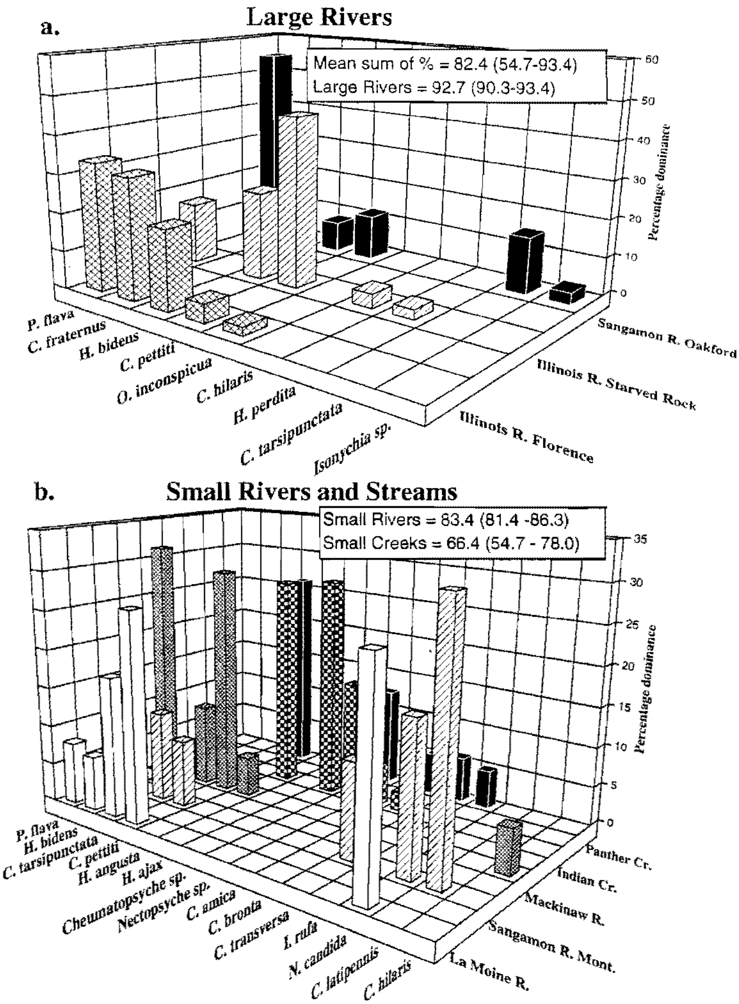

Figure 3. Percentage contribution of the top five numerically dominant EPT taxa at three large rivers (a) and at five small rivers and creeks in the lower Illinois River basin, summer 1997. Provided are the mean sum and ranges of percentages of all five dominants across sites (n = 8), and the mean sums for combinations of large rivers (n = 3), small rivers (n = 3), and small creeks (n = 2). Bars representing *Cheumatopsyche* and *Nectopsyche* spp. are for females, which are not readily identifiable.

DISCUSSION

Streams in the lower Illinois River basin have been drastically modified by agricultural practices (Page 1991). Widespread plowing, fertilizer application, and drainage of fields have aided in nutrient enrichment of streams. However, nutrient enrichment did not seem to impact EPT richness. Stream size and habitat heterogeneity appeared the most important factors influencing EPT richness. For instance, the Sangamon River at Oakford and the Illinois River at Florence were large rivers with shifting sand bottoms and little other stable habitat. They yielded low richness values. Indian and Panther creeks and the Mackinaw and Sangamon (Monticello) rivers had abundant and varied stable substrates and yielded the greatest EPT richness. The La Moine River was an enigma. It was similar in most respects to the Sangamon River (Monticello) site, but supported low EPT species richness.

Species richness was also dependent upon month of collection. June samples were of lowest richness, due in large part to the influence of water temperatures (>3°C cooler than July and August temperatures) on species emergence. Even though July richness was not significantly different from August values, it was numerically greater at five sites, while being equivalent at only two of them (Table 4). If only a single date can be sampled, early July would be preferable since more of the total EPT richness was accounted for by this month than any other.

Streams experiencing degradation often have a less-rich fauna and abundances heavily devoted to a relatively few species (Plafkin et al. 1989). Abundance in large rivers exemplified this trend (Fig. 3a), while smaller drainages (Fig. 3b) displayed more even distributions of abundance. Larger rivers appeared to be, overall, more heavily impacted than small rivers and creeks. The latter were more nutrient enriched than large rivers, but they were also well shaded and had noticeably more stable and heterogeneous habitat available.

Average stream quality, as determined by HBI scores, degraded over the summer months, a trend discussed by Hilsenhoff (1998) for Wisconsin streams. Hilsenhoff's (1987) quality rating criteria provided some insight into the HBI's usefulness for adult-based samples. Overall, 50% of the streams were rated as being of "good" quality (Fig. 4). "Very good" or "fair" quality accounted for another 25% each.

