ILLINOIS
RIVERWATCH
NETWORK

*Stream
Monitoring
Manual*

Illinois
Department of
Natural Resources

Jim Edgar, Governor
Brent Manning, Director

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RIVERWATCH
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IDNR/EEA-95/03

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Table of Contents

Section One: The Illinois RiverWatch Network

Chapter I. A Partnership for Illinois Watersheds	1
Why Illinois needs volunteer stream monitors	1
How the Illinois RiverWatch Network monitors streams	2
Citizen Scientist Stream Monitoring Program	2
RiverWatcher Stream Monitoring Program	2
Chapter II. Monitoring Illinois Streams	3
What is stream monitoring?	3
Biological monitoring	4
What are benthic macroinvertebrates?	5
Life cycles of benthic macroinvertebrates	5
Habitat assessment	6
Streams, watersheds, and drainage basins	6
Streams	6
Watersheds and drainage basins	6
Stream channels	6
Riparian zones	6
Stream bottoms	7
Riffles	7
Runs	7
Pools	7
Chapter III. Getting Started	9
Determining the legal description of the monitoring site	9
What the Group Leader must do	10
Equipment you will need	11
Advance observation of the site	12
Safety procedures	12
Data management and quality assurance	12
Where to find help	13

Section Two: The Citizen Scientist Stream Monitoring Program

Chapter IV. How to Conduct a Citizen Scientist Level Habitat Assessment	14
Assessing your site	14
Marking off your site	14
Making a Site Sketch	15
Filling out the Habitat Assessment Data Sheet	16
Filling out the Habitat Parameter Sheet	18
Channel morphology and flow characteristics	18
Stream banks	18
Watershed features	18
Aesthetics	19
Habitat rating	19

Chapter V. How to Conduct a Citizen Scientist Level Macroinvertebrate Community Assessment	20
How to assess a stream's macroinvertebrate community	20
Riffle sampling	21
Leaf pack sampling	22
Sampling snag areas, tree roots, and submerged logs	22
Sampling undercut banks	22
Sampling sediments	22

Chapter VI. How to Interpret Citizen Scientist Level Stream Monitoring Data	23
Subsampling procedures	23
Metrics	25
Filling out the Macroinvertebrate Data Sheet	26
Identifying the organisms	27
Calculating the biotic indices	28
Problems and comments	28

Section Three: The RiverWatcher Stream Monitoring Program

Chapter VII. How to Conduct a RiverWatcher Level Habitat Assessment	29
Measuring water quality using macroinvertebrates	29
Filling out the Illinois RiverWatcher Stream Monitoring Data Sheet	29
Site identification	29
Habitat Assessment	30

Chapter VIII. How to Conduct a RiverWatcher Level Macroinvertebrate Community Assessment	32
Benthic macroinvertebrates as pollution indicators	32
Group I: Pollution-intolerant	32
Group II: Moderately pollution-intolerant	32
Group III: Fairly pollution-tolerant	33
Group IV: Pollution-tolerant	33
Illinois RiverWatcher macroinvertebrate assessment procedures	34
Riffle sampling	34
Leaf pack sampling	35
Sampling snag areas, tree roots, and submerged logs	35
Sampling undercut banks	36
Sampling sediments	36

Chapter IX. How to Interpret RiverWatcher Level Stream Monitoring Data	37
Subsampling procedures	37
Macroinvertebrate tally	39
What to do if you find poor water quality	39
What to do with your information	39

Appendices

Appendix A. Factors That Affect Stream Quality in Illinois	40
Appendix B. The Life History of Macroinvertebrates	42
Appendix C. Macroinvertebrate Identification Key	50
Appendix D. Macroinvertebrate Identification Reference Guide	72
Appendix E. Glossary	74
Appendix F. Suggested Literature and Sources of Information	78
Appendix G. Biological Equipment Suppliers	79
Appendix H. Data Sheets	81

Chapter I A Partnership For Illinois Watersheds

The time is surely at hand when the people of Illinois will learn to appreciate and develop this great gift of nature in the various directions in which it may be made to serve their interests and their pleasures.

—Stephen A. Forbes, 1919

Founder and First Chief of the Illinois Natural History Survey

Welcome to the Illinois RiverWatch Network!

The State of Illinois is considered a "water-rich state." Three major rivers, the Mississippi, the Ohio, and the Wabash, border the state. Another 900 streams can be found within the state's borders. A stream is a combination of all of its physical, chemical, and biological characteristics. These characteristics change over time in response to both natural and human-caused events. For example, human activities on the land near a stream (such as construction and farming) affect the ecosystem of the stream itself. By observing the number and type of *organisms* living in a stream and relating that information to the condition of the surrounding *habitat*, the extent to which human activities have affected a stream can be measured.

Why Illinois needs volunteer stream monitors

State agencies such as the Illinois Environmental Protection Agency and Illinois Department of Natural Resources are charged to protect Illinois streams. Unfortunately, these agencies have only enough time and resources to monitor a limited number of streams each year. Of the state's 32,190 total *stream miles*, only 14,159 — 44 percent—were monitored by state agencies in 1992-93. Some Illinois streams are monitored only once every five years.

Illinois' state agencies need many additional "eyes" if they are to observe changes in the state's stream environments year by year. Volunteer monitors can collect vital information about the environment that otherwise would never be discovered. Volunteer monitoring programs also give citizens, scientists, and government agencies at various levels a chance to communicate about environmental issues.

The Illinois RiverWatch Network, or IRWN, is a partnership among Illinois citizens to monitor, restore, and protect the state's rivers and streams. It was established in April 1993 under an initiative of Lieutenant Governor Bob Kustra. The program is coordinated through the Illinois Department of Natural Resources.

IRWN has three primary objectives:

- to educate and inform Illinois citizens about the ecology and importance of Illinois streams;
- to provide an opportunity for Illinois citizens to become involved in protecting the health of local streams; and
- to provide consistent high-quality data which can be used by scientists to measure how the quality of stream ecosystems is changing over time.

Any citizen of Illinois can take part in the Illinois RiverWatch Network's training workshops and monitoring activities. By learning to use scientific methods in the field, you will provide valuable information concerning the environmental *integrity* of the state's stream systems. You will also gain knowledge which will increase your respect and enjoyment of Illinois' natural resources.

How the Illinois RiverWatch Network monitors streams

This manual teaches volunteers like you about the ecology of *watersheds*. The manual also explains how to assess both stream biological communities and stream habitats for the Illinois RiverWatch Network. Generally, the biological monitoring procedures described in this manual are best suited for wadeable, small- to medium-size streams. Larger streams and rivers will be included in future monitoring efforts by the Illinois RiverWatch Network.

Two types of stream monitoring programs are organized through IRWN. Both of them - the Citizen Scientist Stream Monitoring Program and the RiverWatcher Stream Monitoring Program - are described in this manual. Both use the same techniques to sample stream life and describe stream conditions, although they use different methods to analyze the data that is collected.

Citizen Scientist Stream Monitoring Program

Volunteers in the Citizen Scientist Stream Monitoring Program will examine the same stream monitoring sites at the same time each year. This program of annual assessments is designed to provide *trend data* to measure changes in these sites over extended periods of time. It is described in detail in Section Two of this manual.

The annual data collected by volunteer *Citizen Scientists* will be entered into a statewide database accessible through Ecoforum, an electronic bulletin board system (BBS) maintained by the Illinois Department of Natural Resources. From the Ecoforum BBS, the data will be retrieved to be validated and analyzed. The information will also be presented in an annual report available to all interested persons.

By having Citizen Scientists report all of their information to one source for validation and analysis, we assure that the information is accurate before any decisions are made concerning the condition of Illinois streams. If the data indicate potential problems at any sampling site, IRWN will forward that information to the proper government agency for their review.

RiverWatcher Stream Monitoring Program

The RiverWatcher Stream Monitoring Program (described in detail in Section Three of this manual) asks volunteers to sample at stream sites at least two times a year. This more limited seasonal data will be maintained by RiverWatcher volunteers, who will report any changes in the quality of their stream to their respective IRWN regional coordinator.

Chapter II Monitoring Illinois Streams

*There is a phenomenal resiliency in the mechanisms of the earth.
A river or lake is almost never dead. If you give it the slightest chance
by stopping pollutants from going into it, then nature usually comes back.*

—Rene Dubos, 1981

What is stream monitoring?

As a volunteer of the Illinois RiverWatch Network you will study both the organisms of streams (biological monitoring, described below) and their surrounding habitat (habitat assessment, also described below).

Biological monitoring techniques sample certain kinds of organisms that live in streams. *Habitat assessments* describe conditions in the stream itself, including the areas immediately surrounding the stream. Information gained from habitat assessments help to explain changes in stream life identified by biological monitoring. In much the same way, the number and variety of the organisms present in a stream is a useful measure of the health of that habitat.

Habitat assessments also are useful for classifying streams and for documenting how they change over time. For example, many streams in Illinois have had their channels straightened or dammed and their banks cleared. Such changes have destroyed habitats both within and alongside streams. The loss of these habitats has led to the loss to the state of many aquatic organisms, including whole species of fish, freshwater mussels, crayfish, and aquatic insects. Habitat assessments catalog the nature and extent of these kinds of changes.

The data collect will give you an immediate assessment of the condition of a stream at the time you sampled it. Data collected over a period of five years or more also begin to show long-term trends in the conditions of the stream. Scientists need both sets of information to ascertain the quality of the environment.

Here's how it works. Let's say that IRWN Citizen Scientists have studied Stream A for five years. The volunteers used the same methods in sampling at the same sites on the stream during that time. Each year the Citizen Scientists found the stream to be in good condition, according to accepted criteria (see Figure 1, next page).

Figure 1. A demonstration of how volunteer-collected data can provide information concerning stream quality.

Looked at together, however, the five years' worth of data tell a different story. As the graph in Figure 1 shows, the overall number of organisms in the stream is decreasing at a slow and steady rate. The data also show that 1) organisms that can tolerate pollution are becoming more common compared to organisms that are intolerant of pollution; 2) that the stream channel is more straight (or channelized) over time because of the local construction of homes; 3) that the flow of the water in the stream is growing faster and; 4) that the water is more cloudy, or turbid.

Biological monitoring

Biological monitoring focuses on the organisms living in a stream. Scientists want to observe changes in the number of types of organisms present in a stream system to determine the richness of the biological community there. They also want to observe the total number of organisms present, which is a measure of the density of the biological community present. If community richness and community density change over time, it may indicate the effects of human activity on the stream.

Biological stream monitoring is based on the fact that different species react to pollution in different ways. *Pollution-sensitive organisms* such as mayflies, stoneflies, and caddisflies are more susceptible than others to the effects of physical or chemical changes in a stream. *Pollution-tolerant organisms* such as midges and worms can cope with adverse conditions more easily.

The presence or absence of such *indicator organisms* is an indirect measure of *pollution*. When a stream becomes polluted, pollution-sensitive organisms decrease in number or disappear—evidence that the stream has problems. Pollution-tolerant organisms increase in variety and number. Such changes in the composition of the stream's biological community compared to a stream known to have good water quality also suggest that the stream ecology is upset.

What are benthic macroinvertebrates?

Benthic macroinvertebrates are animals that are big enough (*macro*, from the ancient Greek word for long) to see with the naked eye. They also lack backbones (*invertebrate*) and live at least part of their life cycles in or on the bottom (or benthos, another Greek word) of a body of water.

Macroinvertebrates include aquatic insects (such as mayflies, stoneflies, caddisflies, midges, and beetles), snails, worms, freshwater clams, mussels, and crayfish. Some benthic macroinvertebrates, like midges, are small and may grow no larger than 1/2 inch in length. Others, like the three ridge mussel, can be over ten inches long.

In addition to being sensitive to changes in the stream's overall ecological integrity, benthic macroinvertebrates offer other advantages to scientists looking for indications of stream pollution.

- They are relatively easy to sample. Benthic macroinvertebrates are abundant and can be easily collected and identified by trained Citizen Scientists or other volunteers.
- They are relatively immobile. Animals such as fish can escape toxic spills or degraded habitats by swimming away from them. Migratory animals may spend only a small portion of their life cycle in a particular stream before moving on to larger rivers, wetland areas, or other streams. Changes in populations of such mobile species thus do not necessarily signal changes in the sampled stream. In contrast, most macroinvertebrates spend a large part of their life cycle (often more than a year) in the same part of a stream, clinging to surfaces so as not to be swept away with the water's current. When such stable communities change over time, it often indicates problems in the stream.
- They are continuous indicators of environmental quality. The composition of benthic macroinvertebrate communities in a stream reflects the stream's physical and chemical conditions over time. In contrast, monitoring for certain water qualities (such as the amount of oxygen dissolved in it) describes the condition of the water only at the time the samples were taken.
- They are a critical part of the aquatic food web. Benthic macroinvertebrates form a vital link in the food chain that connects aquatic plants, algae, and leaf litter to the fish species of our rivers and streams. Therefore, the condition of the benthic macroinvertebrate community reflects the stability and diversity of the larger aquatic food web.

Life cycles of benthic macroinvertebrates

Most of the benthic macroinvertebrates that you will encounter are aquatic insects. Aquatic insects have complex life cycles and live in the water only during certain stages of their development.

Aquatic insects may go through one of two kinds of development, or *metamorphosis*. Aquatic insects that have *complete metamorphosis* undergo four stages of development. They lay their eggs in water, and they hatch into larvae that feed and grow in the water. (These larval insects do not resemble the adult insects; many appear worm-like.) The fully-grown larvae develop into pupae that do not feed while they develop the many organs and structures they need as adults, such as wings and antennae. The fully-formed adults of some species (midges and flies, for example) emerge from the water and live in the habitat surrounding the stream. Others, such as riffle beetles, continue to live in the stream itself. After mating, adults of all aquatic insect species lay eggs in the water, beginning the life cycle all over again.

Aquatic insects that have *incomplete metamorphosis* undergo only three stages of development. The eggs hatch into *nymphs* (which are referred to as larvae by many authorities). Nymphs feed and grow in the water while they develop adult structures and organs; they do this in stages, or instars, until they emerge as adults. The life cycle begins again when eggs are laid in the water by the adults.

Appendix B describes the life histories of many of the aquatic insects that you will come across during your sampling. Appendix B also provides sketches of the larvae, nymph, and adult stages of these insects so you can see how they look alike or different.

Benthic macroinvertebrates have both common names and *scientific names*. Because common names may vary, this manual uses scientific names for the most part. Common names are used where they can help in the identification process.

Scientific names are commonly derived from Latin or Greek words and reflect the organism's place in the system devised by biologists to classify nature. Each group in this system is called a *taxon*. The various taxa are arranged in *taxonomic ranks* from the largest group to the smallest—*kingdom, phylum, class, order, family, genus, and species*.

For example, the Class Insecta includes all of the insects and is made up of many orders, one of which—the Order Ephemeroptera—includes all mayflies. Volunteers in the River Watcher program will identify benthic macroinvertebrates to the level of Order; volunteers in the Citizen Scientist Stream Monitoring program will learn to identify them more specifically, to the level of Family.

Habitat assessment

Streams, watersheds, and drainage basins

Stream habitats are complex. Assessing their quality requires understanding their many parts, including the following.

Streams. Streams may begin when water flows from ponds or lakes, or they may arise from below-ground, from springs or seepage areas. Such beginner streams are small, and are referred to as *headwater streams*. Headwaters flow toward lower-lying land downstream; as they go, they converge with one or more other headwater streams to form medium-size streams. Medium-size streams then flow and converge with other streams (either headwater or medium-size streams) and form rivers.

Watersheds and drainage basins. Streams thus collect water from the landscape surrounding them. The area of land from which water drains into a given stream is referred to as that stream's watershed. A river's *drainage basin* is a watershed on a bigger scale—that area of land, including watersheds of headwater streams and medium-size streams, from which all of the river's water drains. Since all of the water in a drainage basin flows to a common point, conditions in the headwater streams affect the larger streams and rivers fed by them. Monitoring the conditions in headwater streams thus gives clues to conditions downstream.

Stream channels. The part of a stream in which the water flows is the *stream channel*. The physical characteristics of the stream channel will differ depending on the topography and geology of the area around it. Often the same stream will change at different points along its length as the shape and makeup of the surrounding land changes. Such a stream may contain successive segments (or *reaches*) that are quite different from each other.

Riparian zones. The riparian zone refers to the area of land which is connected with or immediately adjacent to the banks of a stream. The riparian zone includes the stream banks, wetlands and those portions of floodplains and valley bottoms that support *riparian vegetation*, or those plants which are found in the riparian zone. The lower stream banks, where the land meets the water, may be home to *emergent vegetation*—plants that are rooted in the soil below the water, but grow to heights above the water level. The higher upper stream banks may have plants that are rooted in the soil, but that can withstand periodic flooding. When the riparian zone is periodically flooded after heavy rains, food, water, and *sediment* are carried into the stream from surrounding landscape. Plants growing within the riparian zone hold the soil of the stream's banks in place helping to prevent erosion. The plants also provide habitat for macroinvertebrates and other organisms, such as fish, during floods.

Riparian vegetation, such as trees and shrubs also influence the amount of sunlight and heat reaching the stream channel. If a stream has no trees or shrubs to shade the water, temperatures would become too high for most macroinvertebrates to survive. Too much shade would block all sunlight, preventing any algae or aquatic plants to grow in the stream. The amount of shading provided by the trees and shrubs in the riparian zone help to provide the correct amount of heat and light to the stream for the existence of macroinvertebrates, fish and plants.

Figure 2. Diagram of stream habitats.

Stream bottoms

In Illinois, the substrate, or bottom, of all stream reaches is either rocky or soft. The bottom along a soft bottom reach is composed of sand, soft mud, or a mixture of both. The bottom of a rocky bottom reach consists of rocks or gravel. The habitat assessment procedures of both Illinois RiverWatch Network monitoring programs are designed for either rocky bottom or soft bottom reaches.

A *rocky bottom reach* is composed of three different but interrelated habitats known as riffles, pools, and runs.

Riffles are areas of turbulent water created by shallow water passing through or over stones or gravel of fairly uniform size. Riffles are excellent places to collect macroinvertebrates. The gravel and rocks of a riffle create nooks and crannies that macroinvertebrates can cling to, crawl under, and hide behind. Stones in sunlit areas of a riffle are often covered with algae and mosses on which certain stream organisms feed. Leaves and other plant material drifting in the stream current also provide food for some macroinvertebrates in riffle areas. As water tumbles over rocks and gravel in a riffle, oxygen from the air is mixed with it, providing the high levels of *dissolved oxygen* needed by many benthic macroinvertebrates.

Runs are stretches of quieter water commonly found between riffles and pools in larger streams and rivers. Runs have a moderate current and are slightly deeper than riffles.

Pools are found both upstream and downstream from riffles. Pools are deeper parts of the stream with relatively slower-moving water. Water in pools differs from the water in other stretches of a river in its chemistry, depth, and speed of current. Pools are catch basins of organic materials. As the current enters a pool it slows down; as it no longer has the energy to carry it, the heavier part of its load of sediment drops to the bottom. Pools usually have larger organisms living in them that have adapted to these different habitats. Crayfish for example feed on the organic matter that collects in the bottoms of pools.

As noted, riffles, runs, and pools are interrelated habitats. The waters of a pool are affected by what occurs in upstream riffles, and the waters of the riffles are affected by upstream pools. Although pools, runs, and riffles are more or less distinct environments, many organisms inhabit all of them. (Fish, for example, can move among all three.) Some animals of the riffles are carried by the current to downstream pools and/or runs. Many organisms of rocky bottom reaches find food in the riffles of a stream but take shelter in its pools.

Figure 3. Illustration of a rocky bottom reach of a stream.

Riffle-run-pool habitats do not exist in *soft bottom reaches*. Some macroinvertebrates in soft bottom reaches burrow into the sediment of the stream. (Midge larvae and worms do this, for example). Others live in or on submerged and floating logs, submerged roots, vegetation, rip rap along the shore line, or in any leaf or organic debris.

Figure 4. Illustration of a soft bottom reach of a stream.

Chapter III Getting Started

*If we could first know where we are, and whither we are tending,
we could then better judge what to do and how to do it.*

—Abraham Lincoln, 1858

All Citizen Scientist and RiverWatcher groups will be assigned a numbered monitoring site by the Illinois RiverWatch Network Regional Coordinator. This site will be accessible by a bridge. In addition to convenience of access, IRWN sites are chosen to ensure that no single site is over-sampled and that monitoring will not disturb habitat that is critical to endangered species.

