An Inventory of Aquatic Macroinvertebrates and Calculation of Selected Biotic Indices for the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002

By Bret A. Robinson

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[In pocket]

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Conversion Factors and Acronyms

Multiply	By	To obtain
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
acre	4,047	square meter (m^2)
gallon (gal)	3.785	liter (L)
micrometer (µm)	0.000039	inch (in.)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C = (°F - 32) \times 0.555$$

The following acronyms are used in this report:

Acronym	Description
ECBP	Eastern Corn Belt Plains
EPT	Ephemeroptera, Plecoptera, Trichoptera
HBI	Hilsenhoff Biotic Index
ICI	Invertebrate Community Index
IP	Interior Plateau
NWQL	National Water Quality Laboratory
USGS	U.S. Geological Survey

An Inventory of Aquatic Macroinvertebrates and Calculation of Selected Biotic Indices for the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002

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Abstract

An investigation was conducted to establish an inventory of aquatic macroinvertebrates in the streams at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana. The data used to develop this inventory were collected during two sampling efforts in September 2000 and July and August 2002. The inventory identified 173 distinct taxa within the study-area streams. Although no rare or endangered species were found, one identified species, *Cordulegaster maculata* Selys (a twin-spotted spiketail dragonfly), is recognized by the Indiana Department of Natural Resources as being rare enough to warrant special concern.

Biotic indices (indicators of water-quality conditions) were calculated from the macroinvertebrate data. Ephemeroptera, Plecoptera, Trichoptera Richness Index values calculated for 23 samples collected from 16 sites ranged from 5 to 15, with more than 75 percent of the values falling within the range of 7 to 11. Hilsenhoff Biotic Index scores and Invertebrate Community Index scores calculated for samples collected at three sites indicate that water quality at these sites ranged from good to poor. The one site with a poor water-quality index score had a small drainage area. The small drainage area and dry conditions during the sampling period may have contributed to the poor scores calculated for this site.

Introduction

The U.S. Army Atterbury Reserve Forces Training Area (Camp Atterbury) near Edinburgh, Indiana, (fig. 1) has been a military installation since 1942 and was used intermittently for troop training, as a military hospital, and as a prisoner-of-war facility during World War II. In 1969, the installation was placed under the control of the Indiana Army National Guard (Indiana National Guard, 1995).

The mission of Camp Atterbury is to support training for the National Guard as well as other reserve and active forces of the U.S. military. Year-round training incorporates a variety of weapons-firing practice, maneuvers for specialized vehicles including air-assault helicopter and parachute operations, and bombing practice for the Indiana Air National Guard. Additionally, the facility serves as a training area for emergency teams and law-enforcement officers of Federal, State, and local government. The central part of Camp Atterbury contains the approximately 6,300-acre Common Impact Area that includes the weapons-firing ranges and the aerial gunnery and bombing ranges (Risch, 2004).

Based upon the nature of previous activities and the ongoing training exercises at Camp Atterbury, the Indiana Army National Guard Environmental Protection Office is interested in obtaining data regarding environmental conditions at the installation. The concern is twofold—are activities at the facility causing environmental degradation and are environmental hazards likely to be encountered by troops during training?

In 2000, the Indiana National Guard Environmental Protection Office requested that the U.S. Geological Survey (USGS) conduct an investigation to assess surface-water quality at Camp Atterbury. As part of that investigation, aquatic-macroinvertebrate samples were collected from streams in Camp Atterbury. Aquatic macroinvertebrates are good indicators of water-quality conditions because they spend a substantial part of their life cycles in water and are subjected to a full range of environmental effects (physical, chemical, and biological).

As an extension of the initial USGS water-quality investigation, additional macroinvertebrate samples were collected in 2002 to establish an inventory of aquatic macroinvertebrates in the streams at Camp Atterbury. The taxonomic inventory will provide base-line data to evaluate water-quality changes if future macroinvertebrate samples are collected at Camp Atterbury or if physical changes occur within or upstream from the study area.

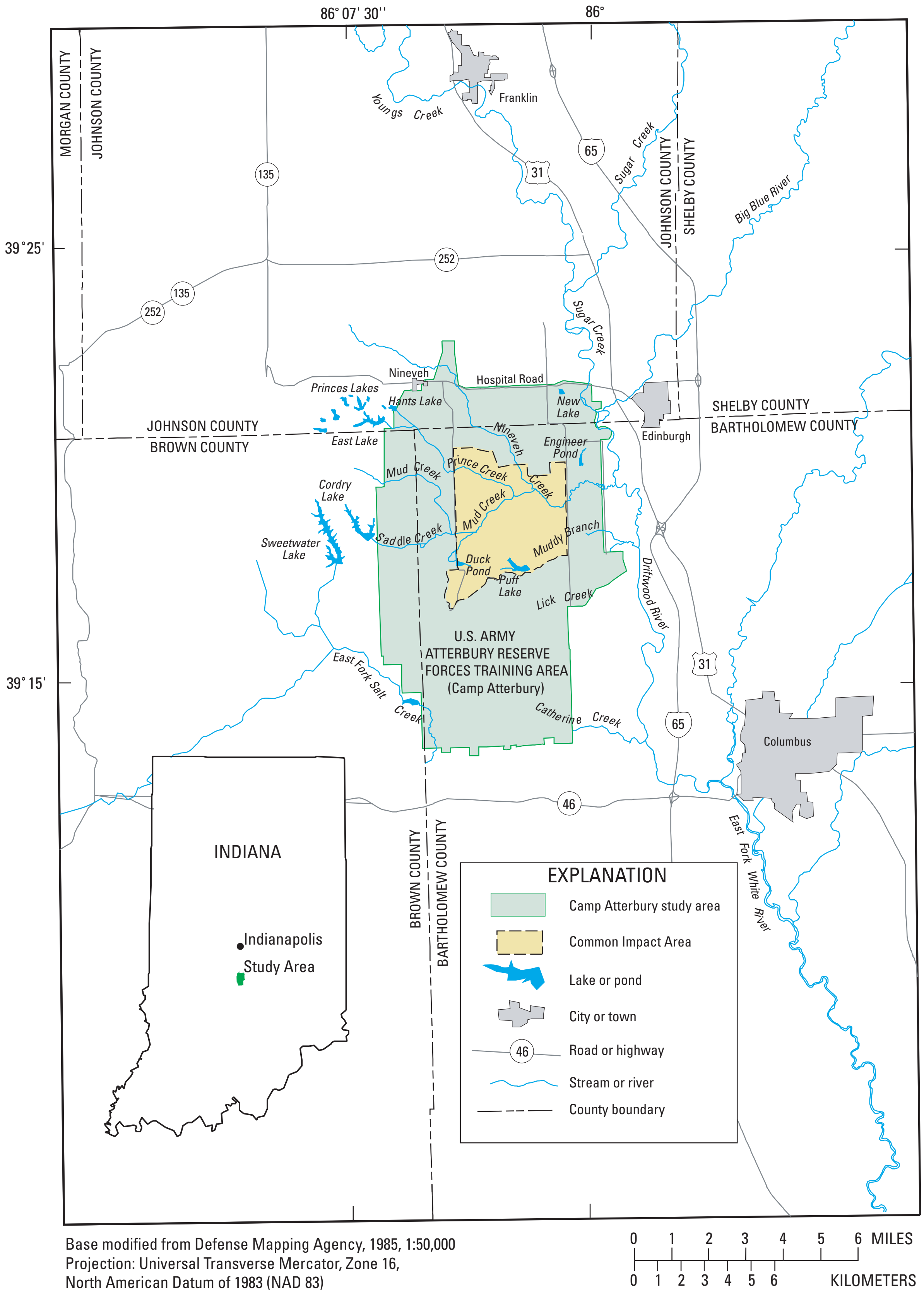


Figure 1. Study area and surrounding region at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana.

