A Survey of the Aquatic Insects of the Lower Wisconsin River, 1985-1986, with Notes on Distribution and Habitat

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Cover photo: Drop-offs below sandbars were sampled intensively in this study and harbored unique fauna. The Woodman site is shown here. Photographed July 1990. Unless otherwise noted, all photos in this report are by Richard Lillie.

ABSTRACT

A qualitative survey of aquatic insects of the Lower Wisconsin River was conducted at 6 primary and 7 secondary sites in 1985 and 1986. A combination of sampling methods, including hand-picking of natural substrates, was employed. Associated physical and limnological data were also obtained.

More than 6,500 insects were collected, representing 9 orders and 63 families. More than 232 species were present, including 172 taxa identified to species and another 60 taxa from 52 genera that could not be identified to species. *Sigara lineata* (Corixidae), *Stenonema terminatum* (Heptageniidae), and *Nectopsyche candida* (Leptoceridae) were the most frequently collected insects. Species of *Baetis, Baetisca, Brachycercus, Caenis, Cheumatopsyche, Hydropsyche,* and *Trichocorixa* were also well represented. Several rare species were collected, including the mayflies *Acanthametropus pecatonica, Cercobrachys* (nr.) *serpentis, Brachycercus* (nr.) *nasutus, Macdunnoa persimplex, Paracloeodes minutus, Pentagenia vittigera, Pseudiron centralis,* and *Stenonema mexicanum;* the dragonflies *Nasiaeschna pentacantha* and *Neurocordulia yamaskanensis;* and the beetles *Hydroporus hybridus* and *Lioporeus triangularis.*

Shorelines and rocky runs were the most productive structural habitats, while sandbar drop-offs, riffles, and sandy runs were least productive. Rocks and wood (snags) were the most productive substrates, while clay and sand were the least productive. Many rare or unusual insects were found near Woodman, Wisconsin.

Management implications and recommendations include protecting the Woodman site, sampling the fauna of rocky runs to assess water quality, and discouraging the removal of snags from the Lower Wisconsin River.

Key Words: Lower Wisconsin River, aquatic insects, endangered species, habitat associations, species distribution, occurrence patterns, limnological data, structural habitats, substrates.

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INTRODUCTION

Aquatic insects are an extremely important but underappreciated natural resource of the Lower Wisconsin River. Insects are important in the diets of fish (Bailey and Harrison 1948, Hoopes 1960) and waterfowl (Schroeder 1973), and are excellent biological indicators of water quality (Hilsenhoff 1982). Aquatic insect data have been collected over the years from tributaries of the Lower Wisconsin River (Lillie 1987); however, little data on the composition and distribution of insects in the main channel of the river have been gathered. Deep water and dangerous currents have made sampling insects in the main channel difficult; these conditions are major reasons for the lack of aquatic insect data from this part of the river.

Three studies conducted in the Portage area (Columbia County) provide most of the data on aquatic insects in the Lower Wisconsin River. Magnuson et al. (1977) reported seasonal data for 1974-76 that showed genera of Chironomidae (midges), Ephemeroptera (mayflies), and Trichoptera (caddisflies) to be dominant. Important Trichoptera included *Cheumatopsyche* sp., *Hydropsyche* sp., and *Nectopsyche* sp. Important Ephemeroptera included *Baetis* sp., *Isonychia* sp., *Stenonema exiguum*, *Stenonema terminatum*, and *Caenis* sp. A less extensive study by Marshall et al. (1985) revealed a similar community structure, in which the dominant insects included *Cheumatopsyche* sp., *Hydropsyche* sp., *Isoperla* sp. (a plecopteran = stonefly), *Stenonema terminatum*, and *Heptagenia flavescens* (a mayfly). Grothe and Steiner (1978) reported finding a mixture of pollution-tolerant, facultative, and intolerant macroinvertebrates at Portage, dominated by *Cheumatopysche* sp., *Hydropsyche* sp., Simuliidae (black flies), and Chironomidae. A fourth study (Hilsenhoff 1977) documented a similar community upstream from the Orion boat landing in Richland County. At this site *Cheumatopsyche* spp., *Hydropsyche* spp., *Stenonema terminatum*, *Potamyia flava* (a hydropsychid caddisfly), *Isonychia* spp., *Heptagenia flavescens*, and *Isoperla bilineata* were shown to be dominant.

The current study was conducted over a 2-year period (1985-86). Insects were collected from selected sites in the main channel of the Lower Wisconsin River during both years. The sampling season spanned the ice-free period from March through December. Limnological data from the study area were collected only during 1986.

The primary objectives of the study were to: (1) provide an inventory of the aquatic insect fauna of the Lower Wisconsin River for future Wisconsin Department of Natural Resources (DNR) fisheries investigations and (2) generate baseline information for monitoring changes in the water quality of the Lower Wisconsin River. Additional research objectives of the study were: (1) to document spatial distributions of insect groups within the river, (2) to document seasonal or chronological patterns associated with insect life cycles, and (3) to identify natural habitat associations (structure, substrate, current, and water depth) of the more common insect taxa inhabiting the Lower Wisconsin River.

BACKGROUND

Hydrology

The Wisconsin River is the largest and longest river system in Wisconsin, extending 692 km from its headwaters on the Wisconsin-Michigan border to its confluence with the Mississippi River. Runoff from a watershed of over 3 million ha is partially regulated through a system of 47 storage reservoirs and 27 hydroelectric power dams (U.S. Dep. Inter. and U.S. Dep. Agric. 1979). Despite this extensive flood-control system, dramatic flow fluctuations occur in the 160-km segment known as the Lower Wisconsin River. Discharge at Muscoda varies from 85 m^3/sec to 850 m^3/sec (95% frequency of occurrence) and averages 244 m^3/sec (U.S. Dep. Inter. and U.S. Dep. Agric. 1979). Maximum flow discharges of 2,044 m^3/sec and 2,288 m^3/sec have been recorded at Wisconsin Dells and Muscoda, respectively (Wis. Dep. Nat. Resour. 1972). Low flow discharge at Portage has been estimated at 52 m^3/sec (Marshall et al. 1985), while low flow discharge at Muscoda generally exceeds 57 m^3/sec.

Low flow usually occurs in late summer or early fall due to retention of water in upstream reservoirs for winter electrical generation. Operation of hydroelectric dams at Wisconsin Dells and Prairie du Sac further modify the river, causing fluctuations in flow and water level that vary with season, stage, and distance downstream from dams. Water levels may rise 4-5 m during floodstage depending on the width of the floodplain, which varies from 1.5 to 8 km (U.S. Dep. Inter. and U.S. Dep. Agric. 1979). Stream width during normal flow ranges from 150-500 m. The main channel of the Lower Wisconsin River is generally 2-3 m deep and may be constricted to <15 m wide during low flow periods.

The stream gradient of the Lower Wisconsin River is gentle (0.3 m/km) and equal to that of the Mississippi River where the 2 rivers join (U.S. Dep. Inter. and U.S. Dep. Agric. 1979, Marshall et al. 1985). Current velocities vary with water depth, localized variations in stream gradient, and differences in channel morphometry. Main current velocities range from an estimated 0.5-1.0 m/sec in unobstructed channels to 1.5-2.0 m/sec in channels adjacent to obstructions or bridges.

Limnology

The water quality of the Lower Wisconsin River exerts a major influence on the flora and fauna of aquatic ecosystems and on human recreational activities. However, little water chemistry information is available for this part of the river. Periodic violations of state fecal coliform standards have been reported for the immediate vicinity of Sauk City (U.S. Dep. Inter. and U.S. Dep. Agric. 1979) and below the Portage wastewater treatment plant outfall (Marshall et al. 1985). Point-source discharge investigations (Wis. Dep. Nat. Resour. 1972, Grothe and Steiner 1978, Marshall et al. 1985) reported conductivities from 140 to 160 µmhos/cm and pH values from 6.8 to 8.4. Low dissolved oxygen concentrations have been recorded below the Prairie du Sac dam (Wis. Dep. Nat. Resour. 1972), and fishkills have occurred in Lake Wisconsin. Discharges of municipal wastewater effluent from Portage have had minimal impact upon the dissolved oxygen, pH, and phosphorus levels in Lake Wisconsin (Marshall et al. 1985). Nitrogen levels were slightly elevated (from 0.9 to 1.2 mg/L), and average chlorophyll *a* concentrations increased from 30 to 59 µg/L.

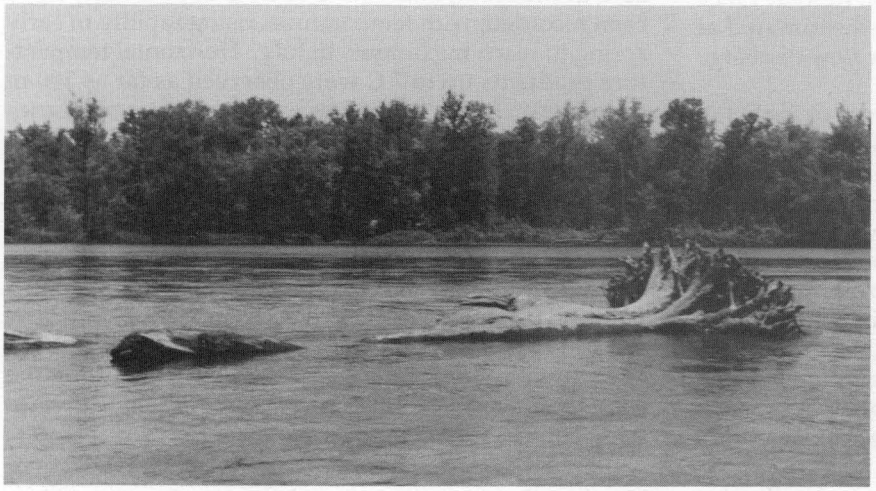
The thermal regime of the Lower Wisconsin River is influenced by its many tributaries, ground-water inputs, and impoundments at Wisconsin Dells and Prairie du Sac. Water temperatures commonly fluctuate 2 C within 24 hours, especially in spring and fall (Wis. Dep. Nat. Resour. n.d.). Annual temperature ranges of -0.5 C to 28 C at Muscoda and +0.5 C to 24 C at Sauk City have been recorded, with temperatures rising rapidly in early spring to reach maximums in July. Horizontal temperature gradients up to 7 C were observed as far as 300 m downstream from confluences with cold water tributaries during the summer months (R. Lillie, Wis. Dep. Nat. Resour., pers. obs.).

The Lower Wisconsin River is predominantly brown in color, the result of organic acids (primarily tannins) originating from the decomposition of vegetation in northern wetlands and by-products discharged by the pulp and paper industry (Mechenich et al. 1980). Inorganic turbidity is almost always relatively low (R. Lillie, pers. obs.), but periodic blooms of phytoplankton during the summer often create high organic turbidity that substantially reduces water clarity.

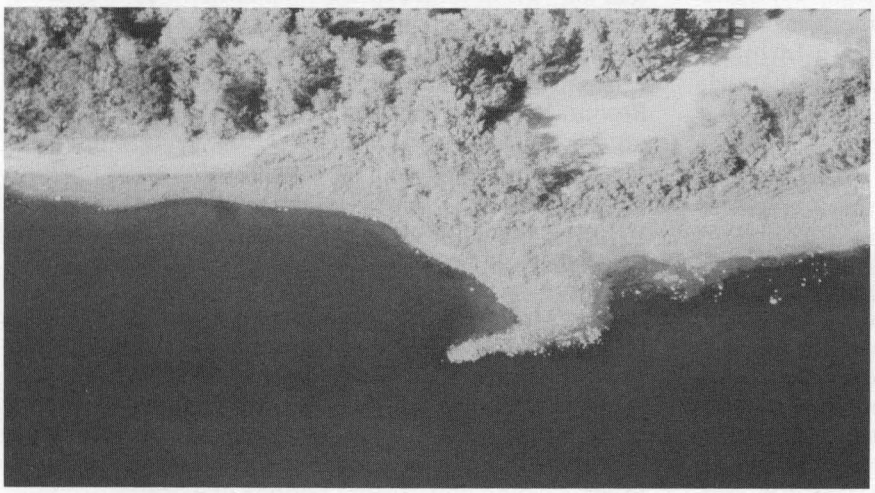
Insect Habitat

The Lower Wisconsin River is a sand-dominated ecosystem (80-90% of total available habitat). Rock (including very limited exposures of limestone and sandstone bedrock) and gravel bars are relatively sparse (combined estimate of 13% of shoreline length) (Wis. Dep. Nat. Resour. 1988) and confined to erosional areas. Silt, mud, organic detritus, and aquatic vegetation are more commonly found in depositional backwater areas. Severe drought can lead to the total desiccation of these areas, with the subsequent loss of large numbers of aquatic invertebrates. Snags (fallen trees along undercut banks) are common along the shoreline. The main channel of the river is an area of strong currents and variable bottom substrates. Strong currents also occur outside the main channel in moderately deep-water runs over sand, gravel, or rock bottoms. While gravel and rock bottom habitats are relatively rare, their value as insect habitat is high. Riffles are extremely rare in the Lower Wisconsin River, existing only during periods of extreme drought. Shoreline habitats with rock or gravel substrates (such as rock wing-dams) are periodically exposed to drying and

Sandbars as far as the eye can see! Sand substrate makes up 95% of the available substrate habitat in the Lower Wisconsin River. Photo undated.



Dead trees or snags are among the most valuable substrate available to aquatic insects in the Lower Wisconsin River, providing food, shelter, and attachment substrate for numerous species. Photographed May 1990.



Rock wing-dams provide valuable substrate for a wide variety of insects. Eddies or snags, located downstream from these structures, also provide valuable habitat. Photographed July 1988.

consequently do not harbor the same fauna as riffle habitat. Periodic lowering of water levels creates a great amount of temporary stagnant pool or slough habitat on sandbars or adjacent to shorelines. Drop-offs, marking the termination of downstream edges of sandbars, and shoreline obstructions (snags or installed structures) create areas of turbulence and/or eddy currents that may harbor unique fauna.

Fish and Wildlife

Fish and wildlife resources of the Lower Wisconsin River are extensive. Fishing is a major recreational activity in the area, attracting more than 75,000 anglers annually (Wis. Dep. Nat. Resour. 1985). Primary sport fish include the channel catfish (*Ictalurus punctatus*), walleye (*Stizostedion vitreum*), sauger (*Stizostedion canadense*), and smallmouth bass (*Micropterus dolomieu*). A number of relatively rare, threatened, or endangered species are also present in the Lower Wisconsin River, including paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), shovelnose sturgeon (*Scaphirhynchus platorynchus*), speckled chub (*Macrhybopsis aestivalis*), blue sucker (*Cycleptus elongatus*), black buffalo (*Ictiobus niger*), and starhead topminnow (*Fundulus dispar*) (D. Fago, Wis. Dep. Nat. Resour., pers. comm. 1987). During the winter, bald eagles (*Haliaeetus leucocephalus*) often congregate to feed on fish in open water below the Prairie du Sac dam.

METHODS

Study Site Selection

Selection of study sites was based on a combination of 3 factors: accessibility for sampling, availability of invertebrate habitats, and diversity of those habitats. Accessibility for sampling was affected by seasonal and daily flow fluctuations, as well as by varying current velocities. Habitat availability and diversity were determined by depth, current velocity, structure, and substrate.

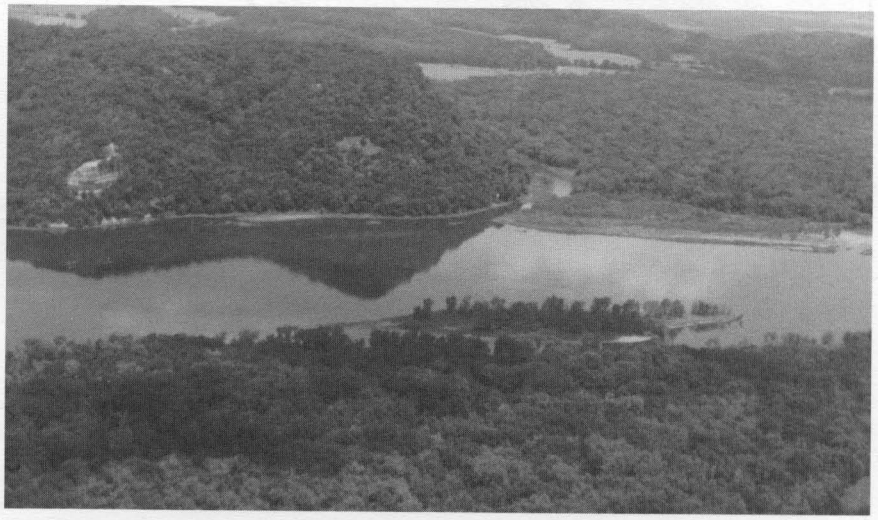
In 1985 we visited many potential sites, but chose few because water level changes during the sampling season had seriously affected accessibility of sites and availability of habitats. Sites chosen for sampling in 1985 were also sampled during 1986, except for 2 sites where the position of the river channel changed dramatically over winter, thus impairing access and reducing habitat diversity. These 2 sites were visited sporadically during 1986, and a few new sites were also sampled during 1986. We sampled as many different combinations of habitat as were available at each site.

Sites sampled regularly during both years of the study are designated in this report as primary sites. Most primary sites contained a wide variety of habitats. The primary sites included 6 widely separated locations: Pine Island, Portage, Sauk Prairie, Ferry Bluff, Orion, and Woodman. All other sites sampled were designated as secondary: Lake Delton, Spring Green, Lone Rock, Muscoda, Port Andrew, Blue River, and Millville (Fig. 1). Table 1 provides the location, access point, and predominant habitat of each sampling site.

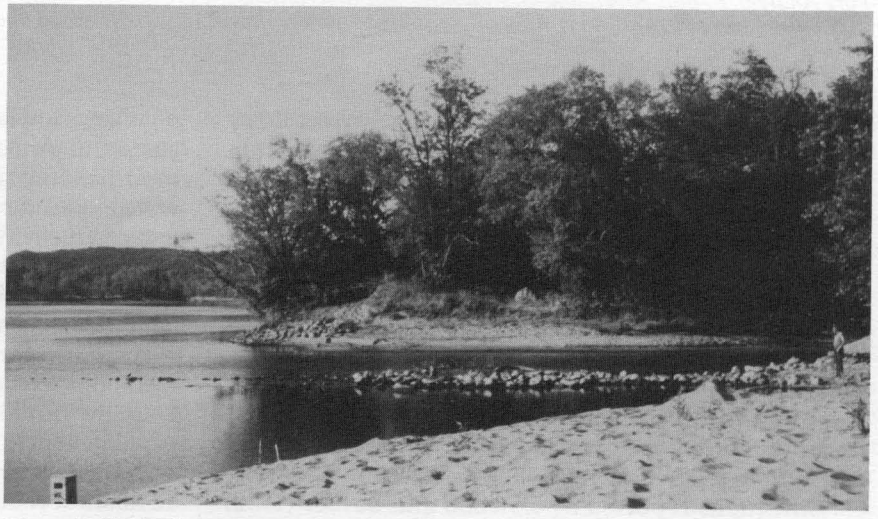
Limnological Data Analyses

Water temperature, level (stage), velocity, and clarity were recorded for primary study sites on each sampling date in 1986. Data for these characteristics were not collected in 1985. Water temperature was measured with either an electronic

The Pine Island site presented a wide variety of sandbar habitats. Photo undated.



The Ferry Bluff sampling site in July 1988.



Many individual sites in the vicinity of Sauk City and Prairie du Sac were sampled. Shown here is a sandbar and rock wing-dam area above the U.S. Highway 12 bridge. Photographed June 1988.

