A program of the National Great Rivers Research and Education Center

Illinois RiverWatch
STREAM MONITORING MANUAL

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This manual replaces all previous versions.

USER NOTE

The Illinois RiverWatch program and this manual were developed by staff of the Illinois Department of Natural Resources and the Illinois Natural History Survey as a volunteer component (EcoWatch) of the Critical Trends Assessment Program. The RiverWatch program was officially transferred to the National Great Rivers Research and Education Center in 2006.

This manual has been developed for use by the Illinois RiverWatch Citizen Scientist Program. It is intended to supplement personalized training and other materials provided by the program. Please be advised that only data collected by trained Citizen Scientists will be accepted into official databases maintained by the RiverWatch Program. Contact the RiverWatch office for training and other information.

This manual replaces all previous editions. Reproduction is permitted for educational purposes.

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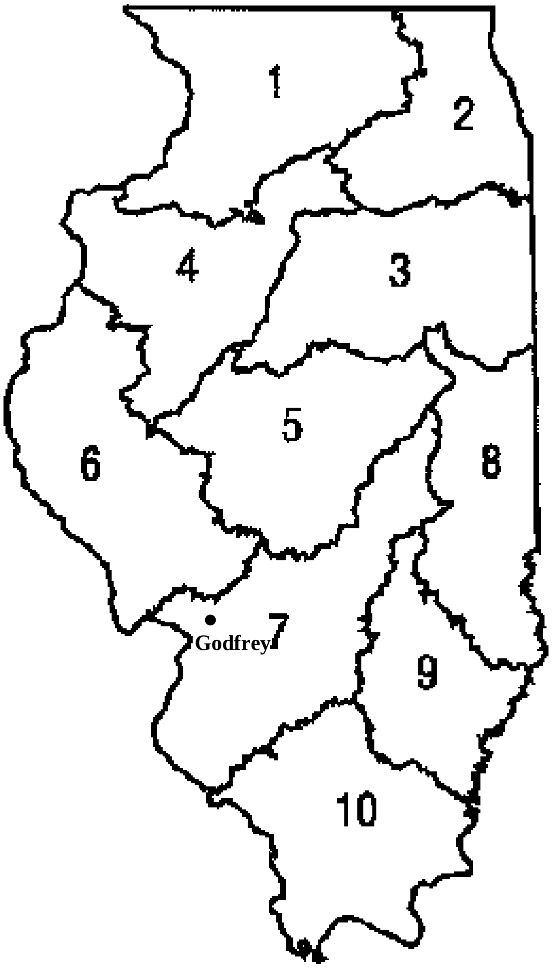

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Introduction

ILLINOIS RIVERWATCH

Illinois RiverWatch is a volunteer stream monitoring program administered by the National Great Rivers Research and Education Center (NGRREC). Established in 2002, The Center's scholars and scientists study the ecology of the big rivers, the workings of the watersheds that feed them, and ties to the river communities that use them. NGRREC aspires to be a leader in scholarly research, education and outreach related to the interconnectedness of large rivers, their floodplains and watersheds, and their associated communities. The Center's unique location, strong partnerships, and overall purpose make it an ideal home for administering the RiverWatch program.

Consistent with NGRREC's mission, RiverWatch provides Illinois citizens volunteers a hands-on opportunity to become involved in the stewardship of our rivers and streams while helping scientists monitor stream conditions across the state. Through RiverWatch, volunteers are trained as Citizen Scientists to conduct biological monitoring of the state's rivers and streams and collect scientific data that can subsequently be used by professionals and the general public to gauge long-term trends in stream health, develop land management strategies, identify potentially degraded waters, and assess the effectiveness of restoration projects.

GOALS

The three primary goals of RiverWatch are:

- to provide consistent high-quality data that can be used by scientists to measure how the conditions of our state's streams are changing over time;
- to educate and inform Illinois citizens about the ecology and importance of Illinois water resources; and
- to provide an opportunity for citizens to become involved in the stewardship of the state's rivers and streams.

WHAT TO EXPECT

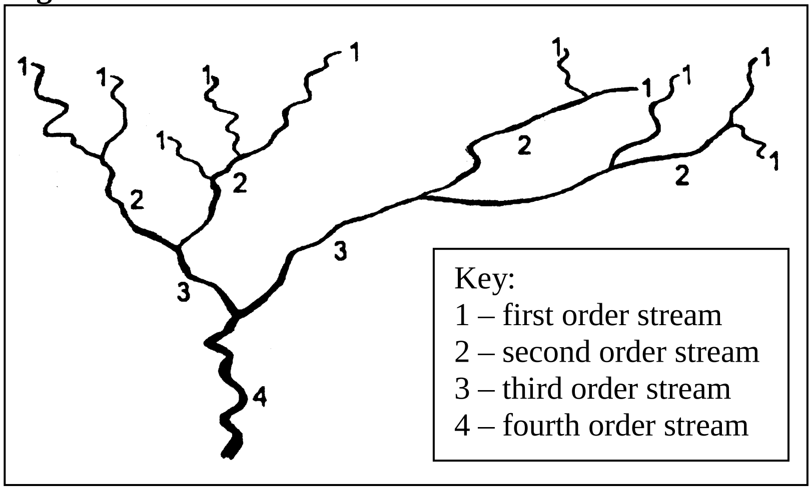
The monitoring procedures developed for Illinois RiverWatch are for small to medium size, wadeable streams. Training to become a Citizen Scientist includes a four-hour field session and a four-hour classroom session provided by a certified RiverWatch Trainer. Once trained, Citizen Scientists adopt a stream site at which they conduct an annual survey between May 1- June 30. Monitoring dates may vary depending on weather and stream conditions. Monitoring data are entered into a statewide database over the internet, validated by the RiverWatch Quality Assurance Officer. Access to the RiverWatch database is limited to trained citizen scientists. Citizen Scientists record information on the organisms in the stream (biological monitoring) as well as the surrounding habitat (habitat survey). Scientists need both biological and habitat information to accurately assess the quality of the environment. This data characterizes the condition of the stream at the time it is sampled. When data has been collected over a period of five or more years trends will begin to emerge.

Watersheds and Streams

STREAM ORDER CLASSIFICATION

Streams are often classified based on their size and the volume of water they carry. Headwater streams eventually intersect with one another (usually at acute angles) to form leaf like patterns called drainage networks. Within these networks, a hierarchical "stream order designation" is sometimes used to classify a stream and its tributaries. Two first order streams form a second order stream; two second order streams form a third order stream, and so on. Stream order increases only when two streams of the same order level converge. In other words, a first order stream merging with a second order stream does not make a third order stream, but remains at the second order level.

Figure 1. Stream Orders



To a biologist, a first order stream is the smallest stream carrying water long enough to support aquatic organisms during part of the year. Lower order streams generally have lower discharge rates (amount of water over a given time period) and smaller drainage areas than higher order streams. RiverWatch typically monitors 2nd and 3rd order streams. These are generally wadeable streams with slow to moderate flow.

In Illinois, the **substrate**, or bottom, of most stream reaches is either rocky or soft. The substrate along a soft bottom reach is composed of sand, soft mud, or a mixture of both. The substrate of a rocky bottom reach consists of rocks or gravel. The habitat and biological survey 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 **(Figure 2)**.

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.

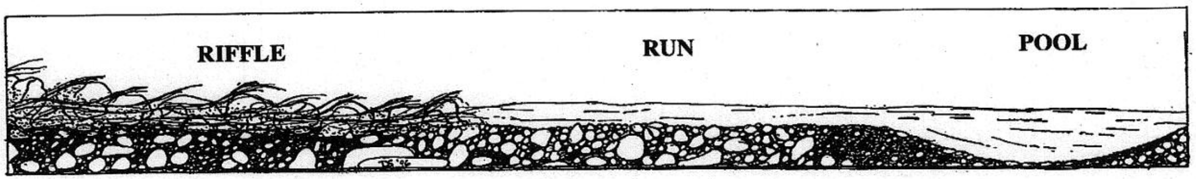
Runs are stretches of quiet water commonly found between riffles and pools in larger streams and rivers. Runs have a moderate current and are slightly deeper than riffles.

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.

Pools are formed where the stream channel becomes wider and deeper. As it enters a pool, the water slows and its energy dissipates. With less energy to keep sediments and organic debris moving, the heavier part of the stream's sediment load drops to the bottom. Pools usually have larger organisms living in them that have adapted to these habitats. For example, crayfish 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 riffles are affected by upstream pools.

Figure 2. Rocky Bottom Reach



Although riffles, pools and runs 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 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

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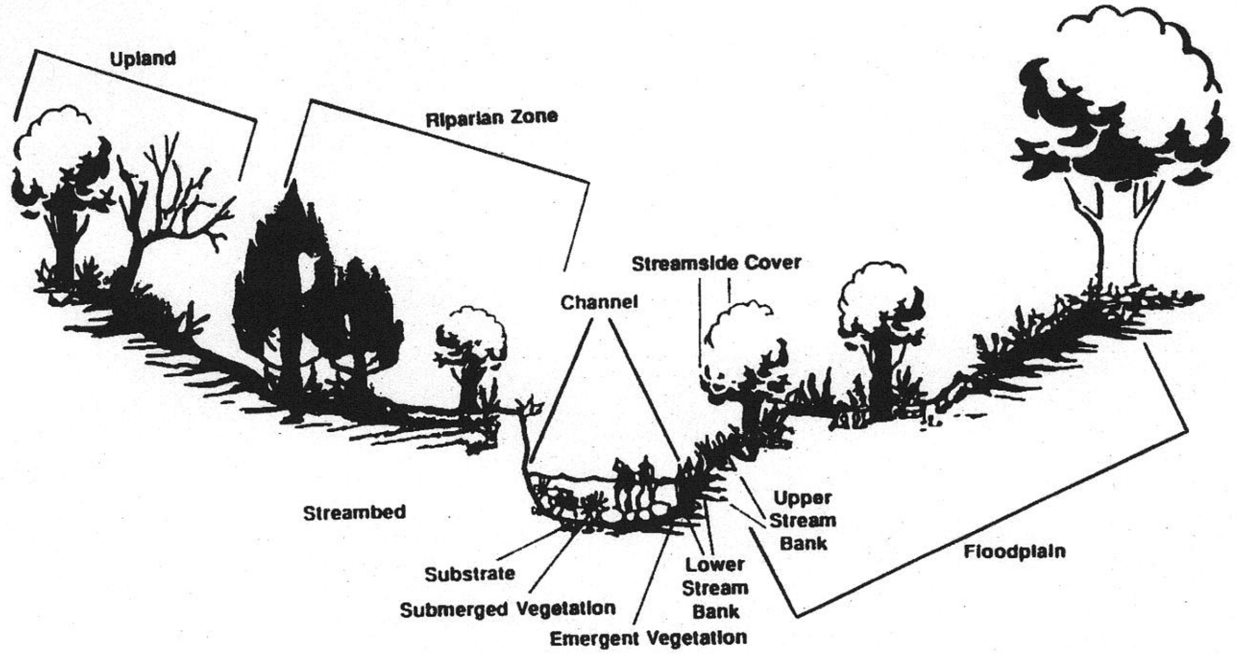
A **soft bottom reach** does not have riffle-run-pool habitats. In these reaches, some macroinvertebrates burrow into the sediment (midge larvae and worms, for example), while others live in or on submerged and floating logs, submerged vegetation, rip rap along the shore line, or in any leaf or organic debris.

The **riparian zone** refers to the area of land which is connected with or immediately adjacent to the banks of a stream (see **Figure 3**). It includes the stream banks, wetlands, and those portions of floodplains and valley bottoms that support streamside vegetation. 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 flooded, food, water, and sediment are carried into the stream from the adjacent landscape. Plants growing within the riparian zone hold the soil of the stream's banks in place, helping to prevent erosion. They also provide habitat for aquatic insects, fish and other organisms during floods.

Trees and shrubs and other forms of riparian vegetation influence the amount of sunlight and heat reaching the stream channel. If a stream has no trees or shrubs to shade the water, the temperature becomes too high for most macroinvertebrates to survive. Too much shade blocks sunlight, preventing algae or aquatic plants from growing in the stream. Riparian cover is also an important factor in determining the level of dissolved oxygen in the stream.

Figure 3. Diagram of Stream Habitats



FACTORS THAT AFFECT STREAM QUALITY IN ILLINOIS

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 and habitat alterations can affect Illinois rivers and streams. They include: sediment, organic wastes, nutrient enrichment, temperature elevation, channelization and toxic chemicals.

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. Farm fields, 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 in which many of these organisms live by filling the spaces between boulders and rocks. 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 like nitrogen and phosphorous can occur naturally in stream water, and are key elements in the growth of aquatic plant life such as algae. However, excessive levels of these nutrients can significantly increase growth of algae in the stream, resulting in algal blooms. Besides being unsightly, algal blooms can cause water to smell and taste foul. Furthermore, the decomposition of algae 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 naturally meandering streams with varied habitats to straight-sided ditches of nearly uniform width, depth, velocity, and substrate. Fewer habitats mean fewer species capable of living in such modified streams. Bank side vegetation is removed when a stream is channelized, further reducing the biodiversity of the stream.

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

However, the concentration of toxic chemicals in stream waters is not necessarily a true reflection of their presence in a stream. Plants and animals often absorb these pollutants either from the water or sediment and accumulate them in their tissues. Monitoring 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 bioaccumulated 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 source and 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. According to The Changing Illinois Environment: Critical Trends, a comprehensive environmental assessment report released in 1994 by the Illinois Department of Energy and Natural Resources (now part of the Illinois Department of Natural Resources), water quality has improved over the past 20 years, in some cases dramatically. This is largely a result of significant reductions in point source pollution inputs and improved municipal sewage treatment facilities. Nevertheless, ecological quality remains low.

Nonpoint source pollution remains 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.

Monitoring Background

MONITORING FOR LONG-TERM TRENDS

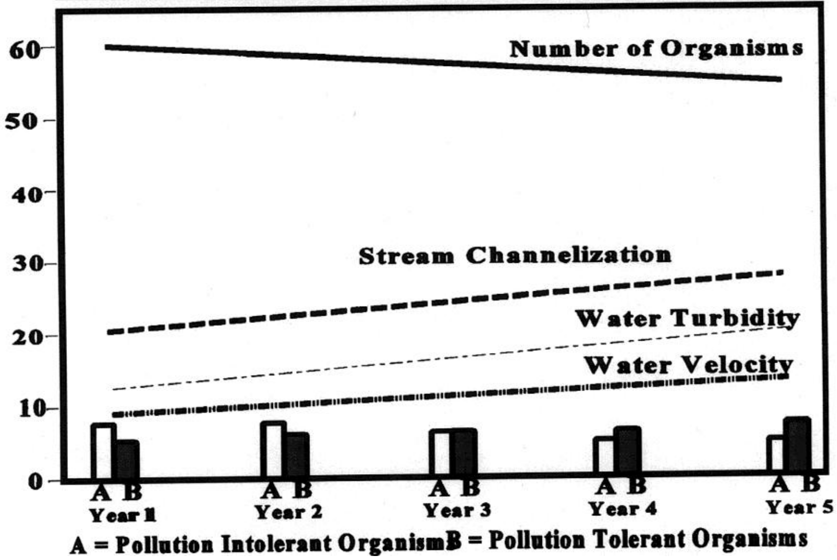
Monitoring an ecosystem provides useful information concerning its present condition. However, even detailed information from a one-time survey is of limited value when questions regarding long-term management are being asked. It is only when data is consistently and systematically collected over time that the bigger picture becomes clear.

To understand why, imagine that Citizen Scientists have monitored a stream for five years, using the same sampling methods at the same study sites each year. When the results are analyzed, stream quality indicators for each year fall in the “good” range on a widely accepted stream rating scale. Viewed independently, each year’s data indicated that the stream’s habitat and biological community are in good condition.

Trends over five years, however, tell a different story (see **Figure 4**). In this case, the Citizen Scientists find that the overall number of organisms in the stream was decreasing at a slow but steady rate. The trends also show that organisms that can tolerate poor water quality and degraded habitat are becoming common compared to organisms that are more sensitive to pollution. Habitat surveys document that the stream channel is becoming increasingly channelized (straightened), streambanks are slowly eroding and the water is becoming increasingly turbid (cloudy). Finally, discharge measurements document that the flow of water is increasing.

As this example illustrates, monitoring data for a single year provide a snapshot suggesting a stream in good health. But when the data are reviewed over five years, trends that show a stream in steady decline become apparent. RiverWatch is designed to provide both the instant snapshot and a look at how the stream’s habitat and biological community are changing over time.

Figure 4. Example of volunteer data used to show water quality trends



STREAM MONITORING: BIOLOGICAL & HABITAT SURVEYS

Biological Surveys

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 changes in habitat quality, water quality and overall stream health.

Biological stream monitoring is based on the fact that different species are more susceptible to changes in stream quality than others. Habitat sensitive organisms react strongly to physical or chemical changes in a stream. Stronger, more tolerant organisms can cope with adverse conditions more easily.

The presence or absence of such indicator organisms is an indirect measure of habitat condition and water quality. When stream habitat is damaged or water quality declines due to pollution, sedimentation or other causes, habitat sensitive organisms decrease in number or disappear, while more tolerant organisms remain stable or 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.