Macroinvertebrate samples were collected in September 2000 from 13 sites (table 1 and fig. 2) within the Camp Atterbury study area (Risch, 2004). Sampling sites were along Mud Creek, Prince Creek, Nineveh Creek, Muddy Branch, Saddle Creek, Lick Creek, Catherine Creek, and one unnamed tributary to Nineveh Creek. Additional samples were collected at 10 sites in July and August 2002. The sampling completed in 2002 added three new macroinvertebrate-sampling sites; one of those sites (site M1) was on Sugar Creek, a stream within the Camp Atterbury study area (fig. 2) that had not been sampled previously. Adding this Sugar Creek sampling site assured that macroinvertebrate data were collected from the broadest possible range of stream sizes within the study area.

Combining the data derived from the 2000 and 2002 sampling allowed the inventory of macroinvertebrates to be developed from a total of 29 samples (12 Surber samples, 10 qualitative samples, 3 artificial-substrate samples, 3 duplicate samples, and 1 grab sample collected from woody debris) collected from 16 widely distributed sites (table 1 and fig. 2). From the sampling data, biotic indices were calculated as indicators of surface-water-quality conditions at Camp Atterbury.

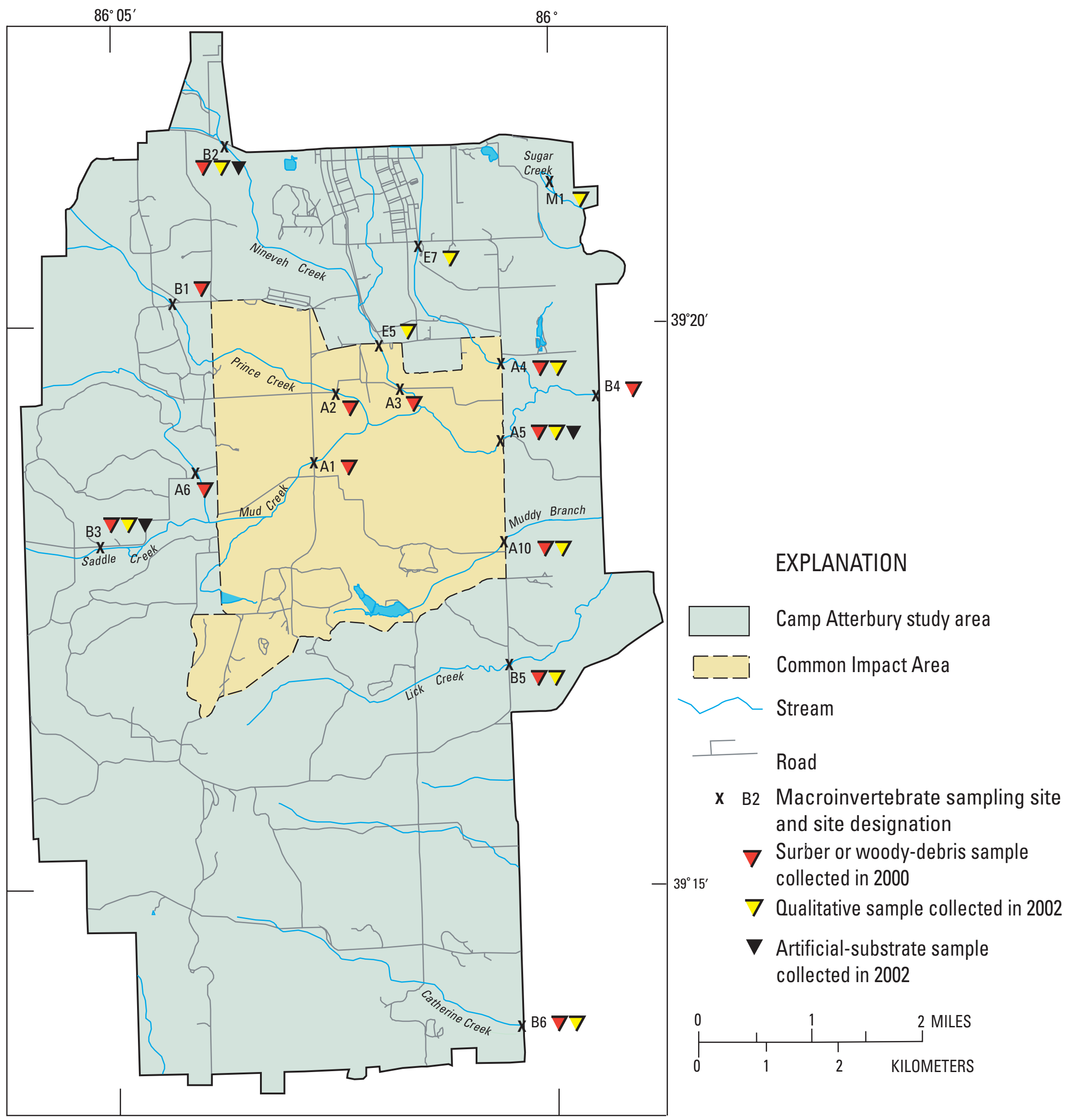
Table 1. Macroinvertebrate sampling sites and sample types collected by the U.S. Geological Survey at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000 and July and August 2002.

[--, no sample collected]

Sampling site (fig. 2)	Site name	Surber sample, 2000	Qualitative sample, 2002	Artificial-substrate sample, 2002
A1	Mud Creek in Common Impact Area	Yes[1]	--	--
A2	Prince Creek in Common Impact Area	Yes	--	--
A3	Nineveh Creek in Common Impact Area	Yes	--	--
A4	Unnamed tributary to Nineveh Creek at Mauxferry Road	Yes	Yes[1]	--
A5	Nineveh Creek at Mauxferry Road	Yes	Yes	Yes
A6	Mud Creek at Mount Moriah Road	Yes	--	--
A10	Muddy Branch at Bearrs Road	Yes[2]	Yes	--
B1	Prince Creek at Wilder Road	Yes	--	--
B2	Nineveh Creek at Hospital Road	Yes	Yes	Yes
B3	Saddle Creek at Mount Moriah Road	Yes	Yes	Yes
B4	Nineveh Creek at Wallace Road	Yes	--	--
B5	Lick Creek at Mauxferry Road	Yes	Yes	--
B6	Catherine Creek at Reservation Boundary Road	Yes	Yes	--
E5	Nineveh Creek at Range Line Road near Kansas Cemetery	--	Yes	--
E7	Unnamed tributary to Nineveh Creek at County Line Road	--	Yes	--
M1	Sugar Creek downstream from Hospital Road	--	Yes[1]	--

[1]A duplicate sample was collected.

[2]Woody debris was sampled because substrate at this site was not appropriate for Surber sampling.



Base modified from Defense Mapping Agency, 1985, 1:50,000
Projection: Universal Transverse Mercator, Zone 16,
North American Datum of 1983 (NAD 83)

Figure 2. Sampling sites for collection of macroinvertebrates at U.S. Army Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002.