If the volunteer group prefers to monitor a site of its own choosing, inform the Regional Coordinator or the IRWN Program Coordinator. Your preferred site will be included in the program.

Determining the legal description of the monitoring site

An accurate legal description of the study site must be determined and entered on the data sheets provided to record information collected in the field. When the volunteer monitoring data is submitted to the Illinois RiverWatch Network, this information will be used to make a permanent record of where the data was obtained. The site's legal description should also be recorded in a permanent place where it can be found easily, such as in the volunteer field book or on the cover of your manual.

The legal description of the study site will be determined only once. Here's how:

Find the stream's name as designated by the U.S. Geological Survey. The stream names used by the USGS should be used for all Illinois RiverWatch Network activities. Stream names shown on county road maps are often inaccurate and should not be relied upon.

Learn which USGS map includes the location of the stream reach you wish to monitor. USGS topographic maps are highly detailed. Both 15-minute and 7 1/2-minute maps are available. The USGS's 7 1/2-minute "topo" map, for example, shows terrain at a scale of 1:24,000. The Index of Topographic Maps of Illinois divides the state into quadrangles, or "quads", based upon map scale. The smallest squares on the index map indicate the 7 1/2-minute quadrangle maps. The 7 1/2-minute quads are identified by the name of a city, town, or some prominent natural feature within it. Use the index map to find the 7 1/2-minute quad in which your monitoring site is located.

Order the map needed. Call or write the Illinois Geological Survey at Natural Resources Building, 615 E. Peabody, Champaign, IL 61820 (217/333-4747; fax 217/333-2830). When ordering, be sure to indicate the name of the map, and that it should be a 7 1/2-minute map. As of 1993, all 7 1/2-minute quad maps cost \$3.00 each.

Determine the township, range, and section number of the one-square-mile block containing your site. First locate the study site on the 7 1/2-minute quad map. Note that each 7 1/2-minute topographic quadrangle map represents an area of 36 square miles, divided into townships and sections, the latter being squares one square mile in area.

Each square-mile block is designated by a township number, a range number, and its own section number. Townships are measured north-south; ranges are measured east-west. To find the township and range of the block on which the site is located, look to the edges of the map. The township numbers are printed in red on the sides of the map, and range numbers are printed in red along the top and bottom of a 7 1/2-minute map. Section numbers are printed in red and are located in the middle of each square-mile block.

Determine the quarter section of your site. After you have determined the township, range, and section number of the square-mile block containing the study site, outline that block with a pencil or pen. Now divide that block into a northwest quarter (NW), a northeast quarter (NE), a southwest quarter (SW), and a southeast quarter (SE). Determine which quarter contains the site and include this quarter section in the legal description of the study site. (See the example below).

Record the legal description of your study site. The legal description of the study site will need to be recorded in two places. Place this information where it can easily be found, such as on the inside cover of the manual or field book. Write down the quarter section of the block first, followed by the block's section number and the range and township numbers (see the figure below for an example). The legal description of the study site will also be listed in the Illinois RiverWatch Site Identification Database. To add the study site to the Illinois RiverWatch Site Identification Database, simply fill out the Site Identification Sheet found in Appendix H Data Sheets. Mail the completed Site Identification Sheet to the Illinois RiverWatch Citizen Scientist Stream Monitoring Program Quality Assurance Officer (Forbes Biological Research Station, 17500 E CR 1950 N, P.O. Box 590, Havana, IL 62644, 309-543-3950). Citizen Scientist Level stream monitoring data will only be accepted from study sites which have been listed in the Site Identification Database.

Figure 5. How to determine the legal description of your sample site.

The above diagram is only part of a U.S.G.S. topographic map. Notice that Section # 25 has been outlined and divided into 4 equal parts. A hypothetical sample site is circled on the map. The range and township numbers are found on the edges of the map in red ink. The legal description of this site is SW 1/4 of Section 25, Range 8 West (R.8W.) and Township 20 North (T.20N.).

What the Group Leader must do

Each group of IRWN volunteers must appoint a leader who will be responsible for filling out, storing, and handling all monitoring paperwork, such as maps and field data sheets. The Group Leader must also:

- Obtain permission from land owners (public or private) before the group enters property.
- Follow your organization's procedures for waiver of liability. Adults and parents of minor children should sign liability waiver forms before undertaking any monitoring activities.
- Receive official Illinois RiverWatch Network training and become familiar with the field data sheets before beginning any monitoring activities.
- Verify all data collected by the group before it is entered into the database, or before it is turned in to a regional coordinator.

The Illinois Department of Natural Resources does not require Illinois RiverWatch Network volunteers to obtain collection permits for the collection of stream macroinvertebrates. It is very important however to stress to your group that they are not to collect or kill any crayfish or freshwater mussels. If your group does happen to collect crayfish or freshwater mussels during their monitoring exercises, simply indicate this on the Subsampling Data Sheet, and then place the organisms back into the stream. If you, or anyone in your group is able to identify the crayfish or freshwater mussel by common or scientific name, we would like to have this information also.

Equipment you will need

Before you leave for your monitoring site, make certain you have the equipment you will need. It includes:

- ___ Reference maps (e.g., state road maps and county maps) indicating general information pertinent to the monitoring area, including nearby roads
- ___ Tape measure or rope at least 50 feet long and marked off in 1/10 foot lengths (Engineering rule)
- ___ Thermometer. A thermometer that measures temperature on the Celsius scale is preferable, but a Fahrenheit thermometer is acceptable.
- ___ Stopwatch or a any watch with a second hand
- ___ Small float (preferably made of some biodegradable material such as cork) to measure velocity. A small orange will also work.
- ___ Walking stick of known length. Useful for balance, probing, and measuring (dip net can also be used as a walking stick)
- ___ Boots or waders; tow line and life jackets. Be sure that chest waders have a belt.
- ___ White tray marked with a grid of squares of known area (such as 5 centimeters by 5 centimeters) to use in subsampling. A photographic developing tray works well.
- ___ Ice-cube tray. (For use by RiverWatcher volunteers only.)
- ___ Jar of 70 % alcohol, or isopropyl alcohol
- ___ Bottle of soda water. (Do not use carbonated mineral water or other beverage.)
- ___ Several small jars with lids (such as baby food jars) for storage of macroinvertebrates
- ___ Pencils
- ___ Sampling labels (small slips of paper of at least 1 inch by 2 inches in size, and some tape)
- ___ 3-gallon bucket (a 5-gallon bucket is also acceptable)
- ___ Hand lens or magnifying glass
- ___ Tweezers or forceps (entomology or soft touch forceps work well)
- ___ Fine-mesh (0.5 millimeter) D-frame or triangular dip net with a frame at least 12 inches wide
- ___ IRWN Stream Monitoring Manual
- ___ Field data sheets, photocopied from the IRWN manual (see Appendix H)
- ___ Rubber gloves, to protect against contamination
- ___ Camera and film to document specific conditions
- ___ Calculator
- ___ Insect repellent, sun screen, sun glasses, and a hat
- ___ Compass
- ___ Whistle
- ___ Towel, a blanket, and a dry change of clothing suitable for the season, in a waterproof bag
- ___ Fire starter (candle and a cheap lighter)
- ___ Small first aid kit, flashlight, and extra batteries
- ___ Water for drinking
- ___ Wash and soap for washing hands
- ___ Water bottle (a clean dishwashing soap bottle)

See Appendix G for a list of suppliers of biological equipment.

Advance observation of the site

It is always best to observe the study site at least one week prior to sampling. This will enable identification of the best sampling areas in advance, which will save time during sampling later. Chapters V and VIII explain how to determine the best sampling areas for the two IRWN monitoring programs.

Safety procedures

Personal safety is one of IRWN's highest concerns. Doing field sampling of any kind requires that certain precautions be observed.

- Before leaving for your site, let someone know where you are going and when you will be expected back.
- Always work in groups, or with partners.
- Please don't put yourself in danger by attempting to collect information alone. Reschedule for a time when other volunteers are available.
- Do not collect under difficult conditions. Collecting samples at certain locations under certain conditions can be testing. Make allowances for your own physical limitations.
- Do not walk on unstable banks. Be careful when stepping on rocks and wood, as they may be slippery when wet.
Bring along or find a suitable walking stick for balance while climbing down steep banks or wading.
- Do not attempt to cross streams that are swift and above the knee in depth. A stream bed can be very slippery and dangerous in places.
- Do not cross private property without the landowner's permission. Use public access points (e.g., city or state roads and parks) to approach a monitoring site.
- Bring fresh water to drink.
- Be careful to disturb streamside vegetation as little as possible. Watch out for poison ivy, which commonly grows on stream banks.
- Wash hands with soap and potable water at the end of the monitoring exercise, and before eating.
- Shoes must be worn rather than sandals or opened-toed shoes. If chest waders are worn, they must be secured at the waist with a belt.
- Wear life vests

Data management and quality assurance

It is important that the data sheets are complete and in a standardized form. Always use the data sheets provided by IRWN to record data during your sampling. Keep the data sheets provided with this manual (see Appendix H) as originals, and make copies to use in the field. If data sheets or analysis procedures are updated, new data sheets will be sent to you or your Group Leader. Use this manual to store all instructions, data sheets, and other information gained from your monitoring experiences.

Site identification information must be complete on all sheets. Site identification blocks are found in the upper right hand corner of the data sheets.

- Site identification number
- Date on which sampling, assessment, or macroinvertebrate identification was performed
- Stream name. Enter the name as it appears on your USGS topo map.
- County

You may make mistakes while entering information on the data sheets. Also, your Group Leader may find a mistake during data verification, such as a mathematical error. If mistakes are made, place one line through the error, initialize the error, and then write the correct value next to the error. Do not make large cross-out marks or otherwise try to hide the error. The original entry must be known for verification purposes. The Group Leader should make a note on the data sheet as to why the correction was made. (Examples include "mathematical error" or "miscount of individuals.")

Make copies of all your data sheets, and send the original data sheets to your Regional Coordinator. Any questions that arise later about the reported data will be easier to address if the Group Leader keeps a copy of the data. Your Regional Coordinator will make sure that the information is accurate and complete before sending it on to the Quality Assurance Officer.

Where to find help

If problems arise, or you have questions concerning any aspect of monitoring work, please call your Illinois RiverWatch Coordinator or the Quality Assurance Officer for the Citizen Scientist Stream Monitoring Program.

Illinois RiverWatch Network Coordinator
 Illinois Department of Natural Resources
 Office of Energy and Environmental Assessment
 (217)785-5409

Citizen Scientist Stream Monitoring Program Quality Assurance Officer
 Illinois Natural History Survey
 Forbes Biological Research Station
 (309)543-3950

Write in the space below the names, addresses, and phone numbers of your Regional Coordinator and other people important for your area:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Chapter IV How to Conduct an Annual Habitat Assessment

The children must be drawn towards and not away from the woods and fields and waters and must be led to see more clearly that...a man cut off from fellowship with the creatures of the open air is like a tree deprived of all its lateral roots and trimmed to a single branch. He may grow down and up, but he cannot grow out.

—Stephen A. Forbes, 1891

The formal procedures for collecting annual stream trend data under IRWN's Citizen Scientist Stream Monitoring Program are given in the next two chapters. These procedures were developed to be carried out by Citizen Scientists once a year during an eight-week period from May to June. The same stream site is to be sampled during the same eight-week period each year by the same Citizen Scientists group.

A Citizen Scientist habitat assessment notes the physical and chemical characteristics of a stream system that affect the stream ecosystem, and thus its biotic (or living) community. Some of these characteristics are "natural" to the watershed system of which the stream is a part; others are "cultural" and reflect human use of the stream. This habitat assessment complements the annual benthic macroinvertebrate assessment described in Chapter V.

Assessing your site

What you will need

1. Citizen Scientist Level Site Sketch Sheet, Habitat Assessment Sheet and Habitat Parameter Sheet
2. Clip Board and pencil/pen
3. Graduate 50-foot length of rope, or a measuring tape in Engineering rule (A measuring tape marked off in tenths of a foot)
4. A watch with a second hand, or a stopwatch
5. An orange or some other similar, biodegradable object
6. Thermometer
7. Empty jar

Marking off the site

If the site is located by a bridge, measure 100 feet upstream from the bridge. If for some reason a sample cannot be taken upstream (for example, no safe access or no owner permission), then measure 100 feet downstream from the bridge. Be sure to indicate this on the Habitat Assessment Sheet. The mapping of the sample area will start at this point. If the site is in an area of public ownership, such as a state park or forest preserve, and there are no physical obstructions nearby (such as bridges or dams), map the site beginning at the location assigned. Use the following instructions in either case.

Note: If you question the condition of the stream site, contact the Regional Coordinator, the IRWN Quality Control Officer, or the IRWN Coordinator.

Making a Site Sketch

By drawing a map of the study site, the volunteer will become familiar with the terrain and stream features and provide a record of conditions in the habitat.

- Using a 50-foot length of string or twine or a tape measure, measure four 50-foot lengths along either side of the stream upstream from the starting point for a total of 200 feet. This marks a study reach that will be the focus of the sampling activities.
- Make a sketch of the study site on the Site Sketch sheet. Draw the sketch to appear as if the observation point is from above (See Figure 6 for example).
- Use a compass or topo map to determine which direction is North and note it on the sheet.
- Note with an arrow the direction the water is moving. Note on the sketch the location of riffles, runs, pools, ditches, wetlands, dams, rip rap, tributaries, landscape features, vegetation, and roads. Include important features outside the 200-foot study site, but note that they are outside the reach.
- Take a photo of the 200-foot study site to provide additional information for later uses. This photo also can be compared to future photos taken of the same site to illustrate any significant changes that may occur since the first visit.

Site ID:	4-6-72-1
Date:	6-5-95
Stream:	Kerton Creek
County:	Fulton Co.

Illinois RiverWatch Network - Citizen Stream Monitoring Program

Site Sketch

Sketch an aerial view of the 200 foot study reach. Be sure to mark North and the direction of stream flow. Note features such as riffles, runs, pools, ditches, wetlands, dams, riprap, tributaries, landscape features, vegetation, and roads. Indicate habitat assessment and macroinvertebrate collection locations. Record notes and observations below sketch or on back.

Figure 6. An example of Site Sketch sheet.

Filling out the Site Identification and Habitat Assessment Data Sheet

Enter the following information on the Site Identification and Habitat Assessment Data Sheet.

Site ID (enter the IRWN site number)

Date

Stream (enter the name as it appears on your USGS topo map)

County

Group name and team members

Start Time/End Time (measured from time all work on site is completed)

Present weather/Weather in past 48 hours. If conditions were mixed over the past 48 hours (e.g., stormy two days ago, and clear/sunny one day ago) select the weather condition that describes the worst recent weather.

Water Appearance is a physical indicator of water pollution. Select the term or terms that best describe the physical appearance of the water in the stream. Please note that the stream bottom can alter the apparent color of the water. To avoid this, put stream water in a white tray or bucket, or fill a clear bottle and place a white sheet of paper behind the bottle. Then check all of the following that apply.

Clear — colorless, transparent.

Turbid — cloudy brown due to silt or organic material suspended in the water.

Milky — cloudy-white or gray; not transparent. May be natural or due to pollution.

Foamy — caused by both nature or pollution from excessive *nutrients* or detergents.

Dark Brown — may indicate that acids are being released into the stream due to decaying plants. This occurs naturally in the fall of the year.

Oily Sheen — a multicolored reflection in the surface of the water. Can occur naturally, or it may indicate oil floating in the stream.

Reddish — may indicate acids draining into the water.

Green — may indicate excess nutrients being released into the stream.

Other — any other observation regarding water color not described above.

Water Odor also is a physical indicator of water pollution.

None — indicates good water quality.

Sewage — may indicate the release of human waste material. (See note below.)

Chlorine — may indicate that a sewage treatment plant is over-chlorinating its effluent.

Fish — may indicate the presence of excessive algal growth or dead fish.

Rotten Eggs — a sulfurous smell that may indicate sewage pollution, as hydrogen sulfide gas is a product of sewage decomposition. (See note below.)

Petroleum — may indicate an oil spill from marine or terrestrial sources.

Other

Note: If you smell sewage or rotten eggs, please do not enter the water. Notify the nearest Illinois RiverWatch Network Regional Field Office.

Temperature limits biological activity in streams because many aquatic organisms need water of specific temperatures (for example, to breed). Also, since cold water holds more dissolved oxygen than warm water does, temperature directly affects the amount of oxygen available to these organisms.

Measure water temperature by submerging a thermometer for at least two minutes in a stream run. Measure air temperature by holding a thermometer in the air for about two minutes. Temperatures may be recorded in either Fahrenheit (°F) or centigrade or Celsius (°C). If your thermometer reads both, please indicate temperature in °C.

Algal Growth. Algae are both an important food source and a habitat for many organisms. However, excessive algal growth is an indicator of possible nutrient problems. Estimate the percentage of the stream bottom covered by algae.

Submerged Aquatic Plants. Are there rooted, vascular plants present underneath the water's surface?

Riparian (streamside) Vegetation. Identify the riparian vegetation by name. If you do not know the specific names of the plants that you see, describe them generically as "ferns" or "small bushes" or "grasses," etc.

Canopy Cover. Estimate the percentage of the 200-foot study reach that is presently shaded by trees and shrubs.

Bottom Substrate is the material in and on the stream bottom that macroinvertebrates attach to, feed from, or crawl on. Estimate the percentage of each of the several kinds of substrate materials described below that make up the stream bottom in the study reach.

Bedrock

Boulder (any rock larger than 10 inches in diameter)

Cobble (2.5-10 inches)

Gravel (0.1-2.5 inches)

Sand (smaller than 0.1 inches)

Silt

Other (includes organic debris such as logs, sticks, and leaves)

Stream Discharge Estimate. To estimate the volume of water flowing through the stream at a particular point, measure the width, depth, and water velocity in the center of the stream site.

Within the 200-foot study reach, find a stretch of stream with a relatively smooth bottom and where the water flows uniformly. (A run works best if one is present).

Measure stream *width* with string or tape measure. Mark this spot by either tying the string across the stream, or by placing sticks on opposite banks to indicate the points between which the width was measured. (Estimates of stream discharge will be measured from this line later.) Be sure to indicate on the site sketch where the width measurement was taken.

The width of streams that are too deep or too wide to measure directly may be estimated by measuring from the bridge. If the stream's width must be estimated, indicate on the data sheet that the width measurement was estimated rather than measured directly.

Measure stream *depth* in the same area that stream width was measured. Measure stream depth at three evenly spaced spots across the stream. Total the three depth values and divide by three to determine the average depth in feet.

The *velocity* calculation requires the following steps.

1. Mark off spots five feet upstream and five feet downstream from the spots where stream depth was measured.
2. Measure the time it takes a stick, leaf, orange, or other biodegradable object to float the 10-foot distance from the upstream marked spot to the downstream one.
3. Record the time in seconds in the appropriate space on the field data sheet.
4. Determine the water velocity in feet per second by dividing 10 feet by the time measured (in seconds).
5. Repeat steps 2-4 for the two remaining spots across the stream.
6. Total the three velocities and divide by three to determine the average velocity in feet per second. (For example: If it took an orange 23 seconds to travel from your partner to you, divide 10 feet by 23 seconds, which is 0.43 feet per second).

Discharge is a measurement of the amount, or volume, of water flowing past a point. To calculate stream discharge, multiply the average stream depth (feet) by stream width (feet) by average velocity (feet/seconds), using the formula on the data sheet.

Record the result in units of cubic feet per second (feet³/second). Space for these calculations are provided on your Site Identification and Habitat Assessment Sheet.

Watershed Features. Record all land uses observed in the watershed area upstream and on either side of the study reach as far as you can see. Indicate which land uses are dominant (D) and which affect only small areas (x). Also note the presence and approximate distance of dams, sewage treatment plants, pig farms, etc., upstream from your study reach.

Channel Alteration. Indicate whether or not the stream segment has been *channelized*, or straightened. If the monitoring site does show channelization, estimate the portion of the 200-foot section that has been affected.

Personal Observations. Enter here any observations that you feel are important to the quality of the habitat of the stream and its environs, including any characteristics not mentioned on the data sheet.