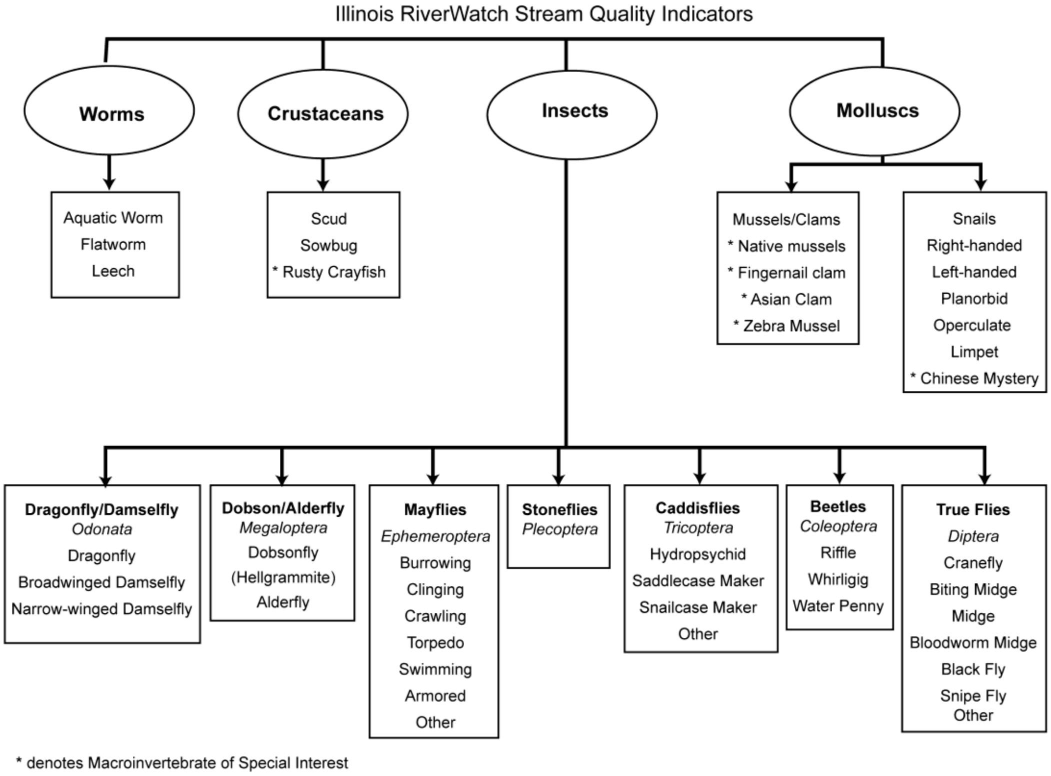
- They are relatively easy to sample. Benthic macroinvertebrates are abundant and can be easily collected and identified by volunteers.
- They are relatively immobile. Animals such as fish can escape toxic spills or degraded habitats by swimming away, and migratory animals may spend only a small portion of their life cycle in a particular stream. Changes in populations of mobile species thus do not necessarily reflect changes in stream quality. 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 quality parameters (such as the amount of oxygen dissolved in it) describes the condition of the water only at the time the samples are 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.

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. Citizen Scientists are trained to identify benthic macroinvertebrates to the level of Order, and in a few instances Family.

The RiverWatch biological survey samples macroinvertebrate communities for 37 different indicator taxa, including insects, worms, crustaceans, and molluscs. A presence and absence survey is also conducted for 6 macroinvertebrates of special interest, including native mussels, zebra mussels, fingernail and Asiatic clams, rusty crayfish, and the Chinese mystery snail.

Indexes calculated in the biological survey include a macroinvertebrate biotic index, number of organisms sampled, taxa richness, and EPT taxa richness.



Habitat Surveys

Habitat surveys describe physical conditions in and immediately surrounding the stream. Information gained from the surveys help 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 surveys 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. These modifications have degraded or altogether 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 surveys help catalog the nature and extent of these kinds of changes.

QUALITY ASSURANCE

Quality assurance and quality control (QA/QC) are critical elements of all standard scientific monitoring procedures. Quality assurance is a management system of checks and balances that ensure data meet a defined standard of quality. Quality control is the specific tasks that are undergone to prevent or correct data errors. Procedures affect every step of the monitoring process. Adherence to QA/QC guidelines helps to 1) establish the credibility of the data by demonstrating that it meets defined quality standards and 2) identify aspects of training and monitoring that need to be improved.

It is important that Citizen Scientists understand that QA/QC procedures are designed to test the validity of the program, not the individual volunteers. QA procedures are integrated throughout the RiverWatch program. By attending training and review sessions, carefully following the procedures, and properly completing the data sheets, Citizen Scientists are already meeting most of the program’s QA guidelines.

Following is a comprehensive list of simple steps Citizen Scientists can follow to help ensure the highest quality data for their site.

Before Monitoring

- Review and discuss all safety procedures listed in the monitoring manual with anyone conducting or assisting with monitoring activities.
- Review the monitoring manual and RiverWatch equipment list to ensure that your monitoring kit contains the proper components. Verify that all equipment meets specifications noted in the monitoring manual.
- Verify that the Site Evaluation Form, Site Identification Form, Property Access Permission Form, and Activity Participation Form (where applicable) are complete and accurate.
- Contact the RiverWatch Coordinator for support (if needed) and notify the RiverWatch office of when and where monitoring will take place. The property owner or manager should also be notified in advance of monitoring activities.

- Visit the monitoring site at least one day prior to monitoring to determine accessibility, parking, and stream conditions.
- Enter the proper information for your stream site (stream name, county, date, etc.) in the Site Identification Boxes on all data sheets.

In the Field

- Adhere to all protocols exactly as written in the monitoring manual. Data collected in any other manner will not be accepted for analysis by the program.
- Always write legibly. Remember that the data sheets will be read by others. Refrain from using jargon and nicknames.
- If an error occurs while recording data onto a data sheet, mark the error with a single line through the middle of the word or number (example: ~~BUG~~). Write the correct information next to the error. Avoid erasing or scribbling out the original answer so that it can be read later for verification purposes. Make a note (such as "mathematical error" or "miscount of individuals") on the data sheet explaining why the correction was made.
- Assign roles to members of your monitoring group so that each is responsible for a specific monitoring activity (e.g., site sketch, habitat survey, sampling, sorting/counting, verifying, etc.).
- If monitoring with a larger group (high school science class, for example), divide your group into teams, and have a trained Citizen Scientist or other "expert" experienced with monitoring protocols rotate from team to team to assist with sampling and to emphasize quality assurance concerns.
- Include explanatory notes for any unusual observations. Feel free to note additional information in the "Notes" section of the data sheet.
- Preserve specimens in alcohol. This must be done on the day the sample is collected. Be sure the vial label is properly filled out with site identification number, stream name, county, date, location and your name in pencil or non-alcohol soluble ink. Place the label inside the jar/vial.
- Review all measurements and calculations for accuracy. Verify that figures make sense with what is observed in the field.
- If possible, take a photograph of the sampling site (digital photos are preferred).
- Prior to leaving the sampling site, check all data sheets for legibility, completeness and accuracy. Initial and date the Citizen Scientist line in the Verification Box on the Habitat Survey Sheet.
- Verify that the Site Identification Box is complete.
- Add fresh alcohol to the sample jar if waiting longer than one week before identifying macroinvertebrates.

In the Lab

- Conduct all macroinvertebrate identification indoors in an area with good lighting and plenty of space. Always allow enough time to complete identification as accurately as possible. Most samples can be identified in two hours or less.
- Review the monitoring manual and equipment list to ensure that the proper components and macroinvertebrate identification aids are available. Verify that all equipment meets specifications noted in the monitoring manual.

- Review the use of identification keys and specific characteristics of each indicator taxa prior to identifying your sample.
- Sort all specimens into groups based on appearance, taxonomic order or general tolerance value group. This will aid in identifying each specimen later.
- Work in teams, with one person identifying specimens and another recording the type and number of each. Switch roles and take frequent breaks to avoid eye strain.
- If monitoring with a larger group (high school science class, for example), divide your group into teams, and have a trained Citizen Scientist or other “expert” experienced with identification techniques rotate from team to team to assist with identification and to emphasize quality assurance concerns.
- If you cannot identify a specimen, contact your RiverWatch office for assistance.
- Once the specimens are identified and counted, store the sample in fresh alcohol to prevent degradation.
- Check all data sheets for legibility, completeness, and accuracy. Initial and date the Citizen Scientist line in the Verification Box on the Macroinvertebrate Identification Sheet.
- Verify that the Site Identification Box is complete.

After Monitoring

- Verify proper completion of the Site Identification Boxes on all data sheets.
- Re-check all data entries for legibility, completeness and accuracy.
- Request a user ID and password from the RiverWatch coordinator if submitting data through the Internet. All electronic data must be accompanied by “hard copy" data sheets and a macroinvertebrate sample. Electronic data submission allows for additional quality control checks that reduce the potential for data entry error.
- Make copies of all completed data sheets and keep them in a safe place. Any questions that arise later will be easier to address if copies of the data sheets are available.
- Send your macroinvertebrate sample with the original “hard copy” monitoring data sheets to the RiverWatch office by the deadline. This sample may be further verified by the RiverWatch staff for quality assurance purposes.
- Notify the RiverWatch coordinator when monitoring has been completed and when to expect completed and verified data sheets.

Throughout the Year

- Keep up to date on current RiverWatch procedures and macroinvertebrate indicators since periodic changes occur.
- Discard old manuals and data sheets when you receive a new edition. Review new editions and highlight changes.
- Look for QA/QC tips and guidelines in the RiverWatch newsletter and on the River-Watch web site.
- Attend a review session at least every two years to maintain and improve your identification skills.

Getting Started

PREPARING FOR YOUR MONITORING SESSION

The key to successful stream monitoring lies in being properly prepared before you reach the stream. This chapter describes several steps Citizen Scientists are expected to complete before they monitor.

Steps Prior to Monitoring

- Receive training / attend a review session
- Find a partner or form a team
- Select a monitoring site
- Complete site documentation
- Obtain monitoring equipment
- Plan your monitoring session

Receive Training / Attend a Review Session

Before monitoring, RiverWatch volunteers must successfully complete the Citizen Scientist training program. This is offered each spring and at other times of the year by request. Only data collected by trained Citizen Scientists is included in the RiverWatch database. The statewide annual monitoring period is May 1 - June 30.

Previously trained Citizen Scientists are strongly encouraged to attend a review session at least once every two years. Review sessions are offered each spring and cover any changes to sampling or data submission procedures. They are also a valuable opportunity to practice macroinvertebrate identification and to meet other Citizen Scientists. Training workshops for new volunteers are also open to previously trained Citizen Scientists. Recent data verification results show that data accuracy and precision increase as a result of attendance at review sessions.

Find a Partner / Form a Team

For safety reasons, Citizen Scientists should never monitor without at least one other person present. Individuals should find a monitoring partner, and groups should form teams of three to five volunteers per site. Where possible, it is recommended that Citizen Scientists work with other trained volunteers. However, non-Citizen Scientists can also be part of your team as long as each site is supervised by at least one trained Citizen Scientist. The RiverWatch Coordinator can help identify possible monitoring partners for those who need assistance.

Select a Monitoring Site

Following training, Citizen Scientists are expected to adopt one or more monitoring sites from which they will collect habitat and biological data once per year. A Citizen Scientist obtains a site in one of two ways:

1. Upon request, the RiverWatch Coordinator will offer one or more sites from a list of available, pre-evaluated sites. When an acceptable site is identified and site registration documents are complete, it is assigned to a Citizen Scientist for monitoring.
2. Citizen Scientists may also select a site of their own choosing based on guidelines and site selection criteria provided during training. Once site registration documents are complete, the site is assigned to the Citizen Scientist for monitoring.

Complete Site Documentation

Once a suitable monitoring site has been identified, proper site identification information must be completed. This information is kept by the RiverWatch office in a site identification file unique to each site. The file includes landowner contact information and copies of any monitoring data sheets previously completed for the site.

The required site documentation includes:

- **RiverWatch Site Evaluation Form** describes the specific (on-site) location of the site, access points, suitability of the site, and landowner permission status.
- **RiverWatch Site Identification Form** describes the general (road map) location of the site, legal description, longitude / latitude coordinates and other location information.
- **Property Access Permission Form** documents the landowner’s or manager’s permission to access the site for evaluation and monitoring purposes. It must be completed before monitoring starts.

See the sample forms on the next two pages.

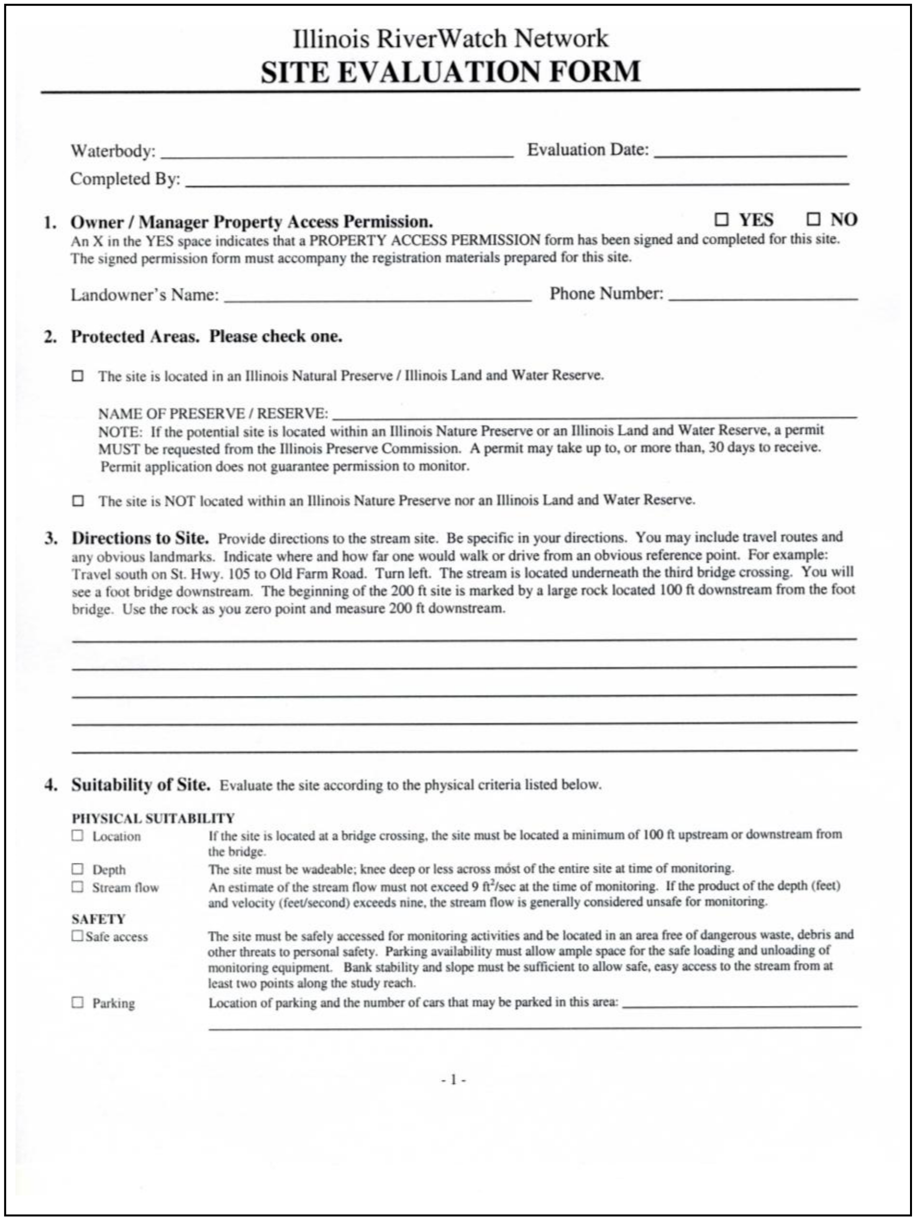
One or more maps (topographic maps, local road maps, etc.) indicating the location of the site should be included with the site file. Surrounding roads and access points should be highlighted.

In many cases, necessary site documentation will already be completed for a given site. Registration of new sites may require more effort. Allow at least 3-4 weeks to complete this step before monitoring.

Generally, it is the Citizen Scientist’s responsibility to ensure that proper site documentation has been completed and filed with the RiverWatch office for his or her site. Once your site has been added to the RiverWatch Site Identification Database, you will receive a confirmation notice, including the official RiverWatch Network Site Identification Number for your site.

Sign Activity Participation Form

All volunteers must sign and submit an Activity Participation Form to the RiverWatch Office prior to monitoring. The form only needs to be submitted once.



Illinois RiverWatch Network

SITE EVALUATION FORM

Waterbody: ______________________ Evaluation Date: ______________

Completed By: ____

1. Owner / Manager Property Access Permission. ☐ **YES** ☐ **NO**
An X in the YES space indicates that a PROPERTY ACCESS PERMISSION form has been signed and completed for this site. The signed permission form must accompany the registration materials prepared for this site.

Landowner's Name: ____________________ Phone Number: ______________

2. Protected Areas. Please check one.

☐ The site is located in an Illinois Natural Preserve / Illinois Land and Water Reserve.

NAME OF PRESERVE / RESERVE: ______________________________
NOTE: If the potential site is located within an Illinois Nature Preserve or an Illinois Land and Water Reserve, a permit MUST be requested from the Illinois Preserve Commission. A permit may take up to, or more than, 30 days to receive. Permit application does not guarantee permission to monitor.