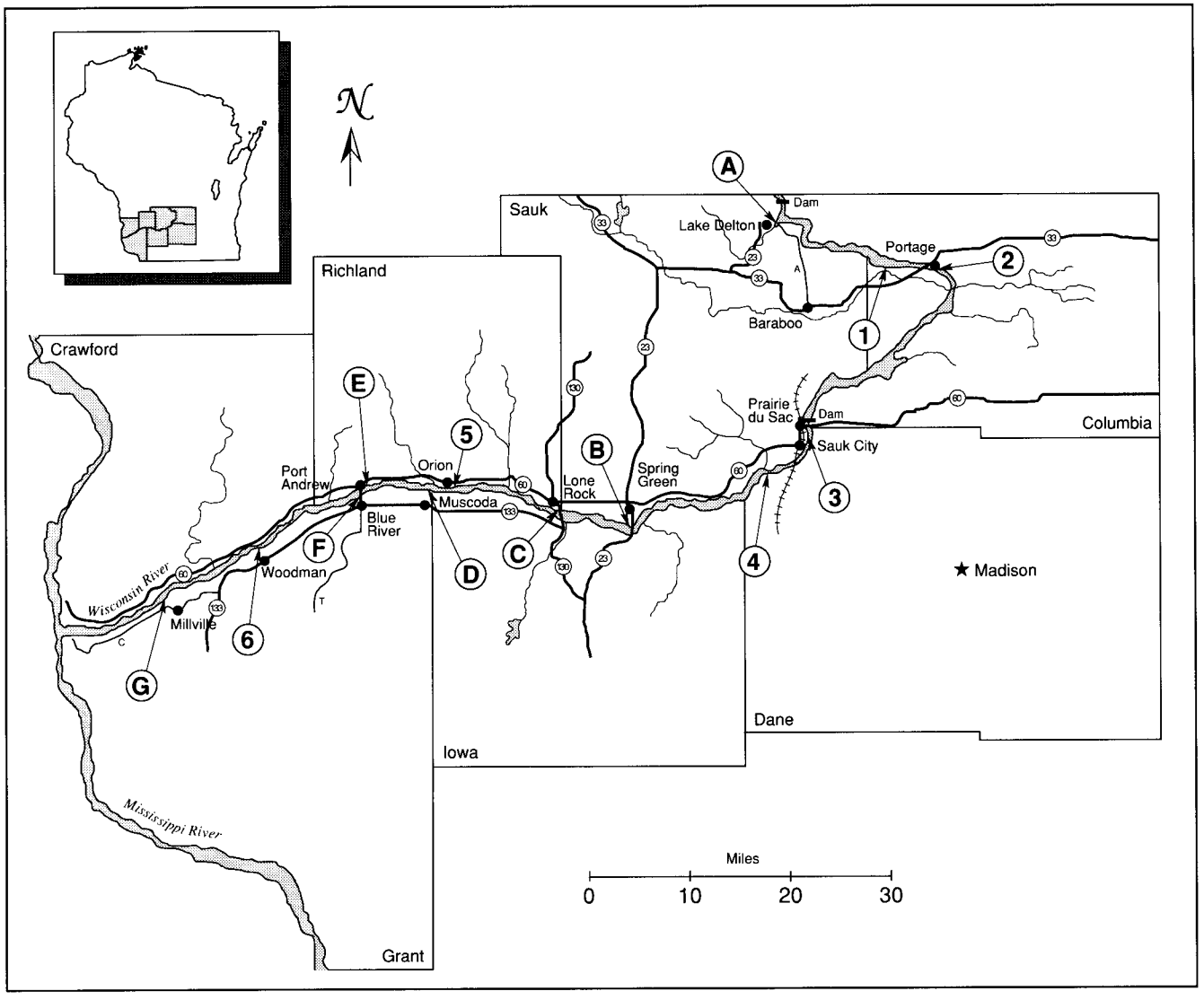


Figure 1. *Location of Lower Wisconsin River sampling stations. Primary sampling locations were: 1. Pine Island, 2. Portage, 3. Sauk Prairie, 4. Ferry Bluff, 5. Orion, and 6. Woodman. Secondary sites were: A. Lake Delton, B. Spring Green, C. Lone Rock, D. Muscoda, E. Port Andrew, F. Blue River, and G. Millville. Site descriptions are provided in Table 1. Base from 1968 U.S. Geological Survey state map (after Gebert 1978).*

thermometer or a calibrated pocket thermometer. Daily noon water temperature records were available from DNR Fish Research stations at Sauk City, Muscoda, and downstream from Woodman. Water level was subjectively evaluated by comparing water height with the normal bank water line. Stage was recorded as flood, bank-full, high, moderate, or low. Current was measured with a Marsh-McBirney portable current meter.[1] On several sampling trips, subjective estimation of current was necessary when equipment malfunctioned or was unavailable. Comparisons of current estimates and electronic current meter readings demonstrated that estimates were relatively accurate and consistent with flow classifications reported by Oswood and Barber (1982) and Schmude and Hilsenhoff (1986).

Water samples were collected monthly in areas of strong current at primary study sites. Dissolved oxygen (Azide modification), alkalinity (titration to a fixed endpoint-mixed indicator solution), pH (color comparison method), and conductivity (potentiometric) measurements followed Standard Methods (Am. Publ. Health Assoc. 1980). Dissolved oxygen samples were fixed immediately upon collection, and analyses were completed within 12 hours. Apparent color (unfiltered samples; color comparative method) and turbidity (Hach Model 2100A Turbidimeter) were measured on refrigerated samples within 14 days of collection. Chlorophyll *a* extraction with 0.45-micron membrane filters and 90% acetone was completed within 12 hours of collection. Laboratory analysis was completed within 1 week of extraction using a Beckman Spec 70

[1]Reference to trade names does not imply government endorsement of commercial products.

Table 1. *Description of sampling sites by location, predominant habitats, and access. Sites are listed in order from upriver to downriver. Primary sites are designated by numbers 1-6; secondary sites by letters A-G.*

Site (Mileage*)	Predominant Habitat	Access (County)	Location (T.R. Sec.)
A Lake Delton (137)	Channel, rock, fast current	Co. Hwy. A (Sauk)	T13N, R6E, SEC. 15
1 Pine Island (121)	Sandbar complex	Pine Island Wildlife Refuge (Columbia)	T12N, R8E, SEC. 4
2 Portage (116-118)	Rocky run and sandbar complex	Several parks in Portage, State Hwy. 33 (Columbia)	T12N, R8E, SEC. 1 T12N, R9E, SEC. 7 + 8
3 Sauk Prairie (89-92)	Main channel, riprap shoreline, and sandbar riffles	Prairie du Sac dam to railroad bridge at Sauk City (Sauk)	T9N, R6E, SEC. 36 T8N, R7E, SEC. 7 T8N, R6E, SEC. 12 + 13
4 Ferry Bluff (83-84)	Sandbar complex, bedrock channel	Ferry Bluff Rd. (Sauk), Mazomanie Wildlife Area (Dane)	T8N, R6E, SEC. 20 + 29
B Spring Green (67)	Sandbar complex	State Hwy. 23 boat landing (Sauk)	T7N, R4E, SEC. 29 + 30
C Lone Rock (59)	Strong eddy	State Hwy. 130 (Richland)	T7N, R3E, SEC. 19
5 Orion (47)	Rocky run	Orion boat landing (Richland)	T8N, R1E, SEC. 6
D Muscoda (45)	Riprap shoreline	Muscoda boat access (Grant)	T8N, R1W, SEC. 1
E Port Andrew (38)	Rocky run	Port Andrew boat landing, State Hwy. 60 (Richland)	T9N, R2W, SEC. 35 + 36
F Blue River (37)	Sandy shoreline	Co. Hwy. T bridge (Grant)	T8N, R2W, SEC. 2
6 Woodman (19-20)	Sandbar complex	Big Green River boat landing, State Hwy. 133 (Grant)	T7N, R4W, SEC. 15 + 16
G Millville (12)	Riprap, strong current	Millville boat landing, Co. Hwy. C (Grant)	T7N, R5W, SEC. 33 + 34

* Distance in miles from the site to the confluence of the Wisconsin River with the Mississippi River (River Mile Index after Fago 1984).

spectrophotometer with an 8-nm slit width. Absorbance readings were corrected to the equivalent of the Wisconsin State Laboratory of Hygiene's (S.L.H.) Beckman DU-6 (2-nm slit width) based on comparative measurements of a U.S. Environmental Protection Agency standard chlorophyll sample. Data are reported as Trichromatic chlorophyll *a*. Water clarity was measured with a standard 20-cm diameter Secchi disc. Strong currents occasionally interfered with the accuracy of measurements. Periodic unavailability of some testing equipment resulted in data gaps.

One set of water samples was collected in late summer 1986 at primary sampling sites and was analyzed by the S.L.H. within 24 hours for calcium, chloride, magnesium, potassium, sodium, sulfate, dissolved phosphorus, total phosphorus, dissolved ammonia, nitrite, nitrate, organic nitrogen, pH, alkalinity, color, turbidity, and conductivity. The latter 5 measurements served as a control for field measurements of these same parameters.

Insect Data Collection

Insects were collected with D-frame nets, long-handled nets (3 m), drift nets, drag nets, and by hand-picking natural substrates. Because determination of natural habitats was a study objective, artificial substrate samplers were not employed. In 1985, all sites were sampled from March through December at irregular intervals due to weather and water level problems. In 1986, primary sites were sampled monthly from March or April through October,

while secondary sites were sampled at irregular intervals. All samples were collected from the 6 primary sites between 7 a.m. and 7 p.m. during a 2- to 7-day period each month. Generally, 1.0-1.5 hours were spent sampling at each site. High water or ice prevented sampling on some dates.

The sampling effort was not standardized within or between sites or habitats. Additional effort was devoted to searching selected habitats at the study sites for suspected rare species (Elmidae [riffle beetles] and Ephemeroptera). Every effort was made to sample as many discrete combinations of habitat as were available at each site; however, substrate irregularities, visual difficulties, bad weather, and insufficient time often made thorough sampling impossible. Consequently, some collections represented integrated samples from several habitats.

For on-site picking, samples were placed in shallow pans to separate insects from debris or substrate. All uncommon species and a representative number of common species from each habitat were placed in labeled jars and preserved in 70% ethanol. One or 2 specimens of each taxon were retained by the senior author, and representative specimens of all insects were deposited in the University of Wisconsin (UW) Insect Collection.

Taxonomy

Scientific names of insects are used throughout this report and can be found by order, suborder, family, subfamily, tribe, genus, and species in Appendix B. Most aquatic insect species do not have common names; for those that do, we have included common names of families in Appendix B and upon the first occurrence of the species in this text.

The use of the plural species (spp.) in this report designates genera in which the authors believed that more than one species of the genus were present. The use of the singular species (sp.) designates those genera in which all specimens appeared to represent a single species. The use of nr. (to abbreviate *near*) indicates that specimens keyed to the species may represent a similar but as yet undescribed species.

Insects were identified to genus in the laboratory using a dissecting microscope and keys by Hilsenhoff (1981), Merritt and Cummins (1984), and in the case of Caenidae (small squaregill mayflies), Soldan (1986). Identification of species was based on appropriate keys and references listed in Hilsenhoff (1981), Brigham et al. (1982), Merritt and Cummins (1984), and the following additional keys: Flowers (1982), Ferkinhoff and Gundersen (1983), Hilsenhoff (1982, 1984*a*, 1984*b*, 1985, 1986), Schmude and Hilsenhoff (1986), and Soldan (1986). Representative Chironomidae from each collection were mounted in Hoyer's medium and identified to genus under a compound microscope using keys by Hilsenhoff (1981) and Coffman and Ferrington (1984).

Habitat Categorization

Habitat was categorized according to water depth, current velocity, structure, and substrate. Water depth was classified as very shallow (<0.5 m), shallow (≥0.5 - <1.0 m), moderate (≥1.0 - <2.0 m), or deep (≥2.0 m). Current was recorded as stagnant (no flow), slow (<0.25 m/sec), moderate (≥0.25-<0.50 m/sec), fast (≥0.50 - <0.75 m/sec), or very fast (≥0.75 m/sec). Habitat structure was classified as channel, run (specified as sand or rock bottom), riffle, eddy, sandbar drop-off, shoreline, or backwater. Backwaters included stagnant pools on sandbars and sloughs directly connected to the main channel during low flow (sloughs separated from the main river channel were not sampled in this study). Substrate was classified as rock (including bedrock), mixed substrates with rock present, gravel, sand, silt, clay, detritus, vegetation, wood, or mixed substrates in any combination. Snags generally consisted of dead trees and were classed with wood substrates.

RESULTS

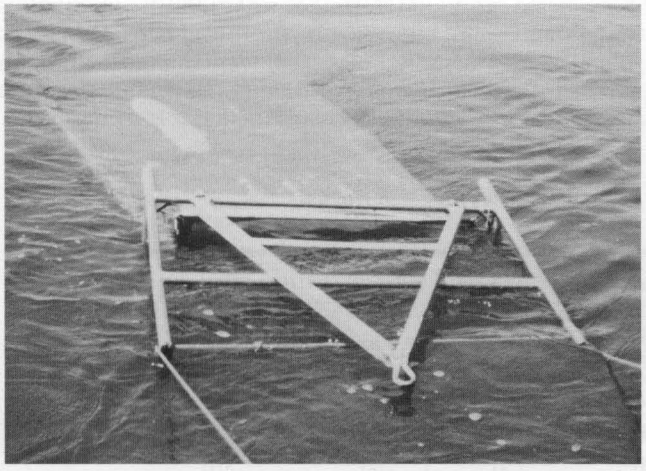
Limnological Data (1986 only)

In 1986, spring flood waters began to recede as normal in early May and continued to decline through early June. Numerous sandbars were exposed, making many deep-water habitats accessible. However, heavy precipitation in late June resulted in the return of high water levels, which continued throughout the summer and culminated in flood stage in late September.

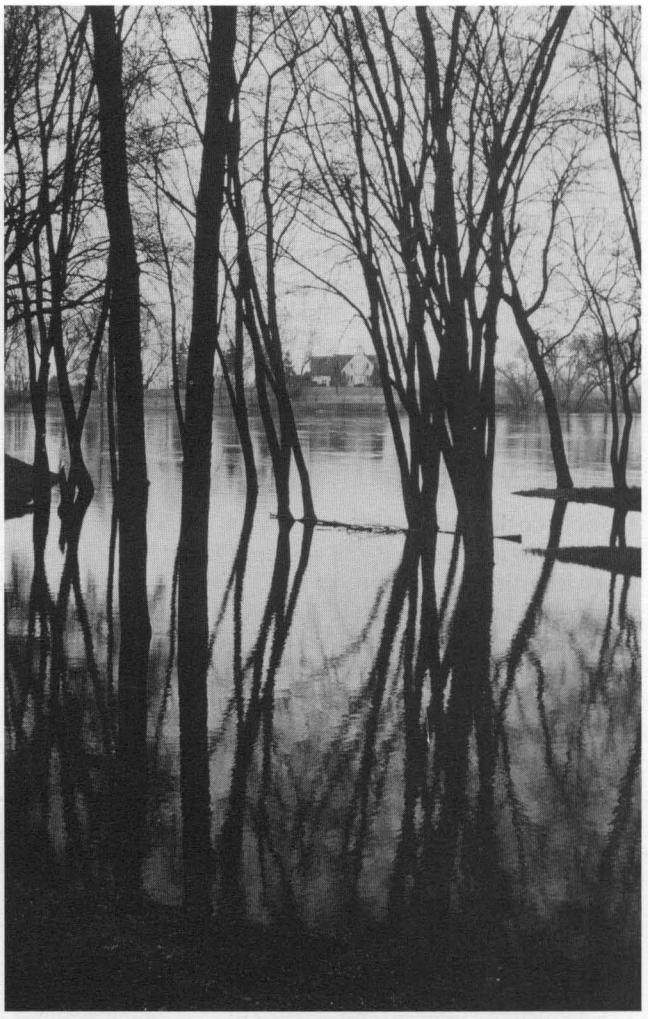
Thermal regimes generally were similar at all sites (Append. A). Water temperatures warmed rapidly after ice-out, reaching 10-11 C by mid-April. Maximum temperatures were observed from late July through early August. Noon water temperatures at Muscoda peaked at 28.3 C on 18 July (Wis. Dep. Nat. Resour., Fishery Research, unpubl. data). Water temperatures at Sauk City were apparently influenced by the hydroelectric dam at Prairie du Sac, as winter and summer temperatures averaged 0.5-1.2 C warmer than downstream sites. However, the dam did not have a substantial impact on either spring-warming or fall-cooling patterns.

Water clarity, which was poorer at downstream sites, declined from early spring to summer, coinciding with rising water temperatures and increased phytoplankton production as shown by higher chlorophyll *a* concentrations. Flooding in late September diluted phytoplankton concentrations, resulting in low turbidities. Color increased from mid-summer to fall. Conductivity, pH, and alkalinity were seasonal and independent of flow or stage, increasing from spring to summer and subsequently

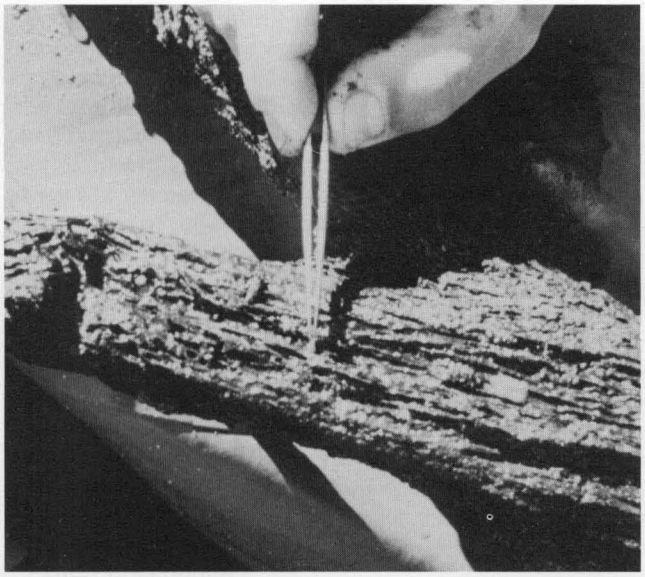
An assortment of collection methods was used, including this small drag net.



A larger dredge net, pulled either by boat or by hand, was also used successfully.



Flood stage on the Lower Wisconsin River makes sampling impossible. Photo undated.



Hand-picking of substrate was a tedious but rewarding method of collecting aquatic insects. Many insects were deeply imbedded in wood and would crawl out after many minutes of exposure to air.

Most of the Lower Wisconsin River is totally ice-covered from December through March. Areas below the Prairie du Sac and Wisconsin Dells dams remain open, but ice along the shorelines prohibits safe access. Photographed in winter 1989-90.

decreasing in fall. Dissolved oxygen was usually at or near saturation at all stations during daylight hours (Append. A). Calcium and magnesium concentrations were slightly elevated at downstream sites, where dolomite bedrock predominates (Table 2). Concentrations of other metal ions were consistent between upstream and downstream sites. Nutrient concentrations were moderately high at all sites (Table 2). A trend toward increasing nitrogen and phosphorus concentrations at downstream sites was associated with similar trends in alkalinity, turbidity, and chlorophyll *a* (Append. A). Inorganic nitrogen was substantially higher below the Prairie du Sac dam than at other sites.

Insect Data

Insects collected in this survey (n = 6,519) represent 63 families and at least 232 species (Table 3); 172 species were identified. Specimens in 52 genera were collected that could not be identified to species. These unidentifiable species represented at least 60 taxa.

Distribution of Commonly Occurring Insects

Species included in this section are those for which 30 or more individuals were found in the study area. Ephemeroptera (mayflies), Heteroptera (bugs), Diptera (flies), Trichoptera (caddisflies), Plecoptera (stoneflies) and Coleoptera (beetles) were the most abundant orders of insects in the study area, with the 27 most common genera comprising 65% of the collection (Table 4). *Sigara lineata* (Heteroptera: Corixidae—water boatmen) was the most common species collected; *Trichocorixa borealis* (Heteroptera: Corixidae) was also very common. In Trichoptera, *Cheumatopsyche* spp. (Hydropsychidae—common netspinners), *Nectopsyche candida* (Leptoceridae—longhorned case makers), *Hydropsyche orris* (Hydropsychidae—common netspinners), and *Potamyia flava* (Hydropsychidae) were dominant. In Ephemeroptera, *Stenonema terminatum* (Heptageniidae—flatheaded mayflies), *Stenacron interpunctatum* (Heptageniidae), *Stenonema exiguum* (Heptageniidae), *Baetis propinquus* (Baetidae—small minnow mayflies), and *Baetisca lacustris* (Baetiscidae—armored mayflies) were the most common species. *Isoperla bilineata* (Perlodidae—perlodid stoneflies)

Table 2. *Laboratory water analyses for primary sampling sites on the Lower Wisconsin River, 28 August - 1 September 1986. Sites are listed in order from upriver to downriver.*

	Locations of Primary Sampling Sites					
Parameter	**Pine Island**	**Portage**	**Sauk Prairie**	**Ferry Bluff**	**Orion**	**Woodman**
Physical						
Color	40	40	30	20	30	30
Conductivity (µmhos/cm)	210	210	270	250	260	270
Turbidity (FTUs)	7.4	7.8	6.4	7.0	8.9	10.0
Chemical						
Alkalinity (mg/L)	58	60	60	76	106	104
pH	7.8	7.9	7.7	8.1	8.4	8.4
Metals (mg/L)						
Ca^{++}	18	18	23	22	27	28
Cl^{-}	13	13	13	13	12	12
K^{+}	2	2	2	2	2	2
Mg^{++}	7	7	10	10	13	13
Na^{+}	8	8	8	8	8	8
SO_4^{--}	12	12	14	13	13	13
Nutrients (mg/L)						
Nitrogen						
Ammonia	<0.02	<0.02	0.08	0.02	<0.02	<0.02
Inorganic	0.16	0.16	0.59	0.08	0.19	0.06
Kjeldahl	0.8	0.9	1.0	1.1	1.0	1.4
Phosphorus						
Dissolved	0.009	0.016	<0.004	0.019	0.008	<0.004
Total	0.08	0.08	0.08	0.10	0.10	0.11

was the dominant plecopteran. *Macronychus glabratus* (Elmidae—riffle beetles) and *Peltodytes edentulus* (Haliplidae—crawling water beetles) were the most abundant coleopterans collected, and *Glyptotendipes* spp. (Chironomidae) was the dominant dipteran.