Filling out the Habitat Parameter Sheet

A parameter (from the Greek word for measure) is a measurable aspect of stream habitat. Each habitat parameter listed on the Habitat Parameter Sheet has four numbered boxes that may be used to rate what you see. (The parameters are described more fully below.) Select the rating that best fits your observation in each case and record the number in the space marked "Score." If you feel the actual condition falls somewhere between two descriptions write in an intermediate value.

Totalling the scores for all the parameters will determine the quality of the stream's habitat, according to a ratings scale devised for this purpose.

Channel morphology and flow characteristics

1. **Embeddedness.** Describes how much of the surface area of the larger materials in the channel (boulders, cobbles, and gravel) is covered by sediment. Embeddedness indicates how suitable the stream substrate is as habitat for benthic macroinvertebrates and as a site for fish spawning and egg incubation.
2. **Substrate Stability.** Describes the availability of stable substrates suitable for macroinvertebrates. Macroinvertebrates in Illinois' soft bottom streams are most abundant on submerged logs or snags, in undercut banks, or on aquatic vegetation.
3. **Instream Cover (availability of fish habitat).** Describes the relative quantity and variety of natural structures in the stream that are available to fish for hiding, resting, or egg laying. These include fallen trees, logs, boulders, and undercut banks.
4. **Pool Substrate Characterization.** Describes the type and condition of bottom substrates found in pools. Firmer sediment types (such as gravel or sand) and rooted aquatic plants support a wider variety of organisms than pool substrates dominated by mud or bedrock that has no plants. The wider the variety of substrate types in a pool (including root mats on the banks) the greater the diversity of organisms it can support.

Stream banks

5. **Streambank Vegetative Stability (water's edge to top of bank).** An estimate of the ability of the bank to resist erosion, and thus of its potential to cause instream sedimentation. Stream bank soil is generally held in place by plant root systems, although protection from erosion may also be provided by boulders, cobbles, or gravel. An estimate of the density of vegetation covering the banks (or its proportion of boulders, cobbles, or gravel) indicates bank stability.
6. **Bank Stability.** An estimate of the steepness of the stream's banks. Steeper banks are generally more subject to erosion and failure, and may not support stable vegetation. Erosion also varies with different types of soils. Sandy soils, for example, normally will erode more than clay soils.
7. **Riparian Vegetation Zone Width.** The width of the natural vegetation found from the edge of the stream bank landward for about 10 feet. Healthy riparian vegetation provides a buffer zone that shades the stream, intercepts nutrients and sediment from adjacent land, and supplies food for the organisms in the stream.

Watershed features

8. *Land Use (top of bank to 30 yards)*. Evaluates the degree to which the region surrounding the monitoring site has been disturbed by humans. Disturbed land uses include crop fields, pastures, barnyards, commercial and residential sites, and levees. Undisturbed land uses include bare rock, woodland, shrubland, and wetlands.

9. *Watershed Erosion*. Estimates the amount of erosion from the surrounding land into the stream. Soil erosion can destroy habitat and reduce the potential of the stream to support aquatic life. Such estimates are made by observing watershed and stream characteristics.

10. *Watershed Nonpoint Source Pollution and Other Compromising Factors*. Estimates the amount of pollution carried into the stream by surface runoff from its watershed. Nonpoint source pollution is defined as diffuse agricultural and urban runoff from such sources as feedlots, septic systems, seepage from dams and impoundments, mines, etc. Such runoff can pollute the water with pesticides, heavy metals, increased nutrients, or bacteria. It can also alter water temperature, and lower levels of dissolved oxygen.

Aesthetics

11. *Aesthetics*. A personal estimate of the condition of the stream. Even though a stream may not be capable of supporting higher organisms such as fish, for example, it may have desirable aesthetic qualities that deserve protection. Factors important in this evaluation include:

- visual attractiveness
- land use
- degree of change in the stream
- recovery potential
- naturalness of the stream
- geologic values
- historical values
- diversity of the plants and animals

Habitat rating

Total Score. Total the ratings scores for all parameters. Compare the total score to the ratings scale to determine if the habitat of the stream is rated as Excellent, Good, Fair, or Poor.

<u>Habitat Score</u>	<u>Rating</u>
> 120	Excellent
90 - 119	Good
60 - 90	Fair
< 60	Poor

Note: If you cannot complete any part of the habitat assessment information, please note this on the data sheet and give a relevant reason, e.g., "water too deep", "not enough time", or "the instructions are unclear."

If you have any suggestions for improving these procedures, please give them to your Regional Coordinator, the IRWN coordinator, or the Quality Assurance Officer.

Chapter V How to Conduct a Citizen Scientist Level Macroinvertebrate Community Assessment

*For real company and friendship,
there is nothing outside of the animal kingdom
that is comparable to a river.*

—Henry VanDyke

The formal procedures, or protocols, for sampling a stream site to collect biological stream trend data under IRWN's Citizen Scientist Stream Monitoring Program are given on the following pages. These procedures were developed to be carried out by citizen scientists once a year during an eight-week period from May to June. The same stream sites are to be sampled during the same eight-week period each year by the same Citizen Scientists.

The procedures for the collection of macroinvertebrates by Citizen Scientists for the purpose of stream quality assessment were developed through the cooperation of state scientists from the Illinois Natural History Survey, Illinois Environmental Protection Agency and Illinois Department of Natural Resources. Every effort was made to create a program which would produce scientifically valid volunteer collected information for the state of Illinois. Therefore it is important that the procedures for the collection and identification of stream macroinvertebrates, as outlined in this manual, be followed with the same amount of attention to detail each time you monitor.

This macroinvertebrate community assessment complements the habitat assessment described in Chapter IV.

How to assess a stream's macroinvertebrate community

What you will need

1. Dip net
2. Bucket (3 or 5-gallon)
3. Forceps
4. Citizen Scientist Level Subsampling Data Sheet

Before you begin sampling, be sure to determine whether the stream reach is a rocky bottom reach or a soft bottom reach. Each is described in Chapter II. If you are not sure which type of stream reach is present at the monitoring site, or which habitats are available to sample from, ask for help from your IRWN Regional Coordinator, the Illinois RiverWatch Network Coordinator, or the IRWN Quality Assurance Officer.

At each monitoring site, you will sample for macroinvertebrates in the same 200-foot section of the stream. More specifically, you will sample from the two habitats within this study reach that contain the highest diversity of macroinvertebrates. These habitats are listed below in order of highest diversity to lowest diversity:

Riffles	Most Diverse Habitat
Leaf Packs	↑
Snag areas, submerged logs, tree roots	
Undercut banks	↓
Sediments	Least Diverse Habitat

Which type of habitats you sample thus will depend upon the characteristics of the particular stream segment you are monitoring. For example, for a rocky bottom reach, a riffle area with various leaf packs would offer the best collecting sites. If the stream segment has a soft bottom reach, a fallen tree that offers built-up debris (a snag area) and undercut banks will be the best place to collect.

Training at Citizen Scientist stream monitoring workshops will provide you with the knowledge to determine which kinds of sites are best for sampling. Also, it is a good idea to observe the stream area at least one week prior to sampling so that the best sampling habitats will already be identified before actual sampling begins.

Before collecting macroinvertebrates, observe what types of habitats are available in the 200-foot study site. Select the two most diverse habitats available and indicate the choices by checking the corresponding habitats listed on the Subsampling Data Sheet.

Next, observe what types of macroinvertebrate habitats are present in that 50-foot section. Select the two most diverse habitats available for sampling and indicate your choices by checking the corresponding habitats listed on the Subsampling Data Sheet.

Riffle sampling

1. Have one member of the team walk down the center of the riffle. Compare all of the riffles within your 50-foot section in terms of speed of water flow and size of rocks. Select two areas in the riffle—one with the greatest flow speed and the largest rocks (up to 14 inches in diameter) and the other with the slowest flow speed and the smallest rocks. Sample from both of these sites. The riffle site that is positioned farthest downstream will be sampled first. Follow steps 2-6 below for the first riffle site, then repeat the procedures for the remaining riffle site.
2. Fill a plastic 3-gallon bucket approximately one-third full with clean stream water. Fill the wash bottle with clean stream water.
3. Position one volunteer with a dip net on the downstream edge of the riffle. Place the bottom of the net flush on the stream bottom, with the net handle perpendicular to the current of the stream. A second volunteer picks up large rocks within a 1 foot by 1 foot area directly in front of the net and place them in the bucket containing water.
4. With the first volunteer ("netter") still holding the dip net in the riffle, the second volunteer ("kicker") approaches the netter from approximately one foot upstream and drags his or her feet so as to disturb the substrate to a depth of about two inches. As the kicker approaches, the netter sweeps the net in an upward fashion to collect the organisms. This procedure should only take about one to two minutes.
5. Carry the net and bucket to the shoreline. Wash the net out in the bucket and pick off those organisms clinging to the edges of the net and place them in the bucket.
6. With your hands, clean the entire surface of the large rocks in the bucket to remove any clinging macroinvertebrates. Make sure to check each rock for any remaining organisms before going on to the next large rock. Once a rock has been cleaned thoroughly and checked for remaining organisms, set it aside.
Do not toss the rock into the stream. You may disturb the area and upset further sampling. Simply place the rock in the water on the edge of the stream, or place all rocks collected on the shore until sampling is completed.

Now sample from the riffle site that is located upstream. After completing steps 2-6 for the second riffle, go on to step 7.

7. Remove any large leaves, sticks, rocks and other debris from the bucket. Before setting them aside, examine each item for any macroinvertebrates clinging to their surfaces.

Leaf pack sampling

Look for *leaf packs* that are about four to six months old. These old leaf packs are dark brown and slightly decomposed. A handful of leaves is all you need.

1. Position the dip net on the bottom of the stream, immediately downstream from a leaf pack.
2. Gently shake the leaf pack in the water to release some of the organisms, then quickly scoop up the net, capturing both organisms and the leaf pack in the net.
3. Inspect the leaves and other large objects of the leaf pack for organisms before returning them to the stream. These macroinvertebrates are then placed in the bucket containing organisms from the previous sampling efforts.

Sampling snag areas, tree roots, and submerged logs

Snag areas are accumulations of debris caught or snagged by logs or boulders lodged in the stream current.

Caddisflies, stoneflies, riffle beetles, and midges commonly inhabit these areas.

1. Select an area on the snag, tree root, or submerged log which is approximately 3 foot by 3 foot in size. This will be the sampling area for these types of habitat.
2. Scrape the surface of the tree roots, logs, or other debris with the net. You can also disturb such surfaces by scraping them with your foot or a large stick, or by pulling off some of the bark to get at the organisms hiding underneath. In all cases, be sure that your net is positioned downstream from the snag, so that dislodged material floats toward the net, not away from it.
3. Place net contents in the bucket. Rinse the net contents with the wash bottle filled with stream water to remove any sediment before placing organisms in the bucket. Carefully inspect any leaf litter and organic debris which may have been collected for organisms.
4. Spend 15 minutes inspecting the chosen sampling area for any organisms not collected previously. Using your hands or forceps, remove any organisms still clinging to tree roots, logs, or other debris. You may remove a log from the water to better see what may be found, but be sure to put it back where it was found.

Sampling undercut banks

Undercut banks consist of areas where moving water has cut out areas of vertical or nearly vertical banks, just below the surface of the water. You will find overhanging vegetation and submerged root mats in such areas that harbor many dragonflies, damselflies, and crayfish.

1. Move the net in a bottom-to-surface motion, jabbing at the bank five times to loosen organisms.
2. Inspect and clean any debris collected and place the collected organisms in the bucket.

Sampling sediments

Select an area within the study reach that consists of mostly sand and/or mud. These areas can usually be found on the edges of the stream, where the water flows more slowly.

1. A netter stands downstream of the sediment area with the dip net resting on the bottom. A kicker disturbs the sediment to a depth of about two inches as he or she approaches the net.
2. The netter sweeps the net upward to collect the organisms as the kicker approaches.
3. Wash out the sediment from the net by gently moving the net back and forth in the water of the stream, keeping the opening of the net at least an inch or two above the surface of the water.
4. Place the organisms captured by the net in the bucket.

Chapter VI How to Interpret Annual Stream Monitoring Data

The acid test of our understanding is not whether we can pick ecosystems to bits and pieces on paper, however scientifically, but whether we can put them together in practice and make them work.

—A. D. Bradshaw, 1983

Subsampling procedures

What you will need

1. Citizen Scientist Subsampling Data Sheet
2. Clip Board and pencil/pen
3. White, gridded subsampling pan
4. Forceps
5. Ice water
6. Bucket with collected organisms
7. Two jars containing alcohol (70% ethanol or isopropyl alcohol)
8. Wash bottle filled with stream water

there will be many organisms collected from the sampling efforts. Counting and identifying them is easier if a random subsample of a least 100 organisms is removed from the total sample collected.

Please note that if fewer than 100 organisms are collected from the study site, there is no need to prepare a subsample. Simply indicate on the Macroinvertebrate Data Sheet that *subsampling* was not performed because fewer than 100 organisms were collected.

If more than 100 organisms are collected, do the following:

1. Transfer the organisms from the bucket to the gridded pan. To do this, pour the bucket's contents through the dip net. Then wash the organisms out of the net into the pan using the wash bottle. Remove any clinging organisms from the net and place them in the pan as well.
2. Add clean stream water to the pan until it is one inch deep. (Measure to the first joint of your index finger).
3. Place the pan on an even surface, preferably one that you can sit next to. (You can place the pan on an upturned bucket, for example, and sit on another upturned bucket beside it.) The availability of a level surface will vary with the sample site, so use your imagination.
4. Gently rock the subsampling pan to evenly distribute organisms across the bottom. Try to avoid "clumps" of organisms in the corners of the pan.
5. Select a numbered square and begin removing organisms lying within that square, counting them as they are removed. Any organism that straddles a line separating two squares is considered to be in the square that contains its head. In the case of organisms whose head is impossible to locate (such as worms), consider the organism to be in the square that contains the largest portion of its body.

6. Place organisms collected from the selected numbered square in a jar or pan containing 70% alcohol, or isopropyl alcohol. Continue until all organisms have been removed from the selected square. Record the total number on the Subsampling Data Sheet.

Note: Place all blood worms collected in a separate jar containing alcohol. This will make it easier to identify and count these organisms later since the alcohol causes these organisms to lose their identifying blood red color. Be sure to label the sample containers with the data, sample site i.d. number, and number of organisms in each jar. This information will be needed later.

7. Select a second numbered square and remove and count the organisms within it, using the above procedures. Clear as many squares as are needed to provide at least 100 organisms. Record the square numbers and the number of organisms picked from each on the data sheet, as you did for the first square. After removing 100 organisms, continue to remove organisms from within the last square until it is empty.
8. Look through the organisms remaining in the pan for any type of organism that was not collected as part of the subsample. You should collect only one organism of each uncollected type you find. If any additional types are found, indicate on the Subsampling Data Sheet which organisms were collected after Step 6 of the subsampling was completed. If you are not sure what type of organisms they are, at least indicate how many types were collected after subsampling.
9. Discard any organisms remaining in the pan by draining the contents of the pan through the net onto the ground. Place the discarded organisms in another large container containing stream water. Now return these organisms to the stream.
10. If you picked organisms from four squares on your tray to obtain the 100 organisms needed for your subsample, the density per square is calculated like this: 100 organisms divided by 4 squares equals 25 organisms per square. To find the density of the whole sample, the number of organisms per square is multiplied by the number of squares in the tray. For example, if the above sample tray had 12 squares, its projected organism density per sample would equal 25 organisms per square multiplied by 12 squares equals 300 organisms per tray. The equations used to make this calculation are provided on the Subsampling Data Sheet.

At the bottom of the Subsampling Data Sheet, indicate if any freshwater mussels were found, fingernail clams, zebra mussels, or Asiatic clams in your stream.

If less than 100 organisms were collected:

1. Transfer the organisms from the bucket to the gridded pan. To do this, pour the bucket's contents through the dip net. Then wash the organisms out of the net into the pan using the wash bottle. Remove any clinging organisms from the net, and place them in the pan as well.
2. Add some clean stream water to the pan until it is one inch deep. (Measure to the first joint of the index finger).
3. Place the pan on an even surface, preferably one you can sit next to the pan on. (You can place the pan on an upturned bucket, for example, and sit on another upturned bucket beside it). The availability of a level surface will vary with the sample site, so use some imagination.

4. Select all of the blood worms, or red chironomid larvae, and place them in a separate container. Blood worms are difficult to identify once they are preserved in alcohol because they lose their blood red color. Keeping them separate from the remaining sample will help you identify and count these important indicator organisms. Be sure to count the number of blood worms picked from the sample. Label the container with the date, sample site i.d. number, and the number of blood worms collected. This information will be needed later.
5. Place all of the macroinvertebrates in the other jar containing alcohol.

NOTE: Be sure to remove all crayfish, mussels or clams from the sample before placing in alcohol! If crayfish, mussels or clams are found at the study site, be sure to indicate what and how many were collected on the Subsample Data Sheet.

Metrics

Many of the macroinvertebrates will be identified to the appropriate taxonomic family. This should be done in a laboratory setting, either in your classroom or meeting place or in a laboratory provided by your regional coordinator.

If you are not familiar with macroinvertebrate identification procedures, attend an Illinois RiverWatch Network workshop after you have completed your collection. If you have already attended such a workshop, the key contained in Appendix C in the back of this manual will be useful as a refresher on the topic.

The Macroinvertebrate Data Sheet will provide information about the types of collected macroinvertebrates (specifically, the various taxa to which they belong) and their numbers. This information will be used to calculate various metrics that can be used to measure the characteristics of streams. The metrics used to assess stream integrity in Illinois by the Citizen Stream Monitoring Program are defined below.

Taxa richness measures the abundance of different types of organisms present in a stream site, as determined by the total number of taxa represented. Generally, community richness increases as water quality, habitat diversity, and habitat suitability increase. However, some pristine headwater streams naturally harbor few taxa, while the number of taxa can actually increase in polluted streams.

Community density estimates the total number of organisms collected from the number of organisms in a subsample of fewer than 100 organisms. This metric thus indicates the community density of your sample site.

Nutrient-enriched water has a high density of organisms. Both toxic chemicals and physical pollutants such as silt or sand usually decrease the density of organisms in a stream.

Tolerance taxonomic groups are the basis of biotic indices used to describe water quality. Biotic indices use scores based on the pollution tolerances of each taxon present in a given body of water. These in turn are averaged by the abundance of organisms within each of these tolerance groups. In general, lower biotic index scores indicate better water quality.

Assessment is made of the presence or absence of tolerance groups by the Macroinvertebrate Biotic Index score and/or by the percent composition of taxa in a stream. The Macroinvertebrate Biotic Index (MBI) was developed by the Illinois EPA to detect organic pollution (such as sewage problems). The MBI summarizes with a single number the various tolerances of the benthic macroinvertebrate community. These tolerance values are used in the calculation of the index.

MBI values reflect stream quality as follows:

1. Less than 6.0 = good water quality
2. 6.0 to 7.5 = fair water quality
3. 7.6 to 8.9 = poor water quality
4. Greater than or equal to 9.0 = very poor water quality

Stream impairment is also reflected in the percent composition (%C) of the various taxa in the macroinvertebrate community. Streams whose macroinvertebrate communities have high percentages of mayflies and stoneflies are considered to be in good health.

Streams that harbor a high percentage of midge larvae and aquatic worms are considered to be in poor health, since these organisms are tolerant to some types of pollution that reduce dissolved oxygen levels.

Filling out the Macroinvertebrate Data Sheet

Use the Macroinvertebrate Data Sheet to identify the organisms that are collected. Be sure to provide all information that is requested on all forms.

To begin, enter the site identification information, date, and names of volunteers involved in the collection in the spaces provided at the top of the data sheet. If the person who is going to identify the organisms did not also collect the organisms, write this person's name last, then add the letter "I" in parentheses. (Example: John Smith (I).) There is also space in which to indicate which type of habitats you collected from in the study reach.

What you will need

1. Citizen Scientist Macroinvertebrate Data Sheet
2. Stereoscope, or dissecting microscope (best to use a scope with magnification range of at least 10X - 30X)
3. Pencil/pen
4. Petri dish
5. Macroinvertebrate sample from the assessment
6. Forceps
7. Illinois RiverWatch Macroinvertebrate Key (or some other aquatic insect identification key)
8. Bottle of alcohol
9. Calculator
10. Extra jars
11. Sample Labels

Identifying the organisms

The data sheet provides blocks of fill-in boxes showing common names and taxon names for all of the possible macroinvertebrate taxa found in Illinois streams. It is in these boxes that the number of organisms within each taxon collected is recorded. It is not expected that volunteers will have found organisms from each taxon listed on the data sheet. Mark only those taxa identified from the sample.

