A Project of the Critical Trends Assessment Program

Illinois
RiverWatch

STREAM MONITORING MANUAL

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

Jim Edgar, Governor
Brent Manning, Director

ILLINOIS RIVERWATCH
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Illinois Department of Natural Resources
Office of Realty and Environmental Planning
Division of Energy and Environmental Assessment
524 South Second
Springfield, Illinois 62701

February 1997
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Printed by the authority of the State of Illinois

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A stream is a combination of all of its physical, chemical, and biological characteristics, characteristics which respond to natural and human-caused events, such as flooding, drought, construction, or channelization. We can measure the extent to which these conditions have affected a stream by observing the number and type of organisms living in the stream and relating that information to the surrounding habitat.

This is what volunteers in Illinois RiverWatch do. They monitor the condition of the habitat and the biology of stream sites, and conduct clean-up and restoration projects. Established in 1993 by Lieutenant Governor Bob Kustra and coordinated through the Illinois Department of Natural Resources, Illinois RiverWatch 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 Illinois citizen can take part in Illinois RiverWatch monitoring. Those who do so will provide valuable information concerning the environmental integrity of the state's stream systems and the knowledge they gain will increase their respect and enjoyment of Illinois' natural resources.

Illinois RiverWatch is a component of the ***EcoWatch Network***, a statewide network of volunteers and high school science classes which collect ecosystem data. In addition to RiverWatch, ForestWatch began functioning in 1996, and WetlandWatch and PrairieWatch will start up in 1997.

The biological monitoring procedures developed for Illinois RiverWatch are for wadeable, small- to medium-size streams. Training to become a Citizen Scientist includes a four-hour field session and a four-hour macroinvertebrate identification session. After being trained, volunteers conduct an Annual Assessment of a designated stream site at the same time each year (between May 1 and June 30), and are encouraged to monitor the site at least one more time during the year (although only the Annual Assessment data is used by Illinois RiverWatch).

The assessment provides trend data which is used by Illinois RiverWatch to measure change at the site over time. The data is entered into a statewide database through EcoForum, an electronic bulletin board system (BBS) maintained by the Illinois Department of Natural Resources, and is downloaded by the Quality Assurance Officer who validates and analyzes the information. The resulting stream assessments are published annually.

As a Citizen Scientist you will study both the organisms of streams (biological monitoring) and their surrounding habitat (habitat characterization). The data you collect will give 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 condition of the stream. Scientists need both sets of information to ascertain the quality of the environment.

For example, imagine that Illinois RiverWatch Citizen Scientists have studied a stream for five years, using the same sampling methods at the same study sites. Each year volunteers found the stream to be in "good" condition, according to accepted criteria.

Trends over five years, however, tell a different story. As Figure 1 shows, the overall number of organisms in the stream were decreasing at a slow but

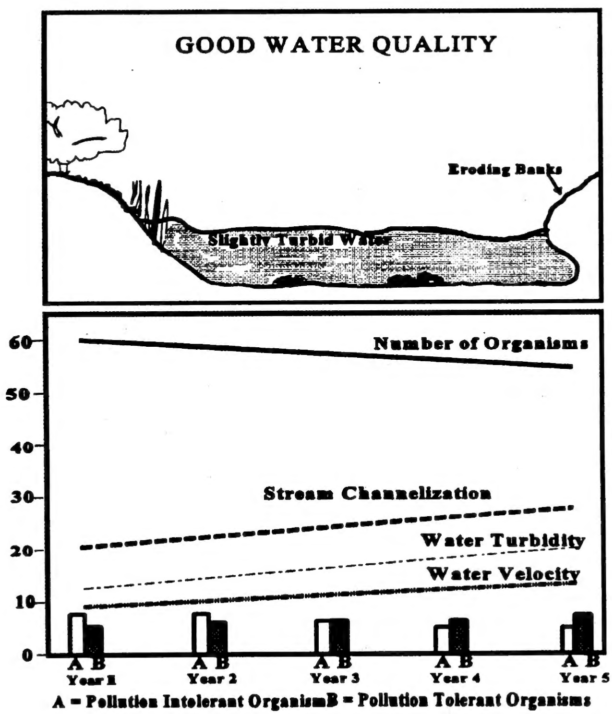


Figure 1. Example of volunteer data used to show water quality trends.

steady rate. The trends also show that 1) organisms that can tolerate pollution were becoming more common compared to organisms that are intolerant of pollution; 2) that the stream channel was being channelized (straightened) as homes were constructed alongside it; 3) that the flow of the water was increasing and; 4) that the water had become more turbid (cloudy).

Biological Monitoring

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

Biological stream monitoring is based on the fact that different species react to pollution in different ways. Pollution-sensitive organisms are more susceptible than others to the effects of physical or chemical changes in a stream. Pollution-tolerant organisms 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, while pollution-tolerant organisms increase in number.

The indicator organisms used by Illinois RiverWatch are benthic macroinvertebrates, animals big enough to see with the naked eye (macro). Benthic macroinvertebrates lack backbones (invertebrate) and live at least part of their life cycles in or on the bottom of a body of water (benthos).

Benthic 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 one-half inch in length. Others, like the three ridge mussel, can be more than ten inches long.

In addition to being sensitive to changes in the stream's overall ecological integrity, benthic macroinvertebrates have other advantages as indicator organisms.

- They are relatively easy to sample. Benthic macroinvertebrates are abundant and can be easily collected and identified by volunteers.

- They are relatively immobile. Animals such as fish can escape toxic spills or degraded habitats by swimming away, and migratory animals may spend only a small portion of their life cycle in a particular stream before moving on. Changes in populations of mobile species thus do not necessarily signal changes in the 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.

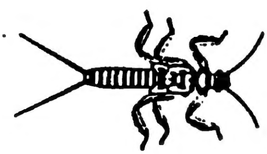
- They are a critical part of the aquatic food web. Benthic macroinvertebrates form a vital link in the web that connects aquatic plants, algae, and leaf litter to the fish species of our rivers and streams. Therefore, the condition of the benthic macroinvertebrate community reflects the stability and 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 larvae, which 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 E describes the life histories of many of the aquatic insects that you will come across during your sampling. Appendix E also provides sketches of the larvae 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 will learn to identify benthic macroinvertebrates to the level of Family.

Habitat Characterization

Streams, watersheds and drainage basins

Habitat characterizations describe conditions in the stream itself, including the areas immediately surrounding the stream. Information gained from the characterizations 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 characterizations are also 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 of many aquatic organisms, including whole species of fish, freshwater mussels, crayfish, and aquatic insects. Habitat characterizations catalog the nature and extent of these kinds of changes. Stream habitats are complex and assessing their quality requires understanding their many parts.

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. 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. It includes the stream banks, wetlands, and those portions of floodplains and valley bottoms that support riparian vegetation -- the plants 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 upper stream banks may have plants that are rooted in the soil, but which 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, the

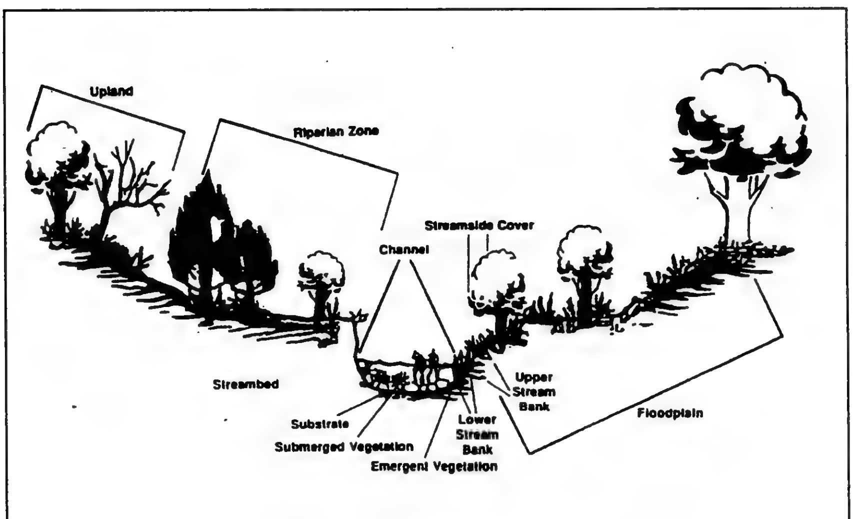


Figure 2. Diagram of stream habitats.

temperature becomes 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 for macroinvertebrates, fish and plants.

Stream bottoms

In Illinois, the substrate, or bottom, of most 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 characterization procedures 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.

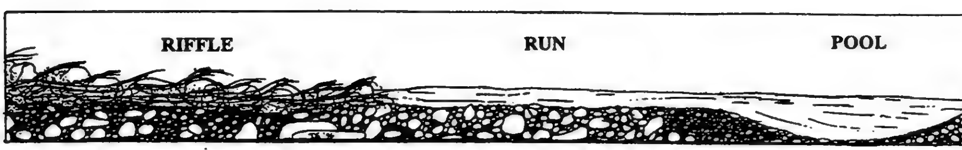


Figure 3. Rocky bottom reach.

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 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.

A **soft bottom reach** does not have riffle-run-pool habitats. In these reaches, some macroinvertebrates burrow into the sediment of the stream (midge larvae and worms, for example), while 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.

Stream sites can either be assigned by Illinois RiverWatch or chosen by the volunteer groups. Assigned sites are screened for safety and accessibility by a bridge. In addition they are chosen to ensure that monitoring will not disturb habitat that is critical to endangered species.

If your group prefers to monitor a site of its own choosing, inform the Regional Office or the Illinois RiverWatch Project Coordinator and the site will be included in the program.

Legal Description of the Site

An accurate legal description of the study site must be determined and entered in the database to record information collected in the field. When monitoring data is submitted to Illinois RiverWatch, 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 field book or on the cover of the manual.

You will need to determine the legal description of your monitoring site only once. Here's how.

1. Use the Index of Topographic Maps of Illinois to learn which USGS map includes the location of the stream reach you wish to monitor. 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, which are identified by the name of a city, town, or some prominent natural feature within it.

Use the index map to find the 71/2-minute quad in which your monitoring site is located. The USGS's 7 1/2-minute "topo" map shows terrain at a scale of 1:24,000.

2. 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. The maps cost $3.00 each.

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

Each square-mile block is designated by a township number, a range number, and a 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. Section numbers are printed in red in the middle of each square-mile block.

4. Determine the quarter section of your site. Outline the square-mile 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 study site and include this quarter section in the legal description of your monitoring site.

5. Record the legal description of the study site. Record this information in two places where it can be easily 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 (Figure 4).

The legal description will also be listed in the Illinois RiverWatch Site Identification Database. To add the study site to this database, fill out the Site Identification Sheet in Appendix G -- Data Sheets. Mail the sheet to the Quality Assurance Officer, Illinois RiverWatch Citizen Scientist Stream Monitoring Program, Forbes Biological Research Station, 17500 E Cr 1950 N, P.O. Box 590, Havana, IL 62644, Phone: 309/543-3950. Monitoring data will only be accepted from study sites listed in this database.

6. Use 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.

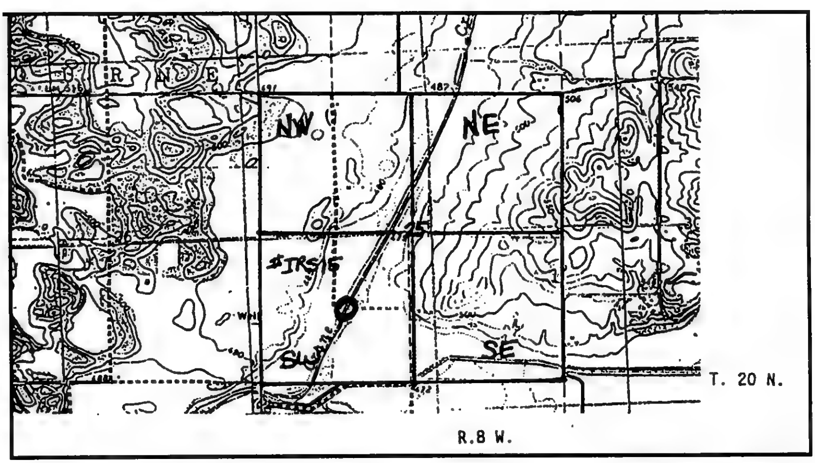


Figure 4. Determining the legal description of a study site.