On the following pages, order and suborder names are shown in boldface capital letters, family and subfamily names are in capital and lowercase boldface letters, species names are in italics, followed by descriptor names in capital and lowercase letters. A descriptor name in parentheses indicates a species that was originally described in another genus. The number of genera and species found in each family is also provided. A plus symbol (+) following the species number indicates that some genera contained more than one unidentifiable species. Distributional records for all species are provided in Appendix B.

Information is presented on the occurrence pattern, distribution, habitat, and identification of each species included in this section. These terms are used as follows:

Occurrence pattern: represents the period or periods during which species were found, based on collection records. Ranges of dates were established by combining the earliest and latest sampling dates from both 1985 and 1986. During some sampling periods, no specimens were found. Interpolation of occurrences between late fall and early spring sampling dates was based on observed larval sizes and knowledge of life cycles from other studies. Where known, emergence patterns and life cycles are indicated. Occurrences of all insect species discussed here are based on larval specimens; in the case of beetles and bugs, occurrences are based on adult specimens.

Distribution: indicates the relative abundance of each species at the sampling sites. *Relative abundance* represents our qualitative estimate based on the number of specimens collected at a site relative to the intensity of the sampling effort at that site. (Sampling effort was not standardized among sampling sites; therefore, the number of specimens collected and recorded in Appendix B does not necessarily reflect true relative abundance.) Categories of relative abundance are defined as follows: *abundant*—a large number of specimens found with minimal sampling effort; *common*—a moderate number of specimens found with minimal sampling effort, or a large number found with moderate sampling effort; *present*—a small number of specimens found with minimal sampling effort, or a moderate number found with moderate sampling effort; *uncommon*—a small number of specimens with moderate sampling effort or, on occasion, a large number with extensive sampling effort; *rare*—a small number of specimens found with extensive sampling effort, or a large number found in a specific microhabitat or short time period.

Habitat: described by current, depth, structure, and substrate where recorded.

Identification: taxonomic references used to key species. Also included are problems encountered and notes on physical characteristics that may assist with rapid identification of particular species. Many larvae were not keyed to species because no species key exists.

A glossary of selected terms used in this section appears at the end of this report.

Table 3. *Relative abundance of aquatic insect orders collected from the Lower Wisconsin River.*

Order	Families	Genera	No. Species Collected	Total Organisms
Ephemeroptera	14	23	42	1,607
Heteroptera	9	16	38	1,550
Diptera	12	40	49	1,046
Trichoptera	7	13	17	1,006
Coleoptera	8	32	53	766
Odonata	6	16	25	342
Plecoptera	4	5	5	184
Lepidoptera	1	1	1	14
Megaloptera	2	2	2	4
Total	63	148	232	6,519

Table 4. *Relative abundance of the commonly collected genera from the Lower Wisconsin River.*

Family	Genus	No. Specimens Collected
Corixidae	*Sigara*	938
Hydropsychidae	*Cheumatopsyche*	350
Heptageniidae	*Stenonema*	344
Baetiscidae	*Baetisca*	223
Baetidae	*Baetis*	221
Caenidae	*Caenis*	190
Tricorythidae	*Trichocorixa*	188
Hydropsychidae	*Hydropsyche*	180
Leptoceridae	*Nectopsyche*	170
Heptageniidae	*Stenacron*	134
Perlodidae	*Isoperla*	120
Hydropsychidae	*Potamyia*	105
Elmidae	*Stenelmis*	103
Simuliidae	*Simulium*	101
Elmidae	*Macronychus*	97
Gyrinidae	*Gyrinus*	93
Chironomidae	*Glyptotendipes*	86
Haliplidae	*Peltodytes*	84
Caenidae	*Brachycercus*	83
Baetidae	*Procloeon*	82
Gyrinidae	*Dineutus*	80
Dytiscidae	*Laccophilus*	72
Gomphidae	*Gomphurus*	60
Limnephilidae	*Pycnopsyche*	57
Gomphidae	*Stylurus*	54
Coenagrionidae	*Enallagma*	54
Isonychiidae	*Isonychia*	54

COLEOPTERA—Beetles (8 families, 32 genera, 53 species)
Although both adult and larval beetles were collected, usually only adults could be identified to species level. Many species were predominantly lentic, occurring in shallow shoreline or depositional areas with stagnant to moderate currents and usually wood or sand substrates. Elmidae occurred mostly in rocky runs with moderate to strong currents.

Dytiscidae—Predaceous Diving Beetles (10 genera, 14 species)
Hydroporus clypealis Sharp
Occurrence pattern: Adults 19 April through 6 July, 1 September through 26 October.
Distribution: Common at Muscoda and Woodman, present at Portage.
Habitat: Shallow depth, slow to moderate currents, on wood and vegetation, along shorelines.
Identification: Unpublished key to Wisconsin Dytiscidae (Hilsenhoff).

Elmidae—Riffle Beetles (5 genera, 9 species)
Macronychus glabratus Say
Occurrence pattern: Adults and larvae 31 May through 26 October.
Distribution: Common at Portage and Orion; present at Pine Island, Woodman, and Ferry Bluff; absent from Sauk Prairie.
Habitat: Shallow depth, moderate to fast currents, on wood and less frequently among rock substrates, in runs and along shorelines.
Identification: Brown 1972. Monotypic genus.

Stenelmis decorata Sanderson
Occurrence pattern: Adults 29 May, 20 July through 1 September.
Distribution: Abundant at Port Andrew; common at Pine Island, Portage, and Orion; present at Spring Green, Lone Rock, and Muscoda; absent from Sauk Prairie, Ferry Bluff, and Woodman.
Habitat: Deep water, fast currents, on rock and wood, in runs and slow eddies.
Identification: Sanderson 1938, Brown 1972; verified by Kurt Schmude, UW-Madison Department of Entomology.

Gyrinidae—Whirligig Beetles (2 genera, 6 species)
Dineutus assimilis Kirby
Occurrence pattern: Adults 22 March through 26 September.
Distribution: Present at all primary sites except Orion.
Habitat: Shallow depths, slow currents, in vegetation or over sand and silt, along shorelines and in pools.
Identification: Ferkinhoff and Gundersen 1983.

Haliplidae—Crawling Water Beetles (2 genera, 4 species)
Peltodytes edentulus (LeConte)
Occurrence pattern: Adults 19 April through 26 October.
Distribution: Rare at Pine Island, more common at downstream sites.
Habitat: Shallow depths, slow currents, on sand or less often on vegetation and silt, along shorelines and sandbars.
Identification: Hilsenhoff and Brigham 1978.

Hydrophilidae—Water Scavenger Beetles (7 genera, 14 species)
Laccobius reflexipenis Malcolm
Occurrence pattern: Adults 20 April through 7 September.
Distribution: Common at Ferry Bluff and Spring Green; rare at Portage, Orion, and Pine Island; absent from Woodman and Sauk Prairie.
Habitat: Shallow depths, stagnant water and slow currents, on sand, in depositional pools.
Identification: Unpublished key to Wisconsin Hydrophilidae (Hilsenhoff).

DIPTERA—True Flies (12 families, 40 genera, 49+ species)
Chironomidae predominated with 29 genera represented, the most common being *Glyptotendipes, Cricotopus, Polypedilum, Dicrotendipes,* and *Chironomus. Simulium verecundum* and *S. jenningsi* were the most frequently encountered Simuliidae, while *Hexatoma* sp. was the most common Tipulidae.

Chironomidae— Midges (24 genera, not identified to species)
Chironominae (subfamily)
Glyptotendipes spp.
Occurrence pattern: 30 May through 7 September.
Distribution: Dominant Chironomidae (23% of all collected); abundant at Orion; common at Sauk Prairie and Woodman; uncommon at Pine Island, Portage, and Ferry Bluff.
Habitat: Shallow depths; stagnant water to very strong currents; on and within wood and on rock, less often on sand; common in runs and along shorelines.
Identification: No species key for larvae. At least 2 species appeared to be present.

Chironomus spp.
Occurrence pattern: Primarily 31 May, with few larvae 31 August through 7 September.
Distribution: Abundant at Ferry Bluff, common elsewhere, absent from Sauk Prairie.
Habitat: Shallow depths, stagnant water and slow currents, sandbar pools.
Identification: No species key for larvae. At least 2 species appeared to be present.

Dicrotendipes sp.
Occurrence pattern: 8 December through 7 September.
Distribution: Abundant at Sauk Prairie; uncommon at Pine Island, Portage, Ferry Bluff, and Orion; absent from Woodman.
Habitat: Shallow depths, slow currents, on sand and rock, along shorelines and in riffles.
Identification: No species key for larvae. All specimens appeared to be the same species.

Polypedilum spp.
Occurrence pattern: 29 May through 1 September, one larva 26 October.
Distribution: Abundant at Orion, common at Ferry Bluff, uncommon to rare elsewhere.
Habitat: Shallow to moderate depths; slow to fast currents; on sand, gravel, wood, and rock; in runs, channels, and along shorelines.
Identification: Maschwitz 1976. Three or possibly 4 species present, including *P. convictum* (Walker), *P. tritum* (Walker), *P. nubeculosum* (Meigen), and *P. scalaenum* (Schrank).

Orthocladiinae (subfamily)
Cricotopus spp.
Occurrence pattern: Primarily 22 March through 13 July, with single larvae 2 August and 28 September.
Distribution: Abundant at Sauk Prairie, common at Orion, uncommon elsewhere.
Habitat: Shallow to moderate depths; moderate to fast currents; on a wide variety of substrates including gravel, aquatic macrophytes, filamentous algae, rock, wood, and occasionally sand; common in riffles and channels.
Identification: No species key for larvae. At least 3 species appeared to be present.

Simuliidae—Black Flies (2 genera, 4 species)
Simulium verecundum Stone and Jamnback
Occurrence pattern: Small larvae 25 October, most older larvae 31 May, a few scattered collections from June through August.
Distribution: Common at Orion and Woodman, rare at Ferry Bluff and Portage, absent from Pine Island and Sauk Prairie.
Habitat: Shallow depths, moderate to fast currents, on wood and attached to submerged vegetation along shorelines.
Identification: Wood et al. 1962. Head patterns varied between individuals. This may be part of a species complex.

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Continued

DIPTERA—True Flies (12 families, 40 genera, 49+ species)

Simulium jenningsi Malloch
Occurrence pattern: Sporadic records 20 April through 26 October.
Distribution: Common at Portage; uncommon to rare at Pine Island, Orion, and Ferry Bluff; absent from Woodman and Sauk Prairie.
Habitat: Moderate depths, moderate to fast currents, on rock and wood, in runs and along shorelines.
Identification: Wood et al. 1962. Separation from *S. luggeri* and *S. fibrinflatum* based on dissection of pupal respiratory gills from 5 larvae.

Tipulidae—Crane Flies (3 genera, undetermined number of species)
Hexatoma sp.
Occurrence pattern: 20 April through 2 September.
Distribution: Common at Pine Island, Orion, and Woodman; uncommon at Portage; absent elsewhere.
Habitat: All depths; slow to fast currents; in sand and gravel; in runs, riffles, and sandbars.
Identification: No species key for larvae. All specimens appeared to be one species.

EPHEMEROPTERA—Mayflies (14 families, 23 genera, 42+ species)
A diverse ephemeropteran fauna represented 25% of all insects collected and 11 of the 25 most abundant insect species or genera. *Stenonema terminatum* was the most common ephemeropteran, but several other species were well represented.

Baetidae—Small Minnow Mayflies (5 genera, 10+ species)
Baetis intercalaris McDunnough
Occurrence pattern: Probably bivoltine; older nymphs 31 May through 2 August.
Distribution: Present at Portage, Ferry Bluff, Orion, and Woodman; absent from Sauk Prairie and Pine Island.
Habitat: All depths and current regimes; associated with rock, gravel, and wood substrates in runs or along shorelines.
Identification: Hilsenhoff 1982.

Baetis longipalpus Morihara and McCafferty
Occurrence pattern: 13 June through 1 September.
Distribution: Common or present at Woodman, Orion, and Ferry Bluff; one nymph at Portage; absent from Sauk Prairie and Pine Island.
Habitat: In deeper water and stronger currents than other Baetidae, in runs and eddies, on rock or occasionally sand.
Identification: Hilsenhoff 1982.

Baetis propinquus (Walsh)
Occurrence pattern: 29 May through 1 September.
Distribution: Dominant Baetidae, absent from Sauk Prairie, common elsewhere.
Habitat: Shallow depths; all currents; almost always associated with shorelines; on submerged vegetation, wood, and rock in moderate currents, or on muck in low-flow areas.
Identification: Hilsenhoff 1982.

Callibaetis spp.
Occurrence pattern: 4 March through 26 October, continuous emergence.
Distribution: Common at Ferry Bluff; present at Pine Island, Portage, Orion, Sauk Prairie; absent from Woodman.
Habitat: Shallow depths, slow currents or stagnant water, adjacent to shorelines and in ponds, occasionally on sandbars in association with vegetation and debris over sand.
Identification: No species key for nymphs. More than one species appeared to be present.

Procloeon sp.
Occurrence pattern: 31 May through 28 September.
Distribution: Present at Pine Island, Portage, Ferry Bluff, Orion, Woodman; absent from Sauk Prairie.
Habitat: All depths and currents, almost always associated with sand in runs and eddies or along shorelines.
Identification: No species key for nymphs. All specimens appeared to be the same species.

Baetiscidae—Armored Mayflies (1 genus, 3 species)
Baetisca lacustris McDunnough
Occurrence pattern: Young nymphs 28 August through 2 September, older nymphs 22 March through 30 May, emergence in May.
Distribution: Common at all sites.
Habitat: All depths; moderate currents; on sand substrates, or less frequently on rock, vegetation, wood, and detritus; along shorelines adjacent to strong currents.
Identification: Hilsenhoff 1984*a*.

Baetisca obesa (Say)
Occurrence pattern: Young nymphs common 25-26 October, older nymphs 22 March through 22 June, emergence probably in late June.
Distribution: Common at all sites.
Habitat: At shallower depths and in slower currents than *Baetisca lacustris*, otherwise distribution similar.
Identification: Hilsenhoff 1984*a*.

Caenidae—Small Squaregills (3 genera, 7+ species)
Brachycercus spp.
Occurrence pattern: 29 May through 1 September, mixed sizes suggest continuous emergence throughout summer or presence of more than one species.
Distribution: Common or present at Pine Island, Portage, Orion, and Woodman; rare at Ferry Bluff; absent from Sauk Prairie.
Habitat: Shallow depths; slow to moderate currents; associated with sand or sands mixed with silt and debris; common in runs, but more common in depositional areas such as sandbar drop-offs, eddies, and shorelines.
Identification: Soldan 1986. Many nymphs were too young to identify. Three or more species present, including *B. prudens* (McDunnough), *B. edmundsi* (Soldan), and *B. nasutus* (Soldan).

Caenis spp.
Occurrence pattern: Young nymphs 6 November through 22 March, older nymphs 29 May through 1 September, represents more than one species.
Distribution: Common at all sites.
Habitat: Shallow depths, stagnant water to fast currents, associated with sand in depositional areas or eddies.
Identification: Provonsha 1991. Most nymphs were too immature to identify. More than 3 species were present. Mature nymphs of *C. diminuta* Walker, *C. punctata* McDunnough, and *C. youngi* Roemhild were identified.

Heptageniidae—Flatheaded Mayflies (5 genera, 9 species)
Heptagenia flavescens (Walsh)
Occurrence pattern: 14 April through 26 October, periodic emergence May to August.
Distribution: Common at Pine Island, Portage, Orion, and Woodman; absent from Sauk Prairie and Ferry Bluff.
Habitat: Moderate depths, moderate to fast currents, on rock and wood in runs and along shorelines.
Identification: Hilsenhoff 1982.

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EPHEMEROPTERA—Mayflies (14 families, 23 genera, 42+ species)

Stenacron interpunctatum (Say)
Occurrence pattern: 19 April through 26 October, mixed sizes throughout period, emergence possibly continuous during open water.
Distribution: Common at Pine Island, Portage, Sauk Prairie, Ferry Bluff, Orion; uncommon at Woodman.
Habitat: Shallow depths; slow to fast currents; on rock, gravel, and wood, never on sand alone; in runs and along shorelines.
Identification: Flowers and Hilsenhoff 1975.

Stenonema exiguum Traver
Occurrence pattern: 3 May through 23 September, more common in May and June.
Distribution: Common at Portage, Orion, and Ferry Bluff; rare at Pine Island; absent from Sauk Prairie and Woodman.
Habitat: Shallow depths; moderate to fast currents; almost always on rock and wood; in channels, runs, and along shorelines.
Identification: Bednarik and McCafferty 1979, Hilsenhoff 1982.

Stenonema terminatum (Walsh)
Occurrence pattern: 22 March through 26 October, emergence probably late May through early June.
Distribution: Abundant at Pine Island, Portage, Ferry Bluff, and Orion; uncommon at Sauk Prairie and Woodman.
Habitat: Shallow depths; all currents, mostly on rock and wood, almost never on sand alone; in runs, sandbars, and along shorelines.
Identification: Bednarik and McCafferty 1979, Hilsenhoff 1982.

Metretopodidae—Cleftfooted Minnow Mayflies (1 genus, 1 species)
Siphloplecton interlineatum (Walsh)
Occurrence pattern: Young nymphs 26 October, older nymphs 22 March through 20 April, emergence completed by end of May.
Distribution: Common at Woodman and Orion; rare to absent at Pine Island, Portage, Ferry Bluff, and Sauk Prairie.
Habitat: Shallow depths; slow to very fast currents; associated with sand, debris, and vegetation; along shorelines, less frequent in runs and eddies.
Identification: Berner 1978. Identified to *interlineatum* group, of which only *S. interlineatum* occurs in the western Great Lakes region.

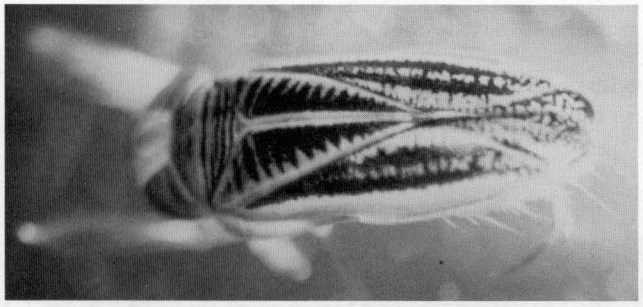
Isonychiidae (1 genus, 1 species)
Isonychia bicolor (Walker)
Occurrence pattern: 29 May through 1 September, continuous emergence throughout summer.
Distribution: Common at Orion and Woodman; rare to absent at Pine Island, Portage, Ferry Bluff, and Sauk Prairie.
Habitat: All depths, moderate to very fast currents, on rock and wood mixed with sand, in runs and along shorelines.
Identification: Kondratieff and Voshell 1984. Key to species requires mature nymphs. All nymphs appeared to be *I. bicolor*.

HETEROPTERA—Bugs (9 families, 16 genera, 38 species)
Corixidae (water boatmen) were the dominant Heteroptera. Of 20 species collected, only *Palmacorixa buenoi*, *Sigara lineata*, *Sigara trilineata*, and *Trichocorixa borealis* were common lotic residents. Most of the remaining Corixidae utilized the river as over-wintering habitat and occurred primarily in fall and early spring. While Corixidae inhabited a wide variety of habitats during the summer, large fall aggregations were concentrated in shallow pools and slow eddies.