Purpose and Scope

This report documents the results of an investigation to collect samples and determine the taxonomic identification of aquatic macroinvertebrates in streams at Camp Atterbury. Samples were collected in September 2000 and July and August 2002. Methods of field-data collection and processing and laboratory identification are described. The report presents an inventory list of distinct taxa identified by the laboratory in at least one sample or duplicate sample. The data also are used to calculate the Ephemeroptera, Plecoptera, Trichoptera (EPT) Richness Index; the Hilsenhoff Biotic Index; and the Ohio Invertebrate Community Index as indicators of environmental quality.

Description of Study Area

Camp Atterbury is a 33,760-acre military installation in central Indiana (fig. 1). The property lies within parts of northwestern Bartholomew, northeastern Brown, and southern Johnson Counties. The town of Edinburgh, Indiana, is approximately 2 mi east of the main Camp Atterbury entrance.

The study area falls within two of the physiographic units defined and described by Malott (1922) and further refined by Schneider (1966). The northeastern one-fourth of the study area is within the Scottsburg Lowland physiographic unit. In the study area, this physiographic unit is described as an area of low relief where glacial deposits up to 150 ft thick cover the underlying bedrock. The southern and western parts of the study area fall within the Norman Upland physiographic unit. Within the study area, this physiographic unit tends to display greater local relief than does the Scottsburg Lowland, and bedrock is usually at or near the land surface.

Following the same general boundary as that which separates the physiographic units, the Camp Atterbury study area falls within two ecoregions. The eastern part of the study area, generally coincident with the Scottsburg Lowland, is within the Eastern Corn Belt Plains (ECBP) ecoregion (Woods and others, 1998). This ecoregion is underlain primarily by Wisconsinan glacial deposits and typically exhibits a subdued rolling topography. The western part of the study area, generally coincident with the Norman Upland, is within the Interior Plateau (IP) ecoregion. This ecoregion is characterized by dissected hills and knobs and narrow valleys; it has more forest cover than the ECBP ecoregion to the north and east.

Most of the soil types of the study area have been grouped into one of five soil associations on the basis of similar soil characteristics (Noble and others, 1990). The Stonelick-Chagrin association is found on the flood plains of the Driftwood River and downstream reaches of Nineveh Creek; it is described as deep, nearly level, well-drained soils formed in loamy alluvial deposits. The Crosby-Miami-Rensselaer association is found in the northern part of the study area; it is described as deep, nearly level to strongly sloping, very poorly drained to well-drained soils formed in loess or till on uplands and terraces. The Pekin-Chetwynd-Bartle association is found in the central part of the study area—roughly bounded by Nineveh Creek on the north and Lick Creek on the south—and within much of the Catherine Creek Watershed. This soil association is characterized as deep, nearly level to very steep, somewhat poorly drained to well-drained soils, formed in silty and loamy deposits on terraces.

Soils of the Hickory-Cincinnati-Rossmoyne association are found in the southeastern part of the study area. This soil association is described as deep, gently sloping to very steep, well-drained and moderately well-drained soils, formed in loess and underlying glacial drift on uplands. In the westernmost and southwestern part of the study area are found the soils of the Berks-Wellston-Trevlac association. These soils are described as moderately deep to deep, moderately sloping to very steep, and well drained. These soils are formed in loess and material weathered from shale, siltstone, and sandstone on uplands.

Streamflow generally is from west to east across the study area. The largest stream is Sugar Creek, with a drainage area of approximately 474 mi^2 at the study-area sampling site. Sugar Creek crosses the northeastern corner of the study area and drains a small part of the study area. Nineveh Creek, the second largest stream in the study area, has a drainage area of approximately 44 mi^2. Nineveh Creek originates upstream from the study area and is joined by numerous tributaries inside Camp Atterbury, including Prince Creek and Mud Creek. All the other streams in the study area have drainage areas less than 10 mi^2. The headwaters of Lick Creek, Muddy Branch, and Catherine Creek are inside the study area; their drainage areas range from 2 to 6 mi^2.

As described by Risch (2004), the study area has a humid continental climate, characterized by distinct winter and summer seasons with large annual temperature ranges. Mean monthly temperatures at Columbus, Ind., about 6 mi southeast of the study area, range from about 28°F in January to about 76°F in July. At Columbus, normal annual precipitation is 42 in. and normal monthly precipitation ranges from about 2.6 in. in February to about 4.6 in. in May (Midwestern Regional Climate Center, 2004).

Study Methods

Sampling sites were selected to provide a broad geographic coverage of the study area and a diversity of stream sizes. Field-sampling protocols established by the USGS National Water-Quality Assessment (NAWQA) Program (Cuffney and others, 1993) were followed during all sampling events discussed in this report.

Macroinvertebrate samples can be collected and processed in a variety of ways. Throughout this report, three types of samples are discussed—qualitative, Surber, and artificial substrate (table 1). Qualitative samples represent a composite of organisms collected from all available habitats at a given sampling site. When these samples are processed in the laboratory, the goal is to identify the variety of taxa found in the sample; no effort is made to determine the relative abundance of each identified taxon. This type of macroinvertebrate sample is desirable when developing a taxonomic inventory; however, these qualitative samples cannot fully describe the compositional details of a macroinvertebrate community.

Unlike qualitative samples, Surber and artificial-substrate samples collect organisms from a defined and measurable area of habitat. For the Surber and artificial-substrate samples discussed in this report, laboratory processing attempted to identify the variety of organisms found in each sample and calculate the relative abundance of each identified taxa. These types of samples, although more expensive to collect and process, allow for a more-detailed understanding of the composition of a macroinvertebrate community. The results then can be used to infer surface-water-quality conditions at a sampling site.

In 2000, Risch (2004) completed sampling to aide in a base-wide assessment of the quality of surface water at Camp Atterbury. As part of that investigation, 12 Surber samples, 1 sample from woody debris, and 1 duplicate sample of macroinvertebrates were collected at 13 sites (table 1). Samples were collected at locations that, on the basis of field observations, were believed to have the best habitat for macroinvertebrates. Sampling locations generally were in riffles.

The 12 Surber samples were collected by placing a Surber sampler on the streambed so that streamflow was directed into the open end of the sampling net. Cobble-sized particles within the sampling frame were collected by hand and placed in a water-filled 2-gal bucket for later brushing. Then, the streambed exposed within the sampling frame was brushed vigorously to free all attached organisms, and streamflow carried the dislodged organisms into the sampling net. All dislodged organisms and detritus—either collected in the sampling net or brushed from the cobbles—were poured onto a 212-µm mesh sieve and rinsed to separate the macroinvertebrates from excessive sediment and algae. The organisms retained on the sieve were placed in sample jars and preserved with formalin prior to shipping to the laboratory. (At site A10, woody debris was sampled because substrate at the site was not appropriate for Surber sampling.)

In July and August 2002, 10 qualitative samples were collected at 10 sites (table 1). Two sites (A6, Mud Creek at Mount Moriah Road; B1, Prince Creek at Wilder Road) scheduled for qualitative sampling could not be sampled because of dry conditions. Therefore, two other sites (E5, Nineveh Creek at Range Line Road near Kansas Cemetery; E7, unnamed tributary to Nineveh Creek at County Line Road) less affected by the dry conditions were substituted.

The qualitative samples were collected from a variety of instream habitats at each site including streambed sediments, accumulations of woody debris, aquatic vegetation, and the water column. Streambed sediment was sampled following the same procedures used by Risch in the 2000 sampling outlined earlier. To collect samples from accumulations of woody debris, approximately 6 ft of 2-in. diameter wood was removed from a debris accumulation and a soft-bristle brush was used to dislodge the attached organisms.