☐ The site is NOT located within an Illinois Nature Preserve nor an Illinois Land and Water Reserve.

3. Directions to Site. Provide directions to the stream site. Be specific in your directions. You may include travel routes and any obvious landmarks. Indicate where and how far one would walk or drive from an obvious reference point. For example: Travel south on St. Hwy. 105 to Old Farm Road. Turn left. The stream is located underneath the third bridge crossing. You will see a foot bridge downstream. The beginning of the 200 ft site is marked by a large rock located 100 ft downstream from the foot bridge. Use the rock as you zero point and measure 200 ft downstream.

____

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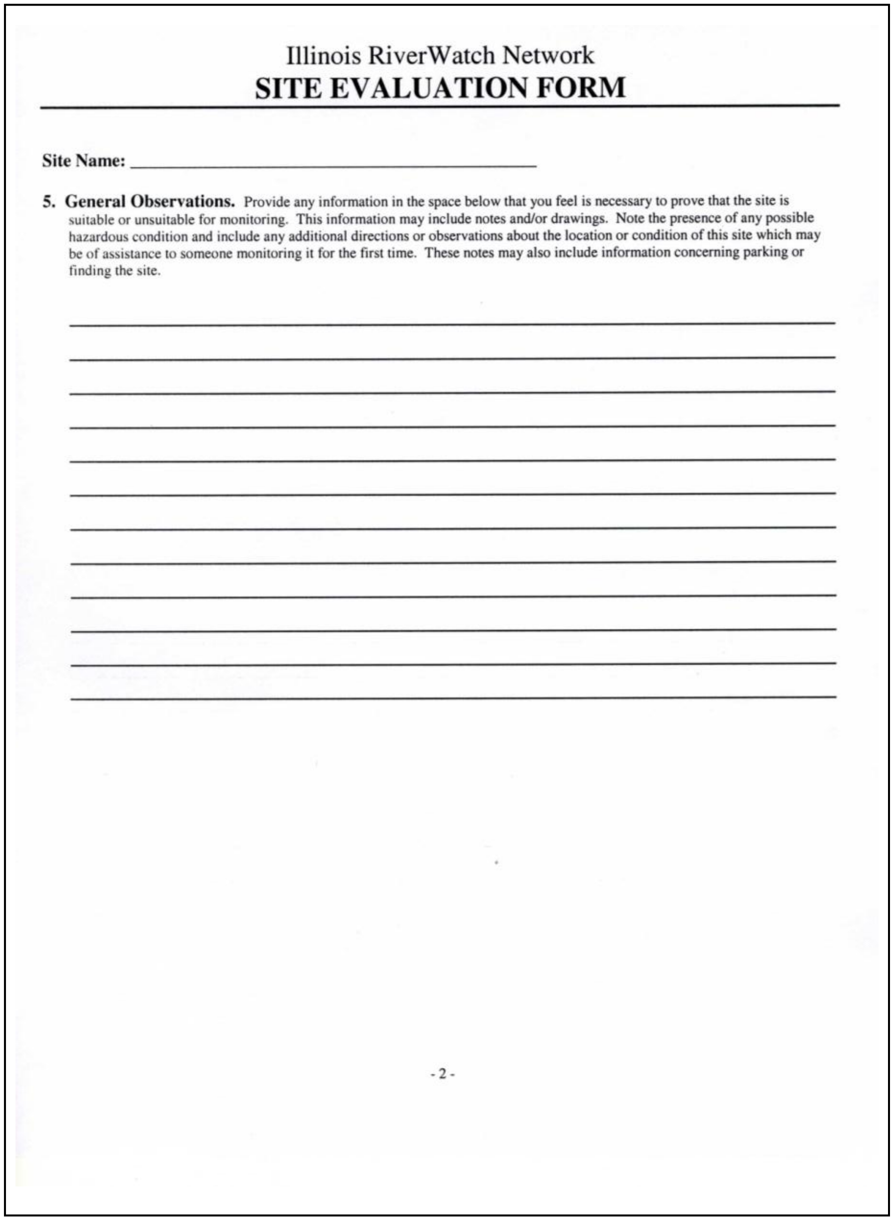
____

4. Suitability of Site. Evaluate the site according to the physical criteria listed below.

PHYSICAL SUITABILITY	
☐ Location	If the site is located at a bridge crossing, the site must be located a minimum of 100 ft upstream or downstream from the bridge.
☐ Depth	The site must be wadeable; knee deep or less across most of the entire site at time of monitoring.
☐ Stream flow	An estimate of the stream flow must not exceed 9 ft^2/sec at the time of monitoring. If the product of the depth (feet) and velocity (feet/second) exceeds nine, the stream flow is generally considered unsafe for monitoring.
SAFETY	
☐ Safe access	The site must be safely accessed for monitoring activities and be located in an area free of dangerous waste, debris and other threats to personal safety. Parking availability must allow ample space for the safe loading and unloading of monitoring equipment. Bank stability and slope must be sufficient to allow safe, easy access to the stream from at least two points along the study reach.
☐ Parking	Location of parking and the number of cars that may be parked in this area: ______________

- 1 -



Illinois RiverWatch Network

SITE EVALUATION FORM

Site Name: ______________________________

5. General Observations. Provide any information in the space below that you feel is necessary to prove that the site is suitable or unsuitable for monitoring. This information may include notes and/or drawings. Note the presence of any possible hazardous condition and include any additional directions or observations about the location or condition of this site which may be of assistance to someone monitoring it for the first time. These notes may also include information concerning parking or finding the site.

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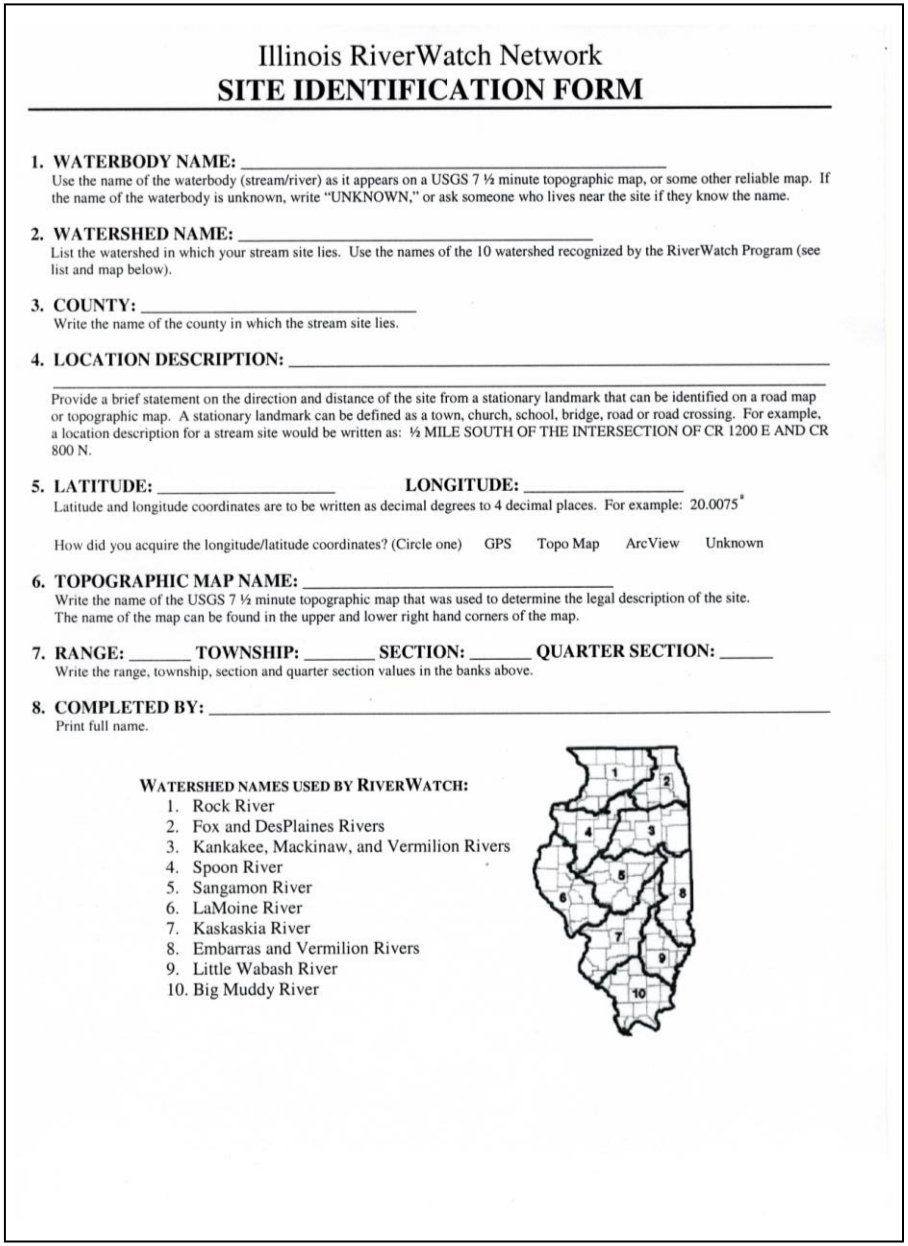
- 2 -



Illinois RiverWatch Network
SITE IDENTIFICATION FORM

1. **WATERBODY NAME:** ______________________________
   Use the name of the waterbody (stream/river) as it appears on a USGS 7 ½ minute topographic map, or some other reliable map. If the name of the waterbody is unknown, write "UNKNOWN," or ask someone who lives near the site if they know the name.

2. **WATERSHED NAME:** ______________________________
   List the watershed in which your stream site lies. Use the names of the 10 watershed recognized by the RiverWatch Program (see list and map below).

3. **COUNTY:** ______________________________
   Write the name of the county in which the stream site lies.

4. **LOCATION DESCRIPTION:** ______________________________
   Provide a brief statement on the direction and distance of the site from a stationary landmark that can be identified on a road map or topographic map. A stationary landmark can be defined as a town, church, school, bridge, road or road crossing. For example, a location description for a stream site would be written as: ½ MILE SOUTH OF THE INTERSECTION OF CR 1200 E AND CR 800 N.

5. **LATITUDE:** ________________ **LONGITUDE:** ________________
   Latitude and longitude coordinates are to be written as decimal degrees to 4 decimal places. For example: 20.0075°

   How did you acquire the longitude/latitude coordinates? (Circle one) GPS Topo Map ArcView Unknown

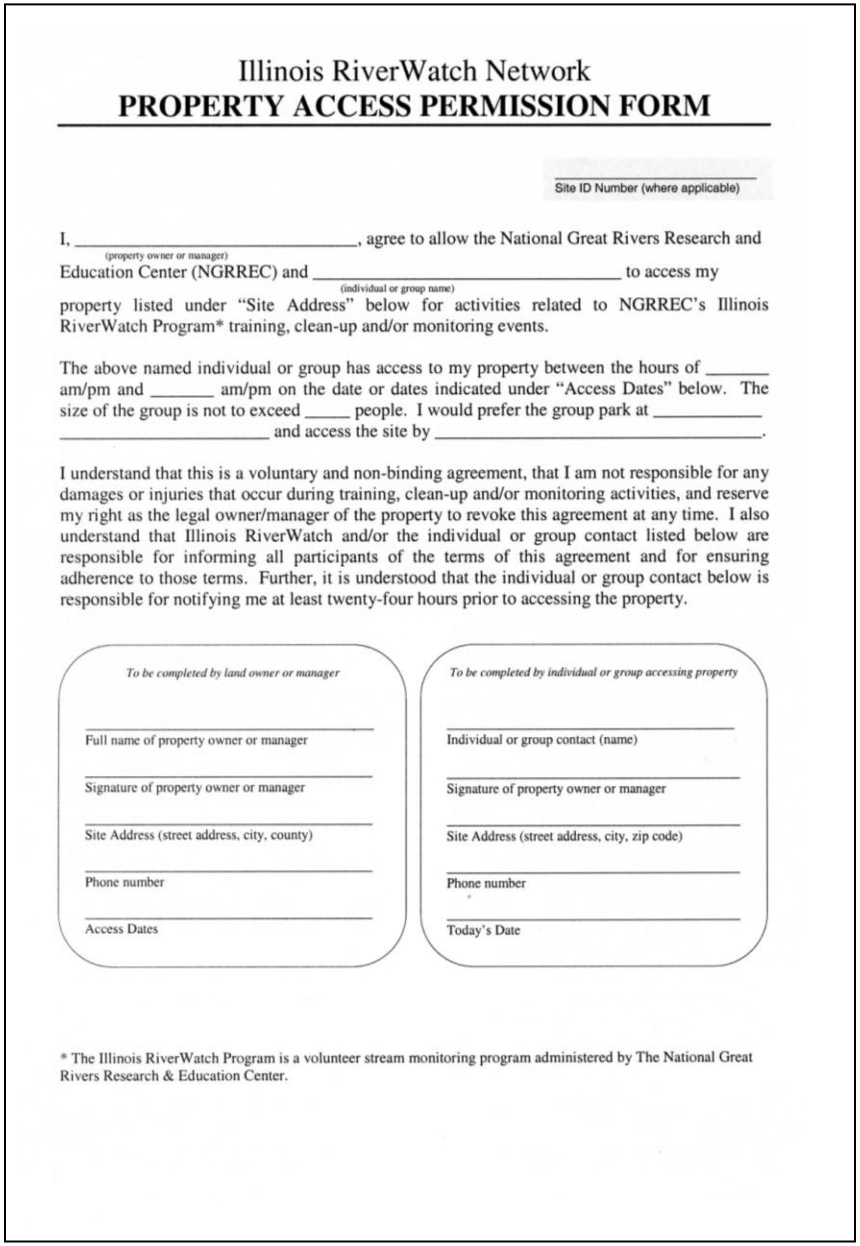
6. **TOPOGRAPHIC MAP NAME:** ______________________________
   Write the name of the USGS 7 ½ minute topographic map that was used to determine the legal description of the site. The name of the map can be found in the upper and lower right hand corners of the map.

7. **RANGE:** ______ **TOWNSHIP:** _______ **SECTION:** ______ **QUARTER SECTION:** ______
   Write the range, township, section and quarter section values in the banks above.

8. **COMPLETED BY:** ______________________________
   Print full name.

WATERSHED NAMES USED BY RIVERWATCH:

1. Rock River
2. Fox and DesPlaines Rivers
3. Kankakee, Mackinaw, and Vermilion Rivers
4. Spoon River
5. Sangamon River
6. LaMoine River
7. Kaskaskia River
8. Embarras and Vermilion Rivers
9. Little Wabash River
10. Big Muddy River



Illinois RiverWatch Network
PROPERTY ACCESS PERMISSION FORM

____
Site ID Number (where applicable)

I, ______________________ (property owner or manager), agree to allow the National Great Rivers Research and Education Center (NGRREC) and ______________________ (individual or group name) to access my property listed under "Site Address" below for activities related to NGRREC's Illinois RiverWatch Program* training, clean-up and/or monitoring events.

The above named individual or group has access to my property between the hours of _______ am/pm and _______ am/pm on the date or dates indicated under "Access Dates" below. The size of the group is not to exceed _____ people. I would prefer the group park at ___________ ______________________ and access the site by ______________________.

I understand that this is a voluntary and non-binding agreement, that I am not responsible for any damages or injuries that occur during training, clean-up and/or monitoring activities, and reserve my right as the legal owner/manager of the property to revoke this agreement at any time. I also understand that Illinois RiverWatch and/or the individual or group contact listed below are responsible for informing all participants of the terms of this agreement and for ensuring adherence to those terms. Further, it is understood that the individual or group contact below is responsible for notifying me at least twenty-four hours prior to accessing the property.

To be completed by land owner or manager

____
Full name of property owner or manager

____
Signature of property owner or manager

____
Site Address (street address, city, county)

____
Phone number

____
Access Dates

To be completed by individual or group accessing property

____
Individual or group contact (name)

____
Signature of property owner or manager

____
Site Address (street address, city, zip code)

____
Phone number

____
Today's Date

* The Illinois RiverWatch Program is a volunteer stream monitoring program administered by The National Great Rivers Research & Education Center.

Obtain Monitoring Equipment

Citizen Scientists are encouraged to purchase their own monitoring equipment. Most items can be obtained from any household or local retail supplier. To assist those unable to obtain their own equipment, a limited number of monitoring kits are available on a short-term loan basis. To find a kit near you, visit www.ngrrec.org/monitoringresources_watch.htm. See Appendix E for A list of equipment provided in kit.

If purchasing your own monitoring equipment, a list of necessary items is provided on the next page. All equipment must conform to the specifications listed. See Appendix F for a list of suggested suppliers of biological equipment.