Also, the taxa listed on the Macroinvertebrate Data Sheet are not all of the types of organisms that will be collected. Only indicator organisms are counted to assess stream quality. If macroinvertebrates which are not listed on the data sheet are collected, write the name of the macroinvertebrate, and how many were collected in the section labeled "NOTE:".

To identify organisms by taxa, first separate them by general appearance. Then identify the taxa to which they belong with the help of an identification key. Appendix C contains a simple key. A list of more complex identification keys is provided in Appendix F. If in doubt, always check the identification of an organism by asking for help or by identifying it by use of another key.

Count the number of organisms identified from each taxon and place this number next to it in the column marked "No. of Organisms (n)."

Labeling the collection

Once the macroinvertebrates in the sample have been identified and counted, they will need to be placed in a properly labeled container. The label should be written in permanent, non-alcohol soluble ink (several pens can be bought from biological suppliers, see Appendix G, or at a local art supply store), and taped to the outside of the jar. The size of the label will be determined largely by the size of the jar, but overall, it should be no smaller than 1 inch by 2 inches.

Regardless of the size, all labels should contain the following information:

DATE	SITE ID
STREAM NAME	COUNTY
LOCATION	
NAME OF IDENTIFIER	

An example label is given below for reference:

July 5, 1995	#43652
Kerton Creek	Fulton Co.
0.5 mi. west of SR 100 on CR 1200 E	
D. Stoeckel	

Calculating the biotic indices

Once you have identified and counted all of the organisms, you are ready to calculate the values necessary to assess the site's biological integrity. To do this:

1. Multiply the number of organisms identified from each taxon by its tolerance rating. The "Tolerance Rating (ti)" is printed on the data sheet in the column next to "No. of Organisms (n)." Enter the resulting number in the last column titled "Tolerance Value (tv)."

2. Add the numbers in all of the columns in each of the three numbered data blocks. Enter the sums from each column in the bottom row of each block in the spaces marked "SUBTOTALS."

3. Enter the subtotals from data blocks 1, 2, and 3 in the SUBTOTAL BLOCK. Now add up each column and place the result in the very last row of boxes marked Totals. You should now have numbers representing the total number of taxa ("ΣTaxa"), the total number of organisms ("ΣN"), and the total tolerance value ("Σ(tv)"). (The Greek letter Σ (sigma) is the symbol for "total.")

Calculate the biotic indices, as follows:

Macroinvertebrate Biotic Index ("MBI"):

Divide the total tolerance value by the total number of organisms, as follows:

$$MBI = \Sigma (tv) \div \Sigma N$$

"Taxa Richness" is the total number of taxa identified:

$$\Sigma \text{ Taxa}$$

"Community Density" is the total number of organisms collected or subsampled. Enter the total number of organism from the sample. (ΣN).

$$\Sigma N$$

"Percent Composition" reflects which organisms were most prominent in the stream. To calculate it, enter in column "(n)" the number of organisms collected from each taxon listed in the column titled "Taxon."

Divide the "No. of Organisms (n)" in each taxon by the community density ("ΣN") and multiply by 100 to obtain the percent composition.

$$(n) \div \Sigma N \times 100 = \%C$$

Problems and comments

In the space at the bottom of the Macroinvertebrate Data Sheet, record the volunteer monitor's observations. For example, note the condition of the organisms, or jot down questions about the identification of a particular taxon.

Problems or questions should be directed to the Illinois RiverWatch Network Coordinator, Quality Assurance Officer, or your local Regional Coordinator.

Chapter VII How to Conduct a RiverWatcher Level Habitat Assessment

[A]ny nation concerned about the quality of life, now and forever, must be concerned about conservation. It will not be merely enough to halt the damage we've done. Our natural heritage must be recovered and restored...

—Vice President George Bush, 1988

The RiverWatcher Stream Monitoring Program is designed for those volunteers who wish to conduct stream monitoring on an easier level than that demanded by the Citizen Scientist Stream Monitoring Program described in Section Two. The RiverWatcher seasonal habitat assessment is:

- less detailed;
- organisms need to be identified only to the level of order, rather than to family;
- identification of the organisms can be done at the stream site rather than in a laboratory setting.

The RiverWatcher program can also be used as a training step for volunteers who would like eventually to advance to the Citizen Scientist level of monitoring expertise.

Measuring water quality using macroinvertebrates

The RiverWatcher assessment of stream quality is based on the macroinvertebrates collected at each sample site. Because they vary in their tolerance of organic water pollution, the number and types of these organisms present at a site indicates overall water quality. In addition to collecting indicator organisms, volunteers must consider the habitat available within the stream channel. For example, a stream with a very soft, muddy bottom and steep banks may harbor only pollution-tolerant organisms even though its water may be clean, since the stream lacks the habitats needed by pollution-intolerant species, such as riffles and fallen trees.

Filling out the Illinois RiverWatcher Stream Monitoring Data Sheet

To conduct a RiverWatcher habitat assessment, fill in the Illinois RiverWatcher Stream Monitoring Data Sheet as follows:

Site identification

Stream (stream name)

Type (e.g., rocky bottom or soft bottom)

Site # (if this sample site is not used in the Citizen Scientist Stream Monitoring Program, the site will not have a number)

Location (for example if you are sampling near a bridge, indicate the road that crosses the stream on that bridge, and your distance upstream or downstream from it)

County and Town/City (the latter is the name of the nearest city or town)

Date

Start Time and End Time (the latter is measured from time all work on site is completed)

Participants

Group Name

Habitat Assessment

1. *Weather Conditions.* Note both present conditions and those of the past 48 hours. If conditions were mixed over the past 48 hours (e.g., stormy two days ago, and clear/sunny one day ago) select the weather condition that describes the worst recent weather.

2. *Water appearance* is a physical indicator of water pollution. Select the term or terms that best describe the physical appearance of the water in the stream. Please note that the stream bottom can alter the apparent color of the water. To avoid this, put stream water in a white tray or bucket, or fill a clear bottle and place a white sheet of paper behind the bottle. Then check all of the following that apply.

Clear — colorless, transparent.

Turbid — cloudy brown due to silt or organic material suspended in the water.

Milky — cloudy-white or gray; not transparent. May be natural or due to pollution.

Foamy — caused by both nature or pollution from excessive *nutrients* or detergents.

Dark Brown — may indicate that acids are being released into the stream due to decaying plants. This occurs naturally in the fall of the year.

Oily Sheen — a multicolored reflection in the surface of the water. Can occur naturally, or it may indicate oil floating in the stream.

Reddish — may indicate acids draining into the water.

Green — may indicate excess nutrients being released into the stream.

Other — any other observation regarding water color not described above.

Water Odor also is a physical indicator of water pollution.

None — indicates good water quality.

Sewage — may indicate the release of human waste material. (See note below.)

Chlorine — may indicate that a sewage treatment plant is over-chlorinating its effluent.

Fish — may indicate the presence of excessive algal growth or dead fish.

Rotten Eggs — a sulfurous smell that may indicate sewage pollution, as hydrogen sulfide gas is a product of sewage decomposition. (See note below.)

Petroleum — may indicate an oil spill from marine or terrestrial sources.

Other

Note: If you smell sewage or rotten eggs, please do not enter the water. Notify the nearest Illinois RiverWatch Network Regional Field Office.

4. *Temperature* limits biological activity in streams because many aquatic organisms need water of specific temperatures (for example, to breed). Also, since cold water holds more dissolved oxygen than warm water does, temperature directly affects the amount of oxygen available to these organisms.

Measure water temperature by submerging a thermometer for at least two minutes in a stream run. Measure air temperature by holding a thermometer in the air for about two minutes. Temperatures may be recorded in either Fahrenheit (°F) or centigrade (or Celsius, °C). If your thermometer reads both, please indicate temperature in °C.

5. *Algal Growth.* Algae are both an important food source and a habitat for many organisms. However, excessive algal growth is an indicator of possible nutrient problems. Estimate the percentage of the stream bottom covered by algae.

6. *Canopy Cover.* Estimate the percentage of the 200-foot study reach that is presently shaded by trees and shrubs.

7. *Bottom Substrate* is the material in and on the stream bottom that macroinvertebrates attach to, feed from, or crawl on. Estimate the percentage of each of the several kinds of substrate materials described that make up the stream bottom in your study reach.

8. *Estimate Stream Discharge*. To estimate the volume of water flowing through the stream at a particular point, measure the width, depth, and water velocity in the center of the stream site. Two people are needed for this measurement.

Within the 200-foot study site, find a stretch of stream with a relatively smooth bottom and where the water flows uniformly. (A run works best if one is present).

The width of streams that are too deep or too wide to measure directly may be estimated by measuring from the bridge. If you must estimate the stream's width, indicate on the data sheet that the width measurement was estimated rather than measured directly.

1. Measure stream width from the water's edge on opposing banks. Enter on Line A.
2. With the measuring tape still in place, measure the depth of the water in the center of the stream. Enter on Line B.
3. Beginning at the same point at which stream depth was measured, measure a distance 5 feet upstream. Another person will stand here with an orange or some other biodegradable object that floats. Walk 5 feet down stream from the point of depth measurement. Use a watch with a second hand or a stop watch to record time.
4. The other person will place the orange in the stream, after which you record the time it takes the orange to travel the 10 feet to where you are standing. Divide 10 by the number of elapsed seconds and place the answer in the space for stream velocity. (For example: If it took an orange 23 seconds to travel to you from your partner, divide 10 feet by 23 seconds, which is 0.43 feet per second). Enter on Line C.
5. Compute the Discharge Estimate by multiplying the stream width by its depth and by its velocity (Line A x Line B x Line C).

9. *Land Uses of the Watershed* Record all land uses observed in the watershed upstream and on either side of the sample site as far as visible.

10. *Personal Observations* Enter here any observations that you feel are important to the quality of the habitat of the stream and its environs, including any characteristics not mentioned on the data sheet. You may also write comments on the habitat assessment procedures themselves if you feel improvements or adjustments should be made.

Chapter VIII How to Conduct a RiverWatch Level Macroinvertebrate Community Assessment

The bundle of sticks crawling about in the water, green worms under stones in the stream, swarms of flies around the lights along river and lake....They are but a few isolated phenomena, however, in a picture of life histories and interrelationships varied in pattern and interesting in detail.

—Herbert H. Ross

Benthic macroinvertebrates as pollution indicators

Biotic indices use scores based on the pollution tolerances for various groups of organisms, which are averaged by the number of types (or taxa) found within each group. In general, lower biotic index scores indicate better water quality.

Four categories of common macroinvertebrate taxa have been selected for use in developing biotic indices for the RiverWatcher Stream Monitoring Program. The pollution tolerances of the various group categories are defined by the relative occurrences of each type of organisms under various water quality conditions. For example, pollution-intolerant organisms will almost never be present in poor quality water. However, in clean water, pollution-tolerant organisms will be represented by only a few individuals, and they are likely to be found only in the slower flowing areas of the stream.

Group I: Pollution-intolerant

Clean-water macroinvertebrate communities generally cannot tolerate organic pollution (sewage or fertilizers, for example) and (in particular) low levels of dissolved oxygen. These organisms generally compose moderately abundant and diverse taxa. Many different types of organisms are present, but none dominate the community by their numbers alone. Members of this group generally feed upon fallen leaves and other natural debris that are generated naturally by the stream environment.

Stoneflies can be found in all types of streams, but they cannot tolerate low dissolved oxygen levels or even low levels of pollution; this group will inhabit a stream all year long with the adult stage lasting only about one month. Alderflies and dobsonflies represent some of the largest aquatic insects, and can be found in a variety of habitats. (Alderflies are commonly found in clean silt deposits.) Snipe flies are somewhat more tolerant of pollution than most of Group I organisms, and can be found in the gravel of very clean riffles.

Group II: Moderately pollution-intolerant

As the nutrients in streams are enriched by agricultural fertilizer, municipal sewage, or other sources, the macroinvertebrate community changes. The number of pollution-intolerant forms (Group I organisms) begins to decline as dissolved oxygen levels decrease, and may even disappear. The community may start to rely on food sources outside the natural stream system such as sewage treatment plants; this food is composed of very fine organic matter that many of the organisms filter and scrape from the rocks. If this type of pollution is present in only slight amounts, however, a large number of Group I organisms will still be present in the stream.

The macroinvertebrate communities in moderately polluted streams are dominated by caddisflies and mayflies. Mayfly nymphs may be the first group to increase in numbers in response to nutrient enrichment. Most mayfly nymphs are more tolerant of lower oxygen levels than Group I organisms, and caddisflies tend to be even more tolerant.

Other organisms will also be found in a moderately polluted stream, but in fewer numbers compared to mayflies and caddisflies.

- Riffle beetles and the water pennies will be present because algae, which they feed on, increase as nutrients in the water increase. However, both of these beetles require moderate water flow in riffles and are not tolerant of severe polluted conditions.
- Crane fly larvae can be found in a variety of habitats but are commonly found in the bottom gravel of riffles; like other taxa in this group, crane fly larvae are not tolerant of severe pollution.
- Crayfish generally require an abundant source of oxygen but do tolerate some nutrient pollution. However, crayfish are very sensitive to toxic substances that accumulate in the plants and animals they feed upon.
- Dragonfly and damselfly nymphs are usually found along the stream margins, in overhanging vegetation, or in slow-moving or standing water. In a moderately polluted stream, burrowing dragonflies may be found in the riffles where the more pollution-sensitive organisms can not survive. Because they are predators, dragonfly and damselfly nymphs are also susceptible to toxic substances that accumulate in their prey.
- Fingernail clams and mussels will also be found in moderately polluted streams. These organisms filter organic matter suspended in the water, and thus may be affected by the pollutants associated with such matter.

Group III: Fairly pollution-tolerant

This group represents macroinvertebrates that can survive in water with lower dissolved oxygen levels. Fairly pollution-tolerant macroinvertebrates often replace the less tolerant organisms in the stream. For example, black fly larvae will replace caddisfly larvae and the mayfly nymphs, which are less tolerant to pollutants in the riffles. Some species of the black fly larvae are often quite abundant downstream from sewage treatment plants, where large amounts of organic matter is available for their food. Sowbugs and scuds eat decomposing animals and can be extremely abundant in heavily nutrient-enriched streams. Right-handed (gill breathing) snails also feed on decomposing matter and are generally found attached to overhanging vegetation or rocks in moderate to slow currents. Midge larvae feed from a variety of food sources and are generally tolerant to fluctuating pollution and dissolved oxygen levels. Two types of midge larvae may be found in this group: the true midges and the biting midges.

Group IV: Pollution-tolerant

This group can survive in water that has extremely low dissolved oxygen levels and is severely polluted by nutrients. In heavily polluted conditions, pollution-tolerant macroinvertebrates may be present in large quantities (hundreds of thousands of organisms) compared to organisms belonging to other tolerance groups; in some cases they may be the only such organisms present in the stream. Aquatic worms are capable of surviving almost without oxygen as they process sediments for organic matter, which they use as food. Leeches are adapted for heavily stressed conditions and eat plant and animal debris.

Some of the pollution-tolerant macroinvertebrates have adaptations which allow them to cope with extremely low dissolved oxygen levels. Left-handed snails (air breathing) pouch snails use a lung-type breathing mechanism rather than gills; this increases their ability to obtain oxygen from the water, since the diffusion of oxygen through gill membranes becomes impossible when oxygen levels become too low. Bloodworms (a type of midge larvae) use a hemoglobin-type "blood" that assists in carrying oxygen throughout their bodies.

Illinois RiverWatch macroinvertebrate assessment procedures**What you will need**

1. Dip net
2. Bucket (3 or 5-gallon)
3. Forceps
4. Citizen Scientist Level Subsampling Data Sheet

Before sampling begins, be sure to determine if the stream reach is a rocky bottom reach or a soft bottom reach. Each is described in Chapter II. If unsure which type of stream reach is present at the monitoring site, or which habitats are available to sample from, ask for help from the IRWN Regional Coordinator, the Illinois RiverWatch Network Coordinator, or the IRWN Quality Assurance Officer.

At each monitoring site, sample for macroinvertebrates in the same 200-foot section of the stream. More specifically, sample from the two habitats within this study reach that contain the highest diversity of macroinvertebrates. These habitats are listed below in order of highest diversity to lowest diversity:

Riffles	Most Diverse Habitat
Leaf Packs	↑↑
Snag areas, submerged logs, tree roots	
Undercut banks	↓↓
Sediments	Least Diverse Habitat

Which type of habitats selected for sampling thus will depend upon the characteristics of the particular stream segment chosen as a monitoring site. For example, for a rocky bottom reach, a riffle area with various leaf packs would offer the best collecting sites. If the stream segment has a soft bottom reach, a fallen tree that offers built-up debris and undercut banks will be the best place to collect.

Training is available from the Illinois RiverWatch Network's regional coordinators that will teach which kinds of sites are best for sampling. Also, it is a good idea to observe the stream area at least one week prior to sampling so that the best sampling habitats will already be identified before actual sampling begins.

Before beginning, observe what types of macroinvertebrate habitats are present in the 200-foot study site. Select the two most diverse habitats available and indicate the choices by checking the corresponding habitats listed on the Subsampling Data Sheet.

Riffle sampling

1. Have one member of the team walk down the center of the riffle. Compare all of the riffles within the study site in terms of speed of water flow and size of rocks. Select two areas in the riffle—one with the greatest flow speed and the largest rocks (up to 14 inches in diameter) and the other with the slowest flow speed and the smallest rocks.
2. Sample from both of these sites. The riffle site that is positioned farthest downstream will be sampled first. Follow steps 2-8 below for the first riffle site, then repeat the procedures for the remaining riffle site.
3. Fill a plastic 3-gallon bucket approximately one-third full with clean stream water. Fill the wash bottle with clean stream water.

4. One volunteer with a dip net should position himself or herself on the downstream edge of the riffle. The bottom of the net should be placed flush on the stream bottom, with the net handle positioned perpendicular to the current of the stream.
5. A second volunteer should pick up large rocks within a 1 foot by 1 foot area directly in front of the net and place them in the bucket containing water.
6. With the first volunteer ("netter") still holding the dip net in the riffle, the second volunteer ("kicker") approaches the netter from approximately one foot upstream and drags his or her feet so as to disturb the substrate to a depth of about two inches. As the kicker approaches, the netter sweeps the net in an upward fashion to collect the organisms. This procedure should only take about one to two minutes.
7. Carry the net and bucket to the shoreline. Wash the net out in the bucket and pick off those organisms clinging to the edges of the net and place them in the bucket.
8. With your hands, clean the entire surface of the large rocks in the bucket to remove any clinging macroinvertebrates. Make sure to check each rock for any remaining organisms before going on to the next large rock. Once a rock has been cleaned thoroughly and checked for remaining organisms, set it aside.

Do not toss the rock into the stream. You may disturb the area and upset further sampling. Simply place the rock in the water on the edge of the stream, or place all rocks collected on the shore until sampling is completed.

9. Now sample from the riffle site that is located upstream. When steps 2-8 are finished, for the second riffle, go on to step 10.
10. Remove any large leaves, sticks, rocks and other debris from the bucket. Before setting them aside, examine each item for any macroinvertebrates clinging to their surfaces.

Leaf pack sampling

Look for leaf packs that are about four to six months old. These old leaf packs are dark brown and slightly decomposed. A handful of leaves is all you need.

1. Position the dip net on the bottom of the stream, immediately downstream from a leaf pack.
2. Gently shake the leaf pack in the water to release some of the organisms, then quickly scoop up the net, capturing both organisms and the leaf pack in the net.
3. Inspect the leaves and other large objects of the leaf pack for organisms before returning them to the stream. These macroinvertebrates are then placed in the bucket containing organisms from the previous sampling efforts.

Sampling snag areas, tree roots, and submerged logs

Snag areas are accumulations of debris caught or snagged by logs or boulders lodged in the stream current. Caddisflies, stoneflies, riffle beetles, and midges commonly inhabit these areas.