Group Leader Duties

Each group of Illinois RiverWatch 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:

- Receive official Illinois RiverWatch Network training and become familiar with the field data sheets before beginning any monitoring activities.
- Obtain permission from land owners (public or private) before the group enters property.
- Observe the monitoring site at least one week prior to sampling to identify the best sampling areas.
- 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.
- Verify all data collected by the group before it is entered into the database, or before it is turned in to the Regional Office.

Safety Procedures

Personal safety is one of Illinois RiverWatch's highest concerns. The following precautions should be observed while doing field sampling of any kind.

- 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; do not collect information alone, reschedule for a time when other volunteers are available.
- Do not collect samples under difficult conditions. 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. If you are unsure about the velocity of the water, take a quick velocity and depth measurement (see page 19) and multiply the numbers. If they equal nine or above, the stream is not safe.
- 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 your own fresh water to drink.
- 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.
- Wear shoes 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.
- If for any reason you do not feel safe monitoring your stream, reschedule to monitor at another time.

Equipment you will need

Monitoring kits are available for loan at each of the Illinois RiverWatch regional offices. But, if you are purchasing your own equipment, here is what you will need.

Monitoring equipment

— Tape measure or twine at least 50-feet long and marked off in one-tenth foot lengths (engineering rule)

— Thermometer - one that measures temperature on the Celsius scale is preferable, but a Fahrenheit thermometer is acceptable

— Compass

— Stopwatch or any watch with a second hand

— Small float to measure velocity - a small orange or practice golf ball (a.k.a. perforated velocity sphere) will work

— 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

— Jar of 70% alcohol, or isopropyl alcohol

— Bottle of soda water or a thermos of ice cold 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 one inch by two inches in size, and some tape)

— 3-5 gallon bucket

— Hand lens or magnifying glass of at least 8x magnification

— 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

— Illinois RiverWatch Stream Monitoring Manual

— Field data sheets, photocopied from Appendix G

— Water bottle (a clean dishwashing soap bottle)

Personal & safety equipment

— Reference maps (e.g., state road maps and county maps) indicating general information pertinent to the monitoring area, including nearby roads

— Walking stick of known length -- useful for balance, probing, and measuring (dip net handle can be used)

— Boots or waders; tow line and life jackets - be sure that chest waders have a belt

— Rubber gloves, to protect against contamination

— Camera and film to document specific conditions

— Calculator

— Insect repellent, sun screen, sun glasses, and a hat

— 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

— Water and soap for washing hands

See Appendix D for a list of suggested suppliers of biological equipment.

Data Management and Quality Assurance

Make copies of Illinois RiverWatch data sheets to use in the field; keep the originals in a safe place. If data sheets or analysis procedures are updated, new data sheets will be sent to you or your Group Leader. Store all instructions, data sheets, and other information gained from your monitoring experiences.

Site identification information must be completed in the blocks found in the upper right hand corner of each data sheet. It includes:

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

If a mistake is made on a data sheet, place one line through the error and 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, such as "mathematical error" or "miscount of individuals."

Make copies of the completed data sheets before sending them to your Regional Office. 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 Office will make sure that the information is accurate and complete before sending it 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 Regional Office.

HABITAT CHARACTERIZATION

Illinois RiverWatch volunteers conduct an annual assessment between May 1 and June 30 every year at their designated stream site. In completing the habitat characterization, they describe and rate the physical and chemical characteristics that affect a stream ecosystem, and thus its biotic (or living) community. Some of these characteristics are "natural" to the watershed of which the stream is a part; others are "cultural" and reflect human use of the stream.

The habitat characterization complements the benthic macroinvertebrate assessment described in the following section.

You will need

- Citizen Scientist Site Sketch Sheet and Habitat Characterization Sheet
- Clip board and pencil or pen
- Graduated 50-foot length of rope, or a measuring tape in engineering rule (marked off in tenths of a foot)
- A watch with a second hand or a stopwatch
- An orange or similar biodegradable object, or a perforated velocity sphere (a practice golf ball)
- Thermometer (°C or °F)
- Empty jar
- Calculator

Site ID

Fill out the site ID blocks on all your data sheets before beginning assessment procedures.

Site ID (RiverWatch site number)
Date
Stream Name (on USGS topo map)
County

Also record:

- Group name and team members
- Start Time/End Time (measured from time all work on site is completed)

Mark Off Your Site

If the site is located by a bridge, measure 100 feet upstream from it. If for some reason a sample cannot be taken upstream from the bridge (for example, no safe access or no owner permission) then measure 100 feet downstream from the bridge, noting it on your Habitat Characterization Sheet. Begin mapping the area 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 your stream site, contact your Regional Office, the RiverWatch Quality Control Officer, or the RiverWatch Coordinator.

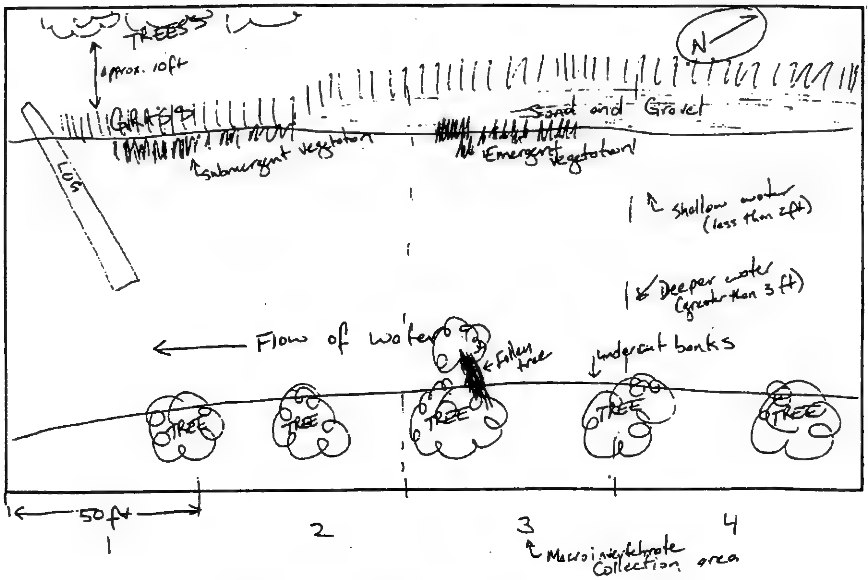


Figure 5. A sketch of a 200-foot study reach.

Make a Site Sketch

Sketch a map of your monitoring site to become familiar with the terrain and stream features and to provide a record of conditions.

1. Using a tape measure or your 50-foot length of string, measure four 50-foot lengths along either side of the stream upstream from the starting point (for a total of 200 feet). This marks the study reach that will be the focus of your sampling activities.

2. Make a sketch of the study reach on the Site Sketch sheet. Draw the sketch to appear as if you are observing the area from above (Figure 5).

3. Use a compass or topo map to determine which direction is North and note it on the sheet.

4. Draw an arrow to indicate the direction the water is moving. Note 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 reach, but show that they are outside the reach.

5. Take a photo of the 200-foot study reach to document conditions at the site or on that date. The photo will be compared to future photos to illustrate conditions over time.

Complete the Habitat Characterization Data Sheet

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

2. **Water Appearance**. Select the term or terms that best describe the physical appearance of the water, which can be an indicator of water pollution. Because the stream bottom can alter the apparent color of the water, put some 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.
- 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 from decaying plants. This occurs naturally in the fall of the year.
- Oily Sheen -- a multicolored reflection on the surface of the water. Can occur naturally, or 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.

3. **Turbidity.** Turbidity describes the amount of sediment suspended in the water. Turbid water is usually cloudy or brown due to the presence of excessive silt or organic material.

Check the level of turbidity that best describes the amount of suspended sediment present.

4. **Water Odor**. Odor can also be 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 your Regional Office.

5. **Temperature**. Temperature can limit 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, temperature directly affects the amount of oxygen available to organisms.

To measure water temperature, submerge a thermometer in a stream run for at least two minutes. To measure air temperature, hold 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.

6. **Algal Growth**. Algae are an important food source and a habitat for many organisms. However, excessive algal growth is an indicator of possible nutrient problems. Estimate what percentage of the bottom of the 200-foot site is covered by algae.

7. **Submerged Aquatic Plants**. These plants have their roots in the stream bottom, and the whole plant remains under water. Indicate by yes or no if you notice any rooted, vascular plants underneath the water's surface in your 200-foot site. If you know the names of these plants, whether common or scientific, write them in the space provided.

8. **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.

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

10. **Bottom Substrate**. 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 substrate material present; your estimate should equal 100% for all substrates.

- Bedrock
- Boulder (any rock larger than 10 inches in diameter)
- Cobble (2.5-10 inches)
- Gravel (0.1-2 inches)
- Sand (smaller than 0.1 inches)
- Silt
- Other (includes organic debris such as logs, sticks, and leaves)

11. **Embeddedness.** Embeddedness describes how much of the surface area of large materials (boulders, cobbles and gravel) is covered by sediment. Embeddedness indicates how suitable the stream substrate is for benthic macroinvertebrate habitat and for fish spawning and egg incubation.

Observe the stream bottom of the 200-foot site, with little regard for the very edges of the stream. Estimate the percentage of stream bottom which is covered by silt. Select the description that best describes your estimate.

12. **Stream Discharge**. 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 ($feet^3$/second).

Space for these calculations are provided on your Habitat characterization Sheet.

To obtain these measurements:

a) Within the 200-foot study reach, find a 10-foot stretch of stream with a relatively smooth bottom where the water flows uniformly. (A run works best).

b) Measure the stream width with a tape measure or a string marked in tenths of a foot. Either tie the string across the stream, or place sticks on opposite banks to indicate the points between which the width was measured. (Estimates of stream discharge will be measured from this line.)

Be sure to indicate on your site sketch where the width measurement was taken. If a stream is too deep or wide to measure directly, estimate by measuring from the bridge, but indicate this on the data sheet.

c) Measure stream depth along the line representing stream width at three evenly spaced spots. Add the three depth values and divide by three to determine the average depth in feet. (See Habitat characterization Sheet.)

d) Calculate velocity:

1. Mark off a spot five feet upstream and another spot five feet downstream from the first spot where stream depth was measured.

2. Measure the time it takes an orange or a perforated velocity sphere to float the 10-foot distance from the upstream spot to the downstream one.

3. Record the time in seconds in the appropriate space on the Habitat Characterization Sheet.

4. Determine the water velocity in feet per second by dividing 10 feet by the time measured (in seconds). 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.

5. Repeat steps 2-4 for the two remaining spots in the stream.

e) Add the three velocities and divide by three to determine the average velocity in feet per second.

f) Calculate estimated stream discharge.

13. **Watershed Features**. Record all land uses 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.

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

15. **Notes**. Enter here any characteristics that you feel are important to the quality of the stream and its environs, including any not mentioned on the data sheet.

BIOLOGICAL SAMPLING

These procedures were developed by scientists from the Illinois Natural History Survey and the Illinois Environmental Protection Agency to produce scientifically valid data. It is important that they are followed in detail each time you monitor.

The macroinvertebrate community assessment complements the habitat characterization.

At the study site, you will sample for macroinvertebrates in the same 200-foot section of the stream that was used for habitat characterization.

You will need

- Dip net
- Bucket (3 or 5-gallon)
- Forceps
- Citizen Scientist Macroinvertebrate Data Sheet
- Wash bottle

More specifically, you will sample from two different habitats within the study site that contain the highest diversity of macroinvertebrates. These habitats are listed in Table 1 in order of highest diversity to lowest diversity:

Observe the study site prior to sampling to identify the best sampling habitats. (You will learn which kinds of habitats are best for sampling when you receive your Citizen Scientist training.) The type of habitats you sample will depend upon the characteristics of the particular stream segment you are monitoring.

For example, if you have a rocky bottom reach, a riffle area with various leaf packs would offer the best collecting habitat. If the stream segment has a soft bottom reach, a fallen tree that offers built-up debris (a snag area) and undercut banks may be the best places to collect.

Do not forget to check off the selected habitats on the Macroinvertebrate Data Sheet.

Table 1.

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

Sampling Procedures

Riffles

1. Have one member of the team walk down the center of the riffle. Compare all of the areas in the riffle in terms of speed of water flow and size of rocks.

Select two areas in the riffle from which to sample -- 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.

Collecting samples from both a fast riffle and a slow riffle constitute one riffle sample.

Sample the riffle area that is positioned farthest downstream first. Follow steps 2-6 below for the first riffle area, then repeat the procedures for the remaining area.