Things to bring

- Walking stick – useful for balance and probing. A dip net handle can be used.
- Insect repellent, sun screen, sun glasses
- Whistle
- Camera to document changes to your site
- Towel, blanket, and a dry change of clothing suitable for the season, in a waterproof bag
- First aid kit and flashlight
- Water for drinking
- Water and soap for washing hands
- Tow line and life jackets
- Reference maps (state road maps and county maps) indicating general information pertinent to the monitoring area including nearby roads
- Cell phone
- Folding chair or stool

Appropriate Dress

- Boots or waders (never open-toed shoes). Chest waders must have a belt.
- Rubber gloves
- Long pants
- Long-sleeved shirt when possible
- Hat

RiverWatch Monitoring Equipment

ITEM	SPECIFICATIONS
FIELD EQUIPMENT	
Dip net	0.50 mm mesh (US #30 sieve size), D-frame, handle length of at least 5 feet and marked in decimal feet (increments of 0.1 feet)
3-5 gallon bucket	
Wash bottle	
Forceps	
Water droppers/pipettes	
Sub-sampling pan	White, no smaller than 10 x 13 inches (marked with grid of 9–12 squares of equal size)
Soda water (NOT carbonated beverages)	
Random number cup	
Alcohol	70% ethyl OR 90% isopropyl
Sample jar w/ lid	
Jar label	
Measuring tape	Length of at least 50 feet, preferably marked in decimal feet (increments of 0.1 feet)
9 site markers / flags	
Alcohol thermometer	Preferably C°
Stopwatch	Any watch w/ a seconds hand will do
Practice golf ball	
Clip board	
Compass	
Pocket magnifier	Magnification no less than 8x
Camera (optional)	
LAB EQUIPMENT	
Microscope	stereo, 20x minimum magnification
Petri dishes	
Forceps/probes	
Water droppers/pipettes	
Alcohol	70% ethyl OR 90% isopropyl
Calculator	
REFERENCE COLLECTION SUPPLIES	
Specimen vials	2-4 oz.
Vial labels	
Non-alcohol soluble pen or pencil	

Plan the Monitoring Session

As the statewide annual monitoring period approaches, plan ahead for the monitoring session. Following these simple steps will help you prepare for the session and ensure things run smoothly:

- Select a date during the statewide annual monitoring period on which to conduct your monitoring session. Consult with your team or monitoring partner to make sure everyone is available on that date.
- Notify the RiverWatch office of the monitoring date and the site you will be monitoring.
- Make a quick visit to your site at least one day prior to monitoring to ensure safe conditions. Real time stream flow is available at http://water.usgs.gov. Check the local weather forecast daily beginning one week prior to the monitoring date. A good source for weather information is www.weather.com.
- Obtain a permit if necessary. Many public lands require that Citizen Scientists obtain permits to monitor. In some cases the application and permitting process may take several weeks. Allow sufficient time to meet permit requirements before monitoring.
- Always contact the owner or manager of the property on which your site is located to notify them of your plans. This should be done a week in advance of your monitoring date, but no less than 24 hours prior to monitoring.

Once you have completed the steps just outlined, you are ready to monitor your site. Procedures for conducting your habitat and biological surveys are described in the chapters that follow. First, review the following safety tips to make your monitoring session as safe as it is successful.

SAFETY

Personal safety is one of RiverWatch's greatest concerns. The following is a brief overview of how to stay safe and comfortable when monitoring. Remember, your safety is far more important than the data you collect.

General Precautions

Always tuck in your shirt. When possible, tuck your pants into your socks to avoid ticks. Wearing light-colored clothing can help to locate ticks. Also, many insects, including mosquitoes, are attracted to dark colors, particularly red and black. Bright colors should be worn during hunting season (orange or yellow; avoid white). Use insect repellent to help keep mosquitoes and other insects from biting you, but do not allow any repellent to come in contact with plastics, like watches, glasses or contact lenses.

Be careful of steep or variable terrain, or various objects which may be dangerous, such as fallen trees, holes, or human artifacts (old fences, broken glass, etc.). If you do not feel comfortable with a site, please inform your RiverWatch office and they will make arrangements to locate a different site for you.

Never monitor when there is lightning or thunder. If the weather conditions worsen while you are outside, finish what you can before conditions become bad and seek shelter. Never stand in the open, under an isolated tree, or in water during periods of lightning.

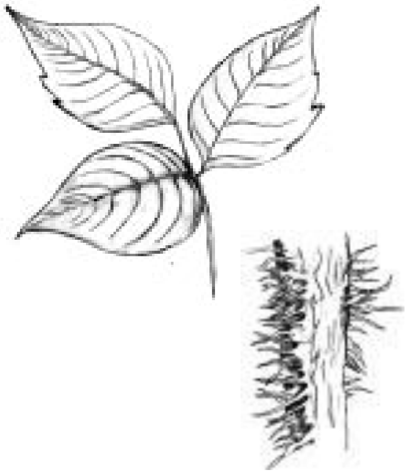
Animals

All ticks should be removed. There are several types of ticks in Illinois, but the deer tick is the most common carrier of diseases, like Lyme disease. Know what a deer tick looks like. Always check your clothing after being outside. Also, closely check your skin for ticks.

Illinois contains many other animals that may be harmful to humans, including cottonmouth (or water moccasin), massasauga rattlesnake, timber rattlesnake, copperhead (snake), black widow spider, brown recluse spider, mosquitoes, biting flies, bees and wasps. Some animals that may not appear dangerous, like a stray dog or a squirrel, can carry rabies (though this is rare). Know where people can receive prompt medical care. It is best to observe animals, not touch.

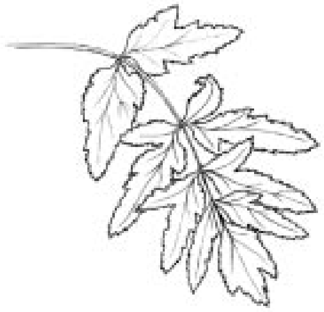
Plants

Poison ivy is found throughout the state and grows in many forms. It can be a small erect ground layer plant, shrub, climbing vine, or trailing vine. Vines tend to appear hairy, but not always. Poison ivy has three leaflets, with the center leaflet having very short stalks. All parts of the plant contain the oil that causes a reaction, generally swelling, blistering and itchiness of the infected area. People vary in their reaction, but direct contact with the plant should always be avoided.
If exposed, promptly (within 1-2 hours) clean the area with hot, soapy water. The oil from poison ivy can remain active for weeks on clothing; launder all field clothes after contact.



Poison sumac mainly grows in bogs and swamps and is not widespread across the state. Chances of exposure are minimal.

Stinging nettle (genus Urtica) usually grows in moist areas, such as bottomland forests. It grows erect up to 4 feet, and is covered with small, stiff, stinging hairs which can irritate the skin on contact. Leaves are opposite, heart-shaped, with a long stalk and large teeth.
Wood nettle (genus Laportea) also grows in moist areas. It resembles stinging nettle, but has alternate leaves. This species is also covered with stinging hairs which can irritate the skin.



Parsnip and **cow parsnip**, a common plant along stream banks, contain toxins that are photoactive. These compounds can cause blistering if you get them on your skin and then expose the area to sunlight. Wear long pants and long-sleeved shirts while monitoring. Parsnip is a biennial, forming a rosette of upright leaves the first year. The second year, it forms a strong, stout, deeply grooved stem with alternate leaves. It can be up to 5’ tall. The leaves are divided into 5–15 stalkless, sharply toothed, ovate leaflets. The flowers, formed the second year, are yellow and form an umbrella like cluster at the top of the stem.

RIVERWATCH MONITORING DOs AND DON'Ts

DOs

- Before leaving for your site, let someone know where you are going and when you plan to return.
- Always work in groups or with partners and make allowances for your own physical limitations.
- Use public access points (e.g., city or state roads and parks) to approach a monitoring site.
- Wear shoes rather than sandals or open-toed shoes. If chest waders are worn, they must be secured at the waist with a belt.
- Bring along or find a suitable walking stick for balance while climbing down steep banks or wading.
- Be careful when stepping on rocks and wood. They are slippery when wet.
- Bring fresh water to drink.
- Watch out for poison ivy, which commonly grows on stream banks.
- Pick up garbage found at your stream site.
- Wash hands with soap and potable water at the end of the monitoring exercise and before eating.
- Contact your RiverWatch office if you do not feel safe at your stream site.

DON'Ts

- Don't monitor alone. A minimum of two people are needed to conduct the monitoring procedures.
- Don't collect samples under difficult conditions. Your safety is far more important than the data you collect.
- Don't walk on unstable banks.
- Don't 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 and multiply the numbers. If they equal nine or above, the stream is not safe.
- Don't cross private property without the landowner's permission.
- Don't disturb streamside vegetation.
- Don't develop your own procedures that you believe are easier or more appropriate.
- Don't leave anything behind at the stream site.
- Don't go near streams or rivers during rain. Flash flooding may occur.

Habitat Survey

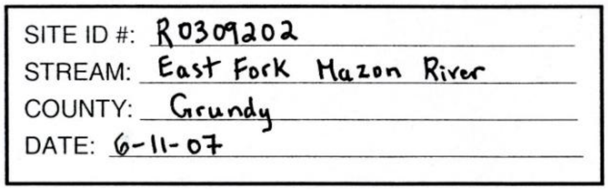
The Habitat Survey describes and rates the physical characteristics that affect a stream ecosystem, and thus its biotic (or living) community. Some of these characteristics are “natural” to the watershed of which the stream is a part; others are “cultural” and reflect human use of the stream.

YOU WILL NEED

- Site Sketch Sheet and Habitat Survey Sheet
- Clip board and pencil
- 50-foot measuring tape, marked off in decimal feet (tenths of a foot)
- 9 flags
- Compass
- Thermometer
- White tray
- Watch with a second hand or a stopwatch
- Practice golf ball

SITE IDENTIFICATION

A site identification box is located in the upper right corner of each data sheet. Fill out the site identification blocks on all data sheets before beginning survey procedures. For example:



SITE ID #: R0309202
STREAM: East Fork Mazon River
COUNTY: Grundy
DATE: 6-11-07

Also, record the names of trained and untrained monitoring participants, and the start time at the top of the Habitat Survey Sheet.

MEASURE AND MARK YOUR SITE

Using a map or other available information on the site’s location, determine the general area where your site is located and go to it. In most cases you will receive walking directions to locate the general area. Select a starting point and establish a 200-foot study reach.

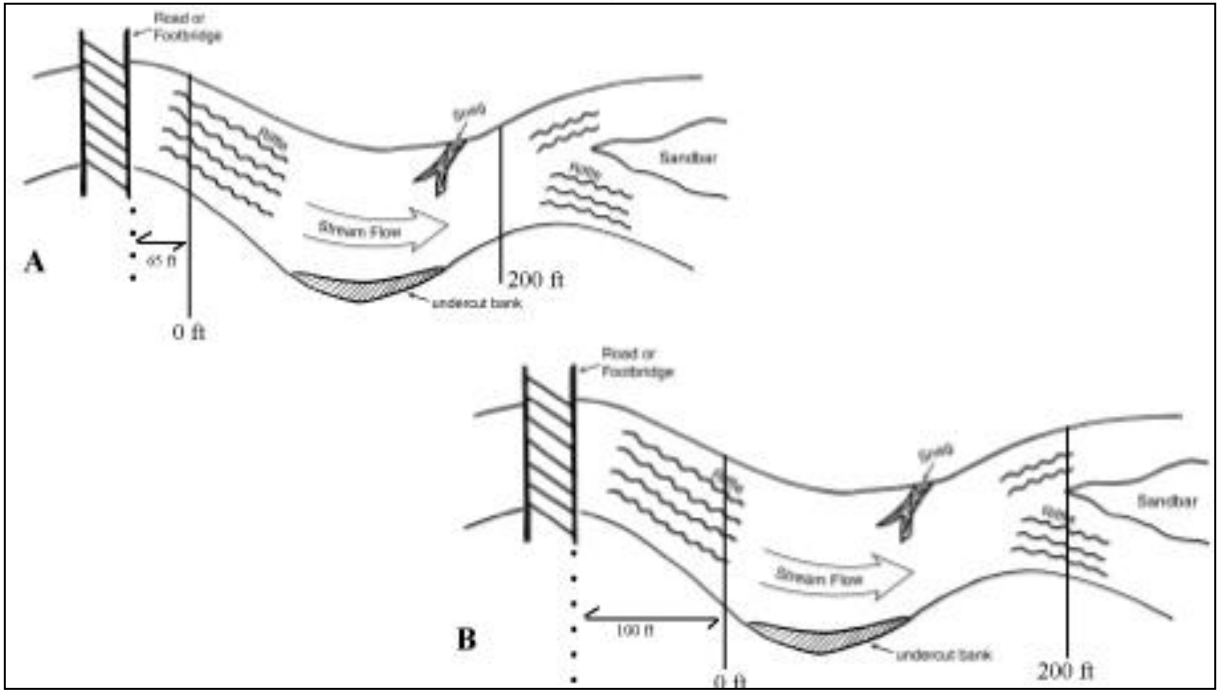
All sites must be a minimum of 100 feet away from any bridge or ford to avoid possible impacts from bridge structures or roadway runoff. This is commonly referred to as “bridge effect.” If your site is near a bridge or ford, measure 100 feet upstream or downstream from the bridge before selecting the starting point of your 200-foot study reach. Upstream is preferred. The study reach does not have to be exactly 100 feet away from the bridge or ford. It may start or end anywhere, as long as the entire 200-foot section maintains a minimum 100-foot buffer zone.

When selecting the 200-foot reach for a new site, choose a stretch that has safe, easy access and is representative of the stream as a whole (see **Figure 5**). Include as many different habitats as possible. Look for transition areas that will allow for multiple habitat types. For example, a study reach with riffle habitats at both ends may be better than one with only one riffle in the middle if it allows for additional sampling options. Often, shifting the study reach just twenty or thirty feet upstream or downstream will cover additional habitat types and better represent the diversity of your stream community. Avoid the temptation to select a site based solely on aesthetics.

Remember that once the 200-foot study reach is chosen, it should not be changed or shifted. While the habitat type selected for sampling may vary depending on the condition of the site, subsequent monitoring must occur within the same 200-foot stretch each year.

Once you decide where to start your study reach, place a flag in the bank to mark the "zero point". The zero point is the starting point from which a site is measured. Placing the zero point closest to where the site is accessed is recommended. Using a tape measure or 50-foot length of rope, measure four 50-foot lengths along either side of the stream, placing flags at each 50-foot interval. This marks the 200-foot study reach that will be the focus of your sampling activities.

Figure 5. Site Placement. A shows poor site placement: upstream buffer is less than 100 feet from bridge crossing. **B** shows good site placement by shifting the site 35 feet downstream, establishing the proper upstream buffer zone. The second riffle now included in the site boundary also increased the number of sampling areas.



When measuring the study area, always measure along the water's edge (rather than the banks). This is particularly important during dry years, when streams are at low flow and may not fill the entire channel. To ensure consistency in measurement, measure from the same side of the stream each time the site is monitored.

PREVIEW THE SITE

Be aware that the features of your site will change over time. Stream channels may move or change throughout the year. Streamflow will fluctuate, and flooding may significantly alter the stream channel or cause debris to be left behind. Each time you monitor, preview current conditions by walking the entire length of the site. Do this at least twice, to become familiar with the location and condition of key habitat features. Note where and how the bottom substrate changes, whether erosion is occurring, where pools, riffles and runs are located, which sampling habitats are present, and where the best locations for measuring stream width and estimating discharge might be. Previewing the site only takes a few minutes and will result in a more accurate and detailed site sketch.

MAKE A SITE SKETCH

Each time a site is monitored, a new site sketch must be completed. This will help you remain familiar with in-stream features and riparian areas surrounding the site. More importantly, the sketch serves as a permanent record for the day that monitoring occurred and can be a valuable resource when locating the site year after year.

On the Site Sketch Sheet, draw an aerial view (from above) of the site (see **pg 42**). Indicate:
- the access point and the start point of the 200-foot reach
- the direction of north,
- the direction of water flow,
- the locations and types of habitats where macroinvertebrates were collected, and
- the location of the discharge measurements (width, depth, velocity).

Also 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.

If possible, take photos of the 200-foot study reach to document conditions at the site on that date. Digital photos are preferred. Take at least three photos of the area monitored: facing upstream, facing downstream, and a cross section. Label the back of the photo with the date, stream name, Site Identification number and direction of view (north, east, upstream, etc.). Try to take pictures from the same location in subsequent years; photos can be compared to illustrate significant changes to the site. Remember to complete a separate site sketch, whether or not a photo is taken.

COMPLETE THE HABITAT SURVEY DATA SHEET

Complete the measurements for each habitat parameter in the order in which they appear on the data sheet. This helps ensure that none are missed.

Present weather / weather over 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 most severe recent weather.

Temperature. Record water and air temperature in the space provided on the data sheet. Temperature can limit biological activity in streams because many aquatic organisms require water of specific temperature ranges (to breed, for example). Also, since cold water holds more dissolved oxygen than warm water, temperature directly affects the amount of oxygen available to organisms.

Begin by measuring air temperature. Hold a thermometer in the air for about two minutes, then take the reading. To measure water temperature, submerge a thermometer in a stream run for at least two minutes. Be sure the thermometer is suspended in the water column and that the bulb is not in direct contact with the stream bottom. If possible, read the temperature before removing the thermometer from the water.

Temperatures may be recorded in either Fahrenheit (°F) or Centigrade or Celsius (°C) degrees. If both scales are shown on the thermometer, indicate temperature in °C. Often, temperature measurements are completed while the site sketch is being made. This saves time and ensures the thermometer is out of harm's way for the rest of the session.

Water Appearance. Select the term that best describes the physical appearance of the water, which is a visual indicator of stream health. 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.

Clear — colorless, transparent
Milky — cloudy-white or gray; not transparent; may occur naturally or as a result of impairment
Foamy — may occur naturally or as a result of excessive nutrients or detergents
Dark Brown — may indicate that acids are being released into the stream from decaying plants. This occurs naturally in autumn
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

Water Odor. Odor is also a physical indicator of stream health. Check the description that best describes the water odor.