Corixidae—Water Boatmen (4 genera, 20 species)
Palmacorixa buenoi Abbott
Occurrence pattern: 19 May through 29 September, most common in June and July.
Distribution: Present at all sites.
Habitat: Shallow depths, slow currents, among vegetation or associated with rock and sand, near shorelines.
Identification: Hungerford 1977, Hilsenhoff 1984*b*. Females cannot always be separated from *P. nana* with certainty.

Sigara alternata (Say)
Occurrence pattern: 22 March through 14 July, 7 September through 21 November, absent at all sites during August.
Distribution: Common at Sauk Prairie; rare or uncommon at Portage, Ferry Bluff, Orion, and Woodman; absent from Pine Island.
Habitat: Shallow depths; stagnant water and slow currents; over sand substrates in depositional shoreline areas and ponds.
Identification: Hungerford 1977, Hilsenhoff 1984*b*.

Sigara lineata (Forster)
Occurrence pattern: Throughout year, 22 March through 22 November.
Distribution: Most common insect collected, very abundant at all sites.
Habitat: Ubiquitous, all depths, all currents, associated with sand and rock substrates, in runs and along shorelines, not as common in depositional areas as other corixids.
Identification: Hungerford 1977, Hilsenhoff 1984*b*.



Sigara lineata, *a small water boatman, was the single most common insect found in the Lower Wisconsin River.*

Trichocorixa borealis Sailer
Occurrence pattern: 22 March through 26 October.
Distribution: Common at Woodman, Orion, and Ferry Bluff; uncommon at Portage and Sauk Prairie; absent from Pine Island.
Habitat: Shallow depths; stagnant water to moderate currents; among vegetation and over silt and sand; along shorelines and in eddies.
Identification: Hungerford 1977, Hilsenhoff 1984*b*.

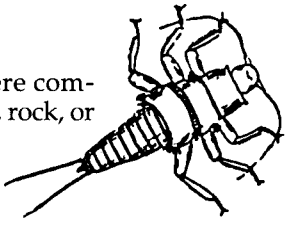
ODONATA—Damselflies and Dragonflies (6 families, 16 genera, 25+ species)
Only 5 genera were common. *Argia apicalis* and *Neurocordulia molesta* were the dominant Odonata on rock and wood substrates, while *Gomphurus fraternus* and *Stylurus notatus* were dominant on finer sediments. Species of *Enallagma* were common along shorelines.

ANISOPTERA (suborder)
Corduliidae—Greeneyed Skimmers (2 genera, 3 species)
Neurocordulia molesta (Walsh)
Occurrence pattern: 19 April through 26 October, 3 distinct size classes suggest a 3-year life cycle.
Distribution: Common at Orion; rare to uncommon at Pine Island, Portage, Ferry Bluff, and Woodman; absent from Sauk Prairie.
Habitat: Shallow to moderate depths, slow to very fast currents, on rock and wood, in runs and along shorelines.
Identification: Needham and Westfall 1955, Hilsenhoff 1982. Distinct frontal horn.

Gomphidae—Clubtails (2 genera, 2+ species)
Gomphurus fraternus (Say)
Occurrence pattern: Young and older nymphs 22 March through 26 October.
Distribution: Common at all sites, absent from Sauk Prairie.
Habitat: All depths; all currents; on sand, silt, detritus, and rock; in shoreline areas adjacent to runs and sandbars.
Identification: Walker 1958. Adults were previously collected from along the Lower Wisconsin River at Ferry Bluff, Orion, and Sauk City (UW-Madison Insect Collection).

Stylurus notatus (Rambur)
Occurrence pattern: 39 May through 26 October; overlapping sizes suggest a 2- or 3-year life cycle.
Distribution: Common at all sites, absent from Sauk Prairie.
Habitat: All depths, all currents, associated with sand and silt, in depositional areas of sandbars.
Identification: Walker 1958.

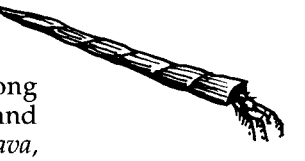
ZYGOPTERA (suborder)
Coenagrionidae—Narrowwinged Damselflies (4 genera, 12 species)
Argia apicalis (Say)
Occurrence pattern: Young nymphs 25-26 October, older nymphs 31 May through 14 July, a few intermittent occurrences throughout summer.
Distribution: Common from Lone Rock downriver to Woodman, absent elsewhere.
Habitat: Shallow depths, all currents, on rocks and wood, in runs and along shorelines.
Identification: Walker 1953, Hilsenhoff 1982.



PLECOPTERA—Stoneflies (4 families, 5 genera, 5 species)
Of the 5 plecopteran species collected from the Lower Wisconsin River, only 2 were common. Most nymphs were collected from April through June along shorelines on wood, rock, or vegetation.

Perlidae—Common Stoneflies (2 genera, 2 species)
Perlesta placida (Hagen)
Occurrence pattern: Nymphs 31 May through 3 July, emergence scattered June through July. The lack of young nymphs in late fall and differences in size suggest that some eggs may hatch in very late fall while most hatch in early spring.
Distribution: Common at Muscoda, Port Andrew, Woodman, and Millville.
Habitat: All depths and currents; variety of substrates, but mostly associated with wood and rock, less frequently on sand.
Identification: Hitchcock 1974. May be a species complex (Stark 1989).

Perlodidae—Perlodid Stoneflies (1 genus, 1 species)
Isoperla bilineata (Say)
Occurrence pattern: Univoltine; early instar nymphs 25 October, older nymphs through 31 May.
Distribution: Dominant Plecoptera, common at all sites.
Habitat: All depths, moderate to strong currents, almost always associated with wood and rock.
Identification: Hilsenhoff 1982.



TRICHOPTERA—Caddisflies (7 families, 13 genera, 17+ species)
Trichoptera were found at all depths, but occurred most frequently in moderate to strong currents where they were associated with rock and wood substrates in runs, channels, and along shorelines. *Cheumatopsyche* spp. were dominant, with *Hydropsyche orris, Potamyia flava,* and *Nectopsyche candida* also abundant.

Hydropsychidae—Common Netspinners (3 genera, 6+ species)
Cheumatopsyche spp.
Occurrence pattern: Throughout sampling period, 22 March through 11 November.
Distribution: The most commonly collected Trichoptera; abundant at all sites, but less common at Pine Island and Woodman.
Habitat: Shallow to medium depths; moderate to fast currents; associated with rock, gravel, and wood; in runs, channels, and along shorelines adjacent to strong currents.
Identification: No species key for larvae. More than one species likely, but only *C. campyla* adults collected in light-trap at Orion by Longridge and Hilsenhoff (1973).

Hydropsyche orris Ross
Occurrence pattern: 19 April through 21 November, most common in late fall and early spring.
Distribution: Common at all sites, absent from Sauk Prairie.
Habitat: Shallow to deep water; moderate currents; on wood and less frequently on rock and sand; in runs, channels, and along shorelines.
Identification: Schmude and Hilsenhoff 1986. A few possible hybrids with *H. bidens* were encountered.

Potamyia flava (Hagen)
Occurrence pattern: 22 March through 26 October, rare in June.
Distribution: Abundant at Woodman and Orion, common at Portage and Ferry Bluff, uncommon at Pine Island and Sauk Prairie.
Habitat: All depths, fast currents, on rocks and less frequently on wood, in runs and along shorelines.
Identification: Hilsenhoff 1981. Monotypic in North America.

Leptoceridae—Longhorned Case Makers (3 genera, 4+ species)
Nectopsyche candida (Hagen)
Occurrence pattern: Young larvae 19 April through 26 October, older larvae 19 April through 2 August, emergence probably throughout summer.
Distribution: Common at all sites.
Habitat: All depths; all currents; on sand and mixtures of sand, wood, rock, vegetation, silt, and detritus; in a wide variety of structures.
Identification: Haddock 1977.

Limnephilidae—Northern Case Makers (2 genera, 2+ species)
Pycnopsyche sp.
Occurrence pattern: 4 March through 8 December; emergence completed by October, after which only small larvae were found.
Distribution: Common at Pine Island, Sauk Prairie, and Orion; uncommon at Ferry Bluff and Woodman; absent from Portage.
Habitat: Shallow depths, slow currents, on all substrates, mostly in eddies or along shorelines.
Identification: No species key for larvae. Only one species appeared to be present.

Polycentropodidae—Trumpetnet and Tubemaking Caddisflies (2 genera, 2 species)
Neureclipsis sp.
Occurrence pattern: 22 March through 26 October.
Distribution: Common at Portage, Orion, and Woodman; rare at Ferry Bluff; absent from Pine Island and Sauk Prairie.
Habitat: Moderate depths, slow to very fast currents, on rock and wood over sand, in runs and along shorelines.
Identification: No species key for larvae. Only one species appeared to be present.

Distribution of Species Rare in Wisconsin

Twelve rare species were collected during the study, including 8 Ephemeroptera, 2 Odonata, and 2 Coleoptera. *Cercobrachys* (nr.) *serpentis* has not been found elsewhere in Wisconsin (reported only in the Snake River, Utah). *Brachycercus* (nr.) *nasutus* has been reported in 2 southeastern U.S. states only (Soldan 1986). Three species, the ephemeropterans *Acanthametropus pecatonica, Macdunnoa persimplex,* and *Paracloeodes minutus,* represented new collection records for Wisconsin. Because of the rarity of *Acanthametropus pecatonica* (Lillie et al. 1987), this species received endangered species status in Wisconsin in 1989. *Pentagenia vittigera, Pseudiron centralis, Lioporeus triangularis, Hydroporus hybridus, Neurocordulia yamaskanensis, Nasiaeschna pentacantha,* and *Stenonema mexicanum* are also extremely rare in Wisconsin collections.

Order and suborder names are shown below in boldface capital letters, family and subfamily names are in capital and lowercase boldface letters, species names are in italics, followed by descriptor names in capital and lowercase letters. A descriptor name in parentheses indicates a species that was originally described in another genus. Distributional records for all species are provided in Appendix B.

Information is presented on the occurrence pattern, distribution, habitat, and identification of each rare species found in the study area. These terms are used as follows:

Occurrence pattern: represents the period or periods during which species were found, based on collection records. Ranges of dates were established by combining the earliest and latest sampling dates from both 1985 and 1986. During some sampling periods, no specimens were found. Interpolation of occurrences between late fall and early spring sampling dates was based on observed larval sizes and knowledge of life cycles from other studies. Where known, emergence patterns and life cycles are indicated. Occurrences of all insect species discussed here are based on larval specimens; in the case of beetles, occurrences are based on adult specimens.

Distribution: indicates the relative abundance of each species at the sampling sites. *Relative abundance* represents our qualitative estimate based on the number of specimens collected at a site relative to the intensity of the sampling effort at that site. (Sampling effort was not standardized among sampling sites; therefore, the number of specimens collected and recorded in Appendix B does not necessarily reflect true relative abundance.) Categories of relative abundance are defined as follows: *abundant*—a large number of specimens found with minimal sampling effort; *common*—a moderate number of specimens found with minimal sampling effort, or a large number found with moderate sampling effort; *present*—a small number of specimens found with minimal sampling effort, or a moderate number found with moderate sampling effort; *uncommon*—a small number of specimens with moderate sampling effort or, on occasion, a large number with extensive sampling effort; *rare*—a small number of specimens found with extensive sampling effort, or a large number found in a specific microhabitat or short time period.

Habitat: described by current, depth, structure, and substrate where recorded.

Identification: taxonomic references used to key species. Also included are problems encountered and notes on physical characteristics that may assist with rapid identification of particular species. Many larvae were not keyed to species because no species key exists.

A glossary of selected terms used in this section appears at the end of this report.

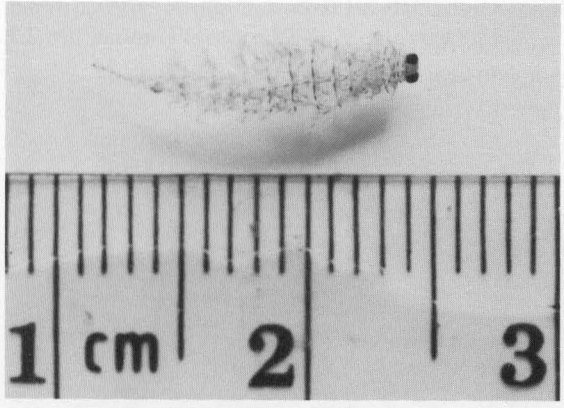
COLEOPTERA—Beetles

Dytiscidae—Predaceous Diving Beetles
Hydroporus hybridus Aube
Occurrence pattern: One adult 28 September 1986.
Distribution: Woodman; southern Wisconsin represents the northern edge of its range.
Habitat: Moderate depth, slow current, vegetation and debris, along shoreline.
Identification: Unpublished key (Hilsenhoff).

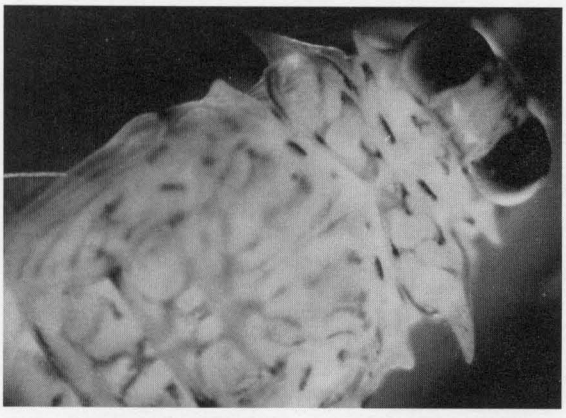
Lioporeus triangularis (Fall)
Occurrence pattern: One adult 15 June 1985.
Distribution: Ferry Bluff; southern Wisconsin represents the northwest edge of its range.
Habitat: Shallow depth, slow current, above sand, on sandbar along shoreline.
Identification: Unpublished key (Hilsenhoff). Described in 1917 by Fall from a series of 10 specimens collected at Sauk City.

EPHEMEROPTERA—Mayflies

Acanthametropodidae
Acanthametropus pecatonica (Burks)
Occurrence pattern: One nymph 6 June 1986, one nymph 13 June 1986; also 2 exuviae 6 June 1987, one nymph 9 June 1987; emergence probably completed by end of June.
Distribution: Only at Woodman; first record for Wisconsin (Lillie et al. 1987); first record for the Midwest since 1927.
Habitat: Moderate depths, moderate currents, sandbar runs.
Identification: Burks 1953. Easily recognized by large size and lateral projections on pronotum and mesonotum.



The common name for the rare mayfly Acanthametropus pecatonica *is the Pecatonica River Mayfly. The common name was derived from the fact that the second specimen ever seen was collected in Northern Illinois from the Pecatonica River and the first was collected from the Sugar River 1/4 mile north of the Pecatonica River. This species is on both the state and federal endangered species lists.*



A close-up of an Acanthametropus pecatonica *nymph shows the distinctive lateral projections on the head, pronotum, and mesonotum.*

(Continued on next page)

Continued

EPHEMEROPTERA—Mayflies

Baetidae—Small Minnow Mayflies

Paracloeodes minutus (Daggy)

Occurrence pattern: Nymphs 13 June through 20 June 1986 (Woodman), 28 August 1986 (Portage).

Distribution: Woodman and Portage; northern edge of its range; new state distribution record.

Habitat: Shallow depths, moderate currents, sandbar runs.

Identification: Hilsenhoff 1981. Only species in Wisconsin.

Caenidae—Small Squaregills

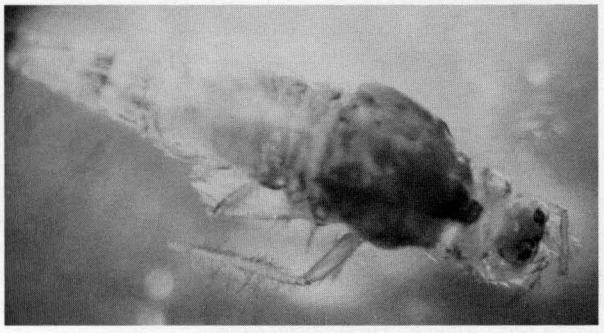
Cercobrachys* (nr.) *serpentis Soldan . Fifty-two specimens were collected as the result of extensive search efforts following the discovery of the first individuals of this unusual nymph; efforts to rear nymphs were not successful.

Occurrence pattern: 31 May through 1 September, mature nymphs 13 June through 1 September, emergence probably occurs throughout summer.

Distribution: Only at Woodman, where it was common; nymphs of this species have not previously been found in Wisconsin.

Habitat: Shallow to moderate depths, moderate currents, sandbar runs or adjacent shorelines.

Identification: Soldan (1986) described several new species of *Brachycercus* and erected a new genus *Cercobrachys*. *Cercobrachys* may be differentiated from typical *Brachycercus* genera by the fan-shaped arrangement of numerous long bristles along the anterior margin of the mesosternum. Our specimens key to *C. serpentis*, but do not fit Soldan's description of this species well. Our specimens may represent an undescribed species.



Cercobrachys *(nr.)* serpentis *nymphs differ slightly from those described as* C. serpentis, *which have been reported only from the Snake River, Utah; therefore, specimens from this study may represent a new species.*

Brachycercus* (nr.) *nasutus Soldan

Occurrence pattern: One nymph 31 August 1986.

Distribution: Orion.

Habitat: Shallow depth, slow current, sand mixed with wood, depositional area below sandbar drop-off.

Identification: Soldan 1986. Extremely long anterior tubercule.

Heptageniidae—Flatheaded Mayflies

Macdunnoa persimplex (McDunnough)

Occurrence pattern: 3 nymphs 31 May 1986.

Distribution: Only at Woodman; first collection in Wisconsin.

Habitat: Moderate depths, slow currents, sand mixed with detritus, depositional area below sandbar drop-off.

Identification: Flowers 1982. Identification confirmed by Flowers.

Stenonema mexicanum (Ulmer)

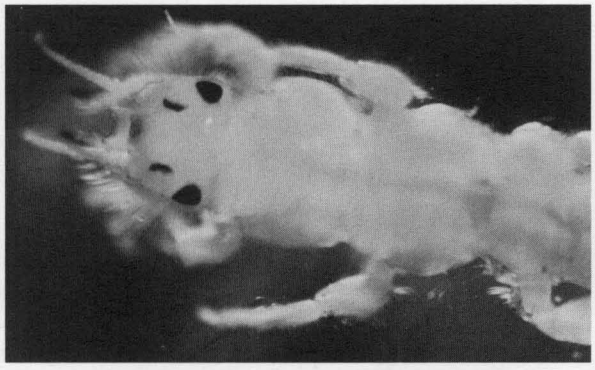
Occurrence pattern: 15 June through 23 September, more common June through early July.

Distribution: Uncommon at all sites.

Habitat: Shallow depths; slow to fast currents; on rock and wood, often over sand; along shorelines and sandbars, less frequently in runs and channels.

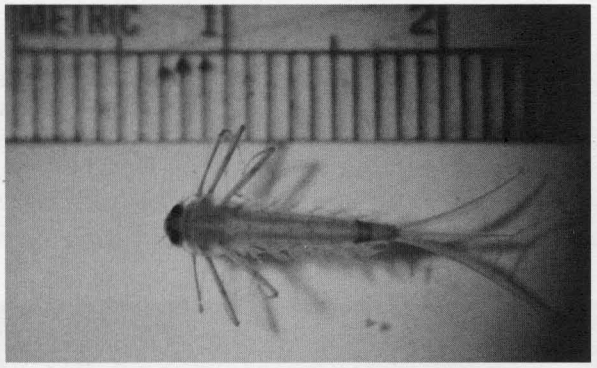
Identification: Bednarik and McCafferty 1979, Hilsenhoff 1982 (as *S. integruum*).

Palingeniidae—Spinyheaded Burrowers
Pentagenia vittigera (Walsh)
Occurrence pattern: One nymph 31 August 1985.
Distribution: Orion; second known collection from Wisconsin; probably exists throughout Lower Wisconsin River; more abundant in Illinois and farther south.
Habitat: In depositional area adjacent to a fast water rocky run at a depth of 1 m; associated with organic debris, silt, and sand; may have drifted from upstream area.
Identification: Burks 1953.