Note: If you cannot differentiate between fast and slow riffles, sample from the downstream edge of the riffle first, then from the upstream edge.

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 should pick up large rocks within a 1 foot by 1 foot area directly in front of the net and rub gently to remove any clinging organisms into the net. Place these rocks in the bucket.

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 "kicks" with his or her toes 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 surfaces of rocks, leaves and twigs in the bucket to remove any clinging macroinvertebrates. Make sure to check each item for remaining organisms before going on to the next item. Once an item has been cleaned thoroughly and checked for remaining organisms, set it aside.

Do not toss rocks 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.*

Sampling procedures

Leaf packs

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. Place the macroinvertebrates in the bucket. Before returning leaves and other large objects to the stream, inspect them for organisms.

Sampling procedures

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 roots, 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 while on the downstream side of the snag. 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. Rinse the net contents with the wash bottle filled with stream water to remove any sediment, then place 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.

Sampling procedures

Undercut banks

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

1. Move the net in a bottom-to-surface motion, jabbing at the bank five times in a row to loosen organisms.

2. Inspect and clean any debris collected and place the collected organisms in the bucket.

Sampling procedures

Sediments

Areas of mostly sand and/or mud 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.

Subsampling Procedures

Before you begin, be sure that your sample jar is labeled properly with the Site ID number, stream name, county, date, and names of collectors.

If you have a large sample, counting and identifying the collected organisms is easier if you remove a random subsample of at least 100 organisms. If you have fewer than 100 organisms, there is no need to subsample. Simply indicate on the Macroinvertebrate Data Sheet that subsampling was not performed because fewer than 100 organisms were collected.

You will need

- Citizen Scientist Macroinvertebrate Data Sheet
- Clip board and pencil or pen
- White, gridded subsampling pan
- Forceps
- Ice water or soda water
- Bucket with collected organisms
- A jar containing alcohol (70% ethanol or isopropyl alcohol) and labels
- Wash bottle filled with stream water
- Calculator

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. 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.

3. Add ice cold water to the pan until it is one inch deep (measure to the first joint of your index finger), or add a couple capfuls of soda water to the pan.

4. Remove all crayfish, mussels or clams -- *do not place them in alcohol* -- and indicate at the bottom of the Macroinvertebrate Data Sheet that you collected them. If you know their scientific or common names, write them in the space provided, then release the crayfish, mussels and clams back to the stream.

5. Place all macroinvertebrates in the labeled sample jar containing alcohol.

If more than 100 organisms are 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. 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.

3. Add ice cold water to the pan until it is one inch deep (measure to the first joint of your index finger), or add two capfuls of soda water to the pan.

4. Remove any crayfish, freshwater mussels, zebra mussels, or Asiatic clams and indicate that you found these. Place the rest of the organisms in the labeled sample jar. Continue until all organisms have been removed from the selected square. Record on the Subsampling Data Sheet the total number of organisms picked. Release all crayfish, mussels and clams back to the stream.

5. Gently rock the subsampling pan to evenly distribute organisms across the bottom. Try to avoid "clumps" of organisms in the corners of the pan.

6. Collect all large organisms that may be scurrying about and place them in a jar of alcohol. In the NOTES section, indicate how many large organisms you remove.

7. 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.

8. 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.

9. 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 you find any additional types, indicate on the Subsampling Data Sheet which organisms were collected after Step 5 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.

10. 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.

11. Now estimate the total number of organisms collected by using the equations on the data sheet. Let's say 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:

organisms divided by 4 squares equals 25 organisms per square.

12. 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 9 squares, its projected organism density per sample would equal:

organisms per square multiplied by 9 squares equals 225 organisms per tray.

This number is an estimate of the total number of organisms that you collected.

MACROINVERTEBRATE IDENTIFICATION

All of the macroinvertebrates that you collected will be identified to the appropriate taxonomic level such as family or order. This should be done in a laboratory setting, either in your classroom or meeting place or in a laboratory provided by your Regional Office.

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 a workshop, but still do not feel secure in your ability, go ahead and attend another one. Also, do not hesitate to ask your Regional Office or the QC Officer for help.

Information on the Macroinvertebrate Data Sheet will be used to calculate various *metrics* that assess stream integrity. These metrics are defined below.

Taxa richness measures the abundance of different types of organisms as determined by the total number of taxa represented in a sample. Generally, taxa 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.

Sample density estimates the total number of organisms collected from your stream site after subsampling. If you did not subsample, your sample represents the total number of organisms collected. If you did subsample, you estimated a sample density before, but the number of subsampled organisms is needed to calculate the Macroinvertebrate Biotic Index.

Nutrient-enriched water has a high density of organisms, while water polluted with toxic chemicals or silt or sand usually have a lower density.

The **Macroinvertebrate Biotic Index** score (MBI) and the **percent composition** of taxa in a stream determine the presence or absence of taxa which have a high pollution tolerance.

The MBI was developed by the Illinois EPA to detect organic pollution such as sewage. It summarizes various pollution tolerance values, which are used to calculate 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

The percent composition (%C) of macroinvertebrate taxa also reflect stream quality. Streams with a high percentages of mayflies and stoneflies are considered to be in good health. Those 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.

Macroinvertebrate Data Sheet

To begin, enter the site identification information and indicate the type of habitats that were used for sampling.

Identify the Organisms

The data sheet provides boxes with common names of macroinvertebrate indicator taxa found in Illinois streams.It is in these boxes that you record the number of organisms collected within each taxon. It is not expected that you will have found organisms from each taxon listed on the data sheet. Mark only those taxa identified from the sample.

You will need

- Citizen Scientist Macroinvertebrate Data Sheet
- Stereoscope, or dissecting microscope (best to use a scope with magnification range of at least 10X - 30X)
- Pencil or pen
- Petri dishes
- Macroinvertebrate sample
- Forceps
- Illinois RiverWatch Macroinvertebrate Key (or some other aquatic insect identification key)
- Bottle of alcohol
- Calculator
- Extra jars

The taxa listed is not inclusive; only indicator organisms used to assess stream quality are included. If other macroinvertebrates are collected, write their names 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 F contains a simple key. If in doubt, double check the identification by using another key or by asking for help from your Regional Office or the Quality Control Officer. Appendix C lists more complex identification keys which can be consulted.

Write the number of organisms identified from each taxon in the column marked "No. of Organisms (n)."

Label the collection

Once the macroinvertebrates have been identified and counted, place them in a properly labeled container. The label should be written in permanent, non-alcohol soluble ink (pens can be purchased from a biological supplier (see Appendix D) or art supply stores), 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:

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

Calculate the Biotic Indices

Now you are ready to calculate the values which will measure your 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 of the subtotal block 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.")

To calculate:

"Macroinvertebrate Biotic Index" is the total tolerance value divided by the total number of organisms -- MBI = Σ (tv) $\div$ ΣN

"Taxa Richness" is the total number of taxa that you identified above -- Σ Taxa

"Sample Density" is the total number of organisms collected or subsampled -- ΣN -- plus the number of non-indicator organisms in your sample.

"Percent Composition" reflects which organisms were most prominent in the stream.

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 its community density ("ΣN") and multiply by 100 to obtain the percent composition -- (n) $\div$ ΣN X 100 = %C.

Add the "% C" of each taxon to obtain a subtotal percentage ("% subtotal").

Subtract "% subtotal" from 100% to obtain the percentage of other organisms in your sample.

Problems and comments

In the space at the bottom of the Macroinvertebrate Data Sheet, record observations such as the condition of the organisms, or jot down questions about the identification of a particular taxon.

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 chemical contamination 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 only stream waters for toxic chemicals 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 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 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
Glossary

-A-

Algae:

Simple plants lacking true stems, roots and leaves but possessing chlorophyll. Most live submerged in water.

Aquifer:

A stratum of permeable rock, gravel or sand containing or conducting ground water; especially one that supplies wells or springs.

-B-

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.

Bedrock:

General term for the rock that underlies the surface soil or other unconsolidated surface material. In some parts of Illinois bedrock lies at the surface.

Benthic:

Relating to all the plants and animals living on or closely associated with the bottom of a body of water.

Biotic:

Concerning or produced by living organisms, such as environmental factors created by plants or microorganisms.

Biotic Factor:

The influence of organisms and their activities on the distribution of other organisms.

Biotic Community:

All of the groups of organisms that live in the same habitat or feeding area, usually interacting or depending on each other for existence. Also called biocoenosis, biocoen or simply community.

Biotic Index (BI):

Measure showing the quality of an environment by identifying the numbers of various species present. The biotic index can give an indication of how clean a pond or river is on the basis of the presence of particular indicator species or of groups of species.

Biological Oxygen Demand (BOD):

The amount of dissolved oxygen that is required by microscopic organisms (e.g. bacteria) to decompose organic matter in streams.

Buffer Strip (Zone):

A strip of erosion-resisting vegetation along a stream or lake after logging. Buffer strips may also occur between or below cultivated strips or fields.

-C-

Catchment Area:

See Drainage Basin

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.

Channels:

A natural or artificial watercourse of perceptible extent, with a definite bed and banks to confine and conduct continuously or periodically flowing water.

Citizen Scientist:

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

Common Name:

A name commonly used to identify an organism. This name may be region specific even though the organism remains the same.

Community Density:

The number per unit area of individuals of a group of plants and animals at a given locale at any given time.

Complete Metamorphosis:

Insect development with four life stages: egg, larva, pupa, and adult

-D-

Dissolved Oxygen (DO):

The concentration of oxygen held in solution in water. Usually it is measured in mg/l (sometimes in $\mu g/m^3$) or expressed as a percentage of the saturation value for a given water temperature and given altitude.

Drainage Basin (Area):

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

-E-

Ecology:

The scientific study of the interrelationships among organisms and between organisms, and between them and all aspects, living and non-living, of their environment.

Ecosystem:

A relatively self-contained and inter-connected system of living plants and animals along with certain essential features of their habitat (e.g. water, oxygen, mineral nutrients).

Effluent:

A discharge or emission of any substance, usually a liquid, that enters the environment via a tap, treatment plant, home devise, etc...

Embeddedness:

The degree that larger particles (boulders, rubble or gravel) or objects are surrounded or covered by fine sediment. Usually measured in classes according to percentage of coverage.

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.

Environment:

The complete range of external conditions, physical and biological, in which an organisms lives.

Erosion:

The wearing down and removal of soil, rock fragments and bedrock through the action of running water, wind, moving ice, and gravitational creep (or mass movement).

-F-

Floodplain:

Areas of land on either side of a river or stream (or the shorelines of oceans or lakes) that are covered with periodic floods.

-G-

Groundwater:

Water found underground in porous rock strata and soils. Some groundwater supplies wells and springs.

-H-

Habitat:

The kind of locality in which a plant or animal naturally grows or lives, such as forest, prairie, or wetland, and which provides a particular set of environmental and ecological conditions.

Habitat Diversity:

The range of habitats within a region.

Habitat Suitability:

The potential of a habitat, based on food availability and cover requirements, to support a selected evaluation species.

Headwater Streams:

Source streams for, or highest stream in, a watershed.

-I-

Incomplete Metamorphosis:

A type of insect development in which the life cycle consists of three stages: egg, larvae, and adult.

Indicator Organism:

Organisms that respond predictably to various environmental changes, and who presence or absence and abundance are used to identify a specific type of biotic community, or as a measure of ecological conditions or changes occurring in the environment.

Instream Cover:

Areas of shelter in a stream channel that provide aquatic organisms protection from predators, competitors or weather extremes and/or a place in which to rest and conserve energy due to a reduction in the force of the current.

-L-

Land Uses:

The present use of land, for example, for agriculture, industry or housing.

Larva (Larvae):

Any of the immature (premetamorphosis) forms of organisms that undergo complete metamorphosis. Tadpoles, grubs, and caterpillars are all larvae (larval forms), radically different from the adult frogs (or toads), beetles and butterflies that they will become after metamorphosis.

Leaf Litter:

Plants and plant parts that have recently fallen and are partially or not at all decomposed.

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, fallen trees or logs in the stream.

-M-

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.

-N-

Nonpoint Source Pollution:

Diffuse sources of contaminants or pollutants that cannot be attributed to a single discharge point. Automobiles are Nonpoint air polluters, atmospheric fallout is a Nonpoint air polluter.

Nutrients:

Anything providing nourishment, especially a mineral element or food compound required for normal functioning of animals or plants.