None — may indicate 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 below)
Petroleum — may indicate an oil spill from marine or terrestrial sources
Other — any other observation regarding water odor not described above

For any site, if a strong sewage or rotten egg odor is present, do not enter the water. Contact the landowner or otherwise attempt to identify the source of the smell. A sulfurous smell caused by hydrogen sulfide gas can occur naturally in some streams as leaves and other organic matter decay on the bottom of the stream or in stormwater drainage pipes. If it is determined that the odor is naturally occurring, proceed with monitoring. However, if the smell is strong, is like sewage or the water appears gray in color, do not monitor the stream. If the condition persists for more than 2-3 days (particularly after a rain event), notify RiverWatch office for further advice. As a general rule, to prevent the risk of exposure to hepatitis, tetanus and other diseases, avoid monitoring sites less than one mile downstream of any sewage treatment plants.

Turbidity. Turbidity is a measure of water clarity. It describes how much the material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, microbes, and other substances. Turbidity can affect the color of the water, causing it to appear cloudy or brown.

To determine turbidity, submerge a white subsampling tray and observe how cloudy or brown the water appears against the white background. This is the recommended method. You may also look at the stream bottom and determine how well you can see the smaller components of the bottom substrate (sand, gravel and cobble). If they are clearly visible the water is not turbid. If they appear hazy or are hard to see, a higher degree of turbidity should be noted. This is a subjective estimate.

Another method of determining if the water is turbid is to place a tray full of water on the stream bank. If the color settles to the bottom and the water becomes clear, the water is turbid to some degree. The greater the degree of change observed, the higher the level of turbidity. This is also a good test to determine if the water color is due to sediment (which eventually settles to the bottom) or pigments from the decay of plants.

Check the description on the data sheet that best describes the degree of turbidity observed.

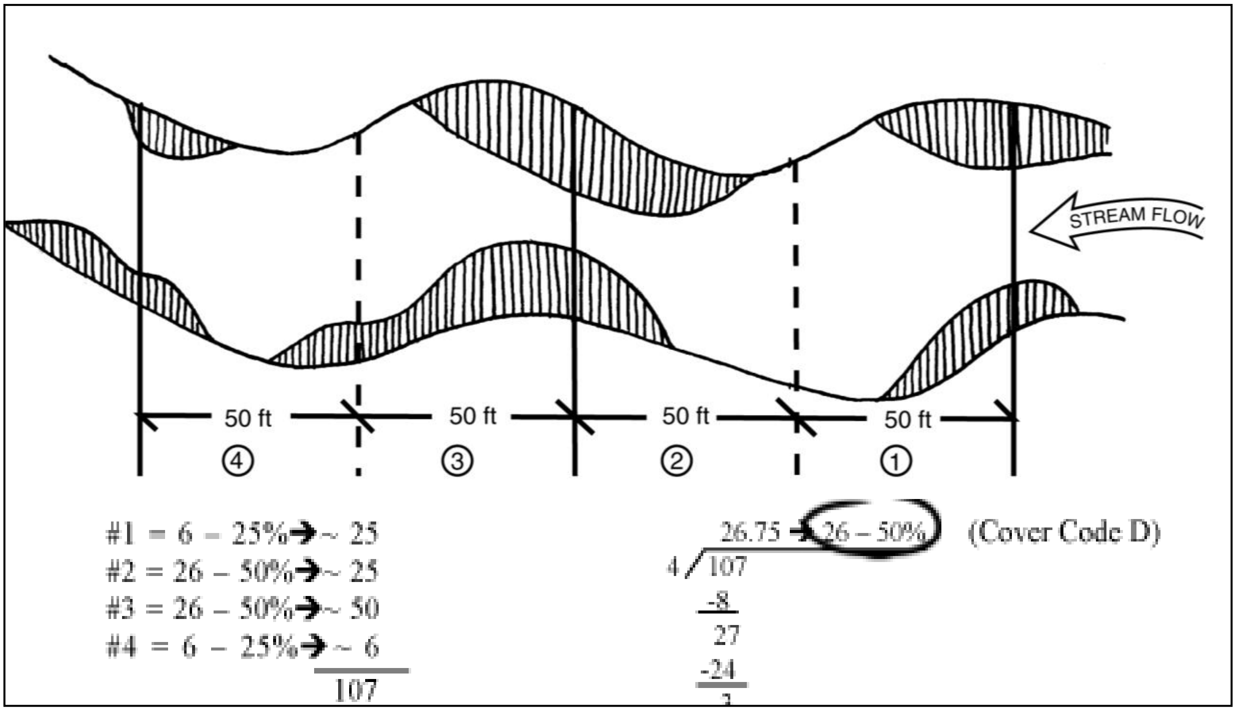
Canopy Cover. Canopy is vegetative cover that hands above the stream channel, such as trees and shrubs. The amount of canopy cover determines the amount of sunlight that reaches the stream, and is a primary factor affecting water temperature and food sources.

To estimate canopy cover, walk the entire length of the 200-foot study reach and estimate the percentage that is presently shaded by trees and shrubs. Indicate the amount of shading by selecting the percent cover class that best describes your estimate. An easy way to do this is to estimate cover for each 50-foot section separately, then add each estimate and divide by 4 (each section represents 1/4 of the study reach). See **Figure 6.**

In many cases, trees and other canopy plants may not have leafed out yet. A common pitfall in estimating canopy cover is the tendency to base them on interpretations of what the canopy might look like at peak foliage. This should be avoided, since using this approach generally increases the subjectivity of the estimate. For all percent cover estimates, estimate based on what is present at the time of monitoring.

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. Observe the stream bottom and estimate what percent is covered by filamentous algae (genus Cladophora). Filamentous algae bloom dramatically in organically and nutrient enriched waters. They grow in mats of long, stringy, hair-like strands attached to the sediment, rocks, or other submerged objects. Observe filamentous algae only; do not include other types of algae. Select the percent cover code that best describes your estimate. To minimize the time and effort required for this task, use the section by-section approach described in **Figure 6**.

Figure 6. Estimating Canopy, Algal Growth, and Substrate Siltation Cover by Section. An easy way to do this is to estimate cover for each 50-foot section separately, then add each estimate and divide by 4 (each section represents ¼ of the study reach).



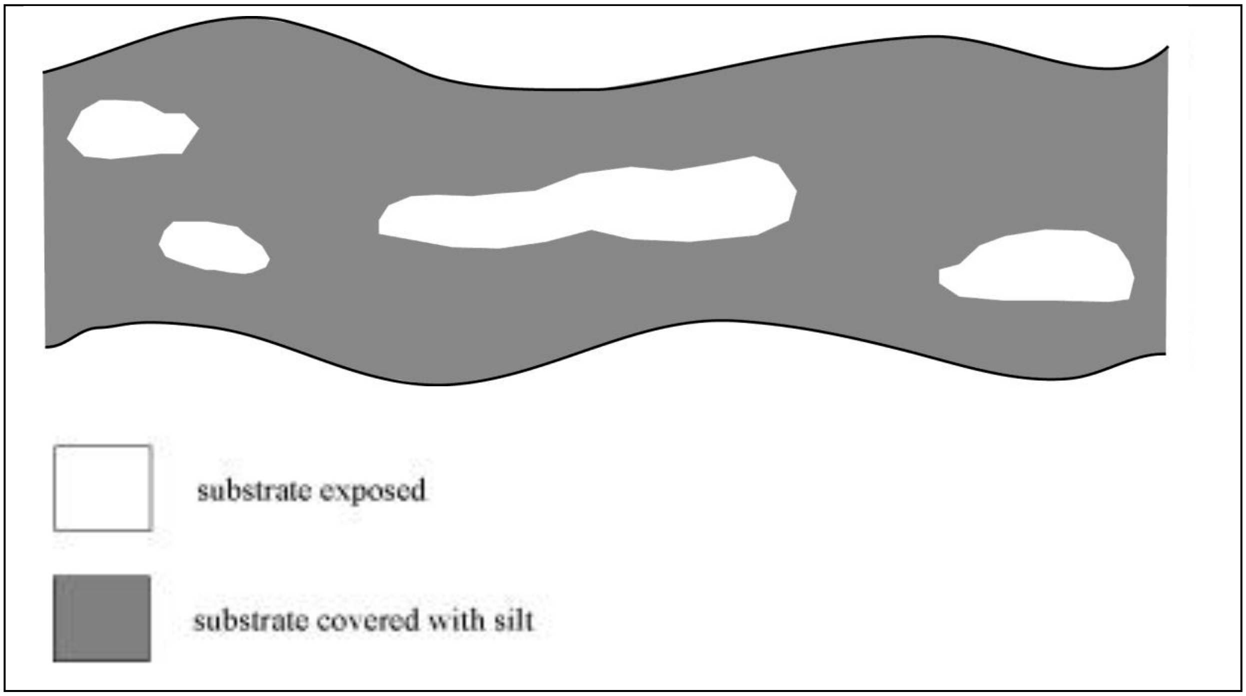
Percent cover codes are used for estimating canopy cover, algal growth, substrate siltation coverage, and bottom substrate:

<u>Percent Cover Codes</u>
A = 0%
B = 1 - 5%
C = 6 - 25%
D = 26 - 50%
E = 51 - 75%
F = 76 - 100%

Substrate Siltation Coverage. Substrate siltation coverage describes how much of the surface area of the stream substrate is covered by silt and sediment. Generally, as the substrate becomes covered with silt, fewer living spaces are available to macroinvertebrates and fish for shelter, spawning and egg incubation.

Observe the stream bottom of the entire 200-foot site. Focus on the stream as a whole. Estimate the percentage of the stream bed that is covered by silt. Select the percent cover code that best describes your estimate. To minimize the time and effort required for this task, use the section-by-section approach outlined for estimating canopy cover above. Be sure to estimate the space or area covered by sediment, not its depth. See **Figures 7 and 8**.

Figure 7. Substrate Siltation Coverage Illustration. Estimate the percentage surface area of substrate material under the water line and above the streambed that is covered by silt and sediment. This illustration shows coverage in the 76-100% range.



Submerged Aquatic Plants. Submerged aquatic plants have their roots in the stream bottom, and the whole plant remains under water. Indicate if any rooted, vascular plants are observed underneath the water's surface in your 200-foot site by circling YES or NO on the data sheet. If you know the common or scientific names of these plants, write them in the space provided.

Be careful not to confuse submerged aquatic plants with filamentous algae. Submerged aquatic plants are vascular plants (have hollow stems) that are rooted in the stream bed. They have an obvious stem, with roots and leaves. Filamentous algae (described above) appear hair-like, grow on rocks, logs and other substrate material and do not have true leaves or identifiable roots.

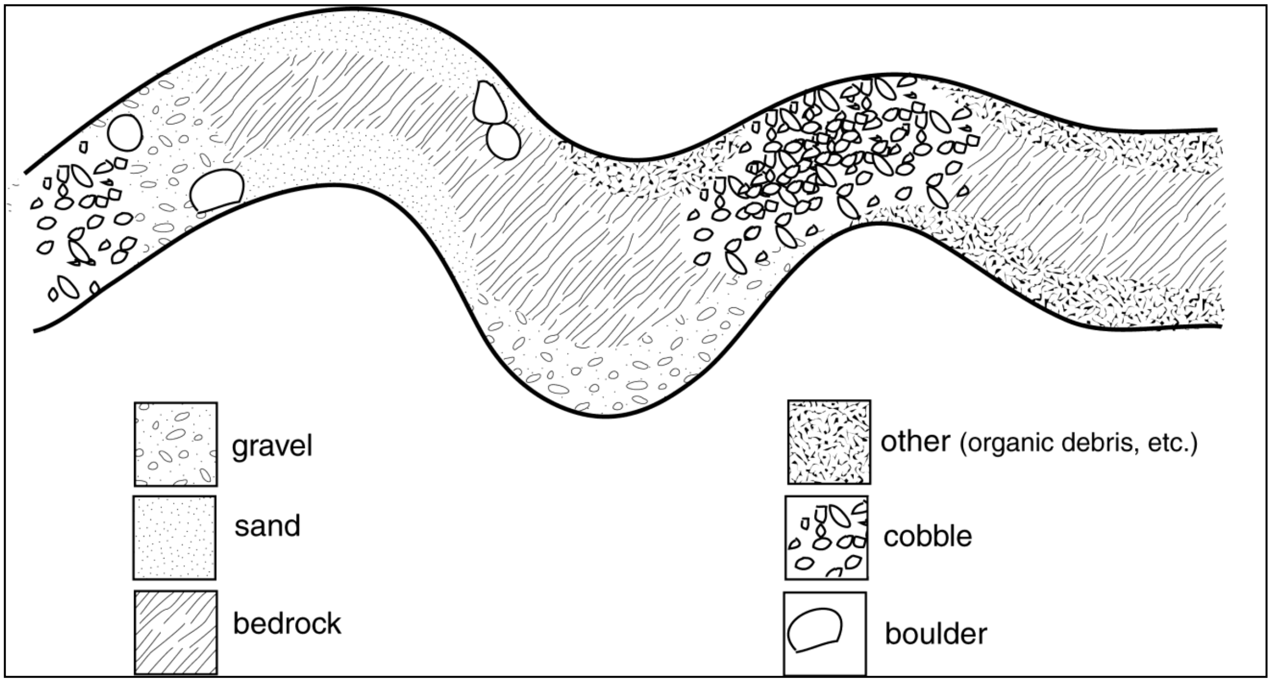
Riparian (Streamside) Vegetation. Identify known riparian vegetation by name. If you do not know the specific names of the plants that you see, describe them generically as “ferns” or “small bushes” or “grasses,” etc. based on their appearance.

Bottom Substrate. Bottom substrate is the material on the stream bottom. Macroinvertebrates attach to, feed from, or crawl on this material. Use the section-by-section approach illustrated in **Figure 6** to estimate the percentage of each substrate material listed below. Record estimates using the percent cover codes. For example, if sand is estimated at 65%, write the letter “E” on the data sheet next to sand. See **Figure 8** for an example of different substrate types in a stream bed.

Substrate materials include:

- Bedrock (solid rock that underlies the surface soil, exposed to form the bottom of the stream channel)
- 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 (soft, fine particles)
- Clay pan

Figure 8. Stream Substrates

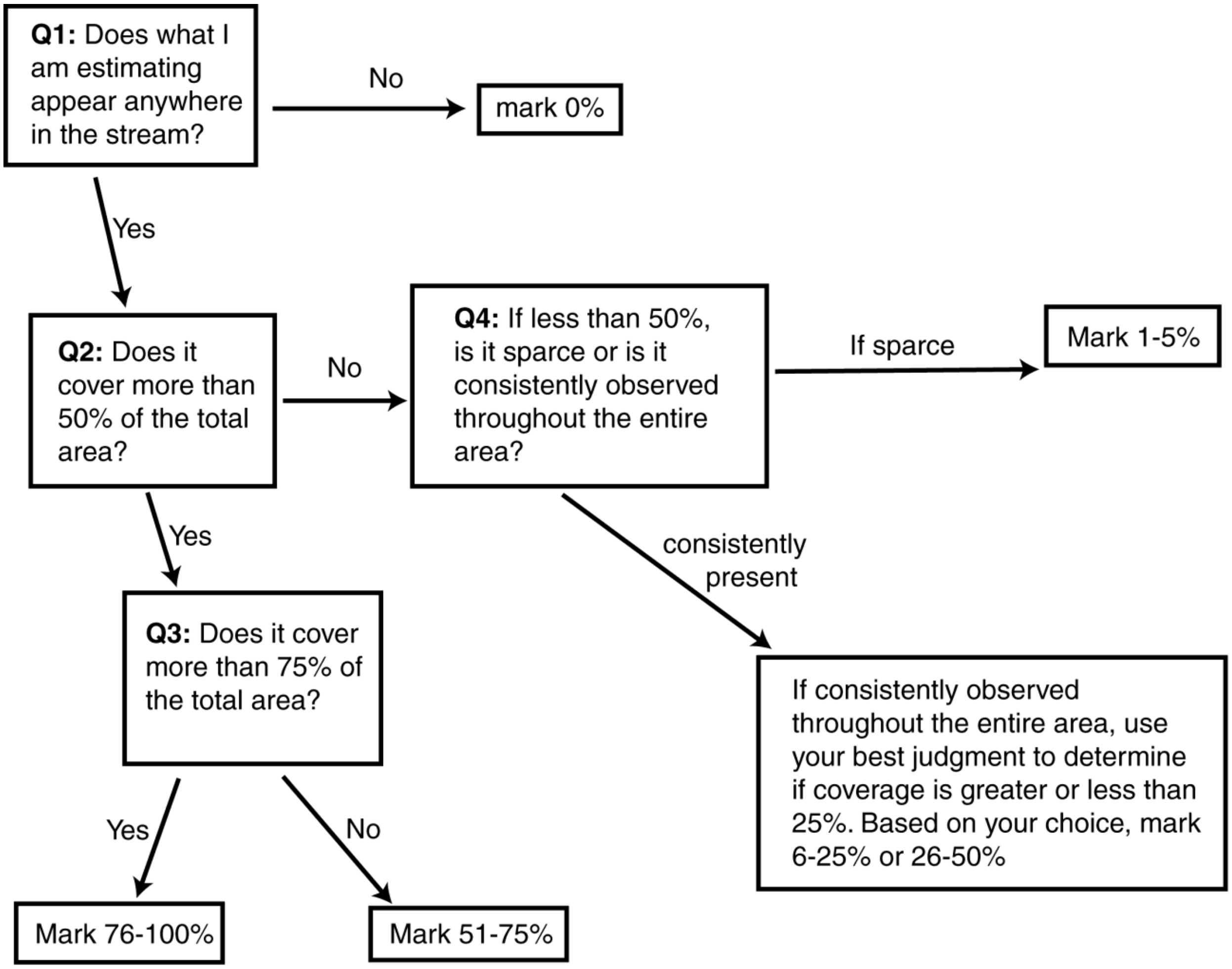


Tips on Estimating Cover Percentages

Estimating canopy cover, substrate siltation coverage, algal cover and bottom substrate types require making subjective observations that Citizen Scientists sometimes find confusing, time consuming or difficult. The following guidelines will help minimize the time and effort required to complete these observations:

- Make all observations from the stream, not the bank. Walk the entire length of the section or study reach before coming to a decision.
- Break the 200-foot study reach into four 50-foot sections and estimate cover for each section separately. Add each estimate and divide by 4 for an overall estimate covering the entire study reach.
- Trust yourself. Your first impression is usually the best.
- Have one person estimate percent cover for the sites. If using a team, be sure each person can justify his or her answer, and come to a consensus for the group.