Organisms clinging to aquatic vegetation or free-swimming/floating within the water column were sampled by sweeping a 500-µm mesh dip net through the pools, riffles, and beds of vegetation. The collected organisms and detritus were rinsed on a 212-µm mesh sieve to remove excess sediment and algae. All organisms collected from these various habitats were combined to produce one qualitative sample for each sampling site. Duplicate qualitative samples were collected at two sites (A4, unnamed tributary to Nineveh Creek at Mauxferry Road; M1, Sugar Creek downstream from Hospital Road).

Artificial-substrate samples were collected in 2002 at three sampling sites (A5, Nineveh Creek at Mauxferry Road; B2, Nineveh Creek at Hospital Road; and B3, Saddle Creek at Mount Moriah Road). These samples were collected by placing modified Hester-Dendy samplers (described by Tertuliani, 1999) in the streams for 6 weeks.

The study design called for all artificial-substrate samplers to be placed in the streams in mid-June 2002; however, military maneuvers at Camp Atterbury prevented access to site B3 in mid-June. On June 17, 2002, two units, each consisting of five plate-type artificial-substrate samplers chained to cinder blocks (fig. 3), were placed in the water at sites A5 and B2. On July 1, 2002, the final two artificial-substrate sampling units were placed at site B3. Two units were placed at each site to prevent a loss of data in the event one unit was lost or damaged.

During the 6-week sampling periods, organisms colonized the open spaces between the artificial-substrate plates. The samplers placed at sites A5 and B2 on June 17, 2002, were retrieved from the field on July 29, 2002. The samplers placed at site B3 on July 1, 2002, were retrieved from the field on August 12, 2002. At the end of the 6 weeks, the artificial-substrate sampling units at each site had not been disturbed or lost. Therefore, at each site, one of the cinder-block sampling units arbitrarily was selected for sampling while the other unit was removed from the field without being sampled.

Once the sampling unit was selected and retrieved, the five artificial-substrate samplers from that unit were dismantled and the colonizing organisms were brushed into their own sample-collection jar. The collected organisms were preserved with formalin and shipped to the USGS National Water Quality Laboratory (NWQL) Biological Group. After preliminary examination by personnel at the laboratory, it was determined that the five samples collected at each site could be composited into a single sample for each sampling site before they were analyzed. This compositioning produced one artificial-substrate sample for each of the three sites where modified Hester-Dendy samples were placed.

Figure 3. Modified Hester-Dendy samplers used to collect artificial-substrate samples. The top photograph shows one of the two sampling units placed in Nineveh Creek at site B2 on June 17, 2002, U.S. Army Atterbury Reserve Forces Training Area, near Edinburgh, Indiana. The bottom photograph shows a plate-type artificial-substrate sampler on dry land before being placed in the stream.

Risch (2004) provides a detailed description of how the macroinvertebrate samples collected in 2000 were processed by the USGS NWQL. In 2002, a total of 15 macroinvertebrate samples (3 artificial-substrate samples, 10 qualitative samples, and 2 duplicate qualitative samples) were submitted to the USGS NWQL Biological Group for processing. This included taxonomic identification for all 15 samples and, for the artificial-substrate samples, calculation of the relative abundance of each taxonomic group identified. Analysis was completed according to the methods documented in Moulton and others (2000). Artificial-substrate samples were processed with a 300-count method similar to the U.S. Environmental Protection Agency Standard Taxonomic Assessment. Qualitative samples were processed through a 2-hour visual sort and taxonomic assessment. Taxonomic identification of all samples was made to the lowest possible taxonomic level.

Inventory of Aquatic Macroinvertebrates

To develop the inventory of macroinvertebrates, data from all USGS macroinvertebrate samples collected at Camp Atterbury were combined. This included 12 Surber samples, 10 qualitative samples, 3 artificial-substrate samples, 1 sample collected from woody debris, and 3 duplicate samples from 16 sites (table 1). The data were reviewed to remove duplicate and ambiguous taxa—those that are not distinct from other taxa identified to a lower taxonomic level. Appendix A presents, in digital format, the macroinvertebrate data collected in 2000, and appendix B presents the same for data collected in 2002. The inventory is presented in table 2 and in digital format in appendix C.

Review of this inventory shows that 173 distinct taxa have been identified; of those, 156 distinct taxa are from the Phylum Arthropoda. Other phyla represented are Mollusca (10 taxa); Annelida (4 taxa); and Cnidaria, Platyhelminthes, and Nematoda (1 taxon each). Within the Phylum Arthropoda, the greatest number of distinct taxa identified are in the Class Insecta, including 66 taxa in the Order Diptera (true flies and mosquitoes), 24 taxa in the Order Coleoptera (beetles), 19 taxa in the Order Ephemeroptera (mayflies), and 17 taxa in the Order Trichoptera (caddisflies).

One of the species identified in samples collected at Camp Atterbury was *Cordulegaster maculata* Selys (a twin-spotted spiketail dragonfly). Although this species has not been listed as endangered or threatened at the State or Federal level, it is recognized by IDNR as being rare enough to warrant special concern (Indiana Department of Natural Resources, 2002).

Calculation of Selected Biotic Indices

Numerous approaches have been used to assess surface-water-quality conditions by evaluating macroinvertebrate data. For this investigation, three indices were used—the Ephemeroptera, Plecoptera, Trichoptera Richness Index; the Hilsenhoff Biotic Index (Hilsenhoff, 1987 and 1988); and the Invertebrate Community Index (Ohio Environmental Protection Agency, 1987 and 1989). Although these three indices are distinct, they follow the same general approach of using the composition of the macroinvertebrate community at each site to infer water-quality conditions.

Ephemeroptera, Plecoptera, Trichoptera Richness Index

Some macroinvertebrates—for example, taxa within the order Diptera (true flies and mosquitoes) and the class Oligochaeta (segmented worms)—tend to be tolerant of poor water-quality conditions. Other organisms—for example, the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)—are more sensitive to pollution. Numerous sensitive taxa are expected only to be found at sites with good water quality (North American Benthological Society, 1996, web site provides a history of the EPT richness metric).

The Ephemeroptera, Plecoptera, Trichoptera (EPT) Richness Index evaluates environmental quality by measuring the abundance of these sensitive taxa at a site. This index is calculated by summing the number of distinct taxa within these three pollution-sensitive orders. The result is taken as an indicator of water quality and allows for between-site comparisons. Low values (few EPT taxa) can indicate degraded water quality.

A summary of the EPT Richness Index values calculated from the macroinvertebrate data collected at Camp Atterbury is provided in table 3. The values listed for 2000 were derived from the Surber samples collected in that year. The values listed for 2002 were derived from the qualitative samples collected in that year. The calculated values for 23 samples collected from 16 sites ranged from 5 to 15, with more than 75 percent of the values within the range of 7 to 11.

When multiple EPT values are calculated for a site, the results can show a high degree of variability. This is illustrated in the values calculated for site A4. A qualitative sample collected at this site on July 30, 2002, produced an EPT value of 5. Without additional data, this low EPT value would appear to indicate poor water quality at this site compared to other sampling locations. A duplicate sample also collected at this site and on the same day, however, produced an EPT value of 10. Furthermore, a Surber sample collected at site A4 in 2000 produced an EPT value of 11. Therefore, the EPT value of 5 may not be a true indicator of poor water quality and simply may reflect natural variation within the macroinvertebrate community or in the sampling and analysis process.

Table 2. Inventory of aquatic macroinvertebrates in the streams at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002.