Pentagenia vittigera *nymphs are more common in the Lower Mississippi River. Only one was collected in the Lower Wisconsin River.*

Pseudironidae
Pseudiron centralis McDunnough
Occurrence pattern: A single exuviae 31 May 1986, another 13 June 1986; also 3 exuviae 29 May through 9 June 1987, one nymph 1 June 1987 (reared to subimago).
Distribution: Only at Woodman; several nymphs also collected by Donald Samuelson at Portage, 8 July 1979; one small nymph collected by authors, 31 May 1988, from the Pine River at Gotham.
Habitat: Moderate depths, moderate to slow currents, over sand, in sandy runs and below sandbar drop-offs. Found in similar habitat in the Rock River, Illinois (Pescador 1985).
Identification: Pescador 1985. Monotypic genus.



Nymphs of Pseudiron centralis *are predaceous and use their long legs and sharp claws to anchor in the sand against strong current.*

ODONATA—Damselflies and Dragonflies

Aeshnidae—Darners
Nasiaeschna pentacantha (Rambur)
Occurrence pattern: One nymph 2 August 1986, one nymph 28 September 1986.
Distribution: Only at Woodman; Wisconsin represents the northern edge of its range.
Habitat: Shallow depths, slow currents, attached to submerged shoreline vegetation.
Identification: Needham and Westfall 1955.

Corduliidae—Greeneyed Skimmers
Neurocordulia yamaskanensis (Provancher)
Occurrence pattern: One nymph 19 April 1986.
Distribution: Only at Orion.
Habitat: Moderate depth, strong current, rocky run.
Identification: Needham and Westfall 1955, Hilsenhoff 1982.

Habitat Associations

Structural Habitats

Insect distribution within the study area was highly dependent on the distribution and availability of various habitats. The community composition associated with particular habitats was fairly distinct, although the distribution of some families and/or species was ubiquitous. The following discussion of structural habitats, substrates, depths, and currents associated with distribution is based on the data provided in Tables 5 and 6 and Appendix C. Table 5 shows the relative distribution of the 25 most common insect families among selected habitats in the study area. Table 6 shows the relative dominance of these 25 families in the habitats. Appendix C shows the generalized habitat distribution of the common and rare insects.

Shorelines were the most productive structural habitat, accounting for 36% of all insects collected. A very diverse assemblage of insects, comprised of various Coleoptera, Diptera, Ephemeroptera, Trichoptera, and Heteroptera (Corixidae), was supported by shoreline habitat. Shorelines were important habitats for many commonly occurring species and several rare species, including *Cercobrachys* (nr.) *serpentis*.

Runs, segregated as to rock or sand bottoms, were second in order of importance, supporting 25% of all insects collected. Each type of run had a characteristic fauna. Rocky runs supported a relatively diverse community consisting of various Ephemeroptera (Heptageniidae dominant), Heteroptera (Corixidae), Trichoptera (Hydropsychidae), and Diptera (Chironomidae). Elmidae (*Macronychus glabratus* and *Stenelmis* spp.), Polycentropodidae (*Neureclipsis* sp.), and Corduliidae (*Neurocordulia molesta* and *N. yamaskanensis*) were mostly confined to this habitat. In addition, all specimens of the very rare mayfly *Anepeorus simplex* (Walsh) from other collections on the Lower Wisconsin River (Append. D) have been from rocky runs. Sandy runs were relatively unproductive, accounting for only 7% of all insects collected. Community composition associated with sandy runs was quite distinct from that of rocky runs, consisting of Ephemeroptera (Baetidae, Caenidae, Isonychiidae, Polymitarcyidae, and Tricorythidae), Diptera (Chironomidae and Tipulidae), and the ubiquitous Heteroptera (Corixidae). Sandy runs were the primary habitat of several rare mayflies, including *Paracloedes minutus*, *Pseudiron centralis*, *Acanthametropus pecatonica*, and *Cercobrachys* (nr.) *serpentis*.

Eddies were moderately productive (12%) and inhabited by a variety of Ephemeroptera, Odonata, Trichoptera, Diptera, and Heteroptera. *Siphloplecton interlineatum*, a metretopodid mayfly, and *Pycnopsyche* sp., a limnephilid caddisfly, were found most often in eddies.

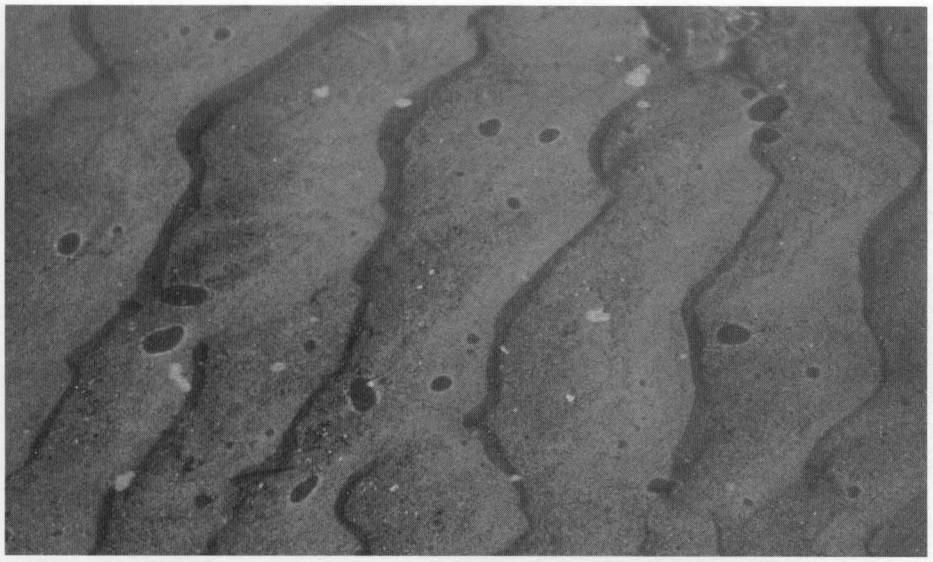
Backwaters areas were relatively productive (12%) and were dominated by Chironomidae, Coleoptera, and Corixidae. Pools and sloughs were important habitats of the beetles *Laccophilus maculosus* and *Laccobius reflexipenis*, the midges *Chironomus* spp., and the mayflies *Caenis* spp.

The main channel was moderately productive (9% of all insects collected) and was dominated by Hydropsychidae (*Cheumatopsyche* spp. and *Hydropsyche orris*), Corixidae (*Sigara lineata*), Chironomidae, and Heptageniidae. Diptera (Simuliidae), Plecoptera (Perlidae and Perlodidae), and Trichoptera (Leptoceridae) were also important. Among the mayflies, the uncommon Heptageniidae *Stenonema exiguum* and *S. mexicanum* exhibited preference for the main channel.

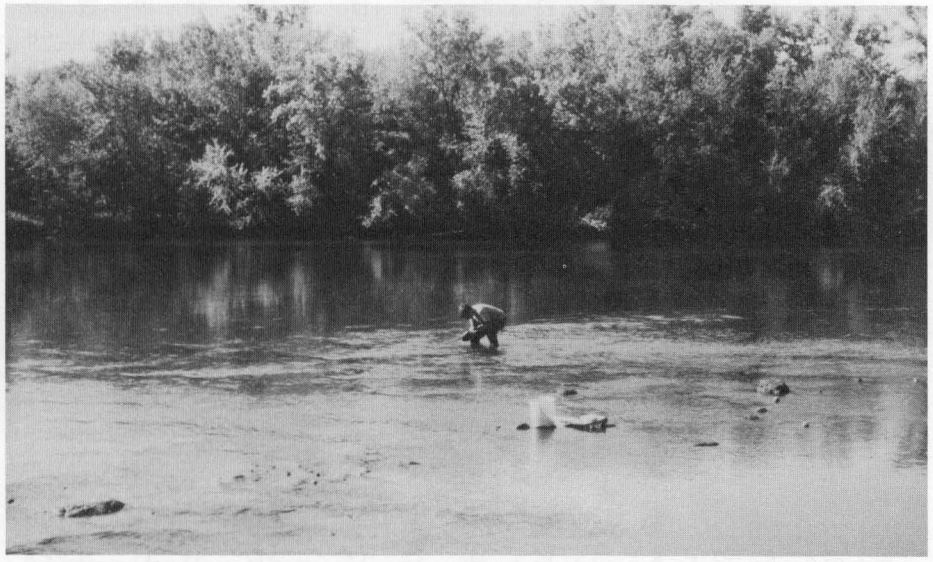
Riffles were very scarce and sparsely populated (3%). Chironomidae and Corixidae were characteristic of riffles, but only Tipulidae (*Hexatoma* sp.) utilized riffles exclusive of other habitats. The dominant chironomid in riffles, *Cricotopus* spp., was associated with filamentous algae.

Sandbar drop-offs were the least productive (1%) areas sampled. The ubiquitous Corixidae were accompanied by Caenidae, Leptoceridae, and Chironomidae. The rare mayfly *Macdunnoa persimplex* was found in this habitat.

Shoreline habitat consists of a mixture of substrates that varies with water stage. Many aquatic insects migrate to shore to emerge as adults. Others find shelter in the slower current behind roots, snags, and vegetation adjacent to shore. Photo undated.



The bottoms of sandy runs appear similar to the deserts of the Sahara, only less dry. The shifting sand habitat was relatively unproductive, but it did harbor many rare species, including Acanthametropus pecatonica *and* Pseudiron centralis. *Photographed at Spring Green, May 1990.*



Sampling rocky runs was generally productive, but when the water level was higher such sites were difficult and dangerous to sample. The Port Andrew site is pictured here. Photographed June 1988.

Backwater areas connected to the main channel of the Lower Wisconsin River provide important habitat. The Mazomanie Wildlife Area is shown here. Photographed July 1988.

Table 5. *Relative distribution of the 25 most common insect families among selected habitats of the study area. Percentage distributions are compared by family (across rows, not up or down columns).**

Order/Family	No. Specimens Collected	Percent (%) of Total Specimens by Family																	
		By Structure**								By Substrate[a]									
		CH	SR	RR	SL	DO	RF	BW	ED	RK	MR	WD	ST	CL	SD	MD	VG	DT	GR
COLEOPTERA																			
Dytiscidae	140	tr[b]	0	0	40	0	tr	49	0	tr	4	16	16	0	38	62	22	13	t
Elmidae	234	3	0	24	55	tr	tr	2	2	25	29	53	5	2	11	20	2	1	3
Gyrinidae	173	tr	0	1	67	0	0	18	7	5	10	61	11	tr	7	69	11	3	tr
Haliplidae	91	0	0	0	55	0	0	16	9	0	2	5	31	2	9	59	48	27	0
Hydrophilidae	112	3	0	3	32	1	0	56	3	3	6	13	23	1	41	68	15	11	1
DIPTERA																			
Chironomidae	828	12	2	9	30	1	10	18	6	18	27	24	12	2	16	46	8	7	15
Simuliidae	112	31	0	25	54	3	0	0	0	28	45	37	10	7	0	43	4	12	17
Tipulidae	57	0	12	4	2	0	30	2	0	2	4	0	4	2	53	93	2	2	37
EPHEMEROPTERA																			
Baetidae	357	3	11	13	34	tr	1	8	5	13	16	26	14	0	22	59	20	6	8
Baetiscidae	223	5	tr	9	42	0	3	4	9	13	30	29	11	4	19	48	19	19	6
Caenidae	325	tr	11	9	23	5	2	3	8	4	13	15	14	tr	49	78	2	11	6
Heptageniidae	528	11	tr	39	26	tr	3	1	4	40	66	28	9	tr	1	22	5	5	16
Isonychiidae	54	9	13	30	20	2	0	0	0	30	39	35	2	0	15	35	2	0	9
Metretopodidae	45	0	0	13	60	0	0	0	20	4	13	0	49	7	2	73	78	22	0
HETEROPTERA																			
Corixidae	1,392	9	2	18	34	2	4	12	10	15	30	6	27	3	19	50	16	15	18
Gerridae	52	0	0	2	44	0	0	33	12	2	6	0	56	0	23	63	13	27	0
ODONATA																			
Coenagrionidae	157	4	0	8	57	tr	2	7	12	11	19	29	22	0	11	47	27	14	4
Corduliidae	54	2	0	44	11	0	0	24	6	30	46	26	22	2	2	33	4	2	13
Gomphidae	114	5	5	17	25	2	3	11	7	11	31	12	25	3	23	67	13	20	10
PLECOPTERA																			
Perlidae	56	42	4	20	33	4	0	0	0	40	40	49	0	0	4	35	0	2	0
Perlodidae	120	30	0	4	77	0	0	0	2	33	39	24	17	10	6	33	23	13	2
TRICHOPTERA																			
Hydropsychidae	635	18	tr	33	27	tr	2	2	5	34	57	31	8	1	1	22	7	8	18
Leptoceridae	226	19	3	9	41	8	2	8	5	13	24	33	12	0	12	53	13	11	8
Limnephilidae	65	6	0	7	51	0	0	4	14	10	24	23	14	4	19	40	14	19	6
Polycentropodidae	48	0	2	46	23	0	0	0	2	27	52	23	2	2	2	35	0	8	4
All Insects		9	7	18	36	1	3	12	12	18	31	22	16	2	16	46	12	11	12

* Sums of row percentages across may not equal 100% because many classifications represent a mixture of 2 or more habitat types.

** CH = Channel
SR = Sandy Run
RR = Rocky Run
SL = Shoreline
DO = Drop-Off
RF = Riffle
BW = Backwater Area
ED = Eddy

[a] RK = Rock
MR = Mixed Rock
WD = Wood
ST = Silt
CL = Clay
SD = Sand
MD = Mixed Sand
VG = Vegetation
DT = Detritus
GR = Gravel

[b] tr = <0.5%.

Table 6. *Relative dominance of the 25 most common insect families (% of total insects by column) in selected habitats of the study area. Percentage distributions are compared by habitat type (up and down columns, not across rows).**

Order/Family	No. Specimens Collected	Percent (%) of Total Specimens by Family																	
		By Structure**								By Substrate[a]									
		CH	SR[b]	RR	SL	DO	RF	BW	ED	RK	MR	WD	ST	CL	SD	MD	VG	DT	GR
COLEOPTERA																			
Dytiscidae	140	tr[c]	0	0	2	0	tr	9	0	tr	tr	2	2	0	5	3	4	3	tr
Elmidae	234	1	0	4	4	1	tr	tr	1	4	3	7	1	3	2	1	tr	tr	1
Gyrinidae	173	tr	0	tr	5	0	0	4	3	1	1	7	2	1	1	4	2	1	tr
Haliplidae	91	0	0	0	2	0	0	2	2	0	tr	tr	3	1	1	2	5	3	0
Hydrophilidae	112	tr	0	tr	2	1	0	9	1	tr	tr	1	3	1	5	3	2	2	tr
DIPTERA																			
Chironomidae	828	17	7	10	11	12	36	20	13	13	11	14	9	19	13	13	8	16	17
Simuliidae	112	6	0	2	3	3	0	0	0	3	3	3	1	6	0	2	1	2	3
Tipulidae	57	0	5	tr	tr	0	8	tr	0	tr	tr	0	tr	1	3	2	tr	tr	3
EPHEMEROPTERA																			
Baetidae	357	2	16	4	5	1	1	4	4	4	3	7	5	0	8	7	9	3	4
Baetiscidae	223	2	1	2	4	0	3	1	5	3	3	4	2	6	4	4	5	6	2
Caenidae	325	tr	15	2	3	16	4	1	7	1	2	3	4	1	16	9	1	5	3
Heptageniidae	528	10	2	18	6	4	8	1	5	18	17	10	4	3	1	4	3	4	11
Isonychiidae	54	1	3	1	tr	1	0	0	0	1	1	1	tr	0	1	1	tr	0	1
Metretopodidae	45	0	0	tr	1	0	0	0	2	tr	tr	0	2	2	tr	1	4	1	0
HETEROPTERA																			
Corixidae	1,392	18	11	22	20	33	26	22	33	18	21	6	35	33	26	23	27	29	33
Gerridae	52	0	0	tr	1	0	0	2	1	tr	tr	0	3	0	1	1	1	2	0
ODONATA																			
Coenagrionidae	157	1	0	1	4	1	1	1	5	2	2	3	3	0	2	3	5	3	1
Corduliidae	54	tr	0	2	tr	0	0	2	1	1	1	1	1	1	tr	1	tr	tr	1
Gomphidae	114	1	3	2	1	2	1	2	2	1	2	1	3	2	2	2	2	3	1
PLECOPTERA																			
Perlidae	56	4	1	1	1	2	0	0	0	2	1	2	0	0	tr	1	0	tr	0
Perlodidae	120	6	0	tr	4	0	0	0	tr	3	2	2	2	9	1	1	3	2	tr
TRICHOPTERA																			
Hydropsychidae	635	19	1	18	7	1	6	2	8	18	18	14	5	4	1	5	5	7	15
Leptoceridae	226	7	3	2	4	18	2	3	3	2	3	5	3	0	3	4	4	3	3
Limnephilidae	65	tr	0	tr	2	0	0	tr	2	tr	1	1	1	2	1	1	1	2	1
Polycentropodidae	48	0	tr	2	tr	0	0	0	tr	1	1	1	tr	1	tr	1	0	1	tr
Totals*		95	68	93	92	96	96	85	98	96	96	95	94	96	97	99	92	98	100

* Sums of column percentages may not equal 100% due to the exclusion of organisms not included in the 25 most common insect families.

** CH = Channel
SR = Sandy Run
RR = Rocky Run
SL = Shoreline
DO = Drop-Off
RF = Riffle
BW = Backwater Area
ED = Eddy

[a] RK = Rock
MR = Mixed Rock
WD = Wood
ST = Silt
CL = Clay
SD = Sand
MD = Mixed Sand
VG = Vegetation
DT = Detritus
GR = Gravel

[b] Also contained many Polymitarcyidae, Tricorythidae, and others.

[c] tr = <0.5%.

Substrates

Substrate composition also affected insect distribution and community composition. Although sand was the dominant substrate (estimated 90-95% of total area searched), only 16% of all insects collected were confined to exclusively sand substrate. Another 30% of the insects collected were from sites with at least some sand present. Characteristic fauna of sand habitats included Heteroptera (Corixidae), Ephemeroptera (Caenidae and Baetidae), and Coleoptera (Dytiscidae and Hydrophilidae). The corixid *Sigara lineata* and mayfly *Caenis* spp. were mostly restricted to sand substrates, as were the rare mayflies *Paracloedes minutus, Pseudiron centralis, Cercobrachys* (nr.) *serpentis,* and *Acanthametropus pecatonica,* as well as the beetle *Lioporeus triangularis.*

Wood, primarily in the form of partially decayed logs, accounted for 22% of all insects collected. Many inhabitants of wood substrates were miners or burrowers, but others were clingers, attached to the external surface of wood above sand or rock bottoms in runs. Trichoptera (Hydropsychidae), Ephemeroptera (primarily Heptageniidae and Baetidae), Diptera (Chironomidae), and Coleoptera (Elmidae and larval Gyrinidae) were characteristic of wood habitats. Several commonly occurring species, including *Macronychus glabratus,* demonstrated an affinity for wood. Among the rare species, only *Stenonema mexicanum* was associated with wood.

Rock substrates (loose rocks and bedrock) were also quite productive, accounting for 18% of all organisms captured (another 13% were collected from mixed substrates where rock was present). Heptageniidae, Corixidae, Chironomidae, and Hydropsychidae were dominant on rock substrates. Several species, including representatives of Plecoptera (Perlidae and Perlodidae), Odonata (Corduliidae), Ephemeroptera (Heptageniidae and Isonychiidae), and Coleoptera (Elmidae), utilized rock as a primary habitat. Many commonly occurring species and 2 rare species (*Neurocordulia yamaskanensis* and *Stenonema mexicanum*) were strongly associated with rock substrate.

Gravel beds were relatively scarce, but fairly well populated (12% of all insects). Corixidae and Hydropsychidae accounted for almost one half of the insects associated with gravel; Chironomidae and Heptageniidae were also common.

The remaining substrates (silt, clay, detritus, and vegetation) were found in depositional areas and supported fairly similar fauna; a mixture of Ephemeroptera, Coleoptera, Odonata, and Trichoptera were characteristic. Rare species found associated with these substrates included *Hydroporus hybridus,* and *Pentagenia vittigera.* The 2 *Nasiaeschna pentacantha* nymphs were found attached to shoreline vegetation.