-O-

Organism(s):

Any unicellular or multicellular living body whose different components work together as a whole to carry our life processes. Animals, plants, fungi and microbes are all organisms.

-P-

Periphyton:

Organisms attached to or clinging to the stems and leaves of plants or other objects projecting above the bottom sediments of freshwater ecosystems. This may be in the form of algae attached to large rocks.

Point Source Pollution:

Pollution entering a stream, river, air, lake or ocean at a specific, detectable site (e.g. a factory's discharge pipe is a point source of pollution)/

Pollution:

An undesirable change in the environment, usually the introduction of abnormally high concentrations of hazardous or detrimental substances, heat or noise. Pollution usually refers to the results of human activity, but volcano eruptions and contamination of a water body by dead animals or animal excrement are also pollution.

Pollution Sensitive Organisms:

Organisms that cannot withstand the alterations of their aquatic environment by pollution.

Pollution Tolerant Organisms:

Those organisms that can withstand polluted environments.

Pool:

A portion of a stream where the flow of water is slower and the depth deeper compared to other areas of a stream. Organisms such as fish and crayfish can be found in this type of habitat.

Pupa (Pupae):

A stage in development of many insects when the organism appears to be inactive but is, within its protective case undergoing metamorphosis from the larval stage into its adult form (imago). The pupa stage is found in those insects with a complete metamorphosis, including beetles, butterflies and moths, flies, bees and ants.

-R-

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:

A general term for the layer of durable materials such as large blocky stones, broken concrete, tires, etc... that are artificially placed to stabilize and to prevent erosion along a riverbank, dam, seawalls or shoreline. This term may also be used to refer to the materials themselves.

Riparian Zone:

A relatively narrow strip of land adjacent to the banks of a stream, river, lake, or wetland that undergoes periodic flooding.

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 a river, stream or lake.

-S-

Scientific Name:

A taxonomic name given to an organism. Unlike a common name, a scientific name never changes according to region and can be recognized throughout the scientific community.

Sediment:

Materials that accumulate on the bottom of streams, rivers, and lakes. These materials are soil particles resulting from erosion.

Silt:

Fine particles of soil and minerals formed from erosion of rock fragments which accumulate on the bottom of streams, rivers, and lakes.

Siltation:

Referring to the deposition of silt particles.

Snags:

A tree or portion of a tree embedded in a river or lake that provides habitat for a broad range of wildlife.

Species:

A population within which all individuals are free to interbreed; alternatively, a population of functionally homogeneous individuals.

Stream Discharge:

A measure of the total volume of water in a stream passing a given point in a given unit of time.

Substrate:

The surface or medium that serves as a base for something. For streams and rivers, the substrate is the mineral and/or organic material that forms the bed of the stream or river.

-T-

Taxon/Taxa:

A grouping of organisms given a formal taxonomic name at any rank: species, genus, family, order, class, division, phylum or kingdom. Plural is taxa.

Taxonomy:

The science of classification as applied to organisms (living or extinct). Classification of individual organisms or higher groupings is based on anatomy, morphology, characteristics of genetic material (chromosomes, genes and nucleic acids), biochemical relationships (such as protein structure and metabolic pathways), and statistical analysis to interpret combinations of the above characteristics.

Trend Data:

Data, or measurements, of a system (e.g. stream system) that show how particular characteristics change over time.

Tributaries:

A stream feeding, joining or flowing into a larger stream.

Turbidity:

Haziness, cloudiness, or muddiness. Applied to water and the atmosphere.

-U-

Undercut Banks:

A bank whose base has been cut away by water or by artificial means and overhangs part of the stream.

Urban Runoff:

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

-V-

Vascular Plants:

Any plant having an organized system for transporting water and nutrients. Vascular plants include many organisms that do not produce seeds, such as ferns and mosses, as well as those that do produce seeds and flowering plants.

-W-

Watershed:

The entire surface drainage area that contributes water to a lake, stream, river, groundwater supply, or coastal waterbody. Many watersheds draining into a common river make up its drainage basin.

Wetlands:

Areas of land where the water table is at or near the surface most of the time, resulting in open water habitats and water logged land areas. Wetlands possess characteristic hydric soils and have one of a number of distinct vegetation types: swamps, marshes, salt marshes (and other coastal wetlands) and bogs.

Appendix C
References

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.

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)

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APPENDIX D
BIOLOGICAL EQUIPMENT SUPPLIERS

Supplier	Equipment
Rivers Curriculum Project Southern Illinois University at Edwardsville Box 2222 Edwardsville, IL 62026 Phone: 618/692-3788 Fax: 618/692-3359	Dip nets
American Biological Supply Company 2405 N.W. 66th Court Gainesville, FL 32606 Phone: 904/377-3329 Fax: 904/377-AMBI	Dip nets
BioQuip Products, Inc. 1703 LaSalle Avenue Gardena, CA 90248-3502 Phone: 310/324-0620 Fax: 310/324-7931	Dip nets Subsampling trays Forceps Magnifiers Thermometers Identification keys Permanent non-soluble ink (Pigma) pens
NASCO - Fort Atkinson 901 Janesville Avenue Fort Atkinson, WI 53538-0901 Phone: 1/800/558-9595 Fax: 414/563-8296	Dip nets Forceps Magnifiers Thermometers

APPENDIX E
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 9). 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.

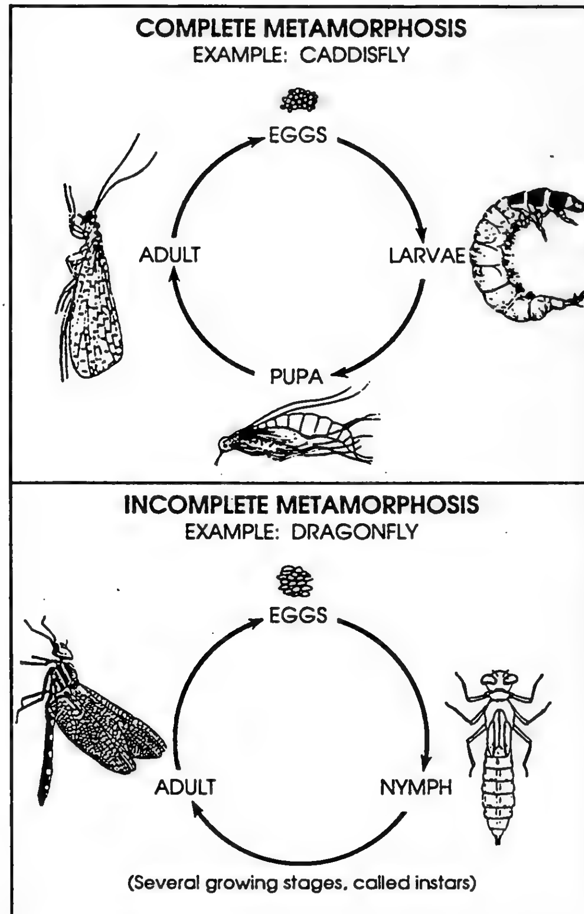


FIGURE 9: METAMORPHOSIS

Organism's development from egg to adult

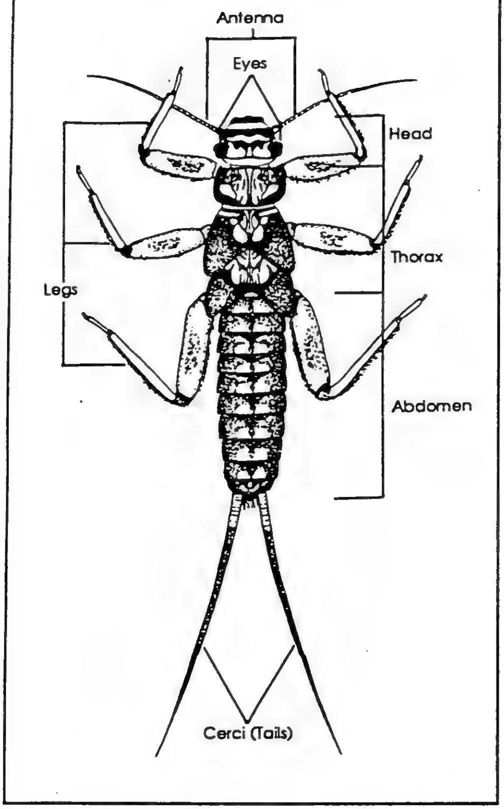
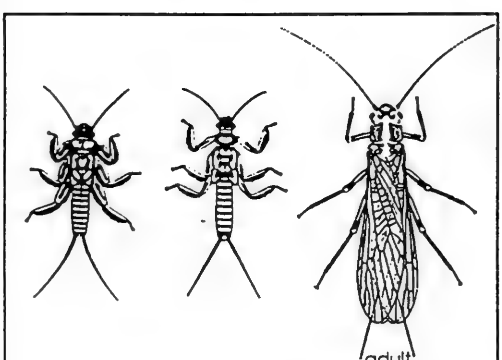


FIGURE 10: AQUATIC INSECT BODY PARTS

Main parts consistant 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 10).

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.

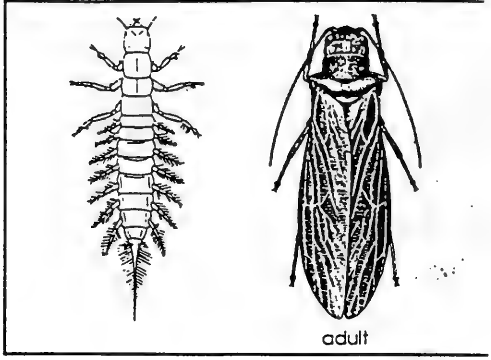
Alderflies
Metamorphosis: complete

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.



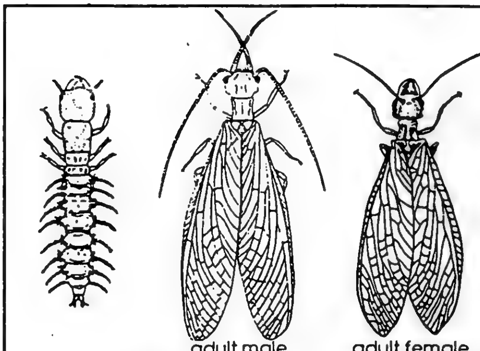
Dobsonflies
Metamorphosis: complete

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.



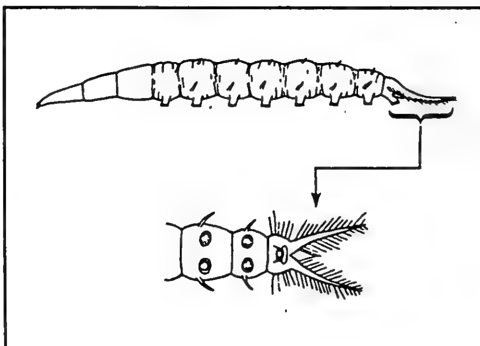
Snipe Flies
Metamorphosis: complete

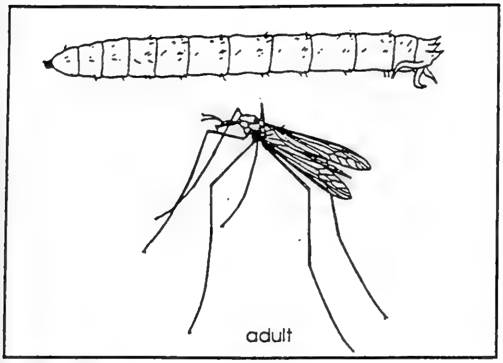
Larvae: elongated, cylindrical, slightly flattened; cone-shaped abdomen is characteristic; two, long, fringed filaments at end of abdomen; color varies; length up to 1/2 inch.

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.





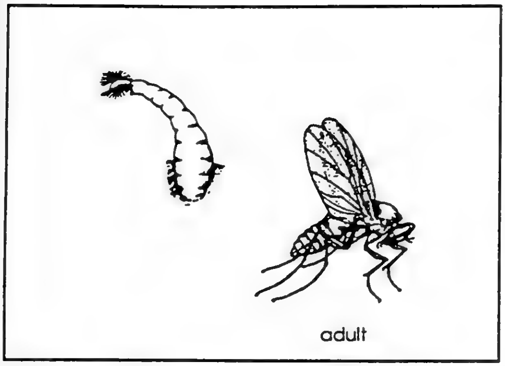
Crane Flies
Metamorphosis: complete

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.