[sp., an unidentified species within the listed genus]

Phylum	Class	Order	Family	Subfamily	Genus	Taxon identification	Taxon level
Cnidaria	Hydrozoa	Hydroida	Hydridae		*Hydra*	*Hydra* sp.	Genus
Platyhelminthes	Turbellaria					Turbellaria	Class
Nematoda						Nematoda	Phylum
Mollusca	Bivalvia	Veneroida	Corbiculidae		*Corbicula*	*Corbicula* sp.	Genus
Mollusca	Bivalvia	Veneroida	Sphaeriidae	Pisidiinae	*Pisidium*	*Pisidium* sp.	Genus
Mollusca	Bivalvia	Veneroida	Sphaeriidae	Sphaeriinae	*Sphaerium*	*Sphaerium* sp.	Genus
Mollusca	Gastropoda	Basommatophora	Ancylidae		*Ferrissia*	*Ferrissia* sp.	Genus
Mollusca	Gastropoda	Basommatophora	Lymnaeidae	Lymnaeinae	*Stagnicola*	*Stagnicola* sp.	Genus
Mollusca	Gastropoda	Basommatophora	Physidae	Physinae	*Physella*	*Physella* sp.	Genus
Mollusca	Gastropoda	Basommatophora	Planorbidae		*Helisoma*	*Helisoma* sp.	Genus
Mollusca	Gastropoda	Basommatophora	Planorbidae		*Planorbella*	*Planorbella* sp.	Genus
Mollusca	Gastropoda	Mesogastropoda	Hydrobiidae			Hydrobiidae	Family
Mollusca	Gastropoda	Mesogastropoda	Pleuroceridae		*Elimia*	*Elimia* sp.	Genus
Annelida	Hirudinea	Rhynchobdellae	Glossiphoniidae			Glossiphoniidae	Family
Annelida	Oligochaeta	Lumbriculida	Lumbriculidae			Lumbriculidae	Family
Annelida	Oligochaeta	Tubificida	Naididae			Naididae	Family
Annelida	Oligochaeta	Tubificida	Tubificidae			Tubificidae	Family
Arthropoda	Arachnida					Acari	Class
Arthropoda	Malacostraca	Amphipoda	Crangonyctidae		*Crangonyx*	*Crangonyx* sp.	Genus
Arthropoda	Malacostraca	Amphipoda	Hyalellidae		*Hyalella*	*Hyalella azteca* (Saussure[1])	Species
Arthropoda	Malacostraca	Decapoda	Cambaridae	Cambarinae	*Orconectes*	*Orconectes* sp.	Genus
Arthropoda	Malacostraca	Isopoda	Asellidae		*Caecidotea*	*Caecidotea* sp.	Genus
Arthropoda	Malacostraca	Isopoda	Asellidae		*Lirceus*	*Lirceus* sp.	Genus
Arthropoda	Insecta	Collembola				Collembola	Order
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Acerpenna*	*Acerpenna macdunnoughi* (Ide)	Species
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Baetis*	*Baetis flavistriga* McDunnough	Species
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Baetis*	*Baetis intercalaris* McDunnough	Species
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Diphetor*	*Diphetor hageni* (Eaton)	Species
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Pseudocloeon*	*Pseudocloeon* sp.	Genus
Arthropoda	Insecta	Ephemeroptera	Baetidae			*Centroptilum/Procloeon* sp.	Family
Arthropoda	Insecta	Ephemeroptera	Caenidae		*Caenis*	*Caenis* sp.	Genus
Arthropoda	Insecta	Ephemeroptera	Ephemerellidae			Ephemerellidae	Family

Table 2. Inventory of aquatic macroinvertebrates in the streams at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002.—Continued

[sp., an unidentified species within the listed genus]

Phylum	Class	Order	Family	Subfamily	Genus	Taxon identification	Taxon level
Arthropoda	Insecta	Ephemeroptera	Ephemeridae		*Ephemera*	*Ephemera* sp.	Genus
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Leucrocuta*	*Leucrocuta* sp.	Genus
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Stenacron*	*Stenacron* sp.	Genus
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Stenonema*	*Stenonema exiguum* Traver	Species
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Stenonema*	*Stenonema femoratum* (Say)	Species
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Stenonema*	*Stenonema mediopunctatum* (McDunnough)	Species
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Stenonema*	*Stenonema terminatum* (Walsh)	Species
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		*Stenonema*	*Stenonema vicarium* (Walker)	Species
Arthropoda	Insecta	Ephemeroptera	Isonychiidae		*Isonychia*	*Isonychia* sp.	Genus
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae		*Tricorythodes*	*Tricorythodes* sp.	Genus
Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae		*Choroterpes*	*Choroterpes* sp.	Genus
Arthropoda	Insecta	Odonata	Aeshnidae		*Basiaeschna*	*Basiaeschna janata* (Say)	Species
Arthropoda	Insecta	Odonata	Aeshnidae		*Boyeria*	*Boyeria vinosa* (Say)	Species
Arthropoda	Insecta	Odonata	Calopterygidae		*Calopteryx*	*Calopteryx maculata* (Beauvois)	Species
Arthropoda	Insecta	Odonata	Calopterygidae		*Hetaerina*	*Hetaerina americana* (Fabricius)	Species
Arthropoda	Insecta	Odonata	Coenagrionidae		*Argia*	*Argia* sp.	Genus
Arthropoda	Insecta	Odonata	Cordulegastridae		*Cordulegaster*	*Cordulegaster maculata* Selys	Species
Arthropoda	Insecta	Odonata	Corduliidae			Corduliidae	Family
Arthropoda	Insecta	Odonata	Gomphidae		*Gomphus*	*Gomphus* sp.	Genus
Arthropoda	Insecta	Odonata	Gomphidae		*Progomphus*	*Progomphus obscurus* (Rambur)	Species
Arthropoda	Insecta	Hemiptera	Corixidae	Corixinae	*Sigara*	*Sigara* sp.	Genus
Arthropoda	Insecta	Hemiptera	Gelastocoridae	Gelastocorinae	*Gelastocoris*	*Gelastocoris oculatus* (Fabricius)	Species
Arthropoda	Insecta	Hemiptera	Gerridae	Rhagodotarsinae	*Rheumatobates*	*Rheumatobates* sp.	Genus
Arthropoda	Insecta	Hemiptera	Gerridae	Gerrinae		Gerrinae	Subfamily
Arthropoda	Insecta	Hemiptera	Gerridae	Trepobatinae	*Trepobates*	*Trepobates* sp.	Genus
Arthropoda	Insecta	Hemiptera	Mesoveliidae		*Mesovelia*	*Mesovelia* sp.	Genus
Arthropoda	Insecta	Hemiptera	Veliidae	Microveliinae	*Microvelia*	*Microvelia* sp.	Genus
Arthropoda	Insecta	Hemiptera	Veliidae	Rhagoveliinae	*Rhagovelia*	*Rhagovelia* sp.	Genus
Arthropoda	Insecta	Megaloptera	Corydalidae	Corydalinae	*Corydalus*	*Corydalus cornutus* (Linnaeus)	Species
Arthropoda	Insecta	Megaloptera	Sialidae		*Sialis*	*Sialis* sp.	Genus
Arthropoda	Insecta	Plecoptera	Leuctridae	Leuctrinae	*Leuctra*	*Leuctra* sp.	Genus

Table 2. Inventory of aquatic macroinvertebrates in the streams at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002.—Continued

[sp., an unidentified species within the listed genus]