Use the following series of questions to narrow percent cover down to a specific cover class:



Stream Discharge Estimate. Discharge is a measurement of the amount, or volume, of water flowing past a point, and is a major factor influencing oxygen generation, erosion and sediment deposition. High stream flow variations can indicate upstream modifications to the stream channel, major discharges from water treatment plants and other facilities, and dam activity. Discharge is expressed in cubic feet per second (ft^3/sec).

To measure stream discharge, follow these steps:

1. Choose a measurement point
Within the 200-foot study reach, find a 10-foot stretch with a relatively smooth bottom and where the water flows uniformly. A run works best.

2. Measure stream width
Measure the stream width from water's edge to water's edge with a tape measure marked in tenths of a foot. Place marker flags on opposite banks to indicate the points between which the width was measured. Estimates of stream discharge will be measured along an imaginary line or "transect" formed between these points. Be sure to indicate on your site sketch where the width measurement was taken.

3. Measure stream depth
Using the handle of the dip net, measure stream depth at three evenly spaced points along the width transect. Record measurements to the nearest tenth of a foot. Locate the first measurement point at the midpoint of the stream channel; locate the other two measurement points midway between the midpoint and either bank (see **Figure 9**). Add the three depth values and divide by three to determine the average depth in feet.

4. Measure stream velocity
Velocity measurements are taken at the same three points that the depth measurements were taken (**see Figure 9**). Using the handle of the dip net as a guide, measure distances along the stream bank five feet upstream and five feet downstream from the width transect. (The dip net handle measures 5 feet from the base of the net to the end of the handle.) Mark each point with a flag. These flags will serve as start and end points.

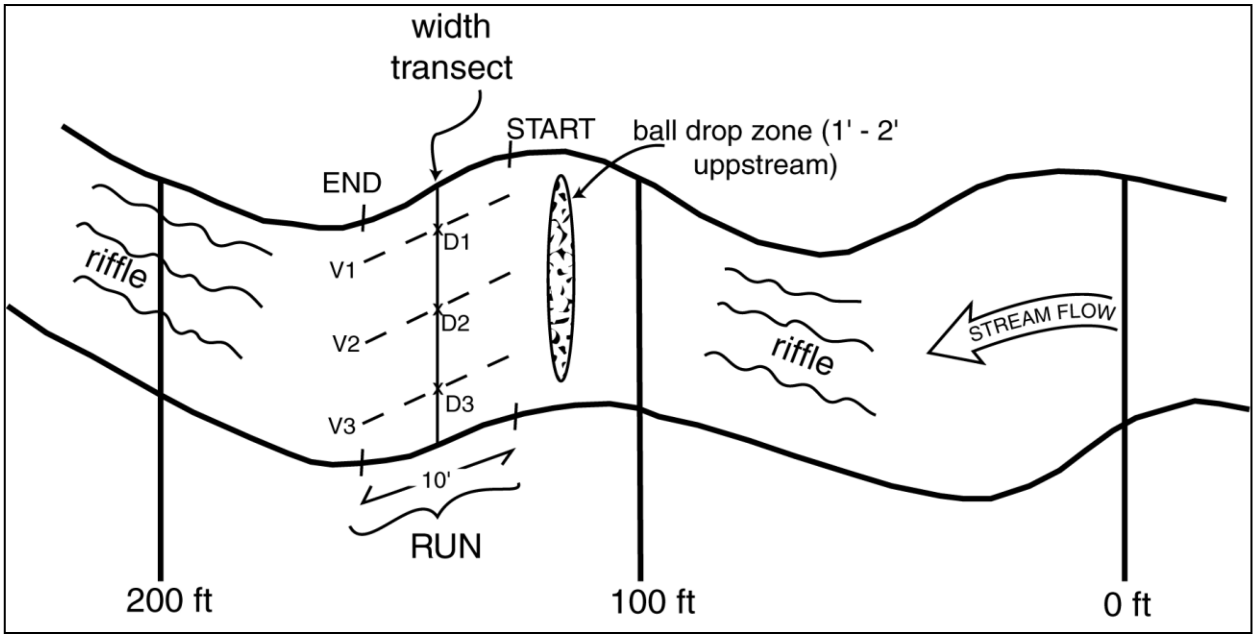
Stand a few feet upstream from the start point and have a partner stand a few feet downstream from the end point. Drop a practice golf ball a foot or so upstream from the start point. Measure the time it takes the ball to float the 10-foot distance from the upstream point to the downstream one. Avoid standing directly upstream of the ball, as any disturbance to streamflow will influence the velocity reading.

Record the time in seconds in the appropriate space on the Habitat Survey Sheet. Repeat this process for the two remaining points along the stream width transect, for a total of three measurements.

Determine the water velocity in feet per second by dividing 10 feet by the time measured (in seconds). For example: If the ball took 23 seconds to travel from the start point to the end point, divide 10 feet by 23 seconds. The result is 0.43 feet per second. Add the three velocities and divide by three to determine the average velocity in feet per second.

Occasionally, a physical characteristic of the site, such as an eddy, obstruction or extremely low water level make it impossible to take three velocity measurements. If only two velocity measurements are possible, calculate the average by dividing the sum by 2. If only one measurement is taken, use the single value as the average. Note this on the data sheet.

Figure 9. Illustration of proper width, depth, and velocity measurement points. Locate transect at a point representing average width and flow for the reach, preferably in a run.

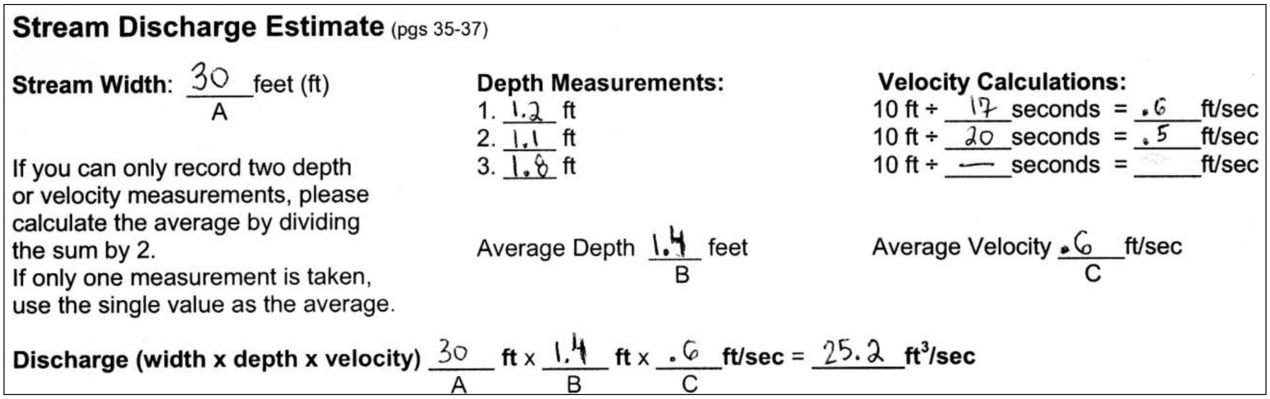


5. Calculate the discharge estimate

To calculate stream discharge, multiply the stream width (feet) by average stream depth (feet) by average velocity (feet/second), using the formula on the data sheet. Record the result in units of cubic feet per second (ft^3/sec) (see **Figure 10**). Space for these calculations is provided on the Habitat Survey Sheet.

Stream Discharge (ft^3/sec) = Width (ft) x Average Depth (ft) x Average Velocity (ft/sec)

Figure10. Discharge Calculations



Stream Discharge Estimate (pgs 35-37)

Stream Width: 30 feet (ft)
A

If you can only record two depth or velocity measurements, please calculate the average by dividing the sum by 2.
If only one measurement is taken, use the single value as the average.

Depth Measurements:
1. 1.2 ft
2. 1.1 ft
3. 1.8 ft

Average Depth 1.4 feet
B

Velocity Calculations:
10 ft ÷ 17 seconds = .6 ft/sec
10 ft ÷ 20 seconds = .5 ft/sec
10 ft ÷ — seconds = ____ ft/sec

Average Velocity .6 ft/sec
C

Discharge (width x depth x velocity) 30 **ft x** 1.4 **ft x** .6 **ft/sec =** 25.2 **ft³/sec**
A B C

Land Uses. Indicate all land uses visible from your site. Focus on the areas upstream and on either side of the study reach as far as you can see. If it is dominant (usually only one or two features are dominant), place a "D" in the blank. If the land use is present, place an "X" in the blank. If the land use is not present, leave it blank.

Land use categories are listed in **Figure 11**. Include all land uses from the list that are visible from where you are standing. If you are aware of additional features or land uses outside your field of view, note their presence and approximate distance upstream from your site. Examples include sewage treatment facilities, residential or commercial development, dams, etc. If a particular feature does not appear on the list, record it in the notes section of the habitat survey data sheet.

Indicate the presence of upstream dams, wastewater treatment and other discharge points observed from the site or otherwise known. Where possible, estimate how far upstream these features appear.

Complete the Land Use Categories survey by indicating whether or not the stream segment has been channelized, or straightened. If the site does show channelization, estimate the percent of the 200-foot section that has been affected.

Habitat Survey Notes. Record any characteristics that are important to the quality of the stream and surrounding area. Include additional information on the characteristics listed or other information that may be important or interesting. Any component of the habitat survey that was not completed (for example, if streamflow only allowed for one velocity measurement) should be clearly noted and explained in the Habitat Survey Notes section. This will help minimize confusion regarding possible gaps in the data.

Verify. Verify that the Habitat Survey Sheet is complete and accurate. Initial and date the first line of the verification box located in the lower right corner of the data sheet.

Figure 11. Habitat Survey Land Use Categories

Forest: covered with trees and shrubs (greater than 50% canopy cover)

Logging: many trees being removed to convert land for other uses

Golf Course: highly manicured lawns, cart paths, occasionally small, fragmented natural areas

Grassland / Ungrazed Fields: covered with grasses (less than 10% tree canopy cover) or occasionally plowed grassy areas not used for grazing. Example: prairie

Commercial: non-residential, larger buildings such as stores or offices, in predominantly paved areas

Scattered Residential: some single family dwellings, may include farm buildings

Moderate / High Density Residential: areas with residential properties that are contiguous to stream or riparian zone

Cropland: agricultural fields that are annually plowed for crops such as corn and soybeans (indicate type of crop, if known)

Sewage Treatment: facility to which sewage material is transported for treatment and release

Park: land used for recreational purposes, often with a high percentage of manicured lawn

Mining: excavation of earth for mineral extraction (indicate type of mining, if known)

Sanitary Landfill: area on which refuse is deposited and / or buried

Livestock Pasture: grassy areas used for grazing (not plowed, but not manicured lawn)

Construction: building of new homes, bridges, roads, commercial or industrial development, etc. (indicate type of construction, if known)

Industrial: warehouses, manufacturing or processing facilities, etc.

SECTION SUMMARY

1. Locate, measure and mark the 200-foot study reach. To establish a new site follow the walking directions provided to arrive in the general area. Determine the exact placement of the 200-foot study reach using the description provided by RiverWatch and the criteria detailed on pages 27-28. At a minimum, be sure to place the site at least 100 feet away from all bridges and fords. Measure and mark the 200-foot reach by placing a flag at the start point and at each 50-foot interval. Record the exact location of the start point by measuring or counting the number of paces to the nearest permanent structure such a bridge.

   In subsequent years, use the site sketches and information from previous monitoring efforts to locate the 200-foot section. Beginning at the start point, measure the study reach as close to the original 200-foot section as can be determined. Mark the site by placing a flag at the start point and at each 50-foot interval.

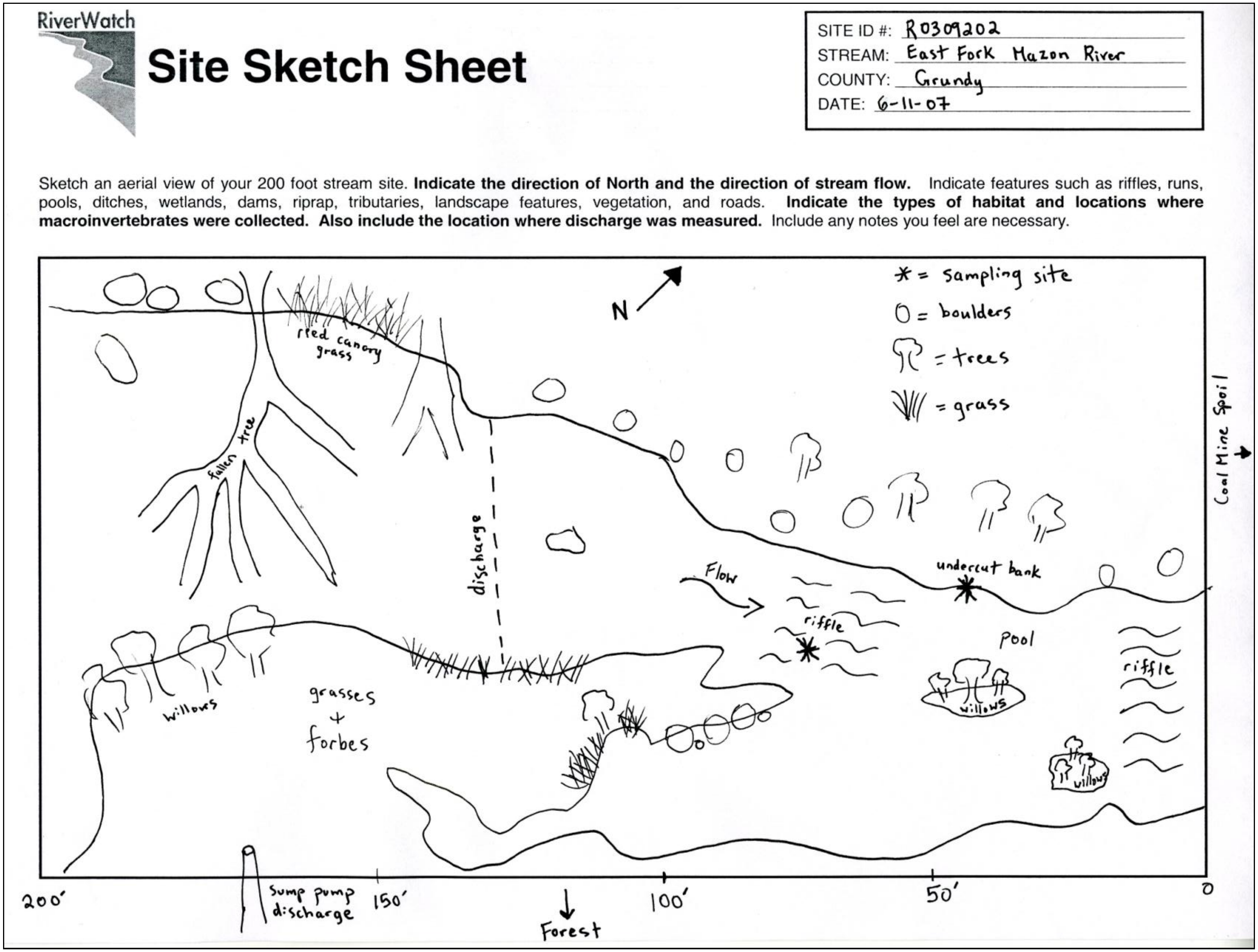
2. Preview the site and make note of any physical changes that occurred since the last monitoring session. First time monitors should pause to observe the overall conditions of the site prior to entering the water.

3. Make a site sketch. Include the direction of north, the direction of water flow, the location of the discharge measurements and the locations and types of habitats present. If possible, take a photo of the site.

4. Complete the habitat survey data sheet.

5. Review the data sheet to ensure it is complete, accurate and legible. Initial and date the first line of the verification box located in the lower right corner of the data sheet.