Depth and Current

Most insects were collected from water less than 1 m deep (ranging from a minimum of 83% of the Heteroptera to 94% of Coleoptera). Lotic Heteroptera (primarily *Sigara lineata*), various Ephemeroptera, and Trichoptera (primarily Hydropsychidae) were characteristic fauna of deeper water. Trichoptera, Ephemeroptera, and Heteroptera (Corixidae) were characteristic of moderate to fast current, while Heteroptera (Corixidae) and Diptera (Chironomidae) were most characteristic of slow current. Coleoptera (other than Elmidae) and Heteroptera were characteristic of stagnant water.

DISCUSSION

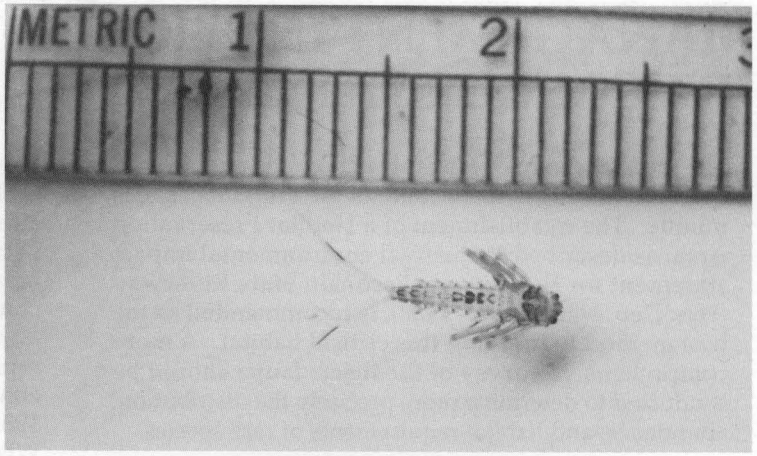
The Lower Wisconsin River contains a diverse assemblage of insects. The 232 species or genera collected in this limited survey far exceed numbers reported in all previous investigations of the Wisconsin River (Hilsenhoff et al. 1966, Hilsenhoff 1977, Magnuson et al. 1977, Grothe and Steiner 1978, Marshall et al. 1985). This number (232) also exceeds the number of species reported for other large rivers in the upper Midwest and Canada (Hubert et al. 1983, Mason and Lehmkuhl 1983, Elstad 1986). Insect community structure and species dominance were similar in the Wisconsin studies, except for the greater importance of Heteroptera in this study.

While this study compiled a long list of relatively rare species and new distribution records for Wisconsin, the list is not complete, as indicated by the absence of some species previously and subsequently recorded from the Lower Wisconsin River (Append. D). The rare mayfly *Anepeorus simplex,* which was previously collected at the Orion site (Flowers and Hilsenhoff 1975, 1978; name changed from *Spinadis* sp. in McCafferty and Provonsha 1988), was not collected during the study period; however, one specimen was captured from a rocky run at Port Andrew in May 1988. *Anepeorus simplex* was added to the DNR's endangered species list in August 1989. Kurt Schmude, UW-Madison Department of Entomology, who is revising *Stenelmis,* collected adults of 2 rare elmid beetles in the Lower Wisconsin River. Specimens of *Stenelmis douglasensis* Sanderson were found on wood near the mouth of a small tributary east of Spring Green in Sauk County and at the mouth of the Big Green River in Grant County (near the Woodman site). Several specimens of *Stenelmis knobeli* Sanderson were collected at Port Andrew, and one specimen was collected at Orion. *Stenelmis knobeli* was listed as an endangered species by the DNR in August 1989. Some of the other distributional records listed in Appendix D are from light-trap collections, which very likely include species attracted from habitats other than the Lower Wisconsin River. Also, some occurrences may represent incidental drift from adjacent tributaries.

Insect distribution in the Lower Wisconsin River is primarily influenced by structure and substrate. Numerous studies have documented the impact of water velocity, water depth, substrate size, and substrate heterogeneity on insect distribution (Williams and Hynes 1973; Williams 1978, 1980; Sheldon and Haick 1981; Culp et al. 1983; Vodopich and Cowell 1984; Petts and Greenwood 1985; Rae 1985; Peckarsky 1986; and many others). Only a few insects have adapted to the harsh, shifting-sand environment of large rivers (Giberson and Galloway 1985, Rae 1985, Soluk 1985, Soluk and Clifford 1985, Sheaffer and Nickum 1986). Snags are very important in lotic systems dominated by sandy substrates (Nilsen and Larimore 1973; Benke et al. 1984, 1985, 1986; Herlong and Mallin 1985). Neuswanger et al. (1982) demonstrated the importance of rock and wood to benthos of Mississippi River backwaters. Within the Lower Wisconsin River, shorelines, rocky runs, and snags provide temporary refuge from the harsh environment created by constantly moving sand. In this study, the relative proportion and access to these habitats at each sampling site influenced the composition and diversity of insects collected.

Many studies have shown the detrimental effects of dams on insect diversity and abundance (Fisher and LaVoy 1972; Lehmkuhl 1972; Mason and Lehmkuhl 1983, 1985; Matter et al. 1983; Gurtz and Wallace 1984; Irvine and Henriques 1984; Soballe and Bachmann 1984; Gislason 1985; Novotny 1985; and Walburg et al. 1981). These effects include changes in water temperature, quality, and level of insect distribution and productivity. The Prairie du Sac dam has caused elevated summer and winter water temperatures and dramatic stage fluctuations at sites immediately downstream from the dam (Append. A). These factors were most likely responsible for the lower diversity and abundance of insect species at the Sauk Prairie site, compared with other study sites.

The Woodman site harbored a higher number of unusual and/or rare insect species, as well as other rare and/or endangered aquatic resources, compared with the other study sites (Wis. Dep. Nat. Resour. 1988). This sand-dominated site was very similar physically to the other study sites and chemically to adjacent downstream sites. However, the construction in the late 1800s of a railroad bridge 1 km upriver from the collection site may have permanently diverted the main river channel, reducing erosion in the downstream side channel. This factor may have helped to stabilize banks and may account for the higher occurrences of rare and/or endangered aquatic species at this site.



Anepeorus simplex, *formerly known as* Spinadis *sp., is another rare mayfly present in the Lower Wisconsin River. Nymphs of this species are believed to inhabit deep, swift water, where they cling to rough substrate such as rocks or wood.*

The hydroelectric dam at Prairie du Sac impacts insect diversity and abundance as far downstream as the railroad bridge below Sauk City. Photographed June 1990.

The Woodman site was an exceptionally rich location with many rare species present. The Big Green River enters the Wisconsin River at the bottom of the picture. The large island and side channel adjacent to State Highway 133 (right-center of picture) appear to have been undisturbed for many years. Photographed August 1986 by D. Fago.

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

1. The preponderance of rare, threatened, and endangered species of insects in the vicinity of the Woodman site is unique. The establishment of a Habitat Preservation Area, as described in the final environmental impact statement for the Lower Wisconsin State Riverway (Wis. Dep. Nat. Resour. 1988), is recommended as the best method to preserve this critical habitat. A more comprehensive survey of the insect fauna should be conducted to determine more precisely the distribution, abundance, and habitat requirements of rare species.

2. Rocky runs are extremely productive habitats, and their locations should be identified and mapped for future information. In lieu of sampling riffles, monitoring the fauna of rocky runs can provide an acceptable alternative for assessing the water quality of large rivers.

3. Increased recreational usage may create demands for channel modifications and/or snag removal to improve navigation on the Lower Wisconsin River. Snag removal should be discouraged because snags provide critical habitat for both insects and fish (Marzolf 1978, Benke et al. 1985). Rock wing-dams have been used to improve stream navigation on the Wisconsin River for over 100 years. Although these structures are very productive habitats for both insects and fish (R. Lillie, pers. obs.), construction costs of wing-dams are high, and any improvement in navigation may be short-lived due to rapid burial by shifting sands (Williams 1922). Other enhancement technologies are available (Schnick et al. 1982), but none can be recommended for the Lower Wisconsin River at this time. Rather, the wisest management strategy would be to preserve the river in its natural state.

4. The Wisconsin Dells and Prairie du Sac dams influence the thermal and hydrologic regimes of the river and decrease the diversity and abundance of insect fauna below them. These dams are regulated by state and federal licensing agreements that would require modification to mitigate these negative impacts.

SUMMARY

1. This report documents the results of a qualitative survey of aquatic insects in the main channel of the Lower Wisconsin River. The survey was conducted at 6 primary and 7 secondary sites in 1985 and 1986. The sampling season spanned the ice-free period from March through December. A combination of sampling methods, including hand-picking of natural substrates, was employed. Associated physical and limnological data were also obtained.

2. The study area contained a diverse assemblage of aquatic insects dominated by several species of Coleoptera, Diptera, Ephemeroptera, Heteroptera, Plecoptera, and Trichoptera. Excluding Chironomidae, which were under-sampled, *Sigara lineata* (Corixidae), *Stenonema terminatum* (Heptageniidae), and *Nectopsyche candida* (Leptoceridae) were the most frequently collected insects. Species of *Cheumatopsyche, Baetisca, Baetis, Caenis, Trichocorixa, Hydropsyche,* and *Brachycercus* were also very common.

3. Several rare species were collected, including the only known collection of *Acanthametropus pecatonica* in the Midwest since 1927 and *Macdunnoa persimplex* and *Paracloeodes minutus,* which were new records for Wisconsin. Other species found that are apparently rare in Wisconsin include *Cercobrachys* (nr.) *serpentis, Brachycercus* (nr.) *nasutus, Hydroporus hybridus, Lioporeus triangularis, Nasiaeschna pentacantha, Neurocordulia yamaskanensis, Pentagenia vittigera, Pseudiron centralis,* and *Stenonema mexicanum.* Two additional Elmidae, *Stenelmis knobeli* and *S. douglasensis,* and the extremely rare mayfly *Anepeorus simplex* (formerly known as *Spinadis* sp.) were collected recently from the Lower Wisconsin River but were not found in this study.

4. Shorelines and rocky runs were the most productive structural habitats, containing large numbers of several species. Sandbar drop-offs, riffles, and sand runs were less productive, but contained a few unusual or rare species. Rocks and mixed rocks, wood, silt, and sand were the most productive substrates. Vegetation, gravel, detritus, and clay were the least productive. Most insects were found in relatively shallow water and out of the main current. Deep-water inhabitants included various species of mayflies and caddisflies.

5. Management implications and recommendations include protecting the Woodman site, sampling the fauna of rocky runs to assess water quality, and discouraging the removal of snags from the Lower Wisconsin River.

GLOSSARY

Bivoltine: describes insects with life cycles represented by 2 generations of adults per year.

Burrowers: insects that live in bottom sediments.

Clingers: insects that cling to substrates.

Exuviae: the cast-off skin or exoskeleton of a larva or pupa after molting.

Larva: the newly hatched, earliest stage of insects, differing in form and appearance from a pupa or an adult.

Lentic: standing water, such as lakes or ponds.

Lotic: moving water, such as rivers and streams.

Mesonotum: the top side of the second thoracic segment.

Mesosternum: the underside of the second thoracic segment.

Miners: insects that tunnel into plant tissue.

Molting: the process in which an insect sheds its exoskeleton, enabling it to enlarge or to become a pupa or an adult.

Monotypic: describes a species that alone represents a genus.

Nymph: the immature life stage of some insects (*Heteroptera, Ephemeroptera, Plecoptera, and Odonata*).

Pronotum: the top side of the first thoracic segment.

Thoracic segment: one of 3 middle body segments of insects.

Tubercule: a small bump or pimple-like structure.

Subimago: a winged stage in the development of mayflies that occurs before the final adult stage.

Univoltine: describes insects with life cycles represented by one generation of adults per year.

Appendix A. *Monthly limnological data for primary study sites on the Lower Wisconsin River in 1986.*

Date	Stage*	Temp. (C)	Clarity (cm)	Color units	Turb. (FTUs)	Chl*a* (µg/L)	D.O. (mg/L)	Cond. (µmhos/cm)	pH units	Alk. (mg/L)
Pine Island (Columbia County)										
20 Apr	H	10.0	91	–	–	36	10.8	125	7.4	32
29 May	M	19.7	91	–	–	22	–	–	–	47
29 Jun	H	23.3	49	–	–	54	9.8	–	–	45
31 Jul	V	25.0	64	40	8.1	45	7.9	190	7.4	56
28 Aug	B	18.9	67	40	6.8	28	8.5	194	7.7	63
30 Sep	F	inaccessible, not sampled.								
25 Oct	B	10.6	70	100	5.1	13	10.3	147	7.0	37
Portage (Columbia County)										
20 Apr	H	10.0	91	–	–	29	11.1	120	7.4	32
29 May	M	19.7	91	–	–	6	–	–	–	49
29 Jun	H	24.2	46	–	–	51	10.7	–	–	42
31 Jul	V	25.0	61	40	9.6	52	8.7	196	8.0	54
28 Aug	B	17.5	70	40	6.8	34	8.3	206	7.6	63
30 Sep	F	17.5	107	70	2.7	14	6.6	170	6.9	48
25 Oct	B	10.6	70	100	4.4	20	10.0	150	7.0	39
Sauk Prairie (Sauk County)										
22 Mar	H	3.1	–	–	–	–	9.7	205	7.2	73
30 May	M	17.8	100	–	–	46	8.5	–	–	64
02 Jul	H	21.9	70	–	–	38	6.1	–	–	68
02 Aug	H	25.0	61	40	14.0	73	8.0	215	8.0	73
28 Aug	B	21.7	70	40	5.9	38	8.5	229	8.0	86
28 Sep	F	18.9	67	60	8.7	31	7.5	200	7.2	59
25 Oct	B	11.1	73	100	4.9	21	9.0	180	7.0	56
Ferry Bluff (Sauk County)										
19 Apr	H	11.1	70	–	–	42	11.9	155	7.6	56
30 May	M	18.9	82	–	–	27	9.3	–	–	123
02 Jul	H	21.9	76	–	–	35	6.8	–	–	68
02 Aug	H	24.7	61	30	11.0	64	8.7	284	8.4	104
27 Aug	B	21.4	61	40	5.9	65	9.5	224	8.0	82
28 Sep	F	18.6	64	60	6.7	39	8.3	203	7.2	55
25 Oct	B	11.1	61	100	5.6	18	9.0	183	7.2	61
Orion (Richland County)										
22 Mar	H	3.1	52	–	–	–	11.2	225	7.2	97
19 Apr	H	11.1	76	–	–	47	11.2	205	8.0	89
31 May	M	20.6	70	–	–	45	8.7	–	–	115
03 Jul	H	22.8	67	–	–	42	9.2	–	–	89
02 Aug	V	23.9	55	30	22.0	97	10.1	245	8.6	87
01 Sep	B	20.0	64	40	8.7	59	9.6	276	8.0	108
28 Sep	F	18.9	73	50	4.1	28	6.3	209	7.2	74
26 Oct	B	10.6	67	80	6.2	22	9.5	204	7.2	79
Woodman (Grant County)										
19 Apr	H	–	76	–	–	45	9.2	205	8.0	82
31 May	M	20.6	61	–	–	83	11.1	–	–	110
03 Jul	H	21.7	61	–	–	50	8.3	–	–	85
02 Aug	V	23.1	49	30	16.0	118	8.6	245	8.6	87
01 Sep	B	19.4	58	40	8.7	99	8.6	265	8.0	110
28 Sep	F	19.7	107	50	2.3	13	3.1	245	7.0	84
26 Oct	B	10.6	58	90	6.5	22	8.7	201	7.2	71

* Stage heights reported as: F = Flood, B = Bank-full, V = Very high, H = High, M = Moderate, and L = Low.

Appendix B. *Distribution of aquatic insects collected at primary and secondary sites in the study area. The symbol ✧ indicates the presence of the species at that site; the symbol ✦ indicates 10 or more individuals at that site. An asterisk indicates primarily lentic species. Sites are listed in order from upriver to downriver.*

Order Family Genus Species	No. Individuals	Study Sites** dam A	1	2	dam 3	4	B	C	5	D	E	F	6	G
COLEOPTERA - beetles														
Chrysomelidae - leaf beetles														
Donacia (larva)	1	.	.	.	.	.	.	.	✧	.	.	.	.	.
Curculionidae[a] - weevils														
Listronotus delumbis (Gyll.)	1	.	.	.	.	.	.	.	.	.	.	.	✧	.
Onychylis nigrirostris (Boheman)	1	.	.	.	.	.	.	.	✧	.	.	.	.	.
Tanysphyrus lemnae Fabricius	1	.	.	.	.	.	.	.	.	.	.	.	✧	.
Stenopelmus rufinasus Gyll.	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
Dytiscidae - predaceous diving beetles														
Coptotomus loticus Hilsenhoff	10	.	.	✧	.	.	.	.	✧	.	.	.	✧	.
*Coptotomus longulus** LeConte	2	.	.	✧	.	✧	.	.	.	.	.	.	.	.
Hydroporus clypealis Sharp	33	.	.	✧	.	.	.	.	.	✦	.	.	✦	.
*Hydroporus undulatus** Say	7	.	.	.	.	.	.	.	.	.	.	.	✧	.
Hydroporus hybridus Aube	1	.	.	.	.	.	.	.	.	.	.	.	✧	.
*Hydroporus niger** Say	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
*Hydrovatus pustulatus** (Melsheimer)	3	.	.	.	.	.	.	.	.	.	.	.	✧	.
*Hygrotus sayi** Balfour-Browne	4	.	.	.	✧	✧	.	.	.	✧	.	.	.	.
Laccophilus(larvae)	47	.	.	✦	.	✦	✦	.	✧	.	.	.	.	.
*Laccophilus maculosus** Say	25	.	.	✧	✧	✧	✧	.	✧	.	.	.	✧	.
*Liodessus affinis** (Say)	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Lioporeus triangularis (Fall)	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Matus (larva)	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
*Matus bicarinatus** (Say)	1	.	.	.	.	.	.	.	.	.	.	.	✧	.
*Rhantus consimilis** Motschulsky	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Hydroporini (tribe)														
unidentified larvae	2	.	.	.	.	✧	.	.	.	✧	.	.	.	.
Elmidae[b] - riffle beetles														
Ancyronyx variegata (Germar)	3	.	✧	.	.	.	.	.	✧	.	.	.	.	.
Dubiraphia (larvae)	25	.	.	.	.	✦	✧	.	✧	.	.	.	✧	.
Dubiraphia bivittata (LeConte)	1	.	.	.	.	.	.	.	.	.	.	.	✧	.
Dubiraphia vittata (Melsheimer)	2	.	.	.	.	.	.	.	.	.	.	.	✧	.
Macronychus glabratus Say	97	✧	✧	✧	.	✧	✧	✧	✦	✦	.	.	✧	.
Optioservus fastiditus (LeConte)	3	.	.	.	.	.	.	.	.	.	✧	.	.	.
Stenelmis (larvae)	44	.	✧	✦	.	✧	✧	.	✧	.	✧	.	.	.
Stenelmis crenata (Say)	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
Stenelmis decorata Sanderson	50	.	✧	✧	.	.	.	.	✦	.	.	.	.	.
Stenelmis fuscata (Blatchley)	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
Stenelmis grossa Sanderson	7	.	.	.	✧	✧	.	.	.	.	.	.	.	.
Gyrinidae - whirligig beetles														
Dineutus (larvae)	41	.	✧	✧	.	✧	✦	.	✧	✧	✧	✧	.	.
Dineutus assimilis Kirby	35	.	✧	✧	✧	✧	✧	✧	.	.	.	.	✧	.
Dineutus discolor Aube	3	.	.	.	.	.	.	.	.	.	.	.	✧	.
*Dineutus nigrior** Roberts	1	.	.	.	✧	.	.	.	.	.	.	.	.	.
Gyrinus (larvae)	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
Gyrinus analis Say	90[c]	.	.	✧	✧	✧	.	.	✧	.	.	.	✦	.
*Gyrinus maculiventris** LeConte	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
*Gyrinus minutus** (Fabricius)	1	.	.	✧	.	.	.	.	.	.	.	.	.	.