Phylum	Class	Order	Family	Subfamily	Genus	Taxon identification	Taxon level
Arthropoda	Insecta	Plecoptera	Perlidae	Acroneuriinae	*Acroneuria*	*Acroneuria* sp.	Genus
Arthropoda	Insecta	Plecoptera	Perlodidae			Perlodidae	Family
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	*Ceratopsyche*	*Ceratopsyche bronta* (Ross)	Species
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	*Ceratopsyche*	*Ceratopsyche cheilonis* (Ross)	Species
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	*Cheumatopsyche*	*Cheumatopsyche* sp.	Genus
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	*Hydropsyche*	*Hydropsyche depravata* group	Genus
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	*Hydropsyche*	*Hydropsyche rossi* Flint, Voshell, and Parker	Species
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptilinae	*Hydroptila*	*Hydroptila armata* (Ross)	Species
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptilinae	*Orthotrichia*	*Orthotrichia* sp.	Genus
Arthropoda	Insecta	Trichoptera	Leptoceridae	Leptocerinae	*Oecetis*	*Oecetis furva* group	Genus
Arthropoda	Insecta	Trichoptera	Leptoceridae	Leptocerinae	*Oecetis*	*Oecetis persimilis* (Banks)	Species
Arthropoda	Insecta	Trichoptera	Leptoceridae	Leptocerinae	*Triaenodes*	*Triaenodes* sp.	Genus
Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilinae	*Pycnopsyche*	*Pycnopsyche* sp.	Genus
Arthropoda	Insecta	Trichoptera	Philopotamidae	Chimarrinae	*Chimarra*	*Chimarra* sp.	Genus
Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropodinae	*Neureclipsis*	*Neureclipsis* sp.	Genus
Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropodinae	*Paranyctiophylax*	*Paranyctiophylax* sp.	Genus
Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropodinae	*Polycentropus*	*Polycentropus* sp.	Genus
Arthropoda	Insecta	Trichoptera	Psychomyiidae	Psychomyiinae	*Lype*	*Lype diversa* (Banks)	Species
Arthropoda	Insecta	Trichoptera	Psychomyiidae	Psychomyiinae	*Psychomyia*	*Psychomyia flavida* Hagen	Species
Arthropoda	Insecta	Lepidoptera	Pyralidae	Nymphulinae	*Petrophila*	*Petrophila* sp.	Genus
Arthropoda	Insecta	Coleoptera	Curculionidae			Curculionidae	Family
Arthropoda	Insecta	Coleoptera	Dryopidae		*Helichus*	*Helichus basalis* LeConte	Species
Arthropoda	Insecta	Coleoptera	Dryopidae		*Helichus*	*Helichus fastigiatus* (Say)	Species
Arthropoda	Insecta	Coleoptera	Dryopidae		*Helichus*	*Helichus lithophilus* (Germar)	Species
Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporinae		Hydroporini	Subfamily
Arthropoda	Insecta	Coleoptera	Dytiscidae	Laccophilinae	*Laccophilus*	*Laccophilus* sp.	Genus
Arthropoda	Insecta	Coleoptera	Elmidae		*Ancyronyx*	*Ancyronyx variegata* (Germar)	Species
Arthropoda	Insecta	Coleoptera	Elmidae		*Dubiraphia*	*Dubiraphia* sp.	Genus
Arthropoda	Insecta	Coleoptera	Elmidae		*Macronychus*	*Macronychus glabratus* Say	Species
Arthropoda	Insecta	Coleoptera	Elmidae		*Optioservus*	*Optioservus trivittatus* (Brown)	Species
Arthropoda	Insecta	Coleoptera	Elmidae		*Stenelmis*	*Stenelmis crenata* (Say)	Species
Arthropoda	Insecta	Coleoptera	Gyrinidae		*Dineutus*	*Dineutus* sp.	Genus

Table 2. Inventory of aquatic macroinvertebrates in the streams at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002.—Continued

[sp., an unidentified species within the listed genus]

Phylum	Class	Order	Family	Subfamily	Genus	Taxon identification	Taxon level
Arthropoda	Insecta	Coleoptera	Haliplidae		*Peltodytes*	*Peltodytes* sp.	Genus
Arthropoda	Insecta	Coleoptera	Helophoridae		*Helophorus*	*Helophorus* sp.	Genus
Arthropoda	Insecta	Coleoptera	Hydrochidae		*Hydrochus*	*Hydrochus* sp.	Genus
Arthropoda	Insecta	Coleoptera	Hydrophilidae		*Berosus*	*Berosus* sp.	Genus
Arthropoda	Insecta	Coleoptera	Hydrophilidae		*Cymbiodyta*	*Cymbiodyta* sp.	Genus
Arthropoda	Insecta	Coleoptera	Hydrophilidae		*Enochrus*	*Enochrus* sp.	Genus
Arthropoda	Insecta	Coleoptera	Hydrophilidae		*Laccobius*	*Laccobius* sp.	Genus
Arthropoda	Insecta	Coleoptera	Hydrophilidae		*Paracymus*	*Paracymus* sp.	Genus
Arthropoda	Insecta	Coleoptera	Hydrophilidae		*Tropisternus*	*Tropisternus* sp.	Genus
Arthropoda	Insecta	Coleoptera	Psephenidae		*Psephenus*	*Psephenus herricki* (DeKay)	Species
Arthropoda	Insecta	Coleoptera	Scirtidae			Scirtidae	Family
Arthropoda	Insecta	Coleoptera	Staphylinidae			Staphylinidae	Family
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	*Probezzia*	*Probezzia* sp.	Genus
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae		*Bezzia/Palpomyia* sp.	Subfamily
Arthropoda	Insecta	Diptera	Ceratopogonidae	Dasyheleinae	*Dasyhelea*	*Dasyhelea* sp.	Genus
Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae	*Atrichopogon*	*Atrichopogon* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Chironomus*	*Chironomus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Cladotanytarsus*	*Cladotanytarsus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Cryptochironomus*	*Cryptochironomus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Cryptotendipes*	*Cryptotendipes* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Dicrotendipes*	*Dicrotendipes* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Micropsectra*	*Micropsectra* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Microtendipes*	*Microtendipes* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Nilothauma*	*Nilothauma* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Paracladopelma*	*Paracladopelma* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Paratanytarsus*	*Paratanytarsus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Paratendipes*	*Paratendipes* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Phaenopsectra*	*Phaenopsectra* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Polypedilum*	*Polypedilum ontario* (Walley)	Species
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Pseudochironomus*	*Pseudochironomus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Rheotanytarsus*	*Rheotanytarsus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Saetheria*	*Saetheria* sp.	Genus

Table 2. Inventory of aquatic macroinvertebrates in the streams at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002.—Continued

[sp., an unidentified species within the listed genus]