SAMPLE DATA SHEET: SITE SKETCH



RiverWatch

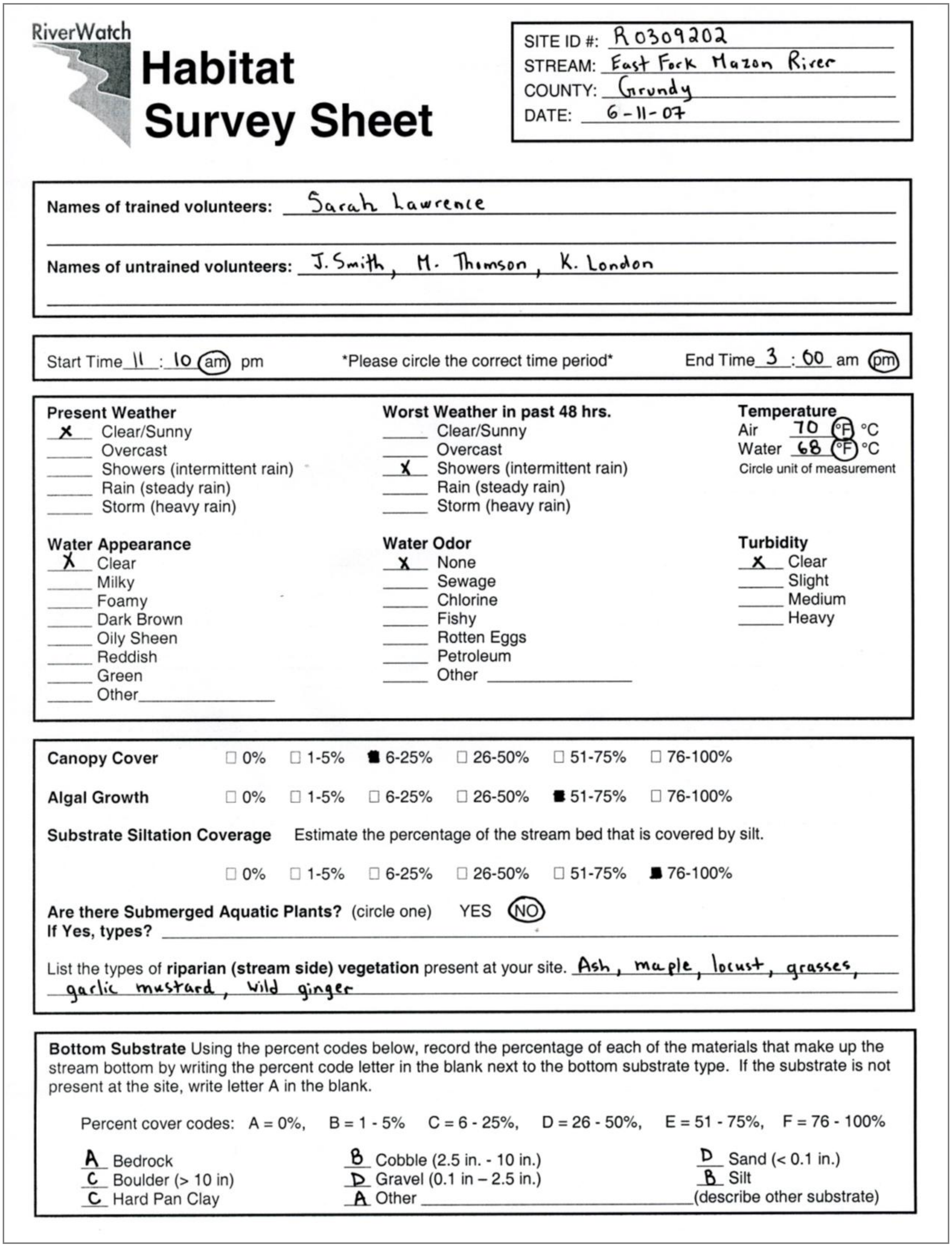
Site Sketch Sheet

SITE ID #: R0309202
STREAM: East Fork Mazon River
COUNTY: Grundy
DATE: 6-11-07

Sketch an aerial view of your 200 foot stream site. **Indicate the direction of North and the direction of stream flow.** Indicate features such as riffles, runs, pools, ditches, wetlands, dams, riprap, tributaries, landscape features, vegetation, and roads. **Indicate the types of habitat and locations where macroinvertebrates were collected. Also include the location where discharge was measured.** Include any notes you feel are necessary.

* = sampling site
O = boulders
= trees
= grass

SAMPLE DATA SHEET: HABITAT SURVEY, pg 1



RiverWatch

Habitat Survey Sheet

SITE ID #: R0309202
STREAM: East Fork Mazon River
COUNTY: Grundy
DATE: 6-11-07

Names of trained volunteers: Sarah Lawrence

Names of untrained volunteers: J. Smith, M. Thomson, K. London

Start Time 11 : 10 [✓ am] pm *Please circle the correct time period* End Time 3 : 00 am [✓ pm]

Present Weather
X Clear/Sunny
___ Overcast
___ Showers (intermittent rain)
___ Rain (steady rain)
___ Storm (heavy rain)

Worst Weather in past 48 hrs.
___ Clear/Sunny
___ Overcast
X Showers (intermittent rain)
___ Rain (steady rain)
___ Storm (heavy rain)

Temperature
Air 70 [✓ °F] °C
Water 68 [✓ °F] °C
Circle unit of measurement

Water Appearance
X Clear
___ Milky
___ Foamy
___ Dark Brown
___ Oily Sheen
___ Reddish
___ Green
___ Other___

Water Odor
X None
___ Sewage
___ Chlorine
___ Fishy
___ Rotten Eggs
___ Petroleum
___ Other ___

Turbidity
X Clear
___ Slight
___ Medium
___ Heavy

Canopy Cover ☐ 0% ☐ 1-5% ☒ 6-25% ☐ 26-50% ☐ 51-75% ☐ 76-100%

Algal Growth ☐ 0% ☐ 1-5% ☐ 6-25% ☐ 26-50% ☒ 51-75% ☐ 76-100%

Substrate Siltation Coverage Estimate the percentage of the stream bed that is covered by silt.

☐ 0% ☐ 1-5% ☐ 6-25% ☐ 26-50% ☐ 51-75% ☒ 76-100%

Are there Submerged Aquatic Plants? (circle one) YES [✓ NO]
If Yes, types? ___

List the types of **riparian (stream side) vegetation** present at your site. Ash, maple, locust, grasses, garlic mustard, wild ginger

Bottom Substrate Using the percent codes below, record the percentage of each of the materials that make up the stream bottom by writing the percent code letter in the blank next to the bottom substrate type. If the substrate is not present at the site, write letter A in the blank.

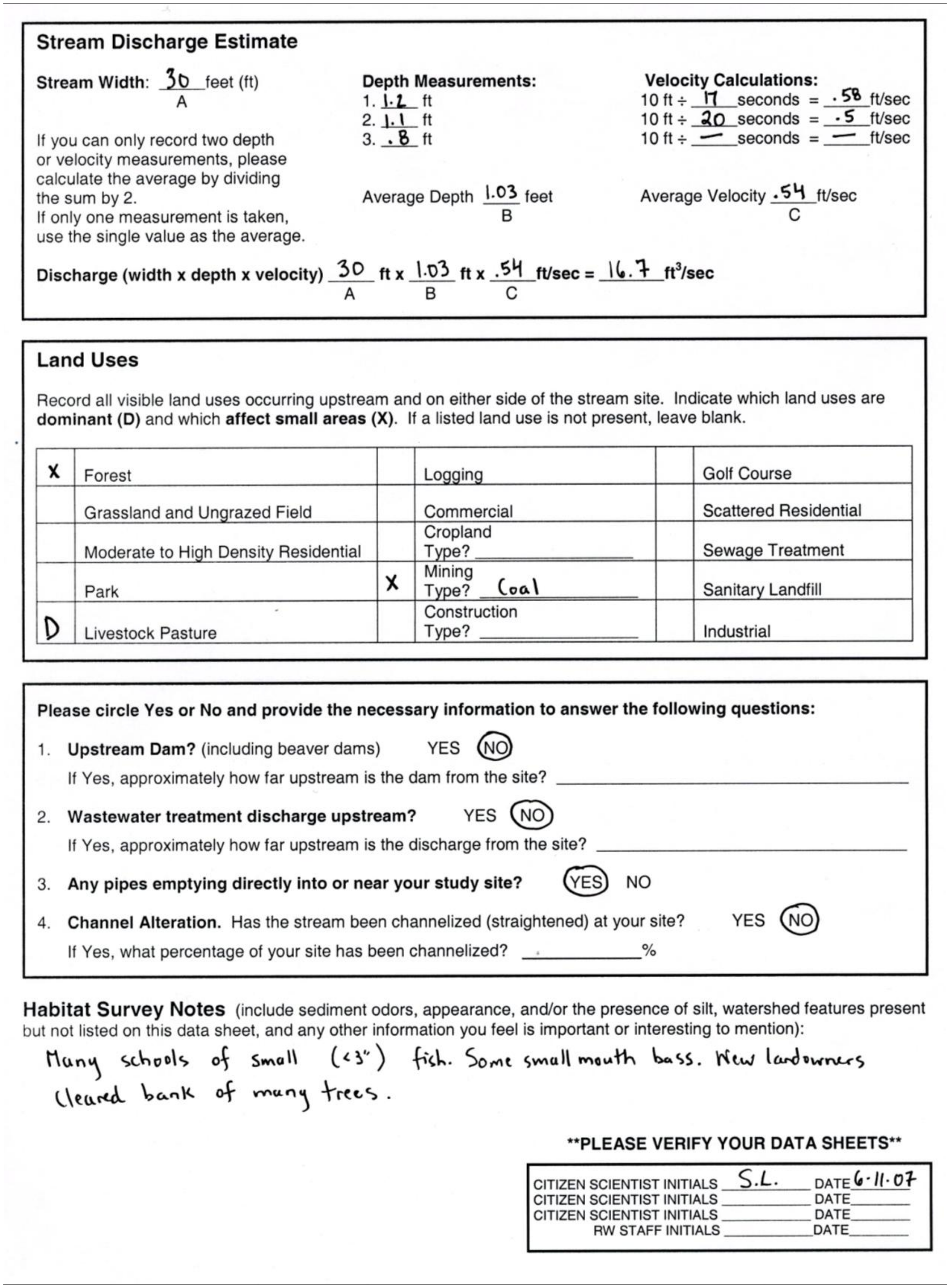
Percent cover codes: A = 0%, B = 1 - 5% C = 6 - 25%, D = 26 - 50%, E = 51 - 75%, F = 76 - 100%

A Bedrock
C Boulder (> 10 in)
C Hard Pan Clay

B Cobble (2.5 in. - 10 in.)
D Gravel (0.1 in – 2.5 in.)
A Other ___ (describe other substrate)

D Sand (< 0.1 in.)
B Silt

SAMPLE DATA SHEET: HABITAT SURVEY, pg 2



Stream Discharge Estimate

Stream Width: 30 feet (ft)
A

If you can only record two depth or velocity measurements, please calculate the average by dividing the sum by 2.
If only one measurement is taken, use the single value as the average.

Depth Measurements:
1. 1.2 ft
2. 1.1 ft
3. .8 ft

Average Depth 1.03 feet
B

Velocity Calculations:
10 ft ÷ 17 seconds = .58 ft/sec
10 ft ÷ 20 seconds = .5 ft/sec
10 ft ÷ — seconds = — ft/sec

Average Velocity .54 ft/sec
C

Discharge (width x depth x velocity) 30 (A) **ft x** 1.03 (B) **ft x** .54 (C) **ft/sec =** 16.7 **ft^3/sec**

Land Uses

Record all visible land uses occurring upstream and on either side of the stream site. Indicate which land uses are **dominant (D)** and which **affect small areas (X)**. If a listed land use is not present, leave blank.

X	Forest		Logging		Golf Course
	Grassland and Ungrazed Field		Commercial		Scattered Residential
	Moderate to High Density Residential		Cropland Type? ______		Sewage Treatment
	Park	X	Mining Type? Coal		Sanitary Landfill
D	Livestock Pasture		Construction Type? ______		Industrial

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

1. **Upstream Dam?** (including beaver dams) YES [✓ NO]
   If Yes, approximately how far upstream is the dam from the site? ______
2. **Wastewater treatment discharge upstream?** YES [✓ NO]
   If Yes, approximately how far upstream is the discharge from the site? ______
3. **Any pipes emptying directly into or near your study site?** [✓ YES] NO
4. **Channel Alteration.** Has the stream been channelized (straightened) at your site? YES [✓ NO]
   If Yes, what percentage of your site has been channelized? ______%

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

Many schools of small (<3") fish. Some small mouth bass. New landowners cleared bank of many trees.

****PLEASE VERIFY YOUR DATA SHEETS****

CITIZEN SCIENTIST INITIALS S.L. DATE 6-11-07
CITIZEN SCIENTIST INITIALS ______ DATE ______
CITIZEN SCIENTIST INITIALS ______ DATE ______
RW STAFF INITIALS ______ DATE ______

Biological Survey *in the field*

In completing the biological survey, you will collect a sample of benthic macroinvertebrates living in the stream, and conduct a presence/absence survey for additional macroinvertebrates of special interest. These organisms are indicators of the quality of the stream's biotic community. The number and type of macroinvertebrates found provide useful information for estimating water quality, habitat conditions and overall stream health.

The procedures described in this chapter were developed by scientists from the Illinois Department of Natural Resources to produce scientifically valid data. The basic collection techniques involve using a D-frame net of defined standards (see equipment list.) to gather organisms dislodged by kicking, jabbing, sweeping and scraping surfaces and sediments. The procedures for selecting and sampling habitats are described below and are designed to ensure the best representation of the macroinvertebrate community. It is important that they are followed in detail each time a site is monitored.

YOU WILL NEED

- Biological Survey Data Sheet
- Clip board and pencil
- Dip net
- Bucket (3 gallon or larger)
- Wash bottle
- Forceps
- Gridded subsampling tray
- Soda water (club soda)
- Jar containing 70% ethyl or 90% isopropyl alcohol (no larger than 8 oz.)
- Vial label
- Random number cup and number tabs representing each square in subsampling pan
- Calculator
- Macroinvertebrates of Special Interest handout

IDENTIFY AND SELECT SAMPLING HABITATS

Most streams have several potential habitat types in which benthic macroinvertebrates will be found. Common habitats include riffles, leaf packs, submerged logs, undercut banks and sediment. Begin by identifying which habitats are present at your site. Select the two habitat types likely to contain the highest diversity of macroinvertebrates. One sample is collected from each. Selecting two habitats gives the best chance of collecting a diverse array of organisms. Table 1 illustrates the hierarchy of habitat types in terms of macroinvertebrate diversity.

The type of habitats you sample will depend on the characteristics of the particular stream segment you are monitoring. For example, if a rocky bottom reach is being monitored, a riffle area with various leaf packs would offer the best collecting habitats. If the stream segment is a soft bottom reach, a fallen tree that is submerged (a snag area) and undercut banks may be the best places to sample.

Once the two most diverse habitats are identified, check to be sure they are properly conditioned for sampling. Organic matter such as leaves and logs must be submerged for several months before they are in a suitable physical condition to attract macroinvertebrates for colonization. Properly conditioned leaf packs and snags are described in detail in the “Tips” box on page 48.

If either of the habitats selected is not conditioned for sampling, try to find another habitat of the same type somewhere else within the study reach. If another, better conditioned habitat of the same type is not present, consult the list of habitats in **Table 1** and search the site for the next most diverse habitat present. For example, suppose you are at a site with riffles and leaf packs. You determine the riffle area is appropriate for sampling but the leaf pack selected is composed of fresh leaves that show no sign of decay. In this instance you would not sample from that particular leaf pack. Instead, you would search the site for an older, more appropriate leaf pack. If one is not found, you would look for the next most diverse habitat listed in Table 1, in this scenario a snag. Once you have selected the 2 most diverse habitats at your site, check the appropriate boxes on the data sheet.

Table 1. The Sampling Habitat Hierarchy

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

RIVERWATCH SAMPLING RULES OF THE ROAD

- All sampling efforts are conducted within the same 200-foot study reach where the habitat survey was completed.
- All sampling begins downstream and proceeds upstream. This prevents any sand, sediment or macroinvertebrates dislodged during the sampling process from disturbing organisms in the next sampling habitat.
- All riffles, leaf packs, snags, undercut banks and sediments are initial candidates for sampling. Final selection is based primarily on the Hierarchy listed in Table 1 and secondarily on the degree to which that habitat is “conditioned” for sampling.
- Always sample from two of the five habitat types listed in Table 1.
- Organisms collected from the two habitats are combined to form one composite sample.
- Sample each habitat thoroughly to ensure all macroinvertebrates are collected. Sampling from two habitats should easily yield a total of at least 50 organisms for the vast majority of Illinois streams.

COLLECT A MACROINVERTEBRATE SAMPLE

Sampling Procedures

Riffles

(Netter and Kicker Team)

Riffles are shallow, turbulent, swiftly flowing stretches of water that flow over partially or totally submerged rocks.

Before sampling a riffle, have one team member walk around the center of the riffle, taking care not to disturb the area. Any disturbance may bias the sample as macroinvertebrates seek cover while sediments are stirred and rocks are moved. Note where the riffle changes in terms of rock size and stream flow velocity.

Select two areas in the riffle from which to sample — one with the greatest streamflow and the largest rocks (up to 14 inches in diameter) and the other with the least streamflow speed and the smallest rocks. Water is generally more turbulent in fast riffle areas; more churning and "white water" occur as water flowing over rocks and other rough surfaces mixes air into the water. Slow riffle areas are characterized by less churning and smoother, slower flowing water. Collections from both a fast riffle area and a slow riffle area constitute one sample for the entire riffle.
Once the best sampling areas have been identified, wait for approximately 5 minutes to allow any sediment that may have been stirred to settle. Then, follow steps 1 through 6 below. Sample the riffle area that is positioned furthest downstream first.