1. Select an area of the snag, tree roots or submerged log which is approximately 3 foot by 3 foot in size. This will be the sampling area for these habitats.
2. Scrape the surface of the tree roots, logs, or other debris with the net. You can also disturb such surfaces by scraping them with your foot or a large stick, or by pulling off some of the bark to get at the organisms hiding underneath. In all cases, be sure that your net is positioned downstream from the snag, so that dislodged material floats toward the net, not away from it.
3. Place net contents in the bucket. Rinse the net contents with the wash bottle filled with stream water to remove any sediment before placing organisms in the bucket. Carefully inspect any leaf litter and organic debris which may have been collected for organisms.
4. Spend 15 minutes inspecting the chosen sampling area for any organisms not collected previously. Using your hands or forceps, remove any organisms still clinging to tree roots, logs, or other debris. You may remove a log from the water to better see what may be found, but be sure to put it back where it was found.

Sampling undercut banks

Undercut banks consist of areas where moving water has cut out areas of vertical or nearly vertical banks, just below the surface of the water. Overhanging vegetation and submerged root mats in such areas may harbor many dragonflies, damselflies, and crayfish.

1. Move the net in a bottom-to-surface motion, jabbing at the bank five times to loosen organisms.
2. Inspect and clean any debris collected and place the collected organisms in the bucket.

Sampling sediments

Select an area within the study reach that consists of mostly sand and/or mud. These areas can usually be found on the edges of the stream, where the water flows more slowly.

1. A netter stands downstream of the sediment area with the dip net resting on the bottom. A kicker disturbs the sediment to a depth of about two inches as he or she approaches the net.
2. The netter sweeps the net upward to collect the organisms as the kicker approaches.
3. Wash out the sediment from the net by gently moving the net back and forth in the water of the stream, keeping the opening of the net at least an inch or two above the surface of the water.
4. Place the organisms captured by the net in the bucket.

Chapter IX How to Interpret Seasonal Stream Monitoring Data

For a clear conception of the general and intricate interdependence of the different forms of organic life upon earth, one cannot do better than to study thoroughly the life of a permanent body of fresh water - a river or smaller stream, ...

—Stephen A. Forbes, 1903

Subsampling procedures

You will collect many organisms from your sampling efforts. Counting and identifying them is easier if a random subsample of at least 100 organisms is removed from the total sample collected. Please note that if fewer than 100 organisms are collected from the study site, there is no need to prepare a subsample. Simply indicate on the data sheet that the subsampling was not performed because fewer than 100 organisms were collected.

What you will need

1. RiverWatcher Data Sheet
2. Gridded subsampling pan
3. Ice water
4. Forceps
5. Wash bottle filled with fresh stream water
6. Ice tray
7. Pencil
8. Two jars
9. RiverWatch Macroinvertebrate Identification Guide (Appendix D)

If more than 100 organisms are collected, do the following:

1. Transfer the organisms from the bucket to the gridded pan. To do this, pour the bucket's contents through the dip net. Then wash the organisms out of the net into the pan using the wash bottle. Remove any clinging organisms from the net and place them in the pan as well.
2. Add clean stream water to the pan until it is one inch deep. (Measure to the first joint of your index finger).
3. Place the pan on an even surface, preferably one that you can sit next to. (You can place the pan on an upturned bucket, for example, and sit on another upturned bucket beside it.) The availability of a level surface will vary with the sample site, so use your imagination.
4. Gently rock the subsampling pan to evenly distribute organisms across the bottom. Try to avoid "clumps" of organisms in the corners of the pan.

5. Select a numbered square and begin removing organisms lying within that square, counting them as they are removed. Any organism that straddles a line separating two squares is considered to be in the square that contains its head. In the case of organisms whose head is impossible to locate (such as worms), consider the organism to be in the square that contains the largest portion of its body.
6. Place organisms collected from the selected numbered square in a jar or pan containing fresh stream water. Continue until all organisms have been removed from the selected square. Record the total number in the Subsampling section of the RiverWatch Data Sheet.
7. Select a second numbered square and remove and count the organisms within it, using the above procedures. Clear as many squares as are needed to provide at least 100 organisms. Record the square numbers and the number of organisms picked from each on the data sheet, as you did for the first square. After removing 100 organisms, continue to remove organisms from within the last square until it is empty.
8. Look through the organisms remaining in the pan for any type of organism that was not collected as part of the subsample. Collect only one organism of each uncollected type. If any additional types are found, indicate on the Subsampling Data Sheet which organisms were collected after the subsampling was completed. If you are not sure what type of organisms they are, at least indicate how many types were collected after subsampling.
9. Discard any organisms remaining in the pan by draining the contents of the pan through the net onto the ground. Place the discarded organisms in another large container containing stream water. Now return these organisms to the stream.
10. You may have had to pick organisms from several squares on your tray to obtain the 100 organisms needed for the subsample. The Density of Organisms per Square is calculated by dividing the total number of organisms collected (Line A) by the number of squares selected (Line B).
11. To find the Density of Organisms in Tray, the number of organisms per square (Line C) is multiplied by the number of squares in the tray.

At the bottom of the Subsampling Data Sheet, indicate if any freshwater mussels, fingernail clams, zebra mussels, or Asiatic clams were found in the study site.

If less than 100 macroinvertebrates were collected, do the following:

1. Transfer the organisms from the bucket to the gridded pan. To do this, pour the bucket's contents through the dip net. Then wash the organisms out of the net into the pan using the wash bottle. Remove any clinging organisms from the net and place them in the pan as well.
2. Add clean stream water to the pan until it is one inch deep. (Measure to the first joint of the index finger).
3. Place the pan on an even surface, preferably one that enables the monitor to sit next to the pan. (Place the pan on an upturned bucket, for example, and sit on another upturned bucket beside it.) The availability of a level surface will vary with the sample site, so use some imagination.

Macroinvertebrate tally

Now you are ready to identify and record the organisms that you have collected. First, put fresh stream water into the spaces of the ice tray. As the macroinvertebrates are identified, place them in one of the four tolerance groups of similar organisms by using the spaces of the ice tray. Use the macroinvertebrate identification reference guide to help you. You may need to look at some of the macroinvertebrates under a magnifying glass, since many are quite small.

Once the organisms are sorted by type:

1. Count how many organisms of each type were collected. Enter this number in the space on the right of the name of the organisms.
2. When you have finished counting the individual organisms, count the number of taxa, or organism types, that you found within each tolerance group.
3. Multiply the number of taxa in each tolerance group by the group's tolerance value to obtain a group score.
4. Add the total number of taxa collected from each tolerance group and enter that number in the space, "E. TOTAL # TAXA."
5. Add all of the group scores and enter the total in the space "F. TOTAL GROUP SCORES."
6. To calculate the Total Cumulative Score, divide "TOTAL GROUP SCORES" (Line F) by "TOTAL # TAXA" (Line E).

The Total Cumulative Score is a rating that will identify the water quality of the stream's habitat, according to the ratings scale devised for this purpose.

What to do if you find poor water quality

If the results of your stream monitoring session indicate poor water quality, don't panic. Such findings may be the result of something as simple as a calculation error. Recheck the results and review the manual to determine if a mistake was made. Call the Regional Coordinator to discuss the results of the monitoring and review the data sheets. If the problem persists, the Coordinator may decide to accompany you back to the site to repeat the monitoring. In any case, there are many different variables that will impact the quality of a stream. Both direct and indirect factors of stream degradation (such as point and non-point sources of pollution) can affect the water quality of a stream. Additionally, unusual weather conditions can temporarily affect the water quality of a stream. It is suggested that volunteers first bring potential water quality problems to the attention of the Regional Coordinator. The Coordinator can then consult with the RiverWatch Network's Quality Assurance Officer to make a determination as to whether further action is necessary.

What to do with your information

The information gathered can be extremely valuable in comparing water quality trends, past and future, in the stream. It is important to share this information with concerned citizens, government officials, resource protection agencies, and conservation organizations.

Remember, it is extremely important that findings of find poor water quality be confirmed by professional water quality experts. The Illinois RiverWatch Regional Coordinator will notify the agency or person who can help.

Appendix A. Factors That Affect Stream Quality in Illinois

Pollutants

Pollutants are unwanted materials ranging from litter to industrial waste. Stream pollution in particular comes from a variety of sources and has many complex effects. Benthic macroinvertebrate communities for example can be affected by pollutants such as sediment, organic wastes, excess nutrients such as phosphates from detergents, and toxic substances.

Several types of pollutants affect Illinois rivers and streams. They include:

Sediment from soil erosion has long been considered the most serious threat to water quality in Illinois. The 1990 Illinois Water Quality Report published by the Illinois Environmental Protection Agency stated that *siltation* affects more than 6,500 miles of Illinois streams. Farmfields, mines, cut-over forests, and unpaved roads are sources of sediment in streams in rural areas. In urban areas, ill-managed construction sites can greatly elevate sediment levels in streams.

Excessive amounts of sediment in the water can destroy macroinvertebrate habitats by filling the spaces between boulders and rocks in which many of these organisms live. Sediment can also harm the filter-feeding mechanisms of some aquatic organisms, clog the gills of others, or bury macroinvertebrates entirely.

Organic wastes originate from industrial operations such as pulp mills, sugar refineries, and some food processing plants. The most common source of organic wastes in Illinois, however, is the discharge from municipal sewage treatment plants. When organic wastes enter a stream, they are decomposed by bacteria in the sediments and water. These bacteria consume the oxygen dissolved in the water. The amount of oxygen needed to decompose a given amount of organic waste in a stream is called its *biological oxygen demand*, or BOD. The decomposition of an organic waste in a stream that has a high BOD leaves very little dissolved oxygen for the fish, aquatic insects, and other organisms that live in the stream.

Nutrient enrichment refers to the addition of *nitrogen* and/or *phosphorous* to an aquatic ecosystem. Wastewater from sewage treatment plants, fertilizers from agricultural runoff, and urban runoff add nitrogen and phosphorous to streams. Other sources of nutrient enrichment include septic tank leakages and farm animal wastes.

Nutrients occur naturally in stream water. But because nitrogen and phosphorous are key elements in the growth of aquatic plant life such as algae, an increase in these nutrients can significantly increase growth by the plants and animals in the stream. Rapid plant growth in streams results in *algal blooms*. Besides being unsightly, algal blooms can cause water to smell and taste bad. Because algal masses are organic, their decomposition depletes the available oxygen in water like any other organic waste. Nutrient enrichment usually increases the number of macroinvertebrates in a stream at first, but these numbers decline as dissolved oxygen levels decrease.

Temperature elevation stresses many species of fish and macroinvertebrates that have limited tolerances to high temperatures. Two main factors contribute to temperature elevation in Illinois streams. The loss of riparian zones removes shade-providing plants, exposing streams to direct sunlight for many hours. Also, streams receive some part of their water from groundwater sources. This (usually) cooler groundwater helps to cool the warmer surface waters entering streams from runoff or rainfall. Irrigation and stream channelization cause water tables to drop, decreasing the volume of cooler groundwater entering streams.

Channelization converts natural meandering streams with varied habitats to straight-sided ditches of nearly uniform width, depth, current velocity, and substrate. Fewer habitats mean fewer species capable of living in such modified streams. Bankside vegetation is removed when a stream is channelized, further reducing the biodiversity of the stream.

Toxic chemicals have helped degrade many stream ecosystems throughout the United States. Truly safe levels of many toxic chemicals have never been determined, and their long-term effects on ecosystems are largely unknown. These chemicals enter streams as a result of irresponsible discharge of industrial wastes, indiscriminate use of agricultural pesticides, and careless dumping of household cleaners. Although toxic chemicals are still getting into Illinois' streams, their concentrations have been reduced to the point where most authorities now consider other pollutants (such as sediment and excess nutrients) more immediate environmental threats.

However, the concentration of toxic chemicals in stream waters is not necessarily a true reflection of their presence in a stream. Plants and animals often absorb these pollutants either from the water or sediment and accumulate them in their tissues. Monitoring stream waters for toxic chemicals only does not reliably assess stream quality, since most such chemicals are concentrated not in the water but in the bodies of the organisms living in the stream and in sediments.

Over time, toxic substances in the tissues of stream organisms may reach levels many times higher than in the stream's water or sediments. When stream organisms that have accumulated toxic chemicals are eaten by other organisms (such as raccoons or fish-eating birds), the toxic chemical is passed along the food chain, leading eventually to humans.

Point vs. nonpoint source pollution

Pollution is classified according to its source. *Point source pollution* comes from a single identifiable point such as a factory discharge pipe that empties into a river. *Nonpoint source pollution* does not come from a clearly defined source. Nonpoint source pollution is primarily runoff from land that contains pesticides, fertilizers, metals, manure, road salt, and other pollutants. Nonpoint source pollution originates on farms, lawns, paved streets and parking lots, construction sites, timber harvesting operations, landfills, and home septic systems. Acid rain is another nonpoint source pollutant.

Nonpoint source pollution is a major factor in the deterioration of Illinois' streams. It occurs wherever and whenever soils cannot sufficiently absorb and filter pollutants contained in storm water drainage and runoff. Nonpoint source pollution can quickly kill a stream by introducing organic and inorganic pollutants that silt streambeds, decrease dissolved oxygen, and poison aquatic organisms.

Appendix B. The Life History of Macroinvertebrates

One of the most interesting aspects of this program is that participants become familiar with a new group of animals, the aquatic macroinvertebrates. Most people have little, if any, exposure to these organisms. Group leaders hear comments like "I never knew these things were in here!" What a joy it is to see the surprised faces of both children and adults.

To better explain about these animals, brief life history information for each different organism identified in this program is given in this appendix. The synopsis will outline the organism's general description, how it reproduces, what it eats, and what the adults look like.

Aquatic Insects

The aquatic insects comprise the bulk of benthic macroinvertebrate communities in healthy, freshwater streams. These insects are mostly in their immature form and live their adult life on land, sometimes for only a few hours. Most aquatic insects can be divided into two separate groups: ones that develop through complete metamorphosis, and ones that develop through incomplete metamorphosis.

Metamorphosis is the change that occurs during the organism's development from egg to adult (see Figure 6). Some aquatic insects develop through complete metamorphosis, which consists of four stages. These immature insects are called larvae and they do not resemble the adults and, in fact, may look grossly different. During the pupae stage, the organisms inhabit a "cocoon-like" structure where the transformation from larvae to adult occurs. Incomplete metamorphosis has three main stages of development (except for the mayfly which has two winged growing stages). These immature insects are called nymphs and they undergo a series of molts until the last decisive molt transforms the organism into

an adult or imago. There is no intermediate pupae stage where transformation occurs. The nymphs resemble the adults closely except for wing development.

Figure 7. Aquatic Insect Body Parts: Main parts consistent in all aquatic insects

All insects (whether they are adults or immature, or whether they develop through complete or incomplete metamorphosis) have three main body parts: head, thorax, and abdomen (Figure 7).

Aquatic Insects

Stoneflies

Metamorphosis: incomplete

Nymphs: possess two distinct "tails" called cerci, which are actually sensory feelers; brightly colored in tan, brown, gold, and black; length varies, up to 1 inch.

Reproduction: females deposit eggs on top of water where they drift down to the bottom.

Adults: resemble nymphs, but possess a long pair of wings folded down the length of the body.

Food: some stoneflies are carnivorous, others feed on algae, bacteria, and vegetable debris; eaten by a variety of fish species.

Alderflies

Metamorphosis: complete

Larvae: possess a single tail filament with distinct hairs; body is thick-skinned with 6 to 8 filaments on each side of the abdomen; gills are located near the base of each filament; color brownish.

Reproduction: female deposits eggs on vegetation that overhangs water, larvae hatch and fall directly into water.

Adults: dark with long wings folded back over the body.

Food: larvae are aggressive predators, feeding on other aquatic macroinvertebrates; as secondary consumers, they are eaten by other larger predators.

Dobsonflies

Metamorphosis: complete

Larvae: often called hellgrammites, possess two large mandibles; several filaments are located along the sides of the abdomen; one pair of short tail filaments used for grasping; color brownish to black with a large dark "plate" behind base of head; six legs; length up to 3 inches.

Reproduction: female attaches eggs on overhanging vegetation; when eggs hatch, the larvae fall directly into the water.

Adults: possess two pair of extremely long, colorful wings folded back the length of the body; males possess a pair of long mandibles that can cross that are used to grasp the female during copulation; females possess one pair of mandibles smaller than those of the male.

Food: predaceous larvae feed upon other aquatic macroinvertebrates; larvae widely used as fish bait; important food source for larger game fish.

Snipe Flies

Metamorphosis: complete

Larvae: elongated, cylindrical, slightly flattened; cone-shaped abdomen is characteristic; two, long, fringed filaments at end of abdomen; color varies; length up to 1/2 inch.

Reproduction: female deposits eggs on overhanging vegetation and immediately dies and remains attached to egg mass; larvae hatch and drop into water.

Adults: a moderately sized fly that is usually found around low bushes, shrubbery, and tall grasses.

Food: larvae are predaceous, adults mostly feed on blood.

Crane Flies

Metamorphosis: complete

Larvae: definitely "worm-like," thick-skinned, and brownish-green to somewhat transparent or whitish; pointed or rounded at one end and a set of disk-like spiracles at the other; color may be stained greenish or brownish; length up to 3 inches.

Reproduction: female deposits eggs on submerged vegetation or other debris.

Adults: best described as "giant mosquitoes" and possess long legs and plump bodies, but are harmless.

Food: mostly plants and plant debris; some are predaceous.

Black Flies

Metamorphosis: complete

Larvae: small, worm-like and bulbous at one end; when out of water, they fold themselves in half while wiggling; color varies from green, brown, gray, but usually black; length up to 1/3 inch.

Reproduction: females deposit eggs on submerged vegetation or other debris.

Adults: fly-like; known as a serious pest because they inflict painful bites to warm-blooded animals.

Food: larvae eat organic debris filtered from water; adult females of many species feed on blood.

Midges (flies)

Metamorphosis: complete

Larvae: most species are extremely small and thin; worm-like and wiggle intensely when out of water; color varies from gold, brown, green, and tan to black; length is usually less than 1/2 inch.

Reproduction: female deposits a gelatinous mass of eggs on the water surface or attaches it to submerged vegetation.

Adults: resemble small mosquitoes with fuzzy antennae on males.

Food: primarily algae and other organic debris; many feed on other insect larvae.

Caddisflies

Metamorphosis: complete

Larvae: worm-like, soft bodies; head contains a hard covering; color can vary from yellow or brown, but usually green; larvae are known for their construction of hollow cases that they either carry with them or attach to rocks; cases are built from sand, twigs, small stones, crushed shells, rolled leaves, and bark pieces; cases used for protection and pupation; length up to 1 inch.

Reproduction: eggs are encased in a gelatinous mass and are attached to submerged vegetation or logs.

Adults: moth-like, brownish and usually nocturnal; wings thickly covered with hairs.

Food: larvae feed on algae, small bits of plant material, and animals; some species build nets where they catch drifting food; fed upon by several species of fish.

Mayflies

Metamorphosis: incomplete

Nymphs: three distinct cerci (tails), occasionally two; cerci may be fuzzy or thread-like, but never paddle or fan-like; color varies from green, brown, grey, but usually black; total length up to 1 inch.

Reproduction: female deposits eggs on top of water where they drift to the bottom; some species crawl under water and attach eggs to submerged objects.

Adults: resemble nymphs, but usually possess two pair of long, lacy wings folded upright; adults usually have only two cerci.

Food: consists of small plant and animal debris, such as algae, diatoms, and plankton; preyed upon by fish and play an important role in the food chain.

Riffle Beetles

Metamorphosis: complete

Larvae: resemble small "torpedos" with circular stripes or rings around body; pointed at both ends with a "fuzzy" mass at one end; color usually grayish; length less than 1/2 inch.

Reproduction: females deposit eggs on plant materials under water.

Adults: unique in that they are also aquatic and are found more often than the larvae; adults are beetle-like, tiny, and usually black.

Food: primarily plant material such as diatoms and algae.

Water Penny Beetle
Metamorphosis: complete

Larvae: resemble circular incrustations on rocks; sucker-like; color green, black, but usually tan or brown; length usually no more than 1/2 inch.

Reproduction: adult females crawl into water and deposit eggs on undersides of stones.

Adults: typical beetle shaped-body; resemble an extremely large riffle beetle (not truly aquatic; can be found on emergent rocks in riffles).

Food: primarily plant debris such as algae and diatoms.