Phylum	Class	Order	Family	Subfamily	Genus	Taxon identification	Taxon level
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Stempellinella*	*Stempellinella* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Stenochironomus*	*Stenochironomus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Stictochironomus*	*Stictochironomus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Sublettea*	*Sublettea coffmani* (Roback)	Species
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Tanytarsus*	*Tanytarsus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Tribelos*	*Tribelos* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Xestochironomus*	*Xestochironomus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Brillia*	*Brillia* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Cardiocladius*	*Cardiocladius* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Corynoneura*	*Corynoneura* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Cricotopus*	*Cricotopus bicinctus* group	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Cricotopus*	*Cricotopus trifascia* group	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Eukiefferiella*	*Eukiefferiella* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Nanocladius*	*Nanocladius* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Orthocladius*	*Orthocladius lignicola* Kieffer	Species
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Parakiefferiella*	*Parakiefferiella* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Parametriocnemus*	*Parametriocnemus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Psectrocladius*	*Psectrocladius* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Pseudosmittia*	*Pseudosmittia sp.*	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Rheocricotopus*	*Rheocricotopus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Synorthocladius*	*Synorthocladius semivirens* (Kieffer)	Species
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Thienemanniella*	*Thienemanniella* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Tvetenia*	*Tvetenia* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	*Xylotopus*	*Xylotopus par* (Coquillett)	Species
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Ablabesmyia*	*Ablabesmyia* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Labrundinia*	*Labrundinia* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Larsia*	*Larsia* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Natarsia*	*Natarsia* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Nilotanypus*	*Nilotanypus* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Paramerina*	*Paramerina* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Procladius*	*Procladius* sp.	Genus
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	*Zavrelimyia*	*Zavrelimyia* sp.	Genus

Table 2. Inventory of aquatic macroinvertebrates in the streams at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002.—Continued

[sp., an unidentified species within the listed genus]

Phylum	Class	Order	Family	Subfamily	Genus	Taxon identification	Taxon level
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae		*Thienemannimyia* group sp. (Coffman and Ferrington, 1996)	Subfamily
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae		Pentaneurini	Subfamily
Arthropoda	Insecta	Diptera	Culicidae		*Anopheles*	*Anopheles* sp.	Genus
Arthropoda	Insecta	Diptera	Dixidae		*Dixella*	*Dixella* sp.	Genus
Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae	*Hemerodromia*	*Hemerodromia* sp.	Genus
Arthropoda	Insecta	Diptera	Psychodidae			*Pericoma/Telmatoscopus* sp.	Family
Arthropoda	Insecta	Diptera	Simuliidae		*Simulium*	*Simulium* sp.	Genus
Arthropoda	Insecta	Diptera	Stratiomyidae	Stratiomyinae	*Odontomyia*	*Odontomyia* sp.	Genus
Arthropoda	Insecta	Diptera	Tabanidae		*Chrysops*	*Chrysops* sp.	Genus
Arthropoda	Insecta	Diptera	Tabanidae		*Tabanus*	*Tabanus* sp.	Genus
Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	*Antocha*	*Antocha* sp.	Genus
Arthropoda	Insecta	Diptera	Tipulidae	Limoniinae	*Hexatoma*	*Hexatoma* sp.	Genus
Arthropoda	Insecta	Diptera	Tipulidae	Tipulinae	*Tipula*	*Tipula* sp.	Genus
Arthropoda	Insecta	Diptera				Nematocera	Order

[1]The author's name follows the species name without punctuation if the species, when originally described, was assigned to the same genus in which it appears; if the species was originally described in another genus, the author's name appears in parentheses.

Table 3. Ephemeroptera, Plecoptera, Trichoptera (EPT) Richness Index values, listed by sample type and year for samples collected at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana, September 2000–August 2002.

[--, no sample collected]

Sampling site	Site name	EPT Richness Index value	
		Surber samples collected in 2000 (duplicate sample)	Qualitative samples collected in 2002 (duplicate sample)
A1	Mud Creek in Common Impact Area	10 (9)	--
A2	Prince Creek in Common Impact Area	10	--
A3	Nineveh Creek in Common Impact Area	6	--
A4	Unnamed tributary to Nineveh Creek at Mauxferry Road	11	5 (10)
A5	Nineveh Creek at Mauxferry Road	7	11
A6	Mud Creek at Mount Moriah Road	7	--
A10	Muddy Branch at Bearrs Road	8	8
B1	Prince Creek at Wilder Road	7	--
B2	Nineveh Creek at Hospital Road	7	11
B3	Saddle Creek at Mount Moriah Road	8	8
B4	Nineveh Creek at Wallace Road	8	--
B5	Lick Creek at Mauxferry Road	8	6
B6	Catherine Creek at Reservation Boundary Road	7	8
E5	Nineveh Creek at Range Line Road near Kansas Cemetery	--	12
E7	Unnamed tributary to Nineveh Creek at County Line Road	--	8
M1	Sugar Creek downstream from Hospital Road	--	15 (14)

Hilsenhoff Biotic Index

The Hilsenhoff Biotic Index (HBI) (Hilsenhoff, 1987 and 1988) provides a means of assessing water quality at sites where macroinvertebrate samples have been collected and the number of individuals in each taxon has been identified. In this method, individual taxa are assigned pollution-tolerance values based on the taxon's tolerance to organic pollution. These pollution-tolerance values range from 0 to 10, where 0 applies to those taxa that are least tolerant, and 10 applies to those taxa that are most tolerant. When evaluating water-quality conditions at a site, only those taxa with assigned tolerance values are included in the analysis.

The pollution-tolerance values used in this investigation came from tables published by Hilsenhoff (1987). To calculate an HBI from a macroinvertebrate sample, the number of individuals within a given taxon is multiplied by the tolerance value for that taxon. The resultant products then are summed and divided by the number of individuals in the sample that contributed to the calculated products. This calculation procedure produces an HBI that is a tolerance score for the sample weighted by the number of individuals in each contributing taxon.

The calculated HBI scores can range from 0 to 10. An HBI score at the high end of the scale indicates that the invertebrate community is dominated by pollution-tolerant organisms and indicates that the site has been subjected to organic pollution. In contrast, a low score indicates that organisms intolerant of organic pollution dominate the invertebrate community and implies that water quality at the site is good. A widely recognized rating system used to evaluate HBI scores is outlined in table 4.

In this investigation, HBI scores were calculated for the three artificial-substrate samples collected in 2002 (table 5). The artificial-substrate samples collected at sites A5 and B2 produced HBI scores (5.6 and 5.7, respectively) that suggest water quality at these two sites is fair. The HBI score calculated for site B3 (7.9) suggests that water quality at this site is poor.

Chemical analysis of water samples collected at site B3 in 2000 by Risch (2004) showed no signs of organic pollution. Therefore, the high HBI score calculated for this site may not be a true indicator of poor water quality but a reflection of the small drainage area (2.95 mi^2) of this site. Field observations indicate that flow at this site periodically approaches zero. On the day (August 12, 2002) that the artificial-substrate sample was retrieved at site B3, water at this site was found only in isolated pools, and flow between the pools was through streambed gravel deposits.

Invertebrate Community Index

The Ohio Environmental Protection Agency developed the Invertebrate Community Index (ICI) to aid in the evaluation of surface-water-quality conditions at sites where macroinvertebrate samples have been collected (Ohio Environmental Protection Agency, 1987 and 1989). In the Ohio ICI method, a total of 10 metrics are calculated, with each metric providing a measure of an isolated aspect of environmental quality. The Indiana Department of Environmental Management is developing a similar method to evaluate macroinvertebrate data but, at present (2004), no equivalent method has been accepted for Indiana streams. Because geologic and land-use conditions within the study area are similar to conditions in neighboring Ohio, it is appropriate to apply the Ohio ICI methodology to the macroinvertebrate data collected at Camp Atterbury.

Tertuliani (1999) provides a detailed discussion of how each of the 10 metrics relates to environmental-quality conditions at a site. Metrics 1 through 9 are calculated from artificial-substrate samples, whereas metric 10 is calculated from qualitative samples. Each metric receives an ICI score, ranging from 0 to 6, based on the metric values generated from the macroinvertebrate data. The ICI score for a site is generated by summing the individual metric scores.