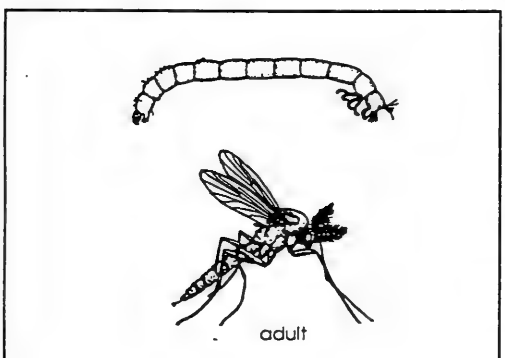
Black Flies
Metamorphosis: complete

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.



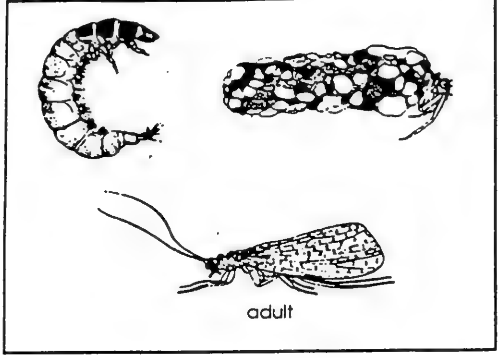
Midges (flies)
Metamorphosis: complete

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.



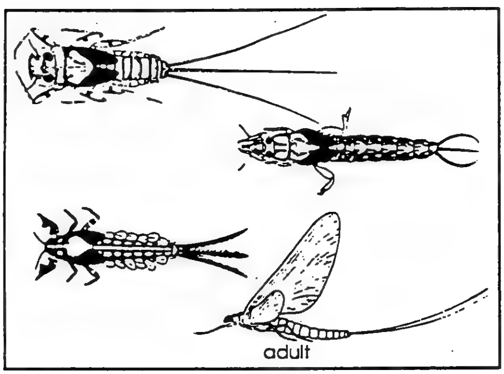
Caddisflies
Metamorphosis: complete

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.



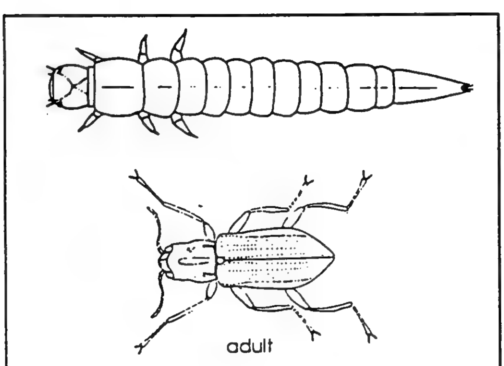
Mayflies
Metamorphosis: incomplete

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.

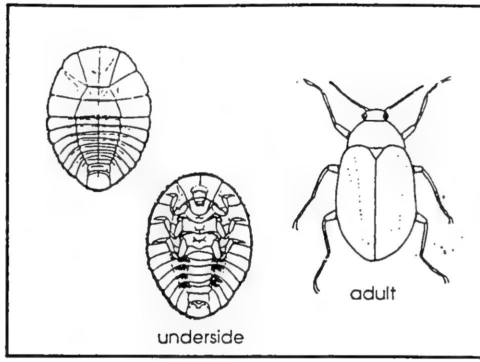
Water Penny Beetle
Metamorphosis: complete

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.



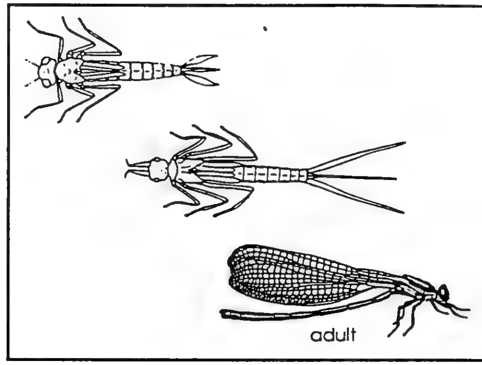
Damselflies
Metamorphosis: incomplete

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.



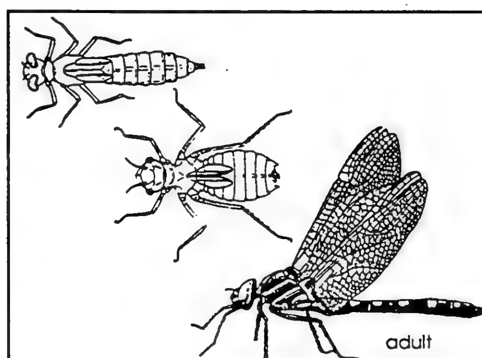
Dragonflies
Metamorphosis: incomplete

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.

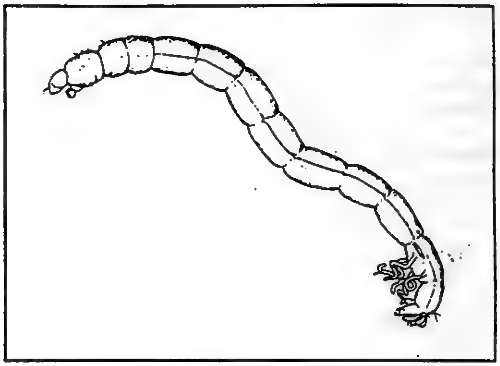
Reproduction: eggs are deposited on surface of water and drift to bottom.

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.



Blood Worm Midges
Metamorphosis: complete



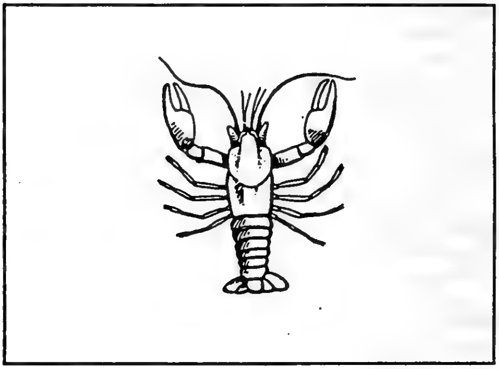
Larvae: similar to other midges, but are larger, robust, and distinctly red in color; length up to 1 inch.

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

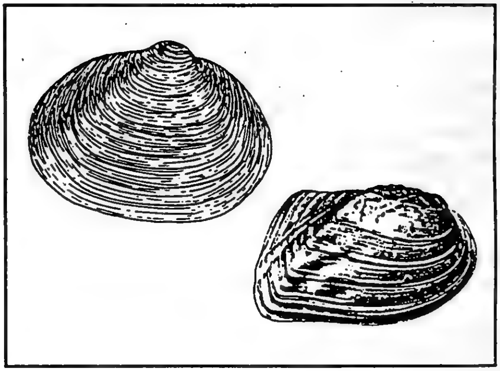
Crayfishes
Description: resemble miniature "lobsters"; possess four pairs of walking legs and a pair of strong pinchers; color can be brown, green, reddish, or black; length up to 6 inches.



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

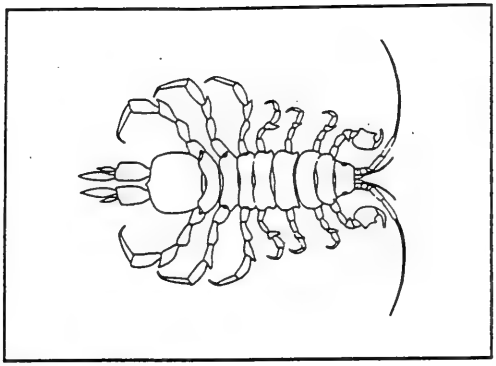
Food: omnivorous, eating plants and animals; pinchers are used for tearing food into edible chunks; crayfish are preyed upon by larger game fish.

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.

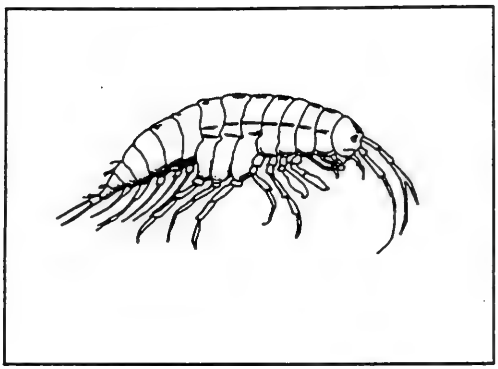
Food: primarily filter feeders; filter organic debris and plankton out of water; preyed upon by numerous fish and mammals.



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.

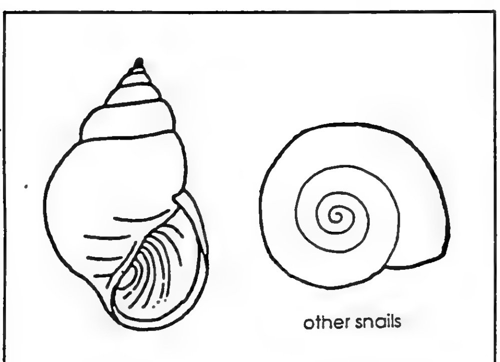
Food: characterized as scavengers, eating both dead and live plant and animal debris.



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.

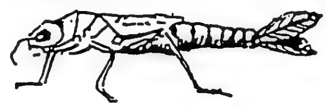
Food: primarily algae that grows on rocks and other debris; occasionally feeds upon decaying plant and animal matter; are preyed upon by fish, turtles, predatory invertebrates, and leeches.

APPENDIX F
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). William Ettinger (Illinois EPA) modified some of the descriptions to include those macroinvertebrates most commonly found in Illinois streams. I (Denise Stoeckel) modified and added a couple of descriptions 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 choose from. 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. For example, let say that the figure below is the organism you trying to identify.



The first set of descriptions read:

1. A. With a hard calcareous shell of one or two valves.
MOLLUSKS 2
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

You would select choice "C" because your organism does not have a hard, calcareous shell or a spiral-shaped sand case. Also, your organism does not have any type of case. Therefore, you would go on to description #7. You continue with your search until you come upon a description which tells you what type of 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 your 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 your path backwards until you find the particular description where a mistake was made. Once you reach this point, decide again which description best fits the organism you are looking at. Proceed on your 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 your regional coordinator or instructor.

An example of a macroinvertebrate description:

Description number

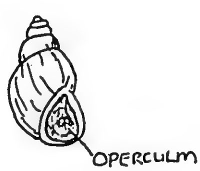
Description which was used to reach this point

3(2). A. Snails with an operculum (a hard covering used to close the aperture or opening). . . . . OTHER SNAILS
Gastropoda: Prosobranchia: Six families. (Operculate Snails) ← Final destination for this organism
MODERATELY TOLERANT ← Tolerance
← Size bar

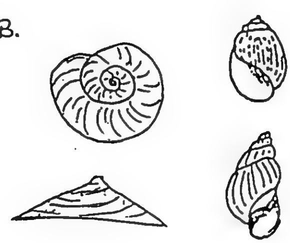
B. Snails without an operculum; lung breathing snails (Pulmonata) . . . . 4 ← Go to this Description.

Description choices

3A.



3B.

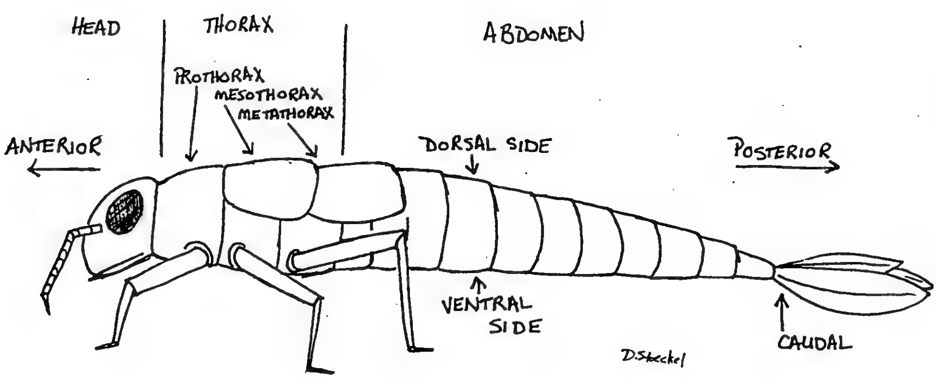


Basic Insect Morphology

An 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 mesothorax and metathorax. 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**. 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.