Damselflies
Metamorphosis: incomplete

Nymphs: bodies elongated with three distinct paddle-like tails (actually gills) located at end of abdomen; six legs positioned near front of body; two large eyes on top of head; colors range from green, brown, and black; some are robust, others slender; length up to 2 inches.

Reproduction: females deposit eggs on top of water where they drift to the bottom.

Adults: possess extremely long abdomens; two pairs of wings that are held upright at rest; very colorful in greens, blues, and reds.

Food: predaceous, nymphs feed on other aquatic macroinvertebrates.

Dragonflies
Metamorphosis: incomplete

Nymphs: vary in shape, but most have robust, elongated, or "spider-like" bodies, often with algae growing on their backs; six legs at side of body or near front on elongated species; two large eyes at sides of heads; a pair of small wings begins to develop on back; color varies from brown, black, but often green; length up to 2 inches.

Reproduction: eggs are deposited on surface of water and drift to bottom.

Adults: similar to adult damselflies, but the two pairs of wings are laid flat or horizontal at rest; some species can attain lengths of over 4 inches.

Food: predaceous, nymphs feed upon other aquatic macroinvertebrates, small fish, and tadpoles.

Sowbugs or Aquatic Pill Bugs

Description: somewhat flattened; resemble their terrestrial cousins; seven pairs of legs; color varies, usually gray, but sometimes brown; length less than 1 inch.

Reproduction: eggs are carried under the female's abdomen until they hatch.

Food: characterized as scavengers, eating both dead and live plant and animal debris.

Scuds or Sideswimmers

Description: possess extremely flattened sides and a hump back; somewhat resemble large "fleas"; several pair of legs; color varies from white, brown, but usually gray; most are very small, but some can reach 1/2 inch in length.

Reproduction: eggs held by the female in a marsupium (sac) until they hatch.

Food: characterized as scavengers, eating both plant and animal debris; scuds are an important food source for a variety of fish species.

Right-handed and other Snails

Description: these are generally the gill-breathing snails; right-handed snails are identified by their swirling shell opening on the right-hand side as the point is straight up in the air and the opening faces you; color is black, brown or grey, often covered with algae; length is up to 1 inch; other snails represent shells resembling ram's horns.

Reproduction: eggs are laid in gelatinous masses usually attached to rocks or other debris.

Food: primarily algae that grows on rocks and other debris; occasionally feeds upon decaying plant and animal matter; are preyed upon by fish, turtles, predatory invertebrates, and leeches.

Blood Worm Midges
Metamorphosis: complete

Larvae: similar to other midges, but are larger, robust, and distinctly red in color; length up to 1 inch.

Reproduction: female deposits gelatinous mass of eggs on the surface of water or on submerged vegetation.

Adults: resemble small mosquitoes with fuzzy antennae on males. Food: primarily algae and other organic debris.

Other Aquatic Macroinvertebrates

Crayfishes

Description: resemble miniature "lobsters"; possess four pairs of walking legs and a pair of strong pinchers; color can be brown, green, reddish, or black; length up to 6 inches.

Reproduction: females carry eggs in a mass underneath their tail, which resembles a large "raspberry."

Food: omnivorous, eating plants and animals; pinchers are used for tearing food into edible chunks; crayfish are preyed upon by larger game fish.

Freshwater Clams and Mussels

Description: include the small fingernail clams, European clam (*Corbicula*), and the larger pearly naiad mussels; fingernail clams are small (no more than 1/2 inch in diameter), fragile, and are whitish or grayish in color; *Corbicula* can be larger, 1 to 2 inches in diameter, light colored; mussels are large (up to 9 inches in diameter), robust, thick- or thin-shelled, and usually dark in color.

Reproduction: fingernail clams are self-fertilizing, the young developing inside the water tubes of the adult; mussels have a very elaborate and intriguing process; the larvae, called glochidia, develop inside the adult female and are released into the water where they eventually attach onto a host fish; they then parasitize the fish for about two weeks until they drop off and develop on the stream bottom into an adult.

Food: primarily filter feeders; filter organic debris and plankton out of water; preyed upon by numerous fish and mammals.

Appendix C. Citizen Scientist Level Macroinvertebrate Identification Key

The following key was adapted from *A Naturalist's Key to Stream Macroinvertebrates for Citizen Monitoring Programs in the Midwest*, by Joyce E. Lathrop (*Proceedings of the 1990 Midwest Pollution Control Biologists Meeting*, Chicago, IL, April 10-13, 1990).

Some of the descriptions have been modified to include those macroinvertebrates most commonly found in Illinois streams. Additionally, a couple of descriptions have been added so that the organisms found in the key matched the organism names on the data sheets for macroinvertebrate sampling and identification used in the Illinois RiverWatch Network Citizen Scientist Stream Monitoring programs (Trends and Assessments).

This key is designed for the person with the least amount of training in macroinvertebrate identification. A more experienced person will find this key to be simplistic, yet useful. It is suggested to use more than one taxonomic key when identifying any organism. A list of suggested taxonomic keys for macroinvertebrates are presented in Appendix E.

The following key is composed of sets of choices from which to select. Read each choice carefully and compare the organism to the description. Once you find the description which matches your organism's features, go on to the next description indicated by the number at the far right. For example, try to identify the organism below.

The first set of descriptions read:

1. A. With a hard calcareous shell of one or two valves. 2
MOLLUSKS
 Mollusca: Bivalvia (Clams and Mussels), Gastropoda (Snails and Limpets). In general, mollusks are found in hard waters with a pH near or above neutral (pH 7).
- B. With a spiral (snail-shaped) case of sand; animal hidden within case; body with 6 jointed legs; small and inconspicuous, often overlooked. ....
SNAIL-CASE CADDISFLIES
 Tricoptera : Helicopsychidae (Helicopsyche).
INTOLERANT.
- C. Without a hard, calcareous shell or spiral-shaped sand case; may or may not have non-spiral case of sand, pebbles or plant material 7

Select choice "C" because your organism does not have a hard, calcareous shell or a spiral-shaped sand case. Also, the organism does not have any type of case. Therefore, you would go on to description #7. Continue the search until you come upon a description which identifies the organism you have, and no more additional descriptions are given.

Size range estimates of the organisms are given as line figures beneath many of the descriptions. Size range estimates look like this:

The smaller of the brackets shows the smallest size range for this organism, and the largest of the brackets shows the largest size range of the organism.

Pollution tolerance information for many of the organisms is also given. Common names are used for identification, but the taxonomic names (order, family and some genera) are also given as an educational tool and as a reference when using additional keys.

Numbers which are in parentheses next to the description's number (see example) indicate which description was used to reach the present position. (This information is provided to help you back track your search in case you made a mistake in the identification of the organism.) If you reach a point in your search where the final description does not match the organism, then follow the path backwards until finding the particular description where a mistake was made. Once this point is reached, decide again which description best fits the organism you are looking at. Proceed on the new path towards identifying the organism. If you have back tracked your way to a description where the mistake was possibly made, ask someone else to make the decision for you, or ask for help from the regional coordinator or instructor.

An example of a macroinvertebrate description:

Description number

Description which was used to reach this point

3(2).A. Snails with an operculum (a hard covering used to close the aperture or opening) .....

Gastropoda: Prosobranchia: Six families. (Operculate Snails)

MODERATELY TOLERANT— Tolerance

Size bar

OTHER SNAILS

Final destination for this organism

B. Snails without an operculum; lung breathing snails (Pulmonata) 4

Description choices

Go to this description

3A.

3B.

Basic Insect Morphology

For those volunteers who have never identified insects, or any other organism, it is a good idea to review some of the terms which are used when describing the body parts of an insect. The insect's body is generally divided into three major sections. The **head**, the **thorax** and the **abdomen**. The thorax of an insect is separated further into three more sections named the **prothorax**, **mesothorax** and **metathorax**. Wings or wing pads are found on the prothorax and mesothorax. One pair of legs are generally found on each of the thoracic segments. The legs of an insect have parts which are similar to our legs. The first leg segment coming from the body is called the **femur**. The next leg segment is called the **tibia** and the feet of an insect are referred to as **tarsi**. The tarsi are separated further into segments called **tarsal segments**.

The following words below are used in the key. These words indicate where to look on an insect's body for a particular identifying mark.

1. **Anterior** - In the direction of the head.
2. **Posterior** - In the direction of the anus (or end of abdomen).
3. **Caudal** - Found at the tip of the abdomen.
4. **Dorsal** - Refers to the back, or top of the organism.
5. **Ventral** - Refers to the belly, or bottom of the organism.

Macroinvertebrate Identification Key

1. A. With a hard calcareous shell of one or two valves. 2
MOLLUSKS .....
 Mollusca: Bivalvia (Clams and Mussels), Gastropoda (Snails and Limpets). In general, mollusks are found in hard waters with a pH near or above neutral (pH 7).
- B. With a spiral (snail-shaped) case of sand; animal hidden within case; body with 6 jointed legs; small and inconspicuous, often overlooked. ....
 ..... **OTHER CADDISFLIES**
 Tricoptera : Helicopsychidae (Helicopsyche). Snail Case Caddisflies.
INTOLERANT.
- C. Without a hard, calcareous shell or spiral-shaped sand case; may or may not have a non-spiral case of sand, pebbles or plant material. 7

1A.

1B.

2(1).A. Shell of one valve. **SNAILS** 3

B. Shell of two valves held together by a non-calcareous ligament. **CLAMS AND MUSSELS** ... 6

2A.

2B.

3(2).A. Snails with an operculum (a hard covering used to close the aperture or opening). ..... OTHER SNAILS

Gastropoda: Prosobranchia: Six families. (Operculate Snails)

MODERATELY TOLERANT

B. Snails without an operculum; lung breathing snails (Pulmonata). 4

3A.

3B.

4(3).A. Shell discoidal (coiled in one plane). ..... PLANORBID SNAILS

Gastropoda: Planorbidae. Generally found in slower waters such as runs.

MODERATELY TOLERANT.

B. Shell patelliform (cup shaped), limpet-like. ..... FRESHWATER LIMPETS

Gastropoda: Ancyclidae. Found in riffles.

MODERATELY TOLERANT.

C. Shell with a distinct spiral. 5

4A.

4B.

4C.

- 5(4). A. Shell sinistral ("left-handed") ..... POUCH SNAILS
 Gastropoda: Physidae (*Physella*). Often found in slower waters.
 GENERALLY TOLERANT.
- B. Shell dextral ("right-handed") ..... RIVER AND POND SNAILS
 Gastropoda: Lymnaeidae.
 GENERALLY TOLERANT

NOTE: "Handedness" is determined by holding the shell spire up and the aperture facing you. If the aperture is on the right, the snail is "right-handed" or dextral; if the aperture is on the left, the snail is "left-handed" or sinistral.

- 6(2). A. Small bivalves, adults <2 cm long. .... FINGERNAIL AND ASIATIC CLAMS
 Bivalvia: Sphaeriidae and Corbiculidae. Fingernail clams are very small, with thin fragile shells. Asiatic clams have larger, thicker shells with obvious growth rings.
 FAIRLY INTOLERANT.
- B. Large bivalves, adults mostly >2 cm long. .... CLAMS AND MUSSELS
 Bivalvia: Unionidae. Very young individuals may be less than 2 cm long.

NOTE: Characteristics used to distinguish different bivalves are internal but most have distinct shells and can be roughly picture keyed.

- 7(1).A. Entire body distinctly segmented, flattened and oval in shape; the head, 6 pairs of jointed legs and gills are hidden ventrally (beneath the body); copper or brown in color; cling tightly to rocks. .... WATER PENNIES
Coleoptera : Psephenidae.
INTOLERANT
- B. Body oval or elongate, soft and indistinctly segmented; head, legs and gills lacking; with anterior and posterior ventral (bottom) suckers. .... LEECHES
Hirudinea
MODERATELY TOLERANT
- C. Body not a distinctly flattened oval shape; with or without legs; without suckers. 8

7A.

7B.

- 8(7).A. With more than 6 true, jointed legs. CRAYFISH, SCUDS AND SOWBUG 9
- B. With 6 true, jointed legs. (Insecta; except Diptera). 11
- C. With less than 6 true, jointed legs, although non-jointed legs (prolegs) may be present; body often worm-like. 31

8A.

8B.

8C.

- 9(8).A. Generally large organisms with 2 large claws (chelipeds), one or both of which may be missing. Small (young) individuals are common in some areas in spring. .... CRAYFISH
Crustacea: Decapoda (Cambaridae).
FAIRLY INTOLERANT.

B. Smaller organism, lacking large claws. 10

9A.

9B.

- 10(9).A. Flattened laterally (from side to side); tan, white or gray in color. .... SCUDS
Amphipoda
INTOLERANT.

- B. Flattened dorsoventrally (top to bottom); gray in color. .... SOWBUGS
Isopoda. Sowbugs resemble the terrestrial "pill bugs" which belong to the same order.
Isopoda
MODERATELY TOLERANT.

10A.

10B.

- 11(8).A. With three broad, oar-like "tails" (gills); body long and thin; wing pads present.
DAMSELFLIES 12
 Odonata (Zygoptera)
- B. With 1, 2, or 3 thin caudal filaments ("tails"). 13
- C. With no thin caudal filaments; prolegs or other appendages such as spines or hooks (tarsal claws) may be present. 18

11A.

11B.

- 12(11)A. Long, slender body with long legs; first antennal segment is much longer than the other segments; caudal gills are long and slender with the outer gills being longer than the inner gill. .... **BROADWINGED DAMSELFLIES**
 Odonata (Zygoptera): Calopterygidae
INTOLERANT

- B. Body is relatively short; antennae are made of segments of similar size; gills are broad and leaflike, and pointed at tips. .... **NARROWWINGED DAMSELFLIES**
 Odonata (Zygoptera): Coenagrionidae
FAIRLY INTOLERANT

12A.

12B.

13(11)A. With 1 caudal filament; body brown or copper in color, head and "tail" lighter in color ..... ALDERFLIES

Megaloptera: Sialidae (*Sialis*).

INTOLERANT

B. With 2 caudal filaments. STONEFLIES and OTHER MAYFLIES 14

C. With 3 caudal filaments. MAYFLIES 15

NOTE: The caudal filaments of mayflies often break off easily; look for "tail stubs". You will need a hand lens to see the tarsal claws.

13A.

13B.

13C.

14(13)A. One tarsal claw; gills present on abdominal segments; one pair of wing pads on thorax; individuals are generally more flimsy. .... OTHER MAYFLIES
Ephemeroptera: Some members of the families Heptageniidae and Baetidae.
SOMEWHAT INTOLERANT

B. Two tarsal claws; gills, if visible, are not located on abdomen but on the underside of the thorax; two pairs of wing pads on thorax; body tan, brown or yellow, sometimes patterned; size varies but most are robust. .... STONEFLIES
Plecoptera: Several families.
INTOLERANT

14A.

14B.

- 15(13)A. Mandibles modified into tusks (elongated past head); body creamy white, tan or with brown and white pattern; gills forked..... **BURROWING MAYFLIES**
 Ephemeroptera: Ephemeridae, Potamanthidae. Found in soft substrates burrowing in sand, mulch, silt, etc.
 FAIRLY INTOLERANT.

B. Without tusks. 16

15A.

15B.

- 16(15)A. Body flattened dorsoventrally (top to bottom); eyes large and located on top of head. ....
 CLINGING MAYFLIES
 Ephemeroptera: Heptageniidae. Tolerance ranges from intolerant to somewhat tolerant; three common genera (*Stenacron*, *Stenonema* and *Heptagenia*) are intolerant.

B. Body not flattened dorsoventrally. 17

16A.

16B.

- 17(16)A. Body slightly compressed from side to side; thorax slightly humped; torpedo-shaped; front legs with a dense row of hairs. .... TORPEDO MAYFLIES
 Ephemeroptera: Oligoneuridae. One of the swimming mayfly groups.
 INTOLERANT
 [ ]
- B. Body not compressed from side to side; front legs without a dense row of hairs; gills on abdomen resemble two plates. .... CRAWLING MAYFLIES
 Ephemeroptera: Caenidae and Tricorythidae
 FAIRLY INTOLERANT
 [ ]
- C. Body not compressed from side to side; front legs without a dense row of hairs; no plate gills on abdomen. .... SWIMMING MAYFLIES
 Ephemeroptera: Baetidae and Siphonuridae
 INTOLERANT
 [ ]

17A.

17C.

17B.

- 18(11)A. Entire body including the front wings are hard; small, dark beetles which are long and thin, or ovoid in shape. .... ADULT RIFFLE BEETLES
 Coleoptera: Elmidae and Dryopidae.
 [ ]
- B. Entire body not hard. 19

18A.

18B.

- 19(18)A. With external wing pads; lower jaw (labium) large, hinged and folded up on itself concealing other mouthparts. .... **DRAGONFLIES**
 Dragonflies are seldom found in riffles, but may be found buried in soft sediments (e.g., sand, silt or mud) or in vegetation and detritus along the stream edge or in slightly slower waters.
 Odonata: Anisoptera.
FAIRLY INTOLERANT

B. Without external wing pads; labium not hinged. 20

19A.

19B.

20(19)A. Abdomen with lateral appendages. 21

B. Abdomen without lateral appendages (ventral gills may be present). 23

20A.

20B.

21(20)A. Lateral appendages long and thick; abdomen terminating in a single slender filament, or in prolegs, each with two terminal hooks; body dark brown to black; most are large, some to 10 cm (4 in.) long. 22

B. Lateral appendages long and thin, or short and thick; abdomen terminating in 2 slender filaments, or in a median proleg with 4 hooks; body lighter in color, tan, whitish or yellow; mostly smaller (< 2 cm long). .... **BEETLE LARVAE**
 Coleoptera: Gyrinidae (Whirligig Beetles)
INTOLERANT

21A.

21B.

- 22(21)A. Abdomen with a single caudal filament ..... ALDERFLY LARVAE
 Megaloptera: Sialidae (*Sialis*)
 INTOLERANT
- B. Abdomen with hooks on short appendages. .... DOBSONFLY LARVAE or HELLGRAMMITES
 Megaloptera: Corydalidae. One genus (*Corydalus*) has abdominal gill tufts under the lateral appendages.
 INTOLERANT

22A.

22B.

- 23(20)A. With hooks at end of abdomen; individuals often curl into a "C" shape when held or preserved; body color variable, but head usually brown or yellow; abdomen whitish, tan or green; pronotum (first dorsal thoracic segment) with a distinctly sclerotized plate; abdomen membranous and of a different color from thoracic plates; many build some sort of portable or stationary case of plant material, sand or pebbles.
 CADDISFLIES 25
- B. Without hooks at the end of the abdomen; no gill structures on abdomen; 6 true (segmented) legs on thorax and no prolegs on abdomen. 24

23A.

23B.

24(23)A. Thorax and abdomen are similar in width giving the organisms a "tube-like" shape; body brown, copper-colored or tan; body somewhat "leathery" in appearance. .. RIFFLE BEETLE LARVAE
Coleoptera: Elmidae and Dryopidae. Riffle beetle larvae resemble midge larvae and are about the same size but riffle beetle larvae are leathery rather than membranous and have segmented legs (true legs) on the abdomen. .... FAIRLY INTOLERANT

B. Body is "submarine shaped"; abdomen made up of 8 segments; legs on thorax have 5 segments with two claws. .... PREDACIOUS WATER BEETLE LARVAE
Coleoptera: Dyticidae.

NOTE: No tolerance value is given for this family, but indicate the number of larvae you collected for trend assessment.

C. Abdomen is largely membranous and wrinkled, sometimes with long filaments; mandibles are large and well developed; legs on thorax have 4 segments with one claw. ....
..... WATER SCAVENGER BEETLE LARVAE
Coleoptera: Hydrophilidae.

NOTE: No tolerance value is given for this family, but indicate the number of larvae you collected for trend assessment.

25(23)A. Without a portable case (some build stationary cases made of small rocks and sand). 26

B. With a portable case. 28

26(25)A. Head as wide as thorax; dorsal plates found either on the first thoracic segment or on all 3 thoracic segments; builds stationary cases of stone and sand on rocks. 27

B. Head narrower than thorax; dorsal plates on first thoracic segment, and on last abdominal segment; free living caddisfly; builds no case. .... OTHER CADDISFLIES
Trichoptera: Rhyacophilidae. (Free-living caddisflies).
INTOLERANT

26A.

25B.