In 2002, artificial-substrate and qualitative samples were collected at three sites at Camp Atterbury: A5, Nineveh Creek at Mauxferry Road; B2, Nineveh Creek at Hospital Road; and B3, Saddle Creek at Mount Moriah Road (fig. 2 and table 6).

To evaluate surface-water-quality conditions with ICI scores, the Ohio Environmental Protection Agency (1987) developed a method that divides Ohio into ecoregions and provides a statistical summary of ICI scores within each ecoregion and water-quality category. That agency traditionally has recognized four water-quality categories—exceptional, good, fair, and poor.

Sites A5 and B2 are within the Eastern Corn Belt Plains (ECBP) ecoregion and are best evaluated by the standards recognized for that ecoregion. The ICI score calculated for site A5 was 42, and the ICI score calculated for site B2 was 36. Based on data for the ECBP ecoregion (Ohio Environmental Protection Agency, 1987), surface-water quality at these sites is described as good.

Site B3 is within the Interior Plateau (IP) ecoregion; the macroinvertebrate data collected at this site generated an ICI score of 26. For data collected in the IP ecoregion in Ohio (Ohio Environmental Protection Agency, 1987), ICI scores for sites with good water quality range from 30 to 56. For sites with fair water quality, ICI scores range from 8 to 18. Therefore, the ICI score of 26 calculated for site B3 was below the threshold for good water quality but was well above the scores for sites with fair water quality. Site B3 has a small drainage area (2.95 mi^2) compared to other sites, and flow at this site periodically approaches zero. Therefore, the lower ICI score calculated for site B3 may represent a physical stress on the macroinvertebrate community and not a chemical stress associated with degraded water quality.

Summary

At the request of the Indiana Army National Guard Environmental Protection Office, macroinvertebrate samples were collected by the USGS at 16 sites within the Camp Atterbury study area between September 2000 and August 2002. The data were combined, and duplicate and ambiguous taxa were removed to develop an inventory of macroinvertebrates in the streams at Camp Atterbury. This inventory and the taxonomic list produced for each site provide base-line data to evaluate environmental changes if future macroinvertebrate samples are collected at Camp Atterbury or if physical changes are made within or upstream from the study area.

In this inventory, 173 distinct taxa have been identified; of those, 156 distinct taxa are from the Phylum Arthropoda. The orders with the greatest number of identified distinct taxa are Diptera, Coleoptera, Ephemeroptera, and Trichoptera.

One of the species identified in the Camp Atterbury samples was *Cordulegaster maculata* Selys (a twin-spotted spiketail dragonfly). This species, while not listed as endangered or threatened at the State or Federal level, is recognized by IDNR as being rare enough to warrant special concern (Indiana Department of Natural Resources, 2002).

Three biotic indices were calculated to evaluate what the macroinvertebrate data may indicate regarding surface-water-

Table 4. Hilsenhoff Biotic Index score ranges and water-quality-evaluation ratings (taken from Hilsenhoff, 1987).

Hilsenhoff Biotic Index score range	Water-quality-evaluation rating	Degree of organic pollution
0.00 – 3.50	Excellent	No apparent organic pollution.
3.51 – 4.50	Very good	Possible slight organic pollution.
4.51 – 5.50	Good	Some organic pollution.
5.51 – 6.50	Fair	Fairly significant organic pollution.
6.51 – 7.50	Fairly poor	Significant organic pollution.
7.51 – 8.50	Poor	Very significant organic pollution.
8.51 – 10.00	Very poor	Severe organic pollution.

Table 5. Hilsenhoff Biotic Index scores, water-quality-evaluation ratings, and drainage area for three sites where artificial-substrate samples were collected in 2002 at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana.

Site	Site name	Hilsenhoff Biotic Index score	Water-quality-evaluation rating	Drainage area (square miles)
A5	Nineveh Creek at Mauxferry Road	5.6	Fair	35.3
B2	Nineveh Creek at Hospital Road	5.7	Fair	8.82
B3	Saddle Creek at Mount Moriah Road	7.9	Poor	2.95

Table 6. Metric values and Invertebrate Community Index (ICI) scores calculated from macroinvertebrate data collected in 2002 at the U.S. Army Atterbury Reserve Forces Training Area near Edinburgh, Indiana.

[<, less than; EPT, taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera]

Metric	Metric value (ICI score), by site		
	A5	B2	B3
1. Total number of taxa	43 (6)	29 (2)	31 (4)
2. Number of mayfly taxa	6 (4)	5 (4)	3 (2)
3. Number of caddisfly taxa	3 (4)	3 (4)	3 (4)
4. Number of Diptera taxa	25 (6)	15 (4)	17 (4)
5. Percent mayflies	23 (4)	30 (6)	<1 (2)
6. Percent caddisflies	6 (4)	1 (2)	1 (2)
7. Percent Tanytarsini midges	10 (2)	1 (2)	1 (2)
8. Percent other Diptera and non-insects	54 (2)	66 (0)	93 (0)
9. Percent tolerant organisms	<1 (6)	<1 (6)	24 (2)
10. Number of Qualitative EPT taxa[1]	11 (4)	11 (6)	8 (4)
Invertebrate Community Index (ICI)	(42)	(36)	(26)

[1]For this metric, the ICI score is a function of the drainage area at the sampling site; therefore, two sites with identical metric values (in this case 11) may not produce identical ICI scores.

quality conditions at Camp Atterbury—the Ephemeroptera, Plecoptera, Trichoptera Richness Index; the Hilsenhoff Biotic Index; and the Invertebrate Community Index. The composition of the macroinvertebrate community at a site is used in these indices to provide insight regarding surface-water quality.

The Ephemeroptera, Plecoptera, Trichoptera Richness Index is a measure of the abundance of these three pollution-sensitive insect orders within a sample. The EPT values calculated for the macroinvertebrate samples collected at Camp Atterbury range from 5 to 15, with more than 75 percent of the values within the range of 7 to 11. The lowest value of 5 came from a qualitative sample collected at site A4 in 2002. This low value could be taken as an indicator of degraded water quality at this site compared to the other sites. At site A4, however, a Surber sample collected in 2000 produced an EPT value of 11, and a duplicate sample collected in 2002 produced an EPT value of 10. Therefore, the low value generated from the 2002 qualitative sample at site A4 seems to have resulted from natural variation within the macroinvertebrate community or the sampling and analysis process and may not be a true indicator of poor water quality.

The Hilsenhoff Biotic Index evaluates surface-water quality at a site, using pollution-tolerance values of individual taxa identified in a sample. For Camp Atterbury, Hilsenhoff Biotic Index scores were calculated for the three artificial-substrate samples collected in 2002. Samples collected at sites A5 and B2 indicated fair water quality, whereas the sample collected at site B3 indicated poor water quality.

The Invertebrate Community Index was developed to aid in the evaluation of surface-water-quality conditions at sites where artificial-substrate and qualitative macroinvertebrate samples have been collected. This index was applied to evaluate environmental conditions at the three sites where artificial-substrate samples were collected in 2002. Results derived from samples collected at sites A5 and B2 indicate good water quality, whereas the Invertebrate Community Index score calculated for site B3 placed water quality between the good and fair categories.

The Hilsenhoff Biotic Index score and the Invertebrate Community Index score calculated for site B3 indicate that water-quality conditions are slightly degraded. The calculated scores, however, simply may reflect the relatively small drainage area of this site compared to other sampling sites in the study area and that flow periodically approaches zero.

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