However, it appeared that a decoupling of the two indices took place. Extreme examples of this decoupling included the Sangamon River at Oakford (lowest EPT and "very good" quality) and Indian Creek (highest EPT and "fair" or "good" quality) (Table 3 and Fig. 4). If both HBI scores and EPT richness, derived from adult EPT, were good predictors of stream health, the two should have a strong, negative relationship like that found by Barbour et al. (1992) in their comparison of the Environmental Protection Agency's Rapid Bioassessment metrics for benthic macroinvertebrate communities. This strong, negative relationship has also been found for benthic EPT ($R^2 = 0.54$, $F = 30.93$, $p = 0.0001$) collected from 26 randomly chosen Illinois stream sites in 1997 (R. DeWalt, unpublished data).

This was not the case during the present study. Although a robust test of this hypothesized relationship cannot be presented due to low sample size and interdependence of monthly EPT and HBI scores, there appears to be little or no relationship derived from adult EPT samples. Graphically, total EPT and total HBI values appeared to be positively related, as did July values, but both June and August values demonstrated no trend whatsoever (Fig. 5). Most probably, this lack of concordance is due to the use of adults. The increased taxonomic resolution obtained by using adults was not

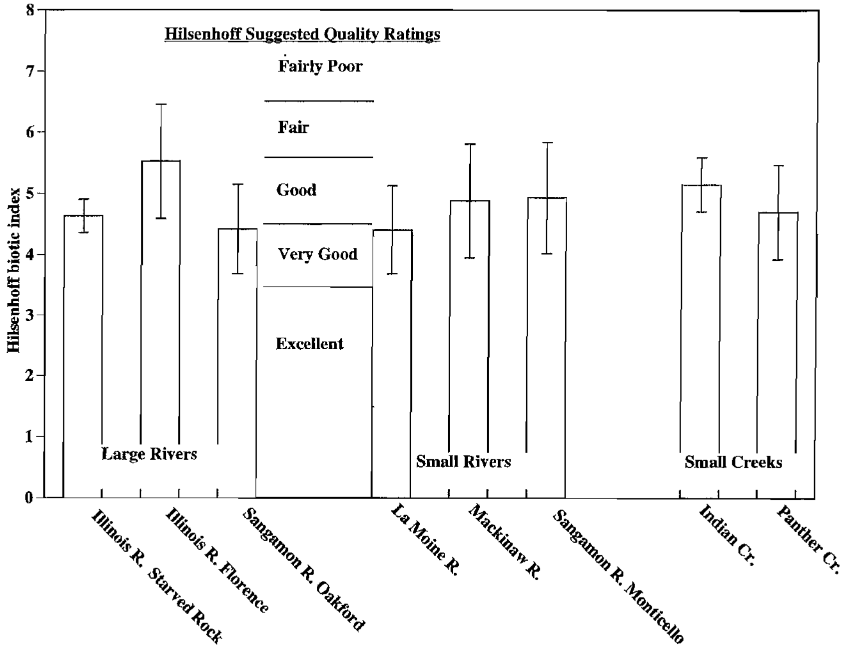

Figure 4. Total Hilsenhoff biotic index scores and range (error bars) of monthly scores calculated from EPT adults for eight streams in the lower Illinois River basin, summer 1997. Sites are organized by relative stream size and Hilsenhoff's (1987) quality ratings criteria are provided for comparative purposes.

matched by the availability of HBI tolerance values for species. The caddisfly genera *Cheumatopsyche*, *Oecetis*, and *Ceraclea* were good examples of there being only one tolerance value available for each of three species (Hilsenhoff 1987) found during this study, even though generalized differences in tolerance were demonstrated long ago (Resh and Unzicker 1975).

Application of the HBI to adult EPT and other aquatics cannot be done effectively at this time. However, if species specific tolerance values become available, especially in those speciose genera with widely varying tolerance, the HBI might be appropriate for use with adult collections. Until such time, it appears that adult EPT richness tracks change in habitat degradation in a predictable manner and may be used effectively to monitor stream health.

The use of adults in biomonitoring of streams can be criticized on several fronts. One such criticism is that adults may have originated from a water source of very different water quality than the target source. A recent study by Griffith et al. (1998) demonstrated that caddisflies and stoneflies in small Appalachian drainages had exceedingly low probabilities of moving any more than 60 m laterally from their parent waters. Additionally, J. Morse (pers. comm.) reports that adult caddisflies in Three Runs Creek, South Carolina, had a similar range of lateral movement. In both instances, it is prudent to