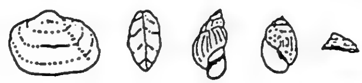


1. A. With a hard calcareous shell of one or two valves.
MOLLUSKS 2
Mollusca: Bivalvia (Clams and Mussels), Gastropoda (Snails and Limpets). In general, mollusks are found in hard waters with a pH near or above neutral (pH 7).

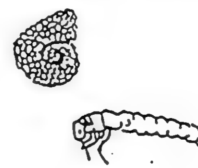
B. With a spiral (snail-shaped) case of sand; animal hidden within case; body with 6 jointed legs; small and inconspicuous, often overlooked.. . . . . .OTHER CADDISFLIES
Tricoptera : Helicopsychidae (*Helicopsyche*). Snail Case Caddisflies. INTOLERANT.

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.

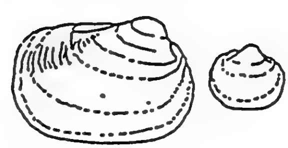


2(1). A. Shell of one valve. SNAILS 3

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

2A.

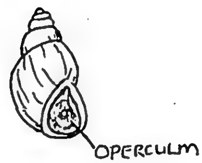
2B.



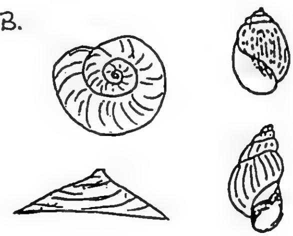
3(2). A. Snails with an operculum (a hard covering used to close the aperture or opening). . . . . OTHER SNAILS
Gastropoda: Prosobranchia: Six families. (Operculate Snails)
MODERATELY TOLERANT

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

3A.



3B.

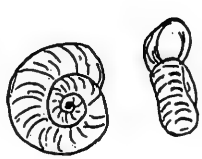


4(3). A. Shell discoidal (coiled in one plane). . . . . .PLANORBID SNAILS
Gastropoda: Planorbidae. Generally found in slower waters such as runs.
MODERATELY TOLERANT.

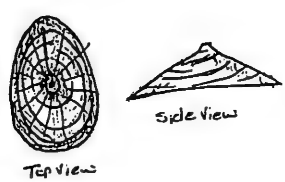
B. Shell patelliform (cup shaped), limpet-like. . . . FRESHWATER LIMPETS
Gastropoda: Ancyclidae. Found in riffles.
MODERATELY TOLERANT.

C. Shell with a distinct spiral 5

4A.



4B.



4C.

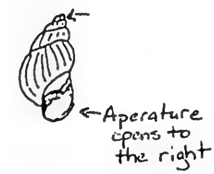
5(4). A. Shell sinistral ("left-handed"). . . . . POUCH SNAILS
Gastropoda: Physidae (*Physella*). Often found in slower waters.
GENERALLY TOLERANT.

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.

5A.

5B.

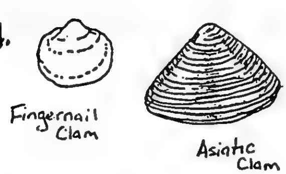


6(2). A. Small bivalves, adults <2 cm long.. . . . . . . FINGERNAIL AND ASIATIC CLAMS
Bivalvia: Sphaeriidae and Corbiculidae. Fingernail clams are very small, with thin fragile shells. Asiatic clams have larger, thicker shells with obvious growth rings.
FAIRLY INTOLERANT.

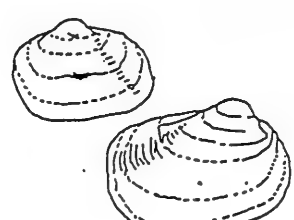
B. Large bivalves, adults mostly >2 cm long. . . . . CLAMS AND MUSSELS
Bivalvia: Unionidae. Very young individuals may be less than 2 cm long.

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

6A.



6B.

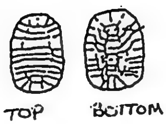


7(1). A. Entire body distinctly segmented, flattened and oval in shape; the head, 6 pairs of jointed legs and gills are hidden ventrally (beneath the body); copper or brown in color; cling tightly to rocks. . . . . WATER PENNIES
Coleoptera : Psephenidae.
INTOLERANT

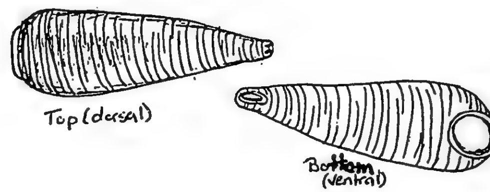
B. Body oval or elongate, soft and indistinctly segmented; head, legs and gills lacking; with anterior and posterior ventral (bottom) suckers. . . . . LEECHES
Hirudinea
MODERATELY TOLERANT

C. Body not a distinctly flattened oval shape; with or without legs; without suckers. 8

7A.



7B.

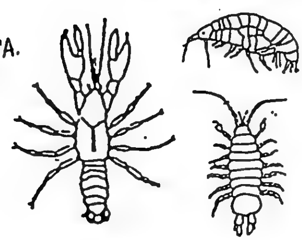


8(7). A. With more than 6 true, jointed legs. CRAYFISH, SCUDS AND SOWBUGS 9

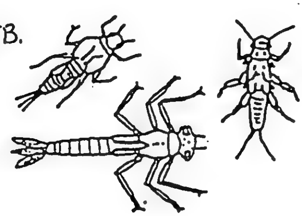
B. With 6 true, jointed legs. (Insecta; except Diptera) 11

C. With less than 6 true, jointed legs, although non-jointed legs (prolegs) may be present; body often worm-like 31

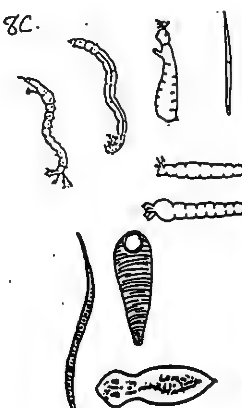
8A.



8B.



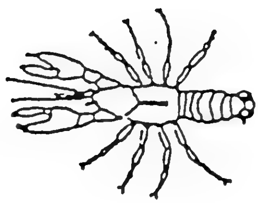
8C.



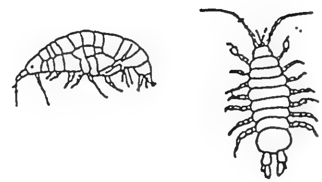
9(8). A. Generally large organisms with 2 large claws (chelipeds), one or both of which may be missing. Small (young) individuals are common in some areas in spring . . . .CRAYFISH
Crustacea: Decapoda (Cambaridae).
FAIRLY INTOLERANT.

B. Smaller organism, lacking large claws. 10

9A.



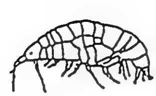
9B.



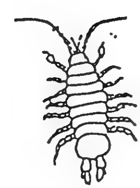
10(9). A. Flattened laterally (from side to side); tan, white or gray in color, ... SCUDS
Amphipoda
INTOLERANT.

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.

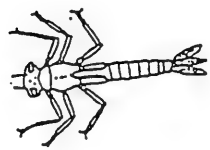


11(8). A. With three broad, oar-like "tails" (gills); body long and thin; wing pads present. DAMSELFLIES 12
Odonata (Zygoptera)

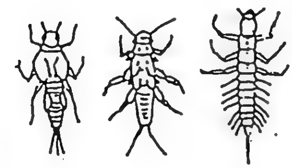
B. With 1, 2, or 3 thin caudal filaments ("tails"). 13

C. With no thin caudal filaments; prolegs or other appendages such as spines or hooks (tarsal claws) may be present 18

11A.



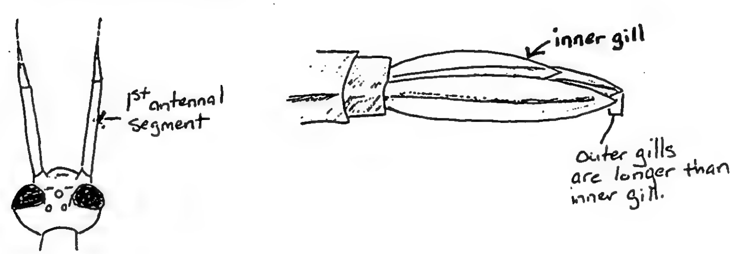
11B.



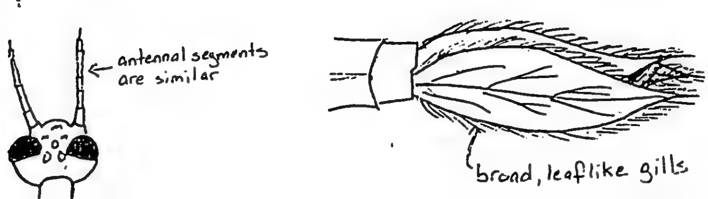
12 (11)A. Long, slender body with long legs; first antennal segment is much longer than the other segments; caudal gills are long and slender with the outer gills being longer than the inner gill. . . . . BROADWINGED DAMSELFLIES
Odonata(Zygoptera): Calopterygidae
INTOLERANT

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.



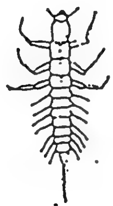
13 (11)A. With 1 caudal filament; body brown or copper in color, head and "tail" lighter in color . . . . .ALDERFLIES
Megaloptera: Sialidae (*Sialis*).
INTOLERANT

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

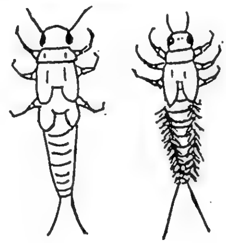
C. With 3 caudal filaments. MAYFLIES. 15

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.

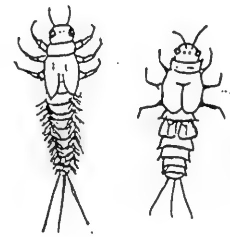
13A.



13B.



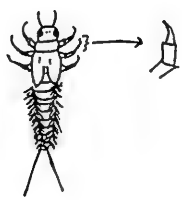
13C.



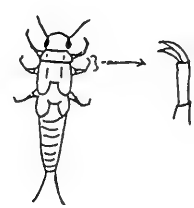
14 (13)A. One tarsal claw; gills present on abdominal segments; individuals are generally more flimsy . . . . .OTHER MAYFLIES
Ephemeroptera: Some members of the families Heptageniidae and Baetidae.
SOMEWHAT INTOLERANT

B. 2 tarsal claws; gills, if visible, are not located on abdomen; 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

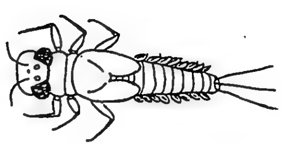
15A.

15B.

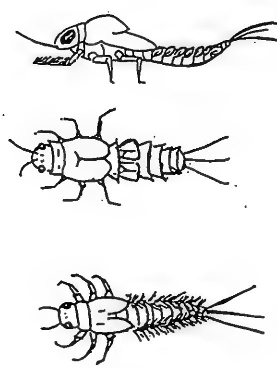
16(15)A. Body flattened dorsoventrally (top to bottom); eyes large and located on top of head. . . . . CLINGING MAYFLIES
Ephemeroptera: Heptageniidae. Tolerance ranges from intolerant to somewhat tolerant; three common genera (*Stenacron*, *Stenonema* and *Heptagenia*) are intolerant.

B. Body not flattened dorsoventrally 17

16A.



16B.

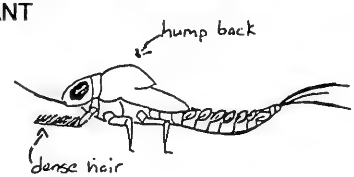


17(16)A. Body slightly compressed from side to side; thorax slightly humped; torpedo-shaped; front legs with a dense row of hairs . . . . TORPEDO MAYFLIES
Ephemeroptera: Oligoneuridae. One of the swimming mayfly groups.
INTOLERANT

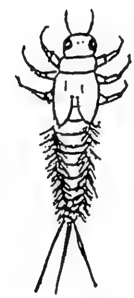
B. Body not compressed from side to side; front legs without a dense row of hairs; gills on abdomen resemble two plates . . . . CRAWLING MAYFLIES
Ephemeroptera: Caenidae and Tricorythidae
FAIRLY INTOLERANT

C. Body not compressed from side to side; front legs without a dense row of hairs; no plate gills on abdomen. . . . . SWIMMING MAYFLIES
Ephemeroptera: Baetididae and Siphlonuridae
INTOLERANT

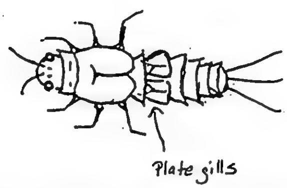
17A.