27(26)A. Each thoracic segment with a single dorsal plate; abdomen with gills ventrally (on bottom); >5 mm in length. .... HYDROPSYCHIDAE

Trichoptera: Hydropsychidae. Net spinning caddisflies.

FAIRLY INTOLERANT

NOTE: Microcaddisflies, which also have 3 dorsal plates on the thorax, resemble Hydropsychids when the former are out of their cases. Microcaddisflies are very small (mostly <5 mm), lack abdominal gills, and their abdomens are swollen (larger than thorax). They build cases of silk which are sometimes covered with sand or other substrates.

B. Prothorax with a dorsal plate, mesonotum (second thoracic segment) and metanotum (third thoracic segment) partly or entirely membranous. .... OTHER CADDISFLIES

Trichoptera: Three families, Psychomyiidae, Philopotamidae and Polycentropodidae (Net-spinning caddisflies).

INTOLERANT

27A.

dorsal plate on each thoracic segment

27B.

28(25)A. Case of organic detritus (e.g., small sticks, leaves). 29

B. Case of sand or small stones. 30

NOTE: There are two groups of Tube-case Caddisflies, one builds organic tubes and the other mineral tubes.

C. Case of silk, may be covered with sand or organic material; animal very small (2-5 mm); each thoracic segment with a single dorsal plate; no ventral abdominal gills. ....

OTHER CADDISFLIES

Trichoptera: Hydropsilidae. (Purse-case or Microcaddisflies). Resemble the Hydropsychidae but much smaller and without ventral abdominal gills.

INTOLERANT.

29(29)A. Case is square in cross section. .... OTHER CADDISFLIES

Trichoptera: Brachycentridae. (Brachycentrid Caddisflies)

INTOLERANT.

B. Case is cylindrical. .... OTHER CADDISFLIES

Trichoptera: Leptoceridae, Phryganiidae, Limnephilidae, and Lepidostomatidae. (Tube-case Caddisflies).

INTOLERANT

30(28)A. Case shaped like a snail shell and made of sand. .... OTHER CADDISFLIES

Trichoptera: Helicopsychidae. (Snail-case Caddisflies)

INTOLERANT

B. Case made of small stones and turtle shell shaped (top is dome shaped; underside is flat)...

..... OTHER CADDISFLIES

Trichoptera: Glossosomatidae. (Saddle-case Caddisflies)

INTOLERANT

C. Tube made of sand or stone, and shaped like a tube. .... OTHER CADDISFLIES

Trichoptera: Three families: Molanidae, Limnephilidae, and Odontoceridae.

INTOLERANT

30A.

30B.

30C.

31(8)A. Head is a distinct structure on the body which appears hard (encapsulated head); eyes and antennae (if present) are plainly visible 32

B. Head is not seen as a distinct structure on the body; may be difficult to distinguish which end of the body is anterior or posterior. Head may be retracted, or withdrawn into the body 36

31A.

31B.

- 32(31)A. Body with 1 or 2 pairs of prolegs either of which may appear as a single leg. 35
- B. Body without prolegs. 33
- C. Body made up of 6 segments; with a row of "suckers" on the underside (or ventral side) of the body. .... OTHER FLIES
Diptera: Blephariceridae. Net-winged midges.

- 33(32)A. End of abdomen with a breathing tube or a tube-like structure. 34
- B. No breathing tube or tube-like structure found at the end of abdomen. Body is straight and slender. .... BITING MIDGES
Diptera: Ceratopogonidae. Also known as "punkies" or "no-see-ums".
FAIRLY INTOLERANT

34(33)A. Body segment behind head (or first thoracic segment) is enlarged. Tip of abdomen with a breathing tube and hair-like bristles. .... OTHER FLIES
Diptera: Culicidae. Mosquitoes.

B. Head is completely visible. Tip of abdomen with a large tube and a tuft of hair. Organism is small in size (under 4 mm). Dorsal plates can be found on each segment. .... OTHER FLIES
Diptera: Psychodidae. Moth Flies.

35(32)A. With 1 pair of anterior prolegs; abdomen with a distinct bulge posteriorly (abdomen is swollen at end); usually gray or mottled brown in color. .... BLACK FLIES
Diptera: Simuliidae. Usually found in very fast moving water.
MODERATELY TOLERANT

B. With 1 pair anterior (near head) and 1 pair posterior (on abdomen) prolegs; body tubular, width about equal throughout (no posterior bulge); color variable but usually white, green or red. 37
Diptera: Chironomidae. True Midges

C. With 2 pairs of prolegs on body segments behind head. Tip of abdomen with two hair fringed lobes and a tube-like process. .... OTHER FLIES
Diptera: Dixidae. Dixid Midges.

36(31)A. Body with tubercles (small thin tubes) on top (dorsal) and sides (lateral) of the body or abdomen. With 8 pairs of abdominal prolegs and a pair of long terminal appendages; head region is long in length. .... **SNIPER FLIES**
 Diptera: Athericidae (*Atherix*)
FAIRLY INTOLERANT

B. Body without dorsal and lateral tubercles; with 8 or less pairs of prolegs; abdomen terminates in 1-4 rounded lobes tipped with short hairs. .... **OTHER FLIES**
 Diptera: Empididae. Dance Flies.

C. With characteristics other than those listed in A.; if prolegs present, then without a pair of long terminal appendages and head is not long in length; prolegs may be lacking altogether. **38**

36A.

36B.

37(35)A. Body is red in color (may be clear or tan if organisms is preserved); eye spots on head are arranged one on top of the other, resembling a colon (:); head is somewhat square; end of abdomen has a short pair of projections (gills) which possess a tuft of hairs. .... **BLOOD WORMS**

B. Body is white or green in color; eyespots on head do not resemble a colon (:) but may resemble one large spot, or two blurred spots; head is elongated, not square; end of abdomen does not possess a short pair of gills. .... **MIDGES**

37A.

37B.

38(36)A. Head is small, dark and usually retracted into thorax; usually with 4 to 8 short tubes at one end (posterior, or on the abdomen) arranged in a circular pattern, although some generally have less than 4 tubes; body usually soft and membranous. .... **CRANEFLIES**
 Diptera: Tipulidae
INTOLERANT

B. Head is small and fleshy (not dark) and not retracted into thorax; body appears leathery and yellow or brown and covered with tubercles (or bumps); tip of abdomen has lobes surrounding the spiracular disk at the tip. .... **OTHER FLIES**
 Diptera: Sciomyzidae. Marsh Flies.

C. Spindled shaped body; no tubercles on end of abdomen; may have prolegs. **39**

38A.

38B.

39(38)A. Possess prolegs and some type of caudal process which may be a long process extending from tip of abdomen, a fleshy bifurcated tail (split in two) or a tube like structure. ....

OTHER FLIES

Diptera: Empididae. Dance Flies
Ephydriidae. Shore Flies

B. Body is spindle-shape with no type of structure on the tip of the abdomen. A "girdle" of false legs on each segment. .... OTHER FLIES

Diptera: Tabanidae. Deer Flies and Horse Flies

C. Body does not have any characteristics listed above. May possess 2 suckers (one anterior and one posterior). May have eyespots. Body flattened. 40

39A.

39B.

40(39)A. Body segmented, thin and hairlike, not flattened; resemble earthworms. ....

AQUATIC WORMS

Annelida: Oligochaeta. Better known as aquatic oligochaetes, they are related to the terrestrial earthworms.

TOLERANT

B. Body flattened and indistinctly segmented (segmentation may not be seen); long or oval in shape; with anterior and posterior ventral suckers (suckers may be found on the bottom of the animal; one located at the head and the other at the end of the abdomen). .... LEECHES

Annelida: Hirudinea.

MODERATELY INTOLERANT

C. Body wide, flattened, and not segmented, often gray; visible eye spots. .... FLATWORMS

Platyhelminthes: Turbellaria

MODERATELY TOLERANT

40A.

40B.

Top View
(Dorsal)

Bottom View
(Ventral)

40C.

Appendix D. RiverWatcher Level Macroinvertebrate Identification Guide

Group I - These organisms are generally considered to be intolerant to pollution.

Stonefly Nymph

Aterfly Larvae

Dobsonfly Larvae

Water Penny
Beetle Larvae

Damselfly Nymph

Mayfly Nymph

Scud

Crane Fly Larvae

Caddisfly Larvae

Group II - These organisms are generally considered to be moderately intolerant to pollution.

Caddisfly Larvae

Adult Riffle
Beetle

Riffle Beetle
Larvae

Damselfly Nymph

Dragonfly Nymph

Mayfly Nymph

Mayfly Nymph

Biting Midge Larvae

Crayfish

Clams/Mussels

Group III - These organisms are generally considered to be fairly tolerant to pollution.

Leech

Midge Larvae

Black Fly Larvae

Right-Handed/Other Snails

Turbellaria

Sowbug

Group IV - These organisms are generally considered to be very tolerant to pollution.

Aquatic Worms

Pouch/Left-Handed Snails

Blood Worm Midge Larvae

Appendix E. Glossary

Algae - Simple one-celled or multi-celled organisms (usually aquatic) capable of photosynthesis. One-celled algae are extremely small and can only be seen with the aid of a microscope. Multicellular algae appear in streams as long filaments.

Algal Blooms - Periods of vigorous algal growth. During a bloom, so many algae cells are present that water turns green. Algal blooms occur naturally and provide valuable food for many aquatic organisms. Algal blooms can also occur when phosphorus and nitrogen are added to water—for example, as when raw sewage or water from washing machines is dumped directly into a body of water. These large and frequent “unnatural” algal blooms can deplete oxygen from the water. Other problems result when massive numbers of algae cells die and sink to the bottom.

Banks - That portion of the stream channel that restricts water from moving out of the channel when water is at normal depth. Consists of a narrow strip of land on either side of the stream beginning at the water's edge.

Benthic - Associated with the bottom, or sediments of a stream.

Biological Oxygen Demand (BOD) - The amount of dissolved oxygen that is required by microscopic organisms (e.g., bacteria) to decompose organic matter in streams.

Channelize - To straighten a stream or dredge a new stream channel to which the stream is diverted. A “channelized” stream resembles a ditch; it is straight with few or no meanders.

Citizen Scientist - An Illinois citizen who has undergone training in stream monitoring procedures as outlined by the Illinois RiverWatch Network.

Class - A taxonomic rank which falls below the taxonomic rank of Phylum (for example, Class Insecta). All organisms in one class will be more similar to each other than to organisms in another class.

Community Density - A measurement of the number of individuals per unit of area in a community.

Complete Metamorphosis - Insect development with four life stages—egg, larva, pupa, and adult.

Dissolved Oxygen - The oxygen that occurs in the water of a stream.

Drainage Basin - The total land area draining to any point in a stream. A drainage basin is composed of many smaller watersheds.

Emergent Vegetation - Plants living along the edges (or banks) of a stream that are rooted in the sediment but grow above the water's surface.

Family - A taxonomic rank which falls below Order (for example, the Family Ephemeridae). All members of a family are more similar to each other than they are to organisms in a different family.

Floodplain - Areas of land on either side of a river that are covered by periodic floods.

Genus - The taxonomic rank below Family (for example the Genus *Hexagenia*). All organisms in a genus are more similar to each other than to other organisms in another genus.

Habitat - The area in which an organism normally lives or occurs. A habitat includes both living and nonliving components. For example, emergent vegetation (living) and the water (nonliving) are part of the habitat for macroinvertebrates. The habitat of an organism includes its sources of food and shelter.

Habitat Assessment - The evaluation of the living and nonliving components of an area. Habitat assessments determine the suitability of a stream area for macroinvertebrate communities.

Headwater Streams - Small streams that begin as outlets of ponds or lakes, or arise from springs and seepage areas.

Incomplete Metamorphosis - A type of insect development in which the life cycle consists of three stages—egg, nymph, and adult.

Indicator Organisms - Organisms that respond predictably to various environmental changes, and whose presence or absence and abundance are used as indicators of environmental conditions.

Insects - Organisms that can be generally characterized by having six legs as adults.

Integrity - Biological health of a stream or ecosystem.

Invertebrates - Organisms that lack backbones, or spinal columns.

Kingdom - The highest taxonomic rank (for example, Kingdom Animalia.) Organisms within kingdoms differ from organisms in other kingdoms.

Larva (Larvae) - The immature form of an insect that undergoes complete metamorphosis.

Leaf Pack - Any cluster or gathering of leaves and organic debris normally found on the edges of streams, or found washed up on the upstream side of large rocks in the stream.

Macro- - A prefix describing the size of something. In biology, macro usually refers to those organisms that can be seen without the use of a microscope, or with the naked eye.

Macroinvertebrate(s) - All invertebrate organisms that can be seen without the aid of a microscope.

Metamorphosis - A series of changes in body structure (form) from egg to adult. In insects, the change from juvenile to adult form involving the reorganization of body tissue. The word literally means "the act of changing form."

Metrics - Mathematical tools that indicate some parameter by measuring some characteristic of a stream. For example, the metric referred to as the Macroinvertebrate Biological Index (MBI) indicates the level of organic pollution present in a stream by measuring the overall pollution tolerance of the macroinvertebrate community.

Nitrogen - A limiting nutrient for the aquatic environment. Nitrogen is considered to be limiting because it is needed by the plants and animals in the stream in moderate amounts. When present in high amounts, such as heavy fertilizer runoff from local farm fields, nitrogen spurs large algal blooms that deplete dissolved oxygen.

Nonpoint Source Pollution - Water pollution that cannot be traced to a specific source. Includes agricultural and urban runoff and atmospheric fallout.

Nutrients - Substances needed for the growth of aquatic plants and animals. The addition of too many nutrients (such as from sewage dumping and agricultural runoff) will cause problems in the aquatic ecosystem. For example, very large algal blooms will occur if too much phosphorus is dumped into a lake or stream, which in turn results in the loss of dissolved oxygen.

Nymph - The juvenile form of an insect that undergoes incomplete metamorphosis.

Order - The taxonomic rank below Class (for example, Order Ephemeroptera). All organisms in an order are more similar to each other than to those in another order in the same class.

Organism - Any living thing. Plants and animals are organisms.

Phosphorus - An element that is a limiting nutrient for the aquatic environment. Phosphorus is required by microscopic plants and animals in moderate amounts. When present in high amounts, as occurs in fertilizer runoff from local farm fields, it stimulates large algal blooms.

Phylum - The taxonomic rank below Kingdom (for example, Phylum Arthropoda). All organisms in a phylum are more similar to each other than to organisms in another phylum.

Point Source Pollution - Pollution entering a stream at a specific, detectable site. For example, a factory's discharge pipe is a point source of pollution.

Pollution - Any unfavorable alteration to the environment produced by human activities.

Pollution Sensitive Organism(s) - Those organisms that cannot withstand the alterations of their aquatic environment by pollution. For instance, organic pollution causes a decrease in dissolved oxygen levels. Many organisms (mayflies, stoneflies, caddisflies) cannot survive in water with low levels of dissolved oxygen. Also referred to as pollution intolerant organisms.

Pollution Tolerant Organism(s) - Those organisms that can withstand polluted aquatic environments. For instance, a group of midge larvae called blood worms have physiological adaptations that allow them to survive in water with low levels of dissolved oxygen.

Pool - A portion of a stream where the flow of water is slower and the depth deeper compared to other areas of a stream. Many organisms such as fish and crayfish have adapted so that they can survive in this type of habitat.

Reach (Stream Reach) - A specified length of stream.

Riffle - An area of a stream where shallow water flows swiftly over completely or partially submerged rocks.

Rip rap - Any material (such as concrete blocks or log pilings) used to protect a stream bank from erosion.

Riparian Zone - A relatively narrow strip of land on either side of a stream that is covered periodically with flood water.

Rocky Bottom Reach - A specified length of stream where the bottom consists of gravel, rocks, and boulders. Rocky bottom reaches are characterized by the presence of the riffle, run, and pool habitats.

Run - An area of swiftly flowing water, without any surface agitation such as riffles. Runs are usually found between riffle and pool habitats.

Runoff - The overflow of water from the surrounding landscape into streams.

Scientific Names - Usually Latin in derivation, given so that all scientists, no matter which language they speak, will understand which organisms are being described.

Sediment - Material that accumulates on the bottom of streams.

Siltation - The erosion of soil and mineral particles from the surrounding landside into a body of water, such as a stream. Silt is a name for the eroded soil and mineral particles which are found in water and settle on the bottom of streams.

Soft Bottom Reaches - Stream segments which have generally sandy or muddy bottoms. These reaches are straight channels and do not contain riffles, runs and pools.

Species - The taxonomic rank under Genus. All organisms of a particular species are more similar to each other than they are to organisms of another species.

Stream Channel - That area of a stream through which water flows.

Stream Miles - The measurement of a stream's length from within the stream or river channel. Since stream miles are measured from within the channel, the distance covered by the various curves in the stream are accounted for in the total length.

Subsampling - A method by which a representative sample of the whole is taken. Used to remove 100 organisms in a random fashion from a larger sample.

Taxa Richness - A measurement of the number of taxa or groups of organisms in a community. The number of taxa found at each sample site represents the taxa richness of the area.

Taxon - One level of a taxonomic rank. For example, Kingdom is the taxon of the highest taxonomic rank.

Taxonomic Ranks - Levels of the classification of living organisms. For example, Kingdom, Phylum, Class, Order, Family, Genus, and Species are the taxonomic ranks of animals.

Trend Data - Data, or measurements, of a stream system that show how particular characteristics change over time.

Urban Runoff - Water that has drained from the surface of land converted for urban development such as paved roads, subdivisions, buildings, and parking lots.

Watershed - The entire surface drainage area that drains into a stream or river. Many watersheds draining into a common river make up its drainage basin.

Appendix F. Suggested Literature and Sources of Information

Macroinvertebrate Identification keys

A Guide to the Study of Fresh-Water Biology. 1988. A 108-page guide by James G. Needham and Paul R. Needham that is designed to facilitate recognition of freshwater organisms in both the field and laboratory. Includes keys, tables, references, and drawings of genera and species. Also discusses methods of sampling and analyzing aquatic organisms and their environments. Source: Reiter's Scientific & Professional Books, 2021 K Street, NW, Washington DC 20006. Phone: (202)223-3327. Fax: (202)296-9103. (\$17.50)

Aquatic Entomology: The Fishermen's and Ecologists' Illustrated Guide to Insects and Their Relatives. 1981. A 450-page illustrated layperson's guide to aquatic insects and stream ecology by W. Patrick McCafferty. Source: Anglers Art, P.O. Box 148, Plainfield, PA 17081. phone: (800)848-1020. (\$50.00)

An Introduction to the Aquatic Insects of North America. Second Edition. 1984. A 772-page text with descriptive keys by Richard W. Merritt and Kenneth W. Cummins. Includes drawings and tables as well as information covering the ecology and distribution of aquatic insects. Also includes instructions for the collection and preservation of insects. Source: Reiter's Scientific & Professional Books, 2021 K Street, NW, Washington DC 20006. Phone: (202)223-3327. Fax: (202)296-9103.

Peterson Field Guides, Insects. 1987. A simplified field guide to the common insects of North America. Source: Houghton Mifflin Company, Trade Order Dept., Wayside Road, Burlington, MA 01803. Phone: (800)225-3362. (paper edition ISBN# 0-395-356407). This guide is also widely sold in bookstores. (\$16.00-\$22.00)

How to Know the Aquatic Insects. 1979. D. M. Lehmkuhl. 168-page text and identification key with index. A good key for beginners. William C. Brown, Publishers, 2460 Kerper Blvd., Dubuque IA 52001 (800)338-5578. (ISBN# 0-697-04767-9). (\$21.50).