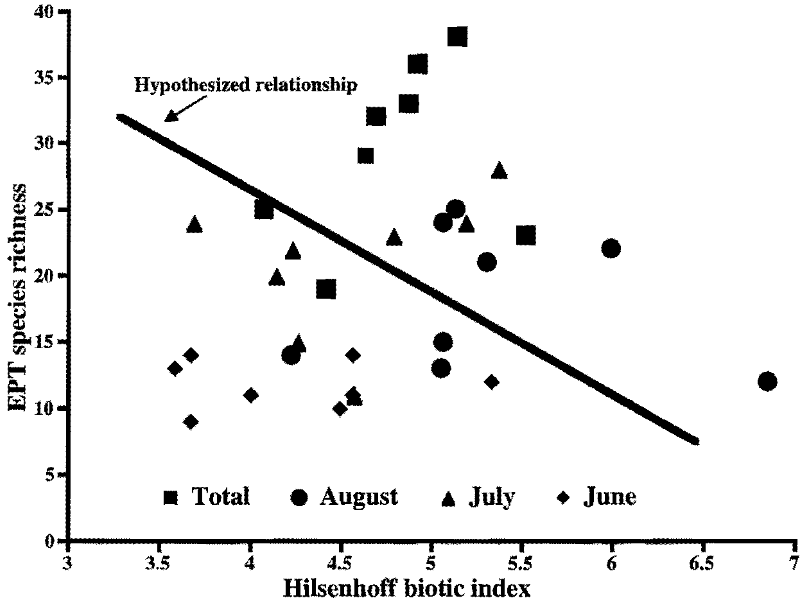

Figure 5. Relationship of adult EPT species richness and HBI scores for eight streams in the lower Illinois River basin, summer 1997. Monthly (June, July, and August), total HBI, and hypothesized relationships (line).

assume that a species came from the target water body unless a larger water body is nearby.

Additional criticism of the use of adults is that ultra-violet lights produced a "trap habitat" favorable to a species assemblage far different from the population in the stream. This might explain why stream sites with poor habitat heterogeneity and low EPT richness had higher HBI scores than expected. Comparable benthic collections are necessary to test this assertion, but were unavailable for this study.

Use of adult insects provides the highest level of taxonomic resolution possible. It also increases the likelihood of correct identification and association of environmental conditions or requirements with a species. Meeting this goal provides useful information to other aquatic ecologists and systematists alike (Resh and Unzicker 1975). For this reason alone, species-level identification should be sought for aquatic biomonitoring whenever possible.

Notes on species and historical distributions. Two new state records and range extensions for several baetid mayfly species resulted from this study. No published records of *Acentrella ampla* (Traver) exist for Illinois (Randolph and McCafferty 1998). Records for three locations (Table 3), stretching across central Illinois, now exist. *Paracloeodes minutus* (Daggy) has never been reported from Illinois (Randolph and McCafferty 1998), but is now known from the Mackinaw River. *Baetis intercalaris* McDunnough was known from extreme northern and southern Illinois (Burks 1953, Randolph and McCafferty 1998), it has now been recorded from central Illinois from the Mackinaw River drainage (Table 3). Burks (1953) recorded *Fallceon quilleri* (Dodds) (as *Baetis cleptis* Burks) at a single location from extreme west central Illinois. It is now known from north central Illinois at two locations (Table 3).

Small streams were inhabited by populations of two heptageniid mayflies rare to Illinois (Table 3). *Leucrocuta aphrodite* (McDunnough), primarily an Appalachian species (Randolph and McCafferty 1998), was known only from the state's eastern border (Burks 1953). It has now been collected from northwestern Illinois. *Nixe inconspicua* (McDunnough) was known from several locations in northern and eastern Illinois (Burks 1953) and is now known from western Illinois.

Stoneflies were not diverse and rarely abundant. Four perlid species were found in the basin, *Perlesta decipiens* (Walsh), *P. golconda* DeWalt and Stark, *P. lagoi* Stark, and *Perlinella drymo* (Banks). *Perlesta decipiens* occurred in all but the smallest streams. DeWalt and Stark (1998) recently described *P. golconda* from southern Illinois, while *P. lagoi* is a new state record and previously known only from Mississippi (Stark 1989). Both were taken only from the Sangamon River, Monticello site. The perlodid *Isoperla bilineata* (Say) occurred in low abundance in the four largest rivers. Historical records from Frison (1935), and from INHS specimen databases, demonstrated that several perlid stonefly species were once commonly found in the larger drainages of the lower Illinois River basin (Table 3). These species included *Acroneuria abnormis* (Newman), *Agnetina capitata* (Pictet), *Attaneuria ruralis* (Hagen), and *Neoperla clymene* (Newman). Lenat (1993) and Hilsenhoff (1987) listed these species as intolerant of watershed disturbance and organic enrichment. These intolerant stoneflies have been largely eliminated from the drainage, while *P. decipiens* and *I. bilineata* (listed as moderately tolerant) have persisted.

Ross (1944) recorded no more than five individuals of the caddisfly *Hydroptila perdita* Morton from Illinois. All were taken from the extreme eastern border. The present study reports them from five of the eight streams studied, demonstrating a wide distribution and common abundance throughout central Illinois. Three rarely collected leptocerid caddisflies were taken during the study. Panther Creek yielded a large population of *Triaenodes melacus* Ross. Ross (1944) reported it from low gradient, sandy streams in southern Illinois, but from nowhere else in the state. It is known from spotty records throughout the Midwest (K. Manuel, pers. comm.). *Nectopsyche pavida* (Hagen) was known from only three Illinois locations (Ross 1944). Several females were collected from the Sangamon River (Monticello), confirming a historical record for that location. *Ceraclea punctata* (Banks) was known from only two locations in Illinois, both in the extreme south (Ross 1944). A single specimen was taken from the Sangamon River at Oakford, extending its range into west central Illinois.

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