(Continued on next page)

Appendix B. *Continued.*

Order Family Genus Species	No. Individuals	Study Sites** dam A	1	2	dam 3	4	B	C	5	D	E	F	6	G
COLEOPTERA - beetles *(continued)*														
Haliplidae - crawling water beetles														
*Haliplus borealis** LeConte	6	.	.	.	.	✧	✧	.	✧	.	.	.	.	.
*Haliplus immaculicollis** Harris	1	.	.	.	.	.	.	.	✧	.	.	.	.	.
*Peltodytes edentulus** (LeConte)	81	.	✧	✧	✧	✦	✧	✧	✦	.	.	✧	✦	.
*Peltodytes tortulosus** Roberts	3	.	.	.	.	.	.	.	.	.	.	✧	.	.
Hydrophilidae - water scavenger beetles														
unidentified immatures	2	.	.	.	.	.	.	.	✧	.	.	.	.	.
*Anacaena limbata** (Fabricius)	2	.	✧	.	.	✧	.	.	.	.	.	.	.	.
Berosus peregrinus (Herbst)	19	.	.	✧	✧	✧	.	✧	✧	.	.	.	.	.
*Berosus striatus** (Say)	1	.	.	.	.	.	.	.	.	.	.	.	✧	.
*Enochrus cinctus** (Say)	6	.	.	.	.	.	.	.	✧	.	.	.	.	.
*Enochrus hamiltoni** (Horn)	3	✧	.	.	.	✧	.	.	.	.	.	.	.	.
*Enochrus ochraceus** (Melsheimer)	3	✧	.	.	.	.	.	.	.	.	.	.	.	.
*Enochrus pygmaeus** (Fabricius)	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
*Helophorus lineatus** Say	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
*Helophorus marginicollis** Smetana	5	.	.	✧	.	.	.	✧	.	.	.	.	.	.
Laccobius (larva)	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
Laccobius reflexipenis Malcolm	40	.	✧	✦	.	✦	✧	.	✧	.	.	.	.	.
Sperchopsis tesselatus (Ziegler)	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Tropisternus (larvae)	5	.	.	✧	.	✧	✧	.	.	.	.	.	✧	.
*Tropisternus lateralis** (Fabricius)	5	.	.	.	.	✧	✧	.	.	.	.	.	.	.
*Tropisternus mixtus** (LeConte)	4	.	.	✧	.	.	.	.	.	.	.	.	✧	.
*Tropisternus natator** d'Orchymont	13	.	.	✧	✧	.	.	✧	✧	.	.	✧	.	.
Scirtidae - marsh beetles														
*Prionocyphon** (larvae)	6	.	.	✧	.	.	.	.	.	✧	.	✧	✧	.
*Scirtes** (larvae)	5	.	.	.	.	.	.	.	✧	✧	.	.	✧	.
DIPTERA - True Flies														
Athericidae - watersnipe flies														
Atherix variegata Walker	10	.	.	✧	.	.	.	.	✧	.	✧	.	.	.
Ceratopogonidae - biting midges														
Bezzia or *Palpomyia* sp.	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Culicoides sp.	2	.	✧	✧	.	.	.	.	.	.	.	.	.	.
Chaoboridae - phantom midges														
*Chaoborus punctipennis** (Say)	2	.	.	✧	.	✧	.	.	.	.	.	.	.	.
Chironomidae - midges														
unmounted/unidentified Chironomidae	461	✧	✦	✦	✦	✦	✦	✦	✦	✦	✧	.	✦	✧
Chironominae (subfamily)														
Chironomini (tribe)														
Chironomus spp.	34	.	✧	✧	.	✦	✧	✧	✧	.	.	✧	✧	.
Cryptochironomus sp.	9	✧	✧	✧	.	.	.	✧	✧	.	.	.	.	.
Dicrotendipes sp.	35	.	✧	✧	✦	✧	✧	.	✧	.	.	.	.	.
Einfeldia sp.	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Endochironomus sp.	21	.	✧	.	✧	✧	.	.	✧	✧	✧	.	✧	.
Glyptotendipes spp.	86	✧	✧	✧	✦	✧	✧	✧	✦	.	✧	.	✦	.
Microtendipes sp.	15	.	.	.	✧	✧	.	✧	✧	.	.	.	.	.
Nanocladius sp.	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Parachironomus sp.	12	.	✧	.	✦	.	.	.	.	.	.	.	.	.
Paracladopelma sp.	5	.	.	.	.	✧	✧	✧	.	.	.	.	.	.
Phaenopsectra sp.	5	.	.	.	.	✧	.	✧	.	.	.	.	✧	.
Polypedilum spp.	36	✧	✧	.	✧	✧	.	✧	✦	.	.	✧	✧	.

Appendix B. *Continued.*

Order Family Genus Species	No. Individuals	Study Sites** dam A	1	2	dam 3	4	B	C	5	D	E	F	6	G
DIPTERA - True Flies *(continued)*														
Chironomini (tribe) *(continued)*														
Pseudochironomus sp.	1	.	.	.	✧	.	.	.	.	.	.	.	.	.
Robackia sp.	8	.	✧	✧	.	.	✧	.	.	.	.	.	✧	.
Smittia sp.	4	.	.	.	✧	✧	.	.	✧	.	.	.	.	.
Stictochironomus sp.	8	✧	✧	.	.	✧	.	.	.	.	.	.	.	.
Tanytarsini (tribe)														
Cladotanytarsus sp.	9	.	✧	.	✧	✧	.	.	.	.	.	.	✧	.
Rheotanytarsus sp.	3	.	✧	.	✧	.	.	.	✧	.	.	.	.	.
Orthocladiinae (subfamily)														
Cricotopus spp.	38	✧	✧	✧	✦	✧	.	.	✧	.	.	.	✧	.
Orthocladius sp.	3	✧	.	.	✧	✧	.	.	.	.	.	.	.	.
Tanypodinae (subfamily)														
unidentified Tanypodinae	12	.	✧	✧	✧	✧	✧	.	✧	.	.	.	.	.
Conchapelopia sp.	1	.	✧	.	.	.	.	.	.	.	.	.	.	.
Larsia sp.	9	.	✧	✧	✧	✧	.	.	.	.	.	.	✧	.
Procladius sp.	10	.	.	.	.	✧	✧	.	✧	.	.	.	✧	.
Thienemannimyia sp.	1	.	.	.	.	.	.	.	✧	.	.	.	.	.
Culicidae - mosquitoes														
*Aedes vexans** (Meigen)	17	.	.	.	✧	.	.	.	.	.	.	.	✧	.
*Anopheles punctipennis** (Say)	5	.	.	✧	.	✧	✧	.	.	.	.	.	.	.
Dolichopodidae - longlegged flies														
unidentified larvae	2	.	.	.	.	.	✧	.	.	.	.	.	.	.
Empididae - dance flies														
unidentified larva	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Muscidae - muscids														
Limnophora sp.	6	.	.	.	.	✧	.	.	.	.	.	.	.	.
Sciomyzidae - marsh flies														
unidentified larvae	2	.	.	.	.	✧	.	.	.	.	.	.	.	.
Simuliidae - black flies														
small larvae	3	.	.	✧	.	.	.	.	✧	.	.	.	.	.
Ectemnia taeniatifrons (Enderlein)	8	.	.	.	.	.	.	.	✧	.	.	.	.	.
Simulium jenningsi Malloch	33	.	✧	✦	.	✧	.	.	✧	.	✧	.	.	✧
Simulium verecundum Stone & Jamnback	56	.	.	✧	.	✧	.	.	✦	✦	✧	.	✦	✧
Simulium vittatum Zetterstedt	12	.	.	.	.	✧	✧	.	✧	.	.	.	✧	.
Tabanidae - horse and deer flies														
Chrysops sp.	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
Tipulidae - crane flies														
Antocha sp.	4	.	.	.	.	.	.	.	✧	.	✧	.	.	.
Hexatoma sp.	49	.	✦	✧	.	.	.	.	✦	.	.	.	✧	.
Tipula sp.	4	.	.	.	✧	.	.	.	✧	.	.	.	✧	.
EPHEMEROPTERA - Mayflies														
Acanthametropodidae														
Acanthametropus pecatonica (Burks)	2	.	.	.	.	.	.	.	.	.	.	.	✧	.
Baetidae - small minnow mayflies														
Baetis sp. "A" [d]	2	.	.	.	.	.	.	.	✧	.	.	.	.	.
Baetis brunneicolor McDunnough	4	.	.	.	.	✧	.	.	✧	.	.	.	.	✧
Baetis dubius[e] (Walsh)	3	.	.	✧	.	.	.	.	✧	.	✧	.	.	.
Baetis flavistriga McDunnough	1	.	.	.	.	.	.	.	.	.	✧	.	.	.
Baetis intercalaris McDunnough	41	.	.	✧	.	✧	.	.	✧	✧	✧	.	✧	.
Baetis longipalpus Morihara and McCafferty	35	.	.	✧	.	✧	.	✧	✦	.	✧	.	✦	.

(Continued on next page)

Appendix B. *Continued.*

Order Family Genus Species	No. Individuals	Study Sites** dam A	1	2	dam 3	4	B	C	5	D	E	F	6	G
EPHEMEROPTERA - Mayflies *(continued)*														
Baetidae - small minnow mayflies *(continued)*														
Baetis propinquus (Walsh)	138	.	✧	✦	.	✦	.	.	✦	✦	.	✧	✦	✧
Callibaetis spp.	48	.	✧	✧	✧	✦	✧	.	✧	.	✧	✧	.	.
Paracloeodes minutus (Daggy)	5	.	.	✧	.	.	.	.	.	.	.	.	✧	.
Procloeon[e] sp.	80	.	✧	✧	.	✧	✦	✧	✦	.	.	✧	✦	.
Baetiscidae - armored mayflies														
Baetisca spp. (small nymphs)	9	.	✧	.	✧	.	✧	.	.	.	.	.	.	.
Baetisca lacustris McDunnough	131	.	✧	✦	✦	✦	.	✧	✦	.	.	.	✧	.
Baetisca laurentina McDunnough	2	.	✧	✧	.	.	.	.	.	.	.	.	.	.
Baetisca obesa (Say)	81	.	✧	✧	✧	✦	✧	.	✦	✧	✧	✧	✧	.
Caenidae - small squaregills														
Brachycercus spp.	82	.	✦	✧	.	✧	✧	.	✦	.	.	.	✧	.
Brachycercus (nr.) *nasutus* Soldan	1	.	.	.	.	.	.	.	✧	.	.	.	.	.
Caenis spp. (small nymphs)	159	.	✦	✦	✦	✦	✦	✧	✦	.	✦	.	✧	.
Caenis diminuta Walker	5	.	.	.	.	.	✧	.	.	.	.	.	.	.
Caenis punctata McDunnough	12	.	✧	✧	.	✧	✧	✧	✧	.	.	.	✧	.
Caenis youngi Roemhild	14	.	✧	.	✧	.	✧	.	✧	.	.	.	✧	.
Cercobrachys (nr.) *serpentis* Soldan	52	.	.	.	.	.	.	.	.	.	.	.	✧	.
Ephemerellidae - spiny crawlers														
Ephemerella dorothea Needham	3	.	.	✧	.	✧	✧	.	.	.	.	.	.	.
Ephemerella excrucians Walsh	4	.	.	✧	.	✧	.	.	.	.	.	.	.	.
Ephemerella needhami McDunnough	4	.	.	.	.	.	.	.	✧	.	✧	.	.	.
Eurylophella (small nymph)	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Eurylophella temporalis McDunnough	5	.	.	.	✧	.	✧	.	.	.	.	.	.	.
Ephemeridae - common burrowers														
Hexagenia (small nymphs)	3	.	.	.	.	.	.	.	✧	.	.	.	.	.
Hexagenia limbata (Serville)	2	.	.	.	.	.	.	.	✧	.	.	.	.	.
Hexagenia rigida McDunnough	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Heptageniidae - flatheaded mayflies														
Heptagenia diabasia Burks	5	.	.	.	.	.	.	.	✧	✧	.	.	✧	.
Heptagenia flavescens (Walsh)	40	.	✧	✧	.	.	✧	✧	✧	✧	✧	.	✦	✧
Macdunnoa persimplex (McDunnough)	3	.	.	.	.	.	.	.	.	.	.	.	✧	.
Stenacron interpunctatum (Say)	134	.	✧	✧	✦	✦	✦	.	✦	✧	.	.	✧	.
Stenonema (small nymphs)	35	.	.	.	✧	.	.	.	✦	.	.	.	.	.
Stenonema exiguum Traver	93	.	✧	✦	.	✦	✧	.	✦	✦	✧	.	.	✦
Stenonema femoratum (Say)	2	.	.	.	✧	.	.	.	.	.	.	.	✧	.
Stenonema mexicanum (Ulmer)	17	.	✧	✧	✧	✧	.	.	✧	.	.	.	✧	.
Stenonema terminatum (Walsh)	197	.	✦	✦	✧	✧	✧	✧	✦	✧	✦	.	✧	✧
Isonychiidae														
Isonychia bicolor (Walker)	54	.	.	✧	.	.	✧	✧	✦	✧	✦	✧	✦	✧
Leptophlebiidae - pronggills														
Leptophlebia sp.	6	.	✧	.	.	✧	.	.	✧	.	.	.	.	.
Metretopodidae - cleftfooted minnow mayflies														
Siphloplecton interlineatum (Walsh)	45	.	.	✧	.	✧	.	.	✦	.	✧	.	✦	.
Palingeniidae - spinyheaded burrowers														
Pentagenia vittigera (Walsh)	1	.	.	.	.	.	.	.	✧	.	.	.	.	.
Polymitarcyidae - pale burrowers														
Ephoron album (Say)	21	.	.	.	.	.	.	.	✧	.	✧	.	✦	.
Pseudironidae														
Pseudiron centralis McDunnough	2	.	.	.	.	.	.	.	.	.	.	.	✧	.

Appendix B. *Continued.*

Order Family Genus Species	No. Individuals	Study Sites**												
		dam			dam									
		A	1	2	3	4	B	C	5	D	E	F	6	G
EPHEMEROPTERA - Mayflies *(continued)*														
Tricorythidae - little stout crawlers														
Tricorythodes sp.	22	.	✧	✧	✧	✧	.	✧	✧	.	✧	.	✧	.
HETEROPTERA - Bugs														
Belostomatidae - giant water bugs														
*Belostoma flumineum** Say	18	.	✧	✧	✧	✧	.	✧	✧	.	.	.	.	.
Corixidae - water boatmen														
immature nymphs	188	✦	✦	✦	.	✧	✦	✧	✦	.	.	✧	✦	✧
*Hesperocorixa atopodonta** (Hungerford)	13	.	✧	✧	.	.	.	.	✧	.	.	.	.	.
*Hesperocorixa kennicottii** (Uhler)	3	.	✧	✧	.	.	.	.	.	.	.	.	.	.
*Hesperocorixa laevigata** (Uhler)	4	.	.	.	.	.	.	.	.	.	.	.	✧	.
*Hesperocorixa semilucida** (Walley)	3	.	✧	.	.	.	.	.	✧	.	.	.	✧	.
*Hesperocorixa vulgaris** (Hungerford)	4	.	.	✧	✧	.	.	.	.	.	.	.	.	.
Palmacorixa buenoi Abbott	36	.	✧	✧	✧	✦	✧	✧	✧	.	.	✧	✧	.
Palmacorixa gillettei Abbott	15	.	.	.	.	✧	✧	.	✧	.	.	✧	✧	.
*Sigara alternata** (Say)	66	.	.	✧	✦	✦	✧	.	✧	.	.	.	✦	.
*Sigara decorata** (Abbott)	16	.	✧	✧	✧	.	.	.	✧	.	.	.	.	.
*Sigara decoratella** (Hungerford)	2	.	.	.	.	.	.	.	✧	.	.	.	✧	.
Sigara grossolineata Hungerford	2	.	.	.	.	✧	.	.	.	.	.	.	✧	.
Sigara lineata (Forster)	827	✧	✦	✦	✦	✦	✦	✦	✦	.	✧	✧	✦	.
Sigara mathesoni Hungerford	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
*Sigara solensis** (Hungerford)	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
Sigara trilineata (Provancher)	22	.	.	✧	.	✦	.	✧	✧	.	.	.	✧	.
*Sigara variabilis** (Hungerford)	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
*Trichocorixa borealis** Sailer	157	.	.	✧	✧	✦	✧	✧	✦	.	.	✧	✧	.
*Trichocorixa calva** (Say)	16	.	.	✧	✧	✧	.	.	.	.	.	.	✧	.
*Trichocorixa kanza** Sailer	5	.	.	.	✧	✧	.	.	.	.	.	.	✧	.
*Trichocorixa naias** (Kirkaldy)	10	.	.	.	✧	✧	.	.	✧	.	.	.	✧	✧
Gerridae - water striders														
Gerris (immature nymphs)	3	.	.	.	.	✧	.	.	✧	.	.	.	.	.
Gerris comatus Drake & Hottes	3	.	.	✧	.	✧	.	.	.	.	.	.	.	.
Gerris marginatus Say	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Gerris remigis Say	2	.	.	.	.	.	✧	.	.	.	.	.	.	.
Metrobates hesperius Uhler	15	.	.	.	.	.	.	✧	✧	.	.	.	✧	.
Rheumatobates palosi Blatchley	23	.	.	✧	.	.	✧	✦	.	.	.	.	.	.
Trepobates subnitidus Esaki	5	.	.	.	.	.	✧	.	.	.	.	.	✧	.
Mesoveliidae - water treaders														
Mesovelia mulsanti White	30	.	.	✧	.	✧	.	✧	✦	.	.	.	✧	.
Naucoridae - creeping water bugs														
Pelocoris femoratus (Palisot de Beauvois)	1	.	.	.	✧	.	.	.	.	.	.	.	.	.
Nepidae - water scorpions														
*Ranatra fusca** Palisot de Beauvois	2	.	.	.	.	.	✧	.	.	.	.	.	.	.
*Ranatra nigra** Herrich-Schaffer	1	.	.	✧	.	.	.	.	.	.	.	.	.	.
Notonectidae - backswimmers														
Buenoa sp. (immature nymphs)	2	.	.	.	.	.	.	.	✧	.	.	.	✧	.
*Buenoa confusa** Hungerford	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Notonecta (immature nymph)	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
*Notonecta irrorata** Uhler	2	.	.	.	.	.	.	.	✧	.	.	.	✧	.
*Notonecta lunata** Hungerford	16	.	✧	✧	✧	.	.	.	✧	.	.	.	✧	.
*Notonecta undulata** Say	2	.	.	.	.	✧	.	.	.	.	.	.	.	.

(Continued on next page)

Appendix B. *Continued.*

Order Family Genus Species	No. Individuals	Study Sites** dam A	1	2	dam 3	4	B	C	5	D	E	F	6	G
HETEROPTERA - Bugs *(continued)*														
Pleidae - pygmy backswimmers														
*Neoplea striola** (Fieber)	24	.	✧	✧	✧	.	.	.	✧	✧	.	✧	✧	.
Veliidae - shortlegged striders														
Microvelia americana (Uhler)	1	.	.	.	.	.	.	.	✧	.	.	.	.	.
*Microvelia pulchella** Westwood	5	.	.	.	.	✧	.	✧	.	.	.	.	.	.
LEPIDOPTERA - Moths														
Pyralidae - aquatic pyralid moths														
Petrephila sp.	14	.	.	✧	.	.	.	.	✧	.	✧	.	.	.
MEGALOPTERA - Fishflies, Dobsonflies, and Alderflies														
Corydalidae - fishflies and dobsonflies														
Chauliodes rastricornis Rambur	2	.	.	.	.	.	.	.	.	.	.	.	✧	.
Sialidae - alderflies														
Sialis velata Ross	2	.	✧	.	.	.	.	.	✧	.	.	.	.	.
ODONATA - Damselflies and Dragonflies														
ANISOPTERA (suborder) - Dragonflies														
Aeshnidae - darners														
Basiaeschna janata Say	2	.	.	.	.	.	.	.	✧	.	.	.	.	.
Boyeria vinosa (Say)	4	.	.	✧	.	.	.	.	✧	.	.	.	.	.
*Nasiaeschna pentacantha** (Rambur)	2	.	.	.	.	.	.	.	.	.	.	.	✧	.
Corduliidae - greeneyed skimmers														
Cordulia (young nymphs)	11	.	.	.	.	.	✦	.	.	.	.	.	.	.
Neurocordulia (young nymphs)	9	.	.	.	.	.	.	.	✧	.	.	.	.	.
Neurocordulia molesta (Walsh)	33	.	✧	✧	.	✧	.	✧	✦	.	✧	✧	✧	.
Neurocordulia yamaskanensis (Provancher)	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
Gomphidae - clubtails														
Gomphurus (young nymphs)	27	.	✧	✧	.	✧	✧	.	✦	.	.	.	✧	.
Gomphurus fraternus (Say)	33	✧	✧	✧	.	✧	✧	.	✧	.	✧	.	✧	.
Stylurus (young nymphs)	4	.	.	.	✧	.	✧	.	✧	.	.	.	.	.
Stylurus notatus (Rambur)	50	.	✧	✧	.	✧	✧	✧	✧	.	.	.	✧	.
Libellulidae - common skimmers														
*Erythemis simplicicollis** (Say)	1	.	.	.	.	✧	.	.	.	.	.	.	.	.
*Leucorrhinia** (young nymph)	1	.	.	.	.	.	✧	.	.	.	.	.	.	.
*Libellula** sp.	1	.	.	.	.	.	✧	.	.	.	.	.	.	.
ZYGOPTERA (suborder) damselflies														
Calopterygidae - broadwinged damselflies														
Calopteryx maculata (Beauvois)	1	.	.	.	.	.	.	.	.	.	.	✧	.	.
Hetaerina americana (Fabricius)	5	.	.	✧	.	.	.	.	✧	.	.	.	✧	.
Coenagrionidae - narrowwinged damselflies														
immature Coenagrionidae	35	.	✧	✦	.	.	✧	.	✦	.	.	.	✧	.
Argia apicalis (Say)	40	.	.	.	.	.	.	✧	✦	.	.	✧	✦	.
Argia moesta (Hagen)	2	.	.	.	.	.	.	.	✧	.	.	.	.	.
Argia tibialis (Rambur)	5	.	.	.	.	.	.	.	✧	.	.	.	.	.
*Coenagrion resolutum** (Hagen)	2	.	.	.	✧	.	.	.	✧	.	.	.	.	.
Enallagma (young nymphs)	17	.	✧	✧	✧	✧	.	✧	.	.	.	.	.	.
Enallagma antennatum (Say)	5	.	.	.	.	.	.	.	✧	.	.	.	.	.
*Enallagma civile** (Hagen)	6	.	.	✧	✧	✧	.	.	.	.	.	.	.	.