17C.



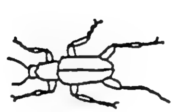
17B.



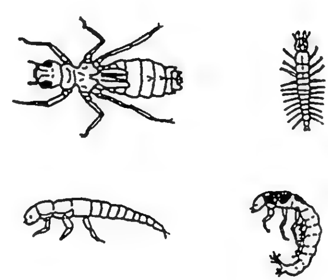
18 (11)A. Entire body including the front wings are hard; small, dark beetles which are long and thin, or ovoid in shape . . . . . ADULT RIFFLE BEETLES
Coleoptera: Elmidae and Dryopidae.

B. Entire body not hard 19

18A.



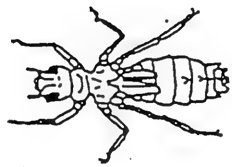
18B.



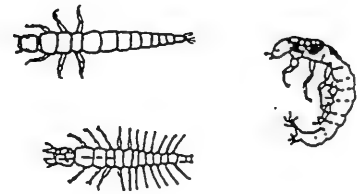
19 (18)A. With external wing pads; lower jaw (labium) large, hinged and folded up on itself concealing other mouthparts . . . . .DRAGONFLIES
Dragonflies are seldom found in riffles, but may be found buried in soft sediments (e.g., sand, silt or mud) or in vegetation and detritus along the stream edge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

B. Without external wing pads; labium not hinged 20

19A.



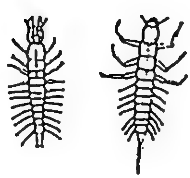
19B.



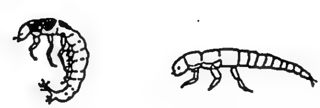
20(19)A. Abdomen with lateral appendages. 21

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

20A.



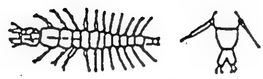
20B.



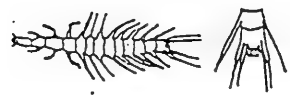
21(20)A. Lateral appendages long and thick; abdomen terminating in a single slender filament, or in prolegs, each with two terminal hooks; body dark brown to black; most are large, some to 10 cm (4 in.) long 22

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.



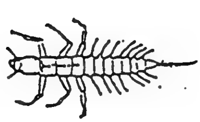
21B.



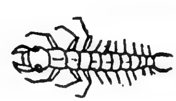
22(21)A. Abdomen with a single caudal filament . . . . .ALDERFLY LARVAE
Megaloptera: Sialidae (*Sialis*)
INTOLERANT

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.

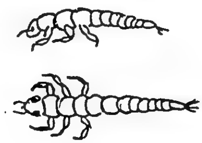


23(20)A. With hooks at end of abdomen; individuals often curl into a "C" shape when held or preserved; body color variable, but head usually brown or yellow; abdomen whitish, tan or green; pronotum (first dorsal thoracic segment) with a distinctly scleriterized plate; abdomen membranous and of a different 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.

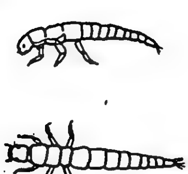


24(23)A. Thorax and abdomen are similar in width giving the organisms a "tube-like" shape; body brown, copper-colored or tan; body somewhat "leathery" in appearance. . . . . .RIFFLE BEETLE LARVAE
Coleoptera: Elmidae and Dryopidae. Riffle beetle larvae resemble midge larvae and are about the same size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

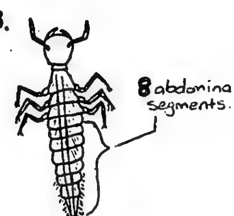
B. Body is "submarine shaped"; abdomen made up of 8 segments; legs on thorax have 5 segments with two claws
. . . . PREDACIOUS WATER BEETLE LARVAE
Coleoptera: Dyticidae.
NOTE: No tolerance value is given for this family, but indicate the number of larvae you collected for trend assessment.

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.

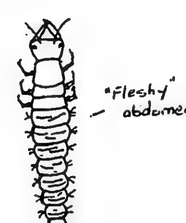
24A.



24B.



24C.



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

B. With a portable case. 28

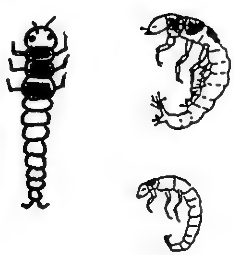
25A.

25B.

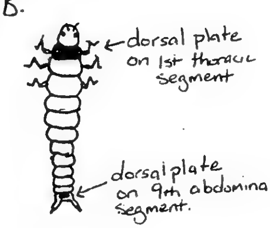
26(25)A. Head as wide as thorax; dorsal plates found either on the first thoracic segment or on all three thoracic segments; builds stationary cases of stone and sand on rocks. 27

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.



26B.

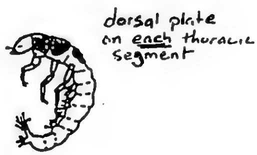


27(26)A. Each thoracic segment with a single dorsal plate; abdomen with gills ventrally (on bottom); >5 mm in length. . . . . HYDROPSYCHIDAE
Trichoptera: Hydropsychidae. Net spinning caddisflies.
FAIRLY INTOLERANT

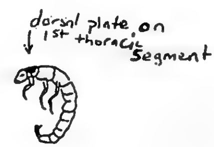
NOTE: Microcaddisflies, which also have 3 dorsal plates on the thorax, resemble Hydropsychids when the former are out of their cases. Microcaddisflies are very small (mostly <5 mm), lack abdominal gills, and their abdomens are swollen (larger than thorax). They build cases of silk which are sometimes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



27B.



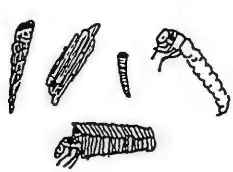
28(25)A. Case of organic detritus (e.g., small sticks, leaves) 29

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.

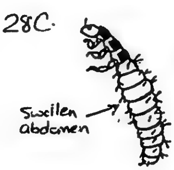
C. Case of silk, may be covered with sand or organic material; animal very small (2-5 mm); each thoracic segment with a single dorsal plate; no ventral abdominal gills . . . . .OTHER CADDISFLIES
Trichoptera: Hydroptilidae. (Purse-case or Microcaddisflies). Resemble the Hydropsychidae but much smaller and without ventral abdominal gills.
INTOLERANT.

28A.



28B.

28C.

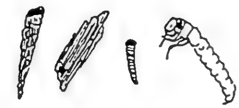


29(29)A. Case is square in cross section . . . . .OTHER CADDISFLIES
Trichoptera: Brachycentridae. (Brachycentrid Caddisflies)
INTOLERANT.

B. Case is cylindrical . . . . .OTHER CADDISFLIES
Trichoptera: Leptoceridae, Phryganiidae, Limnephilidae, and Lepidostomatidae. (Tube-case Caddisflies).
INTOLERANT

29A.

29.B.

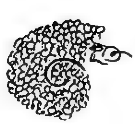


30(28)A. Case shaped like a snail shell and made of sand . . . . .OTHER CADDISFLIES
Trichoptera: Helicopsychidae. (Snail-case Caddisflies)
INTOLERANT

B. Case made of small stones and turtle shell shaped (top is dome shaped; underside is flat) . . . . .OTHER CADDISFLIES
Trichoptera: Glossosmatidae. (Saddle-case Caddisflies)
INTOLERANT

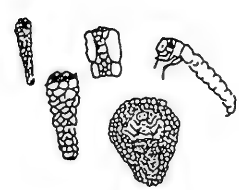
C. Tube made of sand or stone, and shaped like a tube . . . . OTHER CADDISFLIES
Trichoptera: Three families: Molanidae, Limnephilidae, and Odontoceridae.
INTOLERANT

30A.



30B.

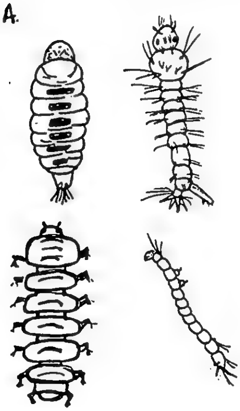
30C.



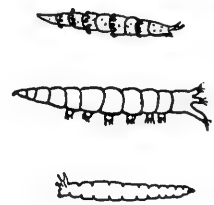
31(8) A. Body with a distinct, visible head capsule 32

B. Body without a distinct head capsule or head capsule retracted. 36

31A.



31 B.

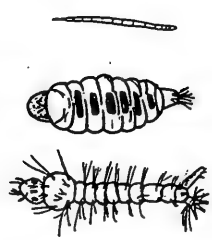


32(31)A. Body with 1 or 2 pairs of prolegs either of which may appear as a single leg 35

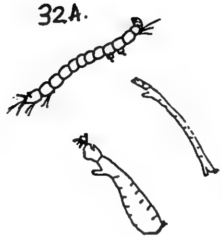
B. Body without prolegs. 33

C. Body made up of 6 segments; with a row of "suckers" on the underside (or ventral) of the body. . . . . OTHER FLIES
Diptera: Blephariceridae. Net-winged midges.

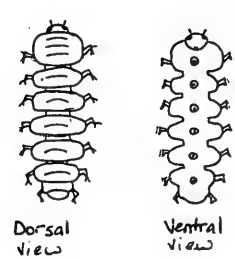
32B



32A.



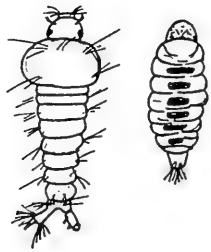
32(C)



33(32)A. End of abdomen with a breathing tube or a tube-like process. 34

B. No breathing tube or tube-like process 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

33A.

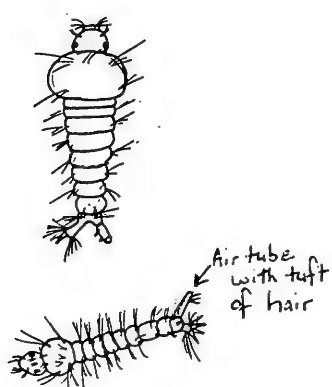


33B.

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.

34A.



34B.

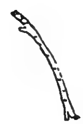
35(32)A. With 1 pair of anterior prolegs; abdomen with a distinct bulge posteriorly (abdomen is swollen at end); usually gray or mottled brown in color . . . . BLACK FLIES
Diptera: Simuliidae. Usually found in very fast moving water.
MODERATELY TOLERANT

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

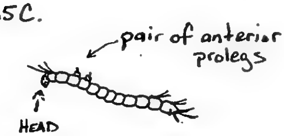
C. With 2 pairs of prolegs on body segments behind head. Tip of abdomen with two hair fringed lobes and a tube-like process . . . . . OTHER FLIES
Diptera: Dixidae. Dixid Midges.

35A.

35 B.



35C.



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 . . . . SNIPE 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: Empipidae. 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

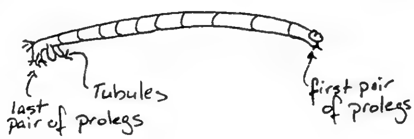
36A.

36B

37(35)A. Body is red in color (may be clear or tan if organism is preserved); end of abdomen has four tubules positioned before the last pair of prolegs. . . . . .BLOOD WORMS
Diptera: Chironomidae.
TOLERANT

B. Body is white or green in color; end of abdomen does not posses four tubules before last pair of prolegs . . . . MIDGES
Diptera: Other Chironomidae.
MODERATELY TOLERANT

37A.



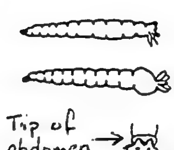
37B.

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.



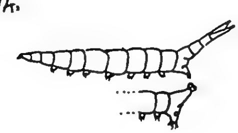
38B.

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
Ephydridae. Shore Flies

B. Body is spindle-shape with not 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. 40

39A.

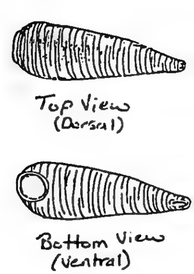


39B.

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



APPENDIX G
DATA SHEETS

The following pages contain the data sheets used for Illinois RiverWatch. Please make copies to use when monitoring the stream site.