Fresh-Water Invertebrates of the United States. 1968. A 628-page technical reference of fresh water biology by Robert W. Pennak that covers a variety of major animal groups and includes illustrated keys identifying the species or genera of each group. Also includes bibliography and appendices covering reagents, solutions, and laboratory apparatus. Source: Reiter's Scientific & Professional Books, 2021 K Street, NW, Washington, DC 20006. Phone: (202)223-3327. Fax: (202)296-9103. (\$74.95)

Field Guide to Freshwater Mussels of the Midwest. 1992. A 925 page pocket-size field guide to freshwater mussels. Color plates and distribution maps of each species are included. Authored by Kevin S. Cummings and Christine A. Mayer of the Illinois Natural History Survey. Source: Illinois Natural History Survey, Natural Resources Building, 607 East Peabody Drive, Champaign, Illinois 61820. (\$15.00)

Appendix G. Biological Equipment Suppliers

Supplier

Rivers Curriculum Project
Southern Illinois University at Edwardsville
Box 2222
Edwardsville, IL 62026
ph: 618-692-3788
fax: 618-692-3359

American Biological Supply Company
2405 N.W. 66th Court
Gainesville, FL 32606
ph: 904-377-3329
fax: 904-377-AMBI

BioQuip Products, Inc.
1703 LaSalle Avenue
Gardena, CA 90248-3502
ph: 310-324-0620
fax: 310-324-7931

NASCO - Fort Atkinson
901 Janesville Avenue
Fort Atkinson, WI 53538-0901
ph: 1-800-558-9595
fax: 414-563-8296

Equipment

dip nets

dip nets

*dip nets, subsampling trays, forceps,
magnifiers, thermometers,
identification keys,
permanent non-soluble ink (Pigma) pens*

*dip nets, forceps, magnifiers,
thermometers*

Appendix H. Data Sheets

The following pages contain the data sheets for the Citizen Scientist and RiverWatcher stream monitoring programs. Please make copies of these data sheets to use when monitoring the stream site. Data sheets are also available from the IRWN Coordinator and from IRWN Field Offices.

Illinois RiverWatch Network - Citizen Scientist
Site Identification Form

These forms are to be completed for each study site. Keep a copy of this sheet for your records and return the original to Denise Stoeckel at Forbes Biological Research Station, 17500 E CR 1950N, P. O. Box 590, Havana, Illinois, 62644.

Date Monitored: _____ (if not monitored yet, leave blank)

IRWN Site Identification Number: _____ (if not known, leave blank)

Stream Name: _____

Watershed Name: _____

(Your site will be in one of ten watersheds: (1)Rock River, (2)Fox and Des Plaines Rivers, (3)Kankakee, Vermilion and Mackinaw Rivers, (4)Spoon River, (5)Sangamon River, (6)Lamoine River, (7)Kaskaskia River, (8)Embaras and Vermilion Rivers, (9)Little Wabash River, and (10)the Big Muddy River. See map on back of form for reference).

County: _____

Location Description (Indicate the distance of your study site from the nearest permanent structure, such as a bridge, road, or town. For example: 0.5 mi. north of bridge crossing of County Road 1950N would indicate that a study site is located at this location):

_____
_____
_____

Latitude: _____ (if not known, leave blank)

Longitude: _____ (if not known, leave blank)

Topo Map Name : _____

Quarter Section _____ Section No. _____ Range _____ Township _____

Name: _____

Daytime phone number: _____

IRWN Field Office: _____

IRWN Region: _____

RIVER BASINS

- 1 ROCK RIVER
- 2 FOX AND DES PLAINES RIVERS
- 3 KANKAKEE, VERMILION AND
MACKINAW RIVERS
- 4 SPOON RIVER
- 5 SANGAMON RIVER
- 6 LAMOINE RIVER
- 7 KASKASKIA RIVER
- 8 EMBARRAS AND VERMILION RIVERS
- 9 LITTLE WABASH RIVER
- 10 BIG MUDDY RIVER

Illinois RiverWatch Network

Site Sketch

Site ID: _____
Date: _____
Stream: _____
County: _____

Sketch aerial view of the 200 foot study reach. Be sure to mark north and the direction of stream flow. Note features such as riffles, runs, pools, ditches, wetlands, dams, riprap, tributaries, landscape features, vegetation, and roads. Record where you take habitat measures and macroinvertebrate collection. Record notes and observations below sketch or on back.

**Illinois RiverWatch Network - Citizen Scientist
Habitat Assessment Sheet**

Site ID: _____
Date: _____
Stream: _____
County: _____

Group name and team members _____

Start Time _____ am pm (circle)

End Time _____ am pm (circle)

Present weather

_____ Clear/Sunny
_____ Overcast
_____ Showers (intermittent rain)
_____ Rain (steady rain)
_____ Storm (heavy rain)

Weather in past 48 hours

_____ Clear/Sunny
_____ Overcast
_____ Showers (intermittent rain)
_____ Rain (steady rain)
_____ Storm (heavy rain)

Water Appearance

_____ Clear
_____ Turbid
_____ Milky
_____ Foamy
_____ Dark Brown
_____ Oily Sheen
_____ Reddish
_____ Green
_____ Other _____

Water Odor

_____ None
_____ Sewage
_____ Chlorine
_____ Fishy
_____ Rotten Eggs
_____ Petroleum
_____ Other _____

Notes: _____
_____
_____

Notes _____

Temperature: Water _____ F °C
Air _____ F °C

*Circle the correct temperature measurement (°F or °C)

Algal Growth _____ % of bottom covered

Are there Submerged Aquatic Plants? Yes No (Circle) Where? Types? _____

Can you identify any of the riparian (streamside) vegetation? _____

Estimate Canopy Cover. _____ % of stream shaded. Notes: _____

Bottom Substrate. Record percentage of each of the materials that make up the stream bottom. Note all that are present.

_____ Bedrock _____ Cobble (2.5in. - 10 in.) _____ Sand (< 0.1 in.)
_____ Boulder (> 10 in) _____ Gravel (0.1 in - 2.5 in.) _____ Silt
_____ Other _____

Notes (include sediment odors, appearance, and/or the presence of silt): _____
_____
_____
_____
_____
_____

(IRWN Citizen Scientist Habitat Assessment Sheet)**Stream Discharge Estimate**

Stream width: _____ feet.

a**Depth Measurement****Velocity Calculation**

1. _____ feet	10 ft ÷ _____	seconds = _____	ft/sec
2. _____ feet	10 ft ÷ _____	seconds = _____	ft/sec
3. _____ feet	10 ft ÷ _____	seconds = _____	ft/sec

Average _____ feet

b

Average _____ ft/sec

c
Discharge (width x depth x velocity) _____ feet x _____ feet x _____ ft/sec = _____ ft³/sec
a **b** **c**
Watershed Features

Land Uses in the Watershed. Indicate whether the land uses are dominant (D) or occur in just small areas (x). If land use is not present, leave blank.:

Forest	Grassland	Scattered Residential	Sanitary Landfill	
Logging	Ungrazed Fields	Urban	Sewage Treatment	
Park	Livestock Pasture	Housing construction	Mining (type)	
Golf Course	Cropland (type?)	Commercial/Industrial		

Upstream Dam? Yes No. If Yes, how far upstream is the dam? _____

Wastewater treatment discharge upstream? Yes No. If Yes, How far upstream? _____

Any pipes emptying directly into or near your study site? Yes No.

Notes: _____

Channel Alteration. Has the stream been channelized (straightened) at your study site? Yes No.
 If Yes, how much of your study site has been channelized? _____

Personal Observations: _____
 _____
 _____

Illinois RiverWatch Network - Citizen Scientist Habitat Parameter Sheet

Site ID: _____
Date: _____
Stream: _____
County: _____

The habitat parameter sheet should be completed in the field to insure all items are rated at the site. The rating items are interrelated so do not dwell on any one item for long.

1. Write the score in the first column which best describes the condition of the rating item.
2. If you feel the actual condition falls somewhere between two descriptions write in an intermediate value.
3. Complete all rating items on the form.
4. Add all scores to arrive at a final ranking score for the stream reach.

Habitat Parameter				
1. Embeddedness	Gravel, cobble, and boulder particles have 0 to 25% of their surface covered by fine sediment.	Gravel, cobble, and boulder particles have 25 to 50% of their surface covered by fine sediment.	Gravel, cobble, and boulder particles have 50 to 75% of their surface covered by fine sediment.	Gravel, cobble, and boulder particles have 75 to 100% of their surface covered by fine sediment.
Score:	12	9	6	3
2. Substrate Stability	Abundance of boulders or cobble; periphyton, aquatic vegetation.	Presence of some boulders or cobble with some periphyton.	Few boulders and cobble; small shifting particles common; periphyton rare; OR predom. claypan or bedrock.	Stable substrate types absent; small gravel, sand, and silt abundant; periphyton usually absent or present only during low flow.
Score:	12	9	6	3
3. Instream Cover (availability of fish habitat)	Abundant submerged logs, undercut banks, and other stable habitat (>12% of stream)	Adequate habitat (6 - 12% of stream).	Habitat availability less than desirable (2 - 6% of stream).	Lack of habitat is obvious (< 2% of stream).
Score:	12	9	6	3
4. Pool Substrate Characterization	Mixture of coarse substrate materials with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud/clay or sandy bottom; little or no root mat, no submerged vegetation; older channelization.	Hard-pan clay or bedrock; no root mat or vegetation; or regularly maintained channel with shifting sand/silt; or pools absent.
Score:	16	12	8	4
5. Streambank Vegetative Stability (waters edge to top of bank)	Over 80% of the streambank surface is covered by vegetation in vigorous condition or by boulders and cobble. If the streambank is not covered by vegetation, it is protected by materials do not allow erosion.	50 - 80% of the streambank surfaces covered by vegetation or by gravel or larger material. Those areas not covered by vegetation are protected by materials that allow only minor erosion.	25 - 49% of the streambank surfaces covered by vegetation or by gravel or larger material. Those areas not covered by vegetation are covered by materials that give limited protection.	Under 25 % of the streambank surfaces covered by vegetation or by gravel or larger material. That area not covered by vegetation provides little or no control over erosion and the banks are usually eroded each year by high water flows.
Score:	16	12	8	4
6. Bank Stability	Stable; no evidence of erosion or bank failure; side slopes generally < 30%.	Moderately stable; infrequent, small areas of erosion mostly healed over; side slopes up to 40% in one bank; slight erosion potential in extreme floods.	Moderately unstable; moderate frequency and size of erosion areas; side slopes up to 60 % on some banks; high erosion potential during extreme high flow.	Unstable; many eroded areas; side slopes >60% common; "raw" areas frequent along straight sections and bends
Score:	16	12	8	4
7. Riparian Vegetation Zone Width	> 18 yards	12 - 18 yards	6 - 12 yards	< 6 yards
Score:	12	9	6	3

(IRWN Citizen Scientist, Habitat Parameter Data Sheet)

8. Land Use (top of bank to 30 yards)	Well vegetated; or >90% in undisturbed land uses	Generally undisturbed (70 - 90%)	Moderately undisturbed (40 - 70%)	Little of immediate watershed undisturbed (<40%)
Score:	12	9	6	3
9. Watershed Erosion	No evidence of significant erosion. Stable forest or grass land. Little potential for future erosion.	Some erosion evident. No significant "raw" areas. Good land management practices in area. Low potential for significant erosion.	Moderate erosion evident. Erosion from heavy storm events obvious. Some "raw" areas. Potential for significant erosion.	Heavy erosion evident. Probable erosion from any run off.
Score:	8	6	4	2
10. Watershed Nonpoint Source Pollution and Other Compromising Factors	No evidence of significant source. Little potential for future problem.	Some potential sources (roads, urban area, farm fields).	Moderate sources (tile fields, urban area, intense agriculture).	Obvious sources (high use urban or industrial area, feed lots, impoundment).
Score:	8	6	4	2
11. Aesthetics	Wilderness characteristics, outstanding natural beauty. Usually wooded or unpastured corridor.	High natural beauty. Trees, historic site. Some development may be visible.	Common setting, not offensive. Developed but uncluttered area.	Stream does not enhance aesthetics. Condition of stream is offensive.
Score:	12	9	6	3

Total Score: _____ Rating: Excellent >120
 Good . . . 90 - 119
 Fair . . . 60 - 89
 Poor . . . . < 60

Comments: _____
 _____
 _____
 _____
 _____

**Illinois RiverWatch Network - Citizen Scientist
SUBSAMPLING DATA SHEET**

Site ID: _____
Date: _____
Stream: _____
County: _____

Names: _____
_____
_____

Size of Squares: _____

Name of Stream: _____

Date of Habitat Assessment: _____

Which two habitats did you sample? (Check the two answers that apply)

RIFFLES ____ LEAF PACKS ____ SNAG AREAS, ETC. ____ UNDERCUT BANKS ____ SEDIMENT ____

1 _____	2 _____	3 _____	4 _____
5 _____	6 _____	7 _____	8 _____
9 _____	10 _____	11 _____	12 _____

A. Total # of Organisms Collected: _____

B. # of Squares Selected: _____

C. Organisms per Square (A/B): _____ organisms /square

D. Organisms in Tray (C x 12): _____ organisms/tray

Are there any NATIVE MUSSELS? YES NO (Circle YES or NO)
ZEBRA MUSSELS? YES NO
FINGERNAIL CLAMS? YES NO
ASIATIC CLAMS? YES NO

NOTES:

Illinois RiverWatch Network - Citizen Scientist
Macroinvertebrate Identification Data Sheet

Date of Macroinvertebrate Identification: _____

Names: _____

BLOCK 1

Common Name	Taxon	No. of Organisms (n)	Tolerance Rating (t)	Tolerance Value (tv)
Flatworms	Turbellaria		6.0	
Aquatic Worms	Oligochaeta		10.0	
Leeches	Hirudinea		8.0	
Sowbugs	Asellidae		6.0	
Scud	Amphipoda		4.0	
Dragonflies	Anisoptera		4.5	
Damselflies				
Broadwinged Damselflies	Calopterygidae		3.5	
Narrowwinged Damselflies	Coenagrionidae		5.5	
Hellgrammites, Dobsonflies or Alderflies	Megaloidea		3.5	
SUBTOTALS:				

No. Taxa: _____

BLOCK 2

Mayflies				
Tungsten Mayflies	Oligoneuridae		3.0	
Burrowing Mayflies	Beetidae or Siphonuridae		4.0	
Clinging Mayflies	Heptageniidae		3.5	
Crawling Mayflies	Caenidae or Tricorythidae		5.5	
Burrowing Mayflies	Potamanthidae or Ephemerae		5.0	
	Other Mayflies		3.0	
Stoneflies	Plecoptera		1.5	
Caddisflies	Hydropsychidae		5.5	
	Other Caddisflies		3.5	
SUBTOTALS:				

No. Taxa: _____

BLOCK 3

Beetles				
Water Beetles	Dryopidae or Elmidae		5.0	
Water Penny	Psephenidae		4.0	
Whirligig Beetles	Gyrinidae		4.0	
Flies				
Craneflies	Tipulidae		4.0	
Biting Midges	Ceratopogonidae		5.0	
Blood Worms	Red Chironomidae		11.0	
Midges	Other Chironomidae		5.0	
Black Flies	Simuliidae		6.0	
Shore Flies	Atherinidae		4.0	
	Other Flies		10.0	
Snails				
Freshwater Snails	Physidae		9.0	
River and Pond Snails	Lymnaeidae		7.0	
Planorbis Snails	Planorbidae		6.5	
Freewater Limpets	Amphipoda		7.0	
	Other Snails		6.0	
SUBTOTALS:				

No. Taxa: _____

SUBTOTAL BLOCK

	No. Taxa	No. Organisms (n)	
Block 1			
Block 2			
Block 3			
Totals			
	Σ Taxa	Σ N	Σ (tv)

MBI: _____ (Σ (tv) Σ N)

< 5 = good water quality
6.1 - 7.5 = fair water quality
7.6 - 8.9 = poor water quality
> 9.0 = very poor water quality

Taxa Richness: _____ (Σ Taxa)

Community Density: _____ (Σ N)

Percent Composition (%C):

No. of
Organisms

Taxon	(n)	$\div \Sigma$ N	$\times 100 =$	% C
Mayflies		$\div$	$\times 100 =$	
Stoneflies		$\div$	$\times 100 =$	
Caddisflies		$\div$	$\times 100 =$	
Blood Worms		$\div$	$\times 100 =$	
Aquatic Worms		$\div$	$\times 100 =$	
Beetles		$\div$	$\times 100 =$	
% SUBTOTAL =				
% SUBTOTAL				
All Others	100 %	-	=	

NOTES:

Illinois RiverWatcher Stream Monitoring Data Sheet

STREAM _____ TYPE _____ SITE I.D.# _____
 LOCATION _____
 COUNTY _____ TOWN/CITY _____
 DATE _____ START TIME _____ ENDTIME _____ #PARTICIPANTS _____
 GROUP NAME _____

HABITAT ASSESSMENT

1. WEATHER CONDITIONS

	PRESENT	PAST 48 HOURS
CLEAR/SUNNY	_____	_____
OVERCAST	_____	_____
SHOWERS (Intermittent rain)	_____	_____
RAIN (Steady rain)	_____	_____
STORMS (Heavy rain)	_____	_____

3. WATER ODOR

_____ NONE
 _____ SEWAGE
 _____ CHLORINE
 _____ FISHY
 _____ ROTTEN EGGS
 _____ PETROLEUM
 _____ OTHER _____

5. ALGAL GROWTH

_____ % STREAM BOTTOM COVERED BY ALGAE

2. WATER APPEARANCE

_____ CLEAR
 _____ TURBID
 _____ MILKY
 _____ FOAMY
 _____ DARK BROWN
 _____ OILY SHEEN
 _____ REDDISH
 _____ GREEN
 _____ OTHER _____

4. TEMPERATURE

WATER _____ °F _____ °C
 AIR _____ °F _____ °C

6. CANOPY COVER

_____ % STREAM SHADED.

NOTES: _____
 _____
 _____

7. BOTTOM SUBSTRATE

_____ % BEDROCK
 _____ % BOULDERS (> 10" STONES)
 _____ % COBBLE (2.5" - 10" STONES)
 _____ % GRAVEL (0.1" - 2.5" STONES)
 _____ % SAND (< 0.1" GRAINS)
 _____ % SILT (mud)

8. ESTIMATE STREAM DISCHARGE

A. STREAM WIDTH _____ FT
 B. STREAM DEPTH _____ FT or IN (circle)
 C. STREAM VELOCITY _____ FT/SEC
 DISCHARGE ESTIMATE = A x B x C
 _____ FT³/SEC

9. LAND USES OF THE WATERSHED

_____ FOREST	_____ GRASSLAND	_____ SCATTERED RESIDENTIAL	_____ SANITARY LANDFILL
_____ LOGGING	_____ UNGRAZED FIELD	_____ URBAN	_____ SEWAGE TREATMENT
_____ PARK	_____ LIVESTOCK PASTURE	_____ HOUSING CONSTRUCTION	_____ MINING (type?)
_____ GOLF COURSE	_____ CROPLAND (type?)	_____ COMMERCIAL/INDUSTRIAL	_____

10. PERSONAL OBSERVATIONS

_____
 _____
 _____
 _____
 _____

SUBSAMPLING

NOTE: If you collect less than 100 total macroinvertebrates, you do not need to subsample.

1 _____	2 _____	3 _____	4 _____
5 _____	6 _____	7 _____	8 _____
9 _____	10 _____	11 _____	12 _____

A. Total # Organisms Collected: _____

B. # Squares Selected: _____

C. Density of Organisms per Square (A/B): _____

D. Density of Organisms in Tray (C X 12): _____

MACROINVERTEBRATE TALLY

GROUP 1		GROUP 2		GROUP 3		GROUP 4	
STONEFLY		CADDISFLY		BLACKFLY		WORM	
ALDERFLY		MAYFLY		MIDGE		LEECH	
DOBSONFLY		RIFFLE BEETLE		SOWBUG		LEFT-HANDED POUCH SNAIL	
SNIFE FLY		WATER PENNY		SCUD		BLOODWORM	
		DAMSELFLY		RIGHT-HANDED/ OTHER SNAILS			
		DRAGONFLY					
		CRAYFISH					
		CRANE FLY					
		CLAM / MUSSEL					
# TAXA = _____		# TAXA = _____		# TAXA = _____		# TAXA = _____	
x 1 = _____		x 2 = _____		x 3 = _____		x 4 = _____	
GROUP SCORES	GROUP 1	GROUP SCORES	GROUP 2	GROUP SCORES	GROUP 3	GROUP SCORES	GROUP 4

E. TOTAL # TAXA = _____

F. TOTAL GROUP SCORES = _____

TOTAL CUMULATIVE SCORE = F/E = _____

1-2 = EXCELLENT

2.1-2.5 = GOOD

2.6 - 3.5 = FAIR

OVER 3.5 = POOR

Please circle the correct answer to the following questions:

Did you see any zebra mussels? YES NO

Did you see any asiatic clams? YES NO

Did you see any native mussels? YES NO

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