Appendix B. *Continued.*

Order Family Genus Species	No. Individuals	Study Sites** dam A	1	2	dam 3	4	B	C	5	D	E	F	6	G
ODONATA - Damselflies and Dragonflies *(continued)*														
ZYGOPTERA (suborder) damselflies *(continued)*														
Coenagrionidae - narrowwinged damselflies *(continued)*														
*Enallagma cyathigerum** (Charpentier)	4	.	✧	.	.	✧	.	.	.	.	.	.	.	.
*Enallagma ebrium** (Hagen)	1	.	.	.	.	.	.	.	.	.	.	.	✧	.
Enallagma exsulans (Hagen)	2	.	.	.	.	.	.	.	.	.	.	✧	.	.
*Enallagma geminatum** Kellicott	4	✧	.	.	.	.	✧	.	.	.	.	.	.	.
Enallagma signatum (Hagen)	15	✧	.	.	✧	.	.	.	✧	.	.	✧	.	.
*Ischnura verticalis** (Say)	17	.	✧	.	✧	✧	.	.	✧	✧	.	.	✧	.
Ischnura (young nymphs)	2	.	.	✧	.	.	.	.	.	.	.	.	.	.
PLECOPTERA - Stoneflies														
Perlidae - common stoneflies														
Acroneuria abnormis (Newman)	5	.	.	.	.	.	.	.	✧	.	✧	.	.	.
Perlesta placida (Hagen)	51	.	.	.	.	.	.	.	.	✧	✧	.	✧	✧
Perlodidae - perlodid stoneflies														
Isoperla bilineata (Say)	120	.	✧	✦	✧	✦	✧	✧	✦	✧	.	.	✧	.
Pteronarcyidae - giant stoneflies														
Pteronarcys sp.	2	.	.	.	.	.	.	.	.	.	✧	.	✧	.
Taeniopterygidae - taeniopterygid broadbacks														
Taeniopteryx nivalis (Fitch)	6	.	.	.	.	.	.	.	✧	.	.	.	.	.
TRICHOPTERA - Caddisflies														
Brachycentridae - humpless case makers														
Brachycentrus numerosus (Say)	3	.	.	.	.	.	.	.	✧	.	✧	.	.	✧
Helicopsychidae - snailcase makers														
Helicopsyche borealis (Hagen)	15	.	.	.	.	.	.	.	✧	.	✦	.	.	.
Hydropsychidae - common netspinners														
Cheumatopsyche spp.	350	.	✧	✦	✦	✦	✧	✧	✦	✦	✧	.	✦	✧
Hydropsyche bidens Ross	4	.	✧	.	.	✧	.	.	✧	.	.	.	.	.
Hydropsyche orris Ross	157	.	✦	✦	✧	✦	✦	.	✦	✦	✧	.	✦	✧
Hydropsyche scalaris Hagen	17	.	.	.	.	✦	.	.	✧	✧	.	.	.	.
Hydropsyche simulans Ross	2	.	.	.	.	.	.	.	.	.	.	.	✧	.
Potamyia flava (Hagen)	105	.	✧	✧	✧	✧	✧	✧	✦	✧	✦	.	✧	.
Hydroptilidae - micro caddisflies														
Hydroptila sp.	14	.	.	.	✧	✦	.	.	✧	.	✦	.	.	.
Leptoceridae - longhorned case makers														
Ceraclea (small larvae)	21	.	.	✧	✧	✧	.	.	✧	✧	.	.	.	.
Ceraclea cancellata (Betten)	2	.	.	.	.	.	.	.	✧	.	.	.	✧	.
Ceraclea tarsipunctata (Vorhies)	28	.	✧	✧	✧	✧	.	.	✧	.	✧	.	✧	.
Nectopsyche candida (Hagen)	170	✧	✦	✦	✧	✧	✦	.	✦	✦	.	✧	✦	.
Oecetis sp.	5	.	✧	✧	.	.	.	.	.	.	.	.	✧	.
Limnephilidae - northern case makers														
Limnephilus sp.	8	.	.	.	✧	.	.	.	.	.	.	.	.	.
Pycnopsyche sp.	57	.	✦	.	✧	✧	✧	.	✦	.	.	✧	✧	.
Polycentropodidae - trumpetnet and tubemaking caddisflies														
Neureclipsis sp.	46	.	✧	✦	.	✧	.	✧	✦	.	✦	.	✧	.
Polycentropus sp.	2	.	✧	✧	.	.	.	.	.	.	.	.	.	.

** See Figure 1 for locations and Table 1 for descriptions of study sites.
[a] Curculionidae identifications made by S. Krauth, UW-Madison Entomology Department.
[b] Elmidae identifications made or confirmed by K. Schmude, UW-Madison Entomology Department.
[c] Includes large aggregation sampled at Woodman on one date.
[d] Bergman and Hilsenhoff (1978).
[e] McCafferty and Waltz (1990).

Appendix C. *Generalized habitat distribution matrix of the commonly occurring and rare genera and species found in the study area.*

Family Genus Species	By Structure*								By Substrate**								Current[a]		Depth[b]	
	CH	SR	RR	RF	DO	ED	SL	BW	RK	GR	SD	MD	CL	DT	WD	VG	F	S	D	S
Commonly Occurring Species																				
Baetidae																				
Baetis intercalaris	.	.	✧	.	.	.	✧	.	✧	✧	.	.	.	.	✧	.	✧	✧	✧	✧
Baetis longipalpus	.	.	✧	.	.	✧	.	.	✧	.	.	.	.	.	.	.	✧	.	✧	.
Baetis propinquus	.	.	.	.	.	.	✧	.	✧	.	.	✧	.	.	✧	✧	✧	✧	.	✧
Callibaetis spp.	.	.	.	.	.	.	✧	✧	.	.	✧	.	.	✧	.	✧	.	✧	.	✧
Procloeon sp.	.	✧	.	.	.	✧	✧	.	.	.	✧	.	.	.	.	.	✧	✧	✧	✧
Baetisca lacustris	.	.	.	.	.	.	✧	.	✧	✧	.	.	.	✧	✧	✧	✧	.	✧	✧
Baetisca obesa	.	.	.	.	.	.	✧	.	✧	✧	.	.	.	✧	✧	✧	.	✧	.	✧
Brachycercus spp.	.	✧	.	.	✧	✧	✧	.	.	.	✧	✧	.	✧	.	.	.	✧	.	✧
Caenis spp.	.	.	.	.	.	✧	.	✧	.	.	✧	.	.	.	.	.	✧	✧	.	✧
Chironomidae																				
Chironomus spp.	.	.	.	.	.	.	.	✧	.	.	.	.	.	.	.	.	.	✧	.	✧
Cricotopus spp.	✧	.	.	✧	.	.	.	.	✧	✧	✧	.	.	.	✧	✧	✧	.	.	✧
Dicrotendipes sp.	.	.	.	✧	.	.	✧	.	✧	.	✧	.	.	.	.	.	.	✧	.	✧
Glyptotendipes spp.	.	✧	✧	.	.	.	✧	.	✧	.	✧	.	.	.	✧	.	✧	✧	.	✧
Polypedilum spp.	✧	✧	✧	.	.	.	✧	.	✧	✧	✧	.	.	.	✧	.	✧	✧	.	✧
Coenagrionidae																				
Argia apicalis	.	.	✧	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	✧	.	✧
Corduliidae																				
Neurocordulia molesta	.	.	✧	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	✧	✧	✧
Corixidae																				
Palmacorixa buenoi	.	.	.	.	.	.	✧	.	✧	.	✧	.	.	.	.	✧	.	✧	.	✧
Sigara alternata	.	.	.	.	.	.	✧	✧	.	.	✧	.	.	.	.	.	.	✧	.	✧
Sigara lineata	.	✧	✧	.	.	.	✧	.	✧	.	✧	.	.	.	.	.	✧	✧	✧	✧
Trichocorixa borealis	.	.	.	.	.	✧	✧	.	.	.	✧	✧	.	.	.	✧	✧	✧	.	✧
Dytiscidae																				
Hydroporus clypealis	.	.	.	.	.	.	✧	.	.	.	.	.	.	.	✧	✧	.	✧	.	✧
Elmidae																				
Macronychus glabratus	.	.	✧	.	.	.	✧	.	.	.	.	.	.	.	✧	.	✧	.	.	✧
Stenelmis decorata	.	.	✧	.	.	✧	.	.	✧	.	.	.	.	.	✧	.	✧	.	✧	.
Gomphidae																				
Gomphurus fraternus	.	.	.	.	.	.	✧	.	✧	.	✧	✧	.	✧	.	.	✧	✧	✧	✧
Stylurus notatus	.	.	.	.	✧	✧	✧	.	.	.	✧	✧	.	.	.	.	✧	✧	✧	✧
Gyrinidae																				
Dineutus assimilis	.	.	.	.	.	.	✧	✧	.	.	✧	✧	.	.	.	✧	.	✧	.	✧
Haliplidae																				
Peltodytes edentulus	.	.	.	.	.	.	✧	.	.	.	✧	✧	.	.	.	✧	.	✧	.	✧
Heptageniidae																				
Heptagenia flavescens	.	.	✧	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	.	✧	.
Stenacron interpunctatum	.	.	✧	.	.	.	✧	.	✧	✧	.	.	.	.	✧	.	✧	✧	.	✧
Stenonema exiguum	✧	.	✧	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	.	.	✧
Stenonema terminatum	.	.	✧	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	✧	✧	.
Hydrophilidae																				
Laccobius reflexipenis	.	.	.	.	.	.	.	✧	.	.	✧	.	.	.	.	.	.	✧	.	✧

Appendix C. *Continued.*

Family Genus Species	By Structure*								By Substrate**								Current[a]		Depth[b]	
	CH	SR	RR	RF	DO	ED	SL	BW	RK	GR	SD	MD	CL	DT	WD	VG	F	S	D	S
Commonly Occurring Species *(continued)*																				
Hydropsychidae																				
Cheumatopsyche spp.	✧	.	✧	.	.	.	✧	.	✧	✧	.	.	.	.	✧	.	✧	.	✧	✧
Hydropsyche orris	✧	.	✧	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	.	✧	✧
Potamyia flava	✧	.	✧	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	.	✧	✧
Isonychiidae																				
Isonychia bicolor	.	.	✧	.	.	.	✧	.	✧	.	✧	.	.	.	✧	.	✧	.	✧	✧
Leptoceridae																				
Nectopsyche candida	✧	.	✧	.	.	✧	✧	✧	✧	.	✧	✧	.	✧	✧	✧	✧	✧	✧	✧
Limnephilidae																				
Pycnopsyche sp.	.	.	.	.	.	✧	✧	.	✧	✧	✧	✧	.	.	✧	.	.	✧	.	✧
Metretopodidae																				
Siphloplecton interlineatum	.	✧	.	.	.	✧	✧	.	.	.	✧	.	.	✧	.	✧	✧	✧	.	✧
Perlidae																				
Perlesta placida	.	.	.	.	.	.	.	.	✧	.	.	.	.	.	✧	.	✧	✧	✧	✧
Perlodidae																				
Isoperla bilineata	.	.	✧	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	.	✧	✧
Polycentropodidae																				
Neureclipsis sp.	.	.	✧	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	✧	✧	.
Simuliidae																				
Simulium jenningsi	✧	.	.	.	.	.	✧	.	✧	.	.	.	.	.	✧	.	✧	.	✧	.
Simulium verecundum	✧	.	.	.	.	.	✧	.	.	.	.	.	.	.	✧	✧	✧	.	.	✧
Tipulidae																				
Hexatoma sp.	.	.	.	✧	.	.	.	.	.	✧	✧	.	.	.	.	.	✧	✧	✧	✧
Rare Species																				
Acanthametropodidae																				
Acanthametropus pecatonica	.	✧	.	.	.	.	.	.	.	.	✧	.	.	.	.	.	✧	.	✧	.
Aeshnidae																				
Nasiaeschna pentacantha	.	.	.	.	.	.	✧	.	.	.	.	.	.	.	.	✧	.	✧	.	✧
Baetidae																				
Paracloeodes minutus	.	✧	.	.	.	.	.	.	.	.	✧	.	.	.	.	.	✧	.	✧	.
Caenidae																				
Cercobrachys (nr.) *serpentis.*	✧	.	.	.	.	✧	.	.	.	✧	.	.	.	.	.	✧	.	✧	✧	
Corduliidae																				
Neurocordulia yamaskanensis	.	.	✧	.	.	.	.	.	✧	✧	.	.	.	.	.	.	✧	.	✧	.
Dytiscidae																				
Hydroporus hybridus	.	.	.	.	.	.	✧	.	.	.	.	.	.	✧	.	✧	.	✧	✧	.
Lioporeus triangularis	.	.	.	.	.	.	✧	.	.	.	✧	.	.	.	.	.	.	✧	.	✧
Heptageniidae																				
Macdunnoa persimplex	.	.	.	.	✧	.	.	.	.	.	✧	.	.	✧	.	.	.	✧	✧	.
Pseudiron centralis	.	✧	.	.	✧	.	.	.	.	.	✧	.	.	.	.	.	✧	.	✧	.
Stenonema mexicanum	✧	.	✧	.	.	.	✧	.	✧	.	✧	.	.	.	✧	.	✧	✧	.	✧
Palingeniidae																				
Pentagenia vittigera	.	.	✧	.	.	.	.	.	.	.	✧	✧	?	✧	.	.	✧	.	✧	.

* CH = Channel
SR = Sandy Run
RR = Rocky Run
RF = Riffle
DO = Drop-Off
ED = Eddy
SL = Shoreline
BW = Backwater Area

** RK = Rock
GR = Gravel
SD = Sand
MD = Mixed Sand
CL = Clay
DT = Detritus
WD = Wood
VG = Vegetation

[a] Current categories were grouped by extremes: F = Fast, S = Slow.
[b] Depth categories were grouped by extremes: D = Deep, S = Shallow.

Appendix D. *Other aquatic insects found in the Lower Wisconsin River (based on observations or collection records from the University of Wisconsin Insect Collection).*

Order Family Genus Species	County	Date	No. Individuals Collected
COLEOPTERA			
Dryopidae			
Helichus lithophilus (Germar)	Richland	10-25-76	1
Dytiscidae			
Agabus ambiguus (Say)	Richland	11-22-74	1
Agabus subfuscatus Sharp	Richland	11-21-84	1
Dytiscus fasciventris Say	Columbia	10-8-64	1
Hydaticus piceus LeConte	Richland	4-29-70	2
Hydroporus mellitus LeConte	Sauk	4-24-71	1
Elmidae			
Dubiraphia minima Hilsenhoff	Richland	9-17-71	1
Stenelmis douglasensis Sanderson	Sauk	8-6-85	2*
Stenelmis knobeli Sanderson	Richland	5-31 to 10-26-86	17*
Gyrinidae			
Dineutus hornii Roberts	Columbia	6-8-66	2
Gyrinus affinis Aube	Dane	6-29-79	2
Gyrinus aquiris LeConte	Crawford	10-24-79	2
	Dane	6-29-79	23
Gyrinus bifarius Fall	Columbia	6-8-66	2
	Columbia	11-12-73	2
	Dane	6-29-79	4
	Iowa	9-16-76	1
Gyrinus frosti Fall	Iowa	9-13-83	1
	Sauk	6-8-66	1
Gyrinus lecontei Fall	Columbia	11-12-73	3
Gyrinus ventralis Kirby	Dane	10-29-79	1
	Iowa	9-13-83	1
Haliplidae			
Peltodytes sexmaculatus Roberts	Grant	10-23-80	1
Hydrophilidae			
Berosus aculeatus LeConte	Sauk	8-10-66	2
Berosus fraternus LeConte	Richland	4-29-70	3
Hydrochara obtusatus (Say)	Richland	4-29-70	1
Tropisternus ellipticus (LeConte)	Grant	10-26-86	1
	Sauk	8-14-86	1
EPHEMEROPTERA			
Caenidae			
Caenis hilaris (Say)	Richland	6-27-72	1
Caenis tardata McDunnough	Richland	6-27-72	1?
Heptageniidae			
Anepeorus simplex (Walsh)	Richland	6-22-73	2
	Richland	6-16-76	1
	Richland	6-6-88	1
Siphlonuridae			
Siphlonurus sp.	Columbia	6-8-66	1

Appendix D. *Continued.*

Order Family Genus Species	County	Date	No. Individuals Collected
HETEROPTERA			
Corixidae			
Hesperocorixa lucida (Abbott)	Columbia	5-23-73	1
Hesperocorixa michiganensis (Hungerford)	Crawford	10-24-79	2
Sigara bicoloripennis (Walley)	Crawford	10-24-79	10
	Richland	10-24-79	1
Sigara defecta Hungerford	Columbia	11-22-65	1
Nepidae			
Nepa apiculata Uhler	Richland	11-17-75	1
	Richland	11-8-82	1
	Sauk	10-30-65	1
Ranatra kirkaldyi Bueno	Sauk	7-5-86	1
NEUROPTERA			
Sisyridae			
Climacia spp.	Sauk	7-1-88	4
ODONATA			
Coenagrionidae			
Enallagma carunculatum Morse	Dane	6-25-70	3
Gomphidae			
Gomphurus externus (Hagen)	Dane	6-25-70	1
TRICHOPTERA			
Glossosomatidae			
Protoptila erotica Ross	Richland	6-11-70	(LT) 1**
	Richland	8-5-70	(LT) 5
Hydropsychidae			
Cheumatopsyche campyla Ross	Richland	8-15-70	(LT) 2
	Richland	6-11-70	(LT) 11
Hydropsyche betteni Ross	Crawford	?-87	1
Hydroptilidae			
Hydroptila scolops Ross	Richland	8-5-70	(LT) 7
Hydroptila waubesiana Betten	Richland	8-5-70	(LT) 20
	Richland	5-11-70	(LT) 10
Mayatrichia ayama Mosely	Richland	8-5-70	(LT) 20
Leptoceridae			
Ceraclea flava (Banks)	Sauk	6-8-66	(LT) 1
Oecetis avara (Banks)	Richland	8-5-70	(LT) 20
Oecetis cinerascens (Hagen)	Richland	6-11-70	(LT) 1
Oecetis inconspicua (Walker)	Richland	8-5-70	(LT) 1
	Richland	6-11-70	(LT) 4
Polycentropodidae			
Neureclipsis crepuscularis (Walker)	Richland	8-5-70	(LT) 4
Polycentropus cinereous Hagen	Richland	8-5-70	(LT) 1

* Collected by K. Schmude, UW-Madison.

** LT = light trap collections.

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Approximate Metric-English Equivalents
1 ha = 2.48 acres
1 m = 3.28 ft
1 cm = 0.39 inches
1 km = 0.62 miles
1 m^2 = 1.20 yd^2
1 L = 1.06 qt
1 g = 0.035 oz
1 kg = 2.21 lb
1 metric ton = 1.10 tons

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