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)Embarras 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 :_______________________________________

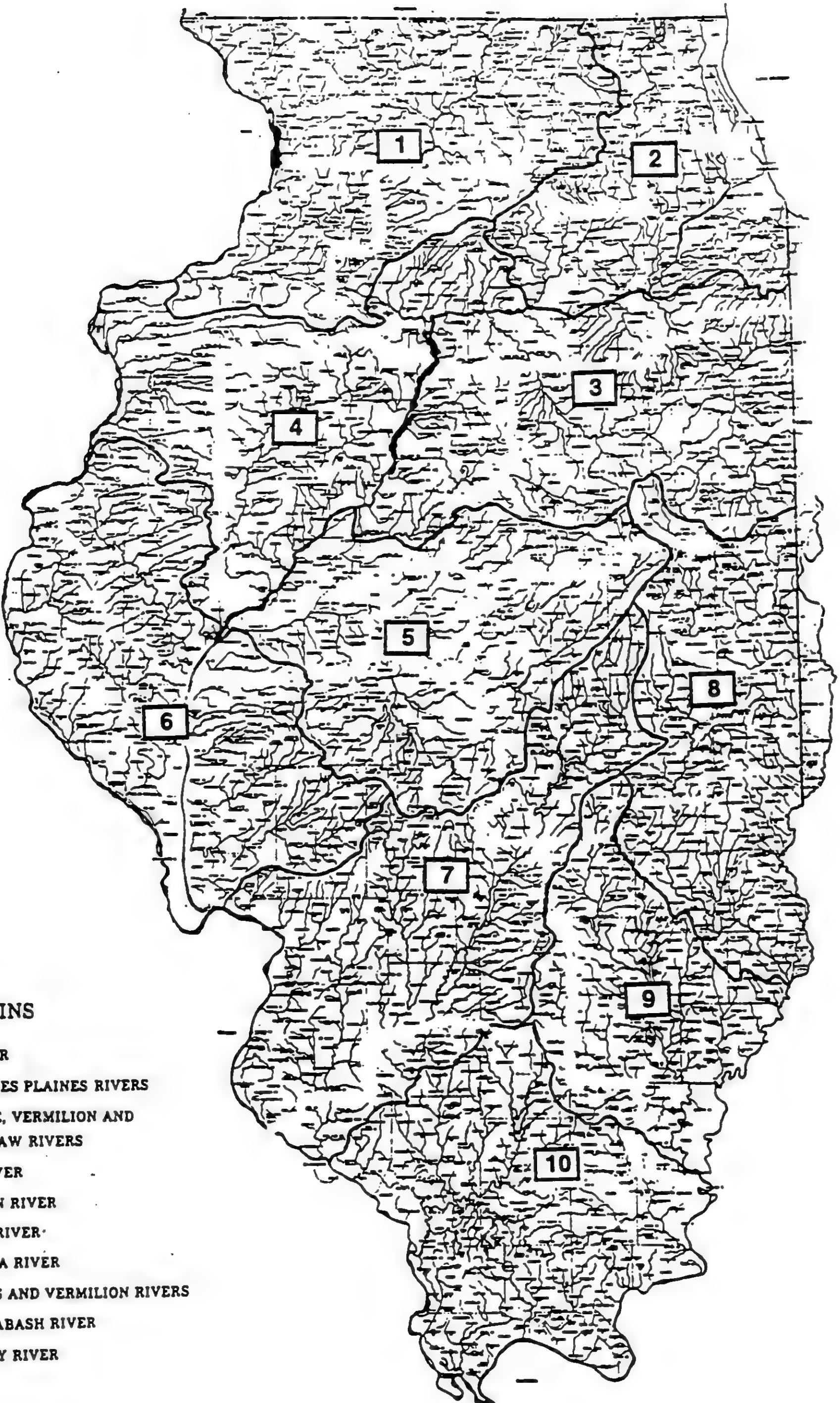
Quarter Section ______ Section No. ________ Range ________ Township _______

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

Site ID:__________
Date:__________
Stream:__________
County:__________

Illinois RiverWatch Network
Site Sketch

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
Habitat Survey Sheet
(Database codes in parentheses)

SITE ID #: ____________________
STREAM NAME: ____________________
COUNTY: ____________________
DATE: ____________________

Names____________________________________

____

*Please circle the correct time period for Start Time and End Time.

Start Time______ am pm
STT

End Time______ am pm
ENT

PRESENT WEATHER (24W)
_____ 1. Clear/Sunny
_____ 2. Overcast
_____ 3. Showers (intermittent rain)
_____ 4. Rain (steady rain)
_____ 5. Storm (heavy rain)

WEATHER IN PAST 48 HOURS (48W)
_____ 1. Clear/Sunny
_____ 2. Overcast
_____ 3. Showers (intermittent rain)
_____ 4. Rain (steady rain)
_____ 5. Storm (heavy rain)

WATER APPEARANCE (WAP)
_____ 1. Clear
_____ 2. Milky
_____ 3. Foamy
_____ 4. Dark Brown
_____ 5. Oily Sheen
_____ 6. Reddish
_____ 7. Green
_____ 8.Other____________________

WATER ODOR (WOD)
_____ 1. None
_____ 2. Sewage
_____ 3. Chlorine
_____ 4. Fishy
_____ 5. Rotten Eggs
_____ 6. Petroleum
_____ 7. Other ______________

TURBIDITY (TUR)
____ 1. Clear
____ 2. Slight
____ 3. Medium
____ 4. Heavy

TEMPERATURE
Water _____ °F °C (WTF or WTC)

Air _____ °F °C (ATF or ATC)
*Circle the correct temperature measurement (°F or °C)

Algal Growth (ALG) _____% of stream bottom covered

Are there **Submerged Aquatic Plants? (SAP)** Yes No (Circle)
Types?____

List the types of the **riparian (stream side) vegetation** present at your stream site.

____

____

Estimate Canopy Cover (CNC). ____% of stream site shaded.

Bottom Substrate. Record percentage of each of the materials that make up the stream bottom. Note all that are present.
___ Bedrock (BDK) ___ Cobble (2.5 in. - 10 in.) (CBB) ___ Sand (< 0.1 in.) (SND)
___ Boulder (> 10 in) (BLD) ___ Gravel (0.1 in - 2.5 in.) (GRV) ___ Silt (SLT)
___ Other (OBS)____________________

EMBEDDEDNESS (EMB) Check the description that best describes the percentage of gravel, cobble, and boulder surface covered by fine sediment or silt.

____ 1. 0 to 25 % ____ 3. 50 - 75 %

____ 2. 25 - 50 % ____ 4. 75 - 100 %

VERIFY 1. ________ DATE:
VERIFY 2. ________ DATE:
VERIFY 3. ________ DATE:

ILLINOIS RIVERWATCH NETWORK
MACROINVERTEBRATE DATA SHEET
Macroinvertebrate Identification

CODE	ORGANISM	N	T_i	T_v
FLW	Flatworm		6.0	
AQW	Aquatic Worm		10.0	
LEE	Leech		8.0	
SBG	Sowbug		6.0	
SCD	Scud		4.0	
DGF	Dragonfly		4.5	
DM1	Broadwing Damselfly		3.5	
DM2	Narrow-winged		5.5	
HLL	Hellgramites		3.5	
MF1	Torpedo Mayfly		3.0	
MF2	Swimming Mayfly		4.0	
MF3	Clinging Mayfly		3.5	
MF4	Crawling Mayfly		5.5	
MF5	Burrowing Mayfly		5.0	
MF6	Two-Tailed Mayfly		3.0	
STF	Stonefly		1.5	
CF1	Hydropsychid Caddisfly		5.5	
CF2	Non-Hydropsy. Caddisfly		3.5	
RFB	Riffle Beetle		5.0	
WHB	Whirligig Beetle		4.0	
WPB	Water Penny Beetle		4.0	
CRF	Cranefly		4.0	
BIM	Biting Midge		5.0	
BLW	Blood Worm		11.0	
MID	Midge		6.0	
BLF	Black Fly		6.0	
SNF	Snipe Fly		4.0	
OTF	Other Fly		10.0	
LHS	Left-Handed Snail		9.0	
RHS	Right-Handed Snail		7.0	
PLS	Planorbid Snail		6.5	
LIM	Limpet		7.0	
OPS	Operculate Snail		6.0	
	TOTALS			
	$\sum$TAXA =	$\sum N$		$\sum T_v$

MBI = $\sum T_v \div \sum N$ =

<6.0 = GOOD Water Quality
6.1 - 7.5 = FAIR Water Quality
7.6 - 8.9 = POOR Water Quality
> or = 9.0 = VERY POOR Water Quality

SAMPLE DENSITY = $\sum N$ =

TAXA RICHNESS = $\sum$TAXA =

PERCENT COMPOSTION OF INDICATOR ORGANISMS

ORGANISM	N	÷	$\sum N$	x 100 =	%C
MAYFLIES (MF#)		÷		x 100 =	
STONEFLIES (STF)		÷		x 100 =	
CADDISFLIES (CF#)		÷		x 100 =	
BLOODWORMS (BLW)		÷		x 100 =	
AQUATIC WORMS (AQW)		÷		x 100 =	

SUBTOTAL % = ________

% ALL OTHERS (100 % - SUBTOTAL %) = ____________

NOTES (MNT):

Stream Discharge Estimate

Stream width (STW): _____feet.
A

Depth Measurement

1. ____feet
2. ____feet
3. ____feet

Average Depth (ASD) ____ feet **B**

Velocity Calculation

10 ft ÷ _____seconds = _____ft/sec

10 ft ÷ _____seconds = _____ft/sec

10 ft ÷ _____seconds = _____ft/sec

Average Velocity (ASV) _____ ft/sec **C**

Discharge (width x depth velocity) _____ feet x _____ feet x _____ft/sec = _______ft^3/sec
A **B** **C** **(SDG)**

Watershed Features
Indicate whether the following land uses are dominant (D) or occur in just small areas (x) **upstream and surrounding your stream site**. If a listed land use is not present, leave blank.:

	Forest (W01)		Logging (W02)		Golf Course (W03)
	Grassland (W04)		Ungrazed Fields (W05)		Commercial/Industrial (W06)
	Scattered Residential (W07)		Urban (W08)		Cropland (type?) (W09 and W09T)
	Sewage Treatment (W10)		Park (W11)		Mining (type) (W12 and W12T)
	Sanitary Landfill (W13)		Livestock Pasture (W14)		Housing construction (W15)

Please circle Yes or No and provide the necessary information to answer the following questions:

Upstream Dam? (UPD)(including beaver dams) Yes No. If Yes, how far upstream is the dam? (DUD) ________________________________

Wastewater treatment discharge upstream? (WTD) Yes No. If Yes, How far upstream?(DWT) _________

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

Channel Alteration (CHA). Has the stream been channelized (straightened) at your study site? Yes No

If Yes, what percentage of your study site has been channelized?(%CH)_____%

Habitat Survey Notes (HNT) (include sediment odors, appearance, and/or the presence of silt, watershed features present but not used on this data sheet, and any other information you feel is important or interesting to mention):

ILLINOIS RIVERWATCH
BIOLOGICAL SURVEY SHEET
SUBSAMPLING PROCEDURE
(Database codes in parentheses)

SITE ID #:______________________
STREAM NAME:______________________
COUNTY:______________________
DATE:______________ ______________

Which two habitats did you sample? (Check the two answers that apply)(HA1 and HA2)

1.RIFFLES ____ 2. LEAF PACKS ____ 3.SNAG AREAS, ETC. ____ 4.UNDERCUT BANKS ____ 5. SEDIMENT ____

NOTE: If you collect 100 or less organisms, there is no need to subsample. Simply indicate which habitats were sampled and preserve the whole sample. If you collect more than an estimated 100 organisms, indicate which habitats were sampled then proceed with subsampling procedures.

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

A. Total # of Organisms Subsampled: ______

B. # of Squares Selected: ______

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

D. Organisms in Tray (C x 9 OR Cx12): _____ organisms/tray
(TRY)

Please indicate whether or not you noticed any of the following organisms at your stream site by circling YES or NO.

NATIVE MUSSELS?(NML)	YES	NO
ZEBRA MUSSELS?(ZML)	YES	NO
FINGERNAIL CLAMS?(FCL)	YES	NO
ASIATIC CLAMS?(ACL)	YES	NO
CRAYFISH?(CFH)	YES	NO

VERIFY 1. ________ DATE:
VERIFY 2. ________ DATE:
VERIFY 3. ________ DATE:

VERIFY 1. ____________ DATE: ____________
VERIFY 2. ____________ DATE: ____________