Tips on Sampling: Uniform Riffle Areas
Not all riffles have fast and slow areas. For example, if depth and width are relatively constant, streamflow will be uniform throughout the riffle. If you cannot differentiate between fast and slow riffles, just sample from the downstream edge of the riffle first, then from the upstream edge.

1. Fill a plastic bucket approximately one-third full with clean stream water. Fill the wash bottle with clean stream water.

2. Position one volunteer (the "netter") with a dip net on the downstream edge of the riffle. Place the bottom of the net flush with the stream bottom, with the net handle perpendicular to the current of the stream and the opening of the net facing upstream. Have a second volunteer pick up any large rocks lying within a 1 foot by 1 foot area directly in front of the net, and gently rub them to remove any clinging organisms into the net. Place these rocks in the bucket.

3. With the netter holding the dip net in the riffle, the second volunteer (the "kicker") "kicks" or "shuffles" his or her feet along the stream bed so as to disturb the substrate to a depth of about three inches. The kicker should begin at the upstream edge of the 1 foot by 1 foot area and work toward the net as he or she kicks. This step should take at least three minutes.

4. When the kicker reaches the net, the netter sweeps the net out of the water in a single upward, forward motion to capture the sample.

5. Using the wash bottle, rinse stream water through the net to remove any sediment. Carry the net and bucket to the streambank. Transfer the contents to the bucket by inverting the net and rinsing it clean with a wash bottle full of stream water. Carefully examine the net. Remove any remaining organisms and place them in the bucket.

Repeat steps 2-5 above for the second riffle area. The combined contents collected from each riffle area represent one sample for the riffle habitat.

6. To complete macroinvertebrate sampling, you must select a second habitat type. This should be the next most diverse habitat available (a leaf pack, snag, undercut bank or sediment). Procedures for each of these habitats are detailed in the next few pages.

Tips on Sampling: Properly Conditioned Leaf Packs and Snags
Before choosing a leaf pack, make sure it is properly "conditioned". Fresh leaf packs or newly submerged logs provide little of the decaying organic matter upon which many macroinvertebrates feed. They are therefore unlikely to serve as abundant sources of macroinvertebrates. Properly conditioned snags and leaf packs have been in the stream for approximately four to six months. They are dark brown, slightly decomposed and may feel slimy to the touch. To determine if a leaf pack is appropriate for sampling, do not remove it from the stream. Instead, compare it to nearby leaf packs, or visually examine it in the water to determine if the leaf pack is suitable for sampling. A large handful of these decaying leaves is all you need. Properly conditioned snags can also be identified based on appearance or touch. The best snags are older, decaying logs with loose bark and soft, mushy wood.

Sampling Procedures

Leaf packs

(Netter and Kicker Team)

Leaf packs are accumulations of leaves that are 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. The best kinds of leaf packs to sample from are described in the shaded box on page 45.

1. The netter positions the dip net on the bottom of the stream, immediately downstream from a leaf pack.

2. The kicker pulls the leaf pack from the rock or log, gently shaking it in front of the net to release any loose organisms. Place the leaf pack into the net.

3. Once the entire leaf pack is in the net, the netter sweeps the net out of the water in an upward, forward motion.

4. Rinse the contents of the net with stream water to remove any sediment. Transfer the contents to the bucket by inverting the net and rinsing it clean with a wash bottle full of stream water. Carefully examine the net. Remove any remaining organisms and place them in the bucket.

Sampling Procedures

Snag areas (submerged logs)

(Netter and Kicker Team)

Snags are trees or portions of trees (branches, trunks, roots, logs) that are submerged in the water and provide a firm surface for macroinvertebrates to cling to. Caddisflies, stoneflies, riffle beetles, and midges commonly inhabit these areas.

1. Select an area on the snag, tree roots, or submerged log that is approximately four feet long and at least two inches in diameter. This will be the sampling area for this habitat type. If branches or logs are less than four feet in length, select enough for a combined length of at least four feet.

2. The netter scrapes the surface of the tree roots, branches, or logs with the net while on the downstream side of the snag. The kicker then disturbs such surfaces by scraping them with his 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 the net is positioned downstream from the snag, so that dislodged material floats toward the net, not away from it.

3. Spend 15 minutes inspecting the chosen sampling area for organisms. You may remove a log from the water to better see what is there. Using forceps, remove any organisms still clinging to tree roots, branches or logs. Replace the log in the stream when finished.

4. Rinse the contents of the net with stream water to remove any sediment. Transfer the contents to the bucket by inverting the net and rinsing it clean with a wash bottle full of stream water. Carefully examine the net. Remove any remaining organisms and place them in the bucket.

Sampling Procedures

Undercut banks

(Netter only)

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. The netter faces the bank. Using a rapid jabbing or scraping motion, the bank is scraped from bottom to top, disturbing any submerged vegetation on the bottom, back and top of the bank along the way. The netter makes 4 additional sweeps, repeating this quick, jabbing motion to loosen the organisms that are clinging to the vegetation.

2. Rinse the contents of the net with stream water to remove any sediment. Transfer the contents to the bucket by inverting the net and rinsing it clean with a wash bottle full of stream water. Carefully examine the net. Remove any remaining organisms and place them in the bucket.

Sampling Procedures

Sediments

(Netter and Kicker Team)

Sediment includes sandy, silty, or muddy stream bottoms. It may also include small algae covered rocks. This is the least productive of the five sampling habitats, and is always present in one form or another (i.e., silt, sand, mud, or gravel). Sandy or muddy areas can usually be found on the edges of the stream, where the water flows more slowly.

1. A netter stands downstream of the sediment area with the dip net resting on the bottom. The kicker kicks or shuffles his or her feet along the stream bed so as to disturb the sediment to a depth of about three inches. The kicker should begin at the upstream edge of the 1 foot by 1 foot area and work toward the net as s/he kicks. This step should take at least three minutes.

2. When the kicker reaches the net, the netter sweeps the net out of the water in a single upward, forward motion to capture the sample.

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. Transfer the contents to the bucket by inverting the net and rinsing it clean with a wash bottle full of stream water. Carefully examine the net. Remove any remaining organisms and place them in the bucket.

Sample each habitat thoroughly.
Recent data verification results show an unusually high number of sites with lower than expected sample size. Be sure to sample each habitat thoroughly to ensure all macroinvertebrates are collected. Sampling from two habitats should easily yield a total of at least 50 organisms for the vast majority of Illinois streams. Exceptions are relatively rare and include highly intermittent streams or drainage ditches with extremely limited or highly degraded habitat.

If fewer than 50 organisms are collected at your site, note this in the “Notes” section of the Biological Survey Sheet and provide a detailed description of habitat conditions in the “Habitat Survey Notes” section of the Habitat Survey Sheet. These notes will provide valuable information for use in accounting for lower than normal sample sizes.

After Sampling

Once sampling is complete, check off the habitat types sampled on the Biological Survey Data Sheet. Also indicate the location of each sample on the Site Sketch Data Sheet.

TRANSFER MACROINVERTEBRATES TO A SUBSAMPLING PAN

Once a macroinvertebrate sample has been collected, transfer the organisms from the bucket to the gridded subsampling pan.

1. Start by filling the subsampling pan with stream water to a depth of approximately 1” (roughly to the depth of the first joint of your index finger).

2. Remove all cobble and gravel sized rocks one by one and carefully inspect the surface of each. Place any macroinvertebrates found in the subsampling pan.

3. Remove all large and medium pieces of leaves, sticks, and bark. Carefully inspect every surface and again place all macroinvertebrates found in the subsampling tray.

4. Pour the remaining contents of the bucket (water, debris and organisms) through the net. Fill the bucket with more water (mouth facing upstream) to re-suspend any remaining contents. Again, pour the suspended contents through the net. Repeat until the bucket is clean.

5. Inspect the net and its contents for macroinvertebrates and place them in the subsampling pan. DO NOT rinse the net into the subsampling pan. Spend as much time as is necessary to thoroughly search the net for any macroinvertebrates that may have been missed. This should take about15 minutes.

6. Return all leaf litter and rocks to the stream. When replacing rocks, do not toss them back into the stream. Instead, gently place the rocks in the water on the edge of the stream or in the stream channel in the area from which they were collected.

Tips on Sampling: Looking Twice Finds More Macros
Before returning rocks, sticks or pieces of bark to the stream, briefly re-inspect them for macroinvertebrates that may have been missed during your initial inspection. Most macroinvertebrates are very adept at hiding themselves. After being exposed to air or direct sunlight, however, they become much less comfortable and begin to move around, seeking more favorable surroundings. It is very common to find additional macroinvertebrates during a brief second inspection of rocks and other debris, especially those with rough surfaces or lots of algal cover.

SUBSAMPLING PROCEDURES

Counting and identifying the collected organisms is easier if a random subsample of at least 100 organisms is selected from the sample. If fewer than 100 organisms were collected, subsampling is not necessary. Indicate on the Biological Survey Data Sheet that subsampling was not performed because fewer than 100 organisms were collected.

Place the pan of macroinvertebrates on an even surface. (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. Be creative, and above all be sure the subsampling pan is on a solid, stable surface so that it won't be tipped or spilled.

Estimate the number of macroinvertebrates in the pan.

If less than 100 organisms were collected:

1. Visually scan the subsampling pan for crayfish, mussels, and clams.

2. Record the presence of any Macroinvertebrates of Special Interest on the Biological Survey Sheet. Use the Illinois RiverWatch Macroinvertebrate Identification Key and Macroinvertebrates of Special Interest handout provided at your training session to help with identification.

3. Collect and preserve 1 specimen for any zebra mussels and Chinese mystery snails present in your sample. Release all crayfish, mussels, and clams back into the stream.

4. Place the remaining macroinvertebrates in the sample jar containing alcohol.

If more than 100 organisms are collected:

1. Visually scan the subsampling pan for crayfish, mussels, and clams.

2. Record the presence of any Macroinvertebrates of Special Interest on the Biological Survey Sheet. Use the Illinois RiverWatch Macroinvertebrate Identification Key and Macroinvertebrates of Special Interest handout provided at your training session to help with identification.

3. Collect and preserve 1 specimen for any zebra mussels and Chinese mystery snails present in your sample. Release all crayfish, mussels, and clams back into the stream.

4. Add four or five capfuls of soda water to the pan. Allow the pan to sit for a few minutes to allow the soda to slow the movement of the macroinvertebrates. Add more soda water if needed.

5. Gently rock the subsampling pan to evenly distribute organisms across the bottom. Try to disperse "clusters" of organisms that gather in the corners of the pan.

6. Shake the random number cup and select a number tab. Remove all organisms from the selected square and place them in the sample jar.

7. Record the number of organisms removed in the corresponding square on the diagram.

8. Repeat steps 6 and 7 for a second numbered square. Continue until at least 100 organisms have been selected. Once the 100th organism is collected, continue removing organisms from within that square until it is completely empty. This may result in the

collection of slightly more than 100 organisms.

9. Record the square numbers and the number of organisms collected from each on the data sheet (see **Figure 12**).

10. Look through the organisms remaining in the pan for any type of organism that was not collected as part of the subsample.

11. Remove one of each uncollected type and place them in the sampling jar. Record the type and number of organisms removed below the subsampling diagram. If you are not sure what type of organisms they are, at least indicate how many types were collected after subsampling.

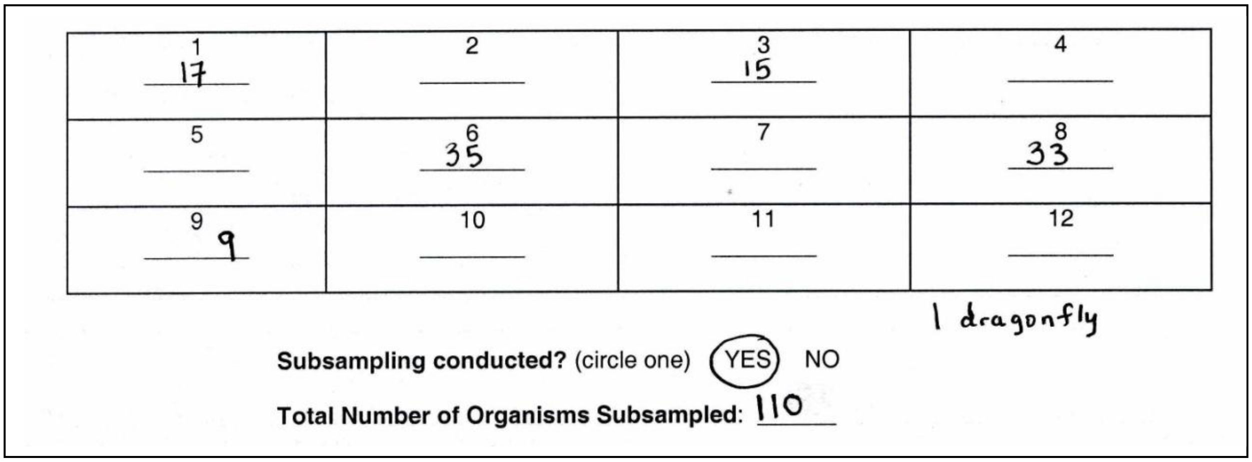
Discard any organisms remaining in the pan by draining the contents of the pan through the net onto the ground. Place the discarded organisms in another large container containing stream water. Now return these organisms to the stream.

Tips on Subsampling: Square Straddlers
Any organism that straddles a line separating two squares is counted with the square that contains its head. In the case of organisms whose head is impossible to locate (such as worms), count the organism with the square that contains the largest portion of its body.

Subsampling Calculations:

Estimate the total number of organisms subsampled by adding the number of organisms removed from each block in the subsampling tray, as well as any additional organisms removed after subsampling. For example, suppose organisms from five squares on the tray were picked to obtain the 100 organisms needed for the subsample, plus 1 dragonfly. The number of organisms subsampled is 110 (17 + 35 + 15 + 33 + 9 + 1).

Figure 12. Subsampling Calculations



1 17	2	3 15	4
5	6 35	7	8 33
9 9	10	11	12

1 dragonfly

Subsampling conducted? (circle one) [✓ YES] NO

Total Number of Organisms Subsampled: 110

PRESERVE SAMPLE

Follow these instructions for preserving samples.

- Use an appropriate sized jar with a tight seal to minimize leaks. Anything about the size of a baby food jar or that holds 3-8 oz is fine. Avoid baby food jars or large mayonnaise and peanut butter jars.

- Fill out a vial label with pencil and place the label INSIDE the jar. Do not tape or rubber band the label to the jar.

- Top your jar with alcohol so the critters do not slosh around and to ensure proper preservation. Use 70% ethyl or 90% isopropyl (rubbing) alcohol. Add fresh alcohol to the jar to prevent degradation if waiting longer than a week before identifying macroinvertebrates.

Tips on Macroinvertebrate Preservation: Proper Alcohol Type
Macroinvertebrate samples should be preserved using 70% ethyl or 90% isopropyl rubbing) alcohol. Use one type or the other — DO NOT MIX. Mixing different concentrations or types of alcohol causes the alcohol to denature (break down) faster and accelerates decay of the organisms being preserved.

SURVEY FOR MACROINVERTEBRATES OF SPECIAL INTEREST

The presence or absence of certain native and (non-native) invasive species can also provide important indications of stream quality. Crayfish, native mussels, and fingernail clams are considered indicators of good stream quality. The non-native rusty crayfish on the other hand, is well known for its aggressive behavior and is suspected of “pushing out” many native crayfish from Illinois streams. Other non-natives, such as zebra mussels, are known as “biofoulers” that clog intake pipes, creating problems for water and power suppliers. Asiatic clams and zebra mussels also interrupt the natural food web.

To help track the distribution and migration of these organisms, spend an additional 15 to 20 minutes looking for the macroinvertebrates of special interest listed on the Biological Survey Data Sheet. Be sure to check a variety of substrates (silt, mud, sand, fine gravel) for native mussels, fingernail clams, and Asiatic clams, and in pools for crayfish. Check hard surfaces such as rock, pipes or native mussel shells for zebra mussels. Use the Illinois RiverWatch Macroinvertebrate Identification Key and the Macroinvertebrates of Special Interest handout provided at your training session to aid with identification in the field.

Indicate the presence or absence of living organisms by circling YES or NO on the data sheet. If you only see empty shells, circle NO and note that empty shells were observed in the “NOTES” section of the Biological Survey data sheet.

If zebra mussels or Chinese mystery snails are present at your site, collect 1 specimen of each and preserve them in a separate jar from your macroinvertebrate sample. These specimens will be verified by the RiverWatch Quality Assurance Officer. This applies to zebra mussels and Chinese mystery snails only -- DO NOT collect native mussels, fingernail clams, Asiatic clams or rusty crayfish.

SECTION SUMMARY

1. Identify all habitats present within the 200-foot monitoring site.

2. Compare all habitat types present and use the Habitat Hierarchy in Table 1 to select the two habitat types likely to contain the highest diversity of macroinvertebrates. Evaluate both habitats to ensure they are properly conditioned for sampling.

3. Conduct the sampling procedures for BOTH habitats selected in the previous step.

4. Indicate the sampling habitats on the biological survey sheet. Record the location and type of habitats sampled on the site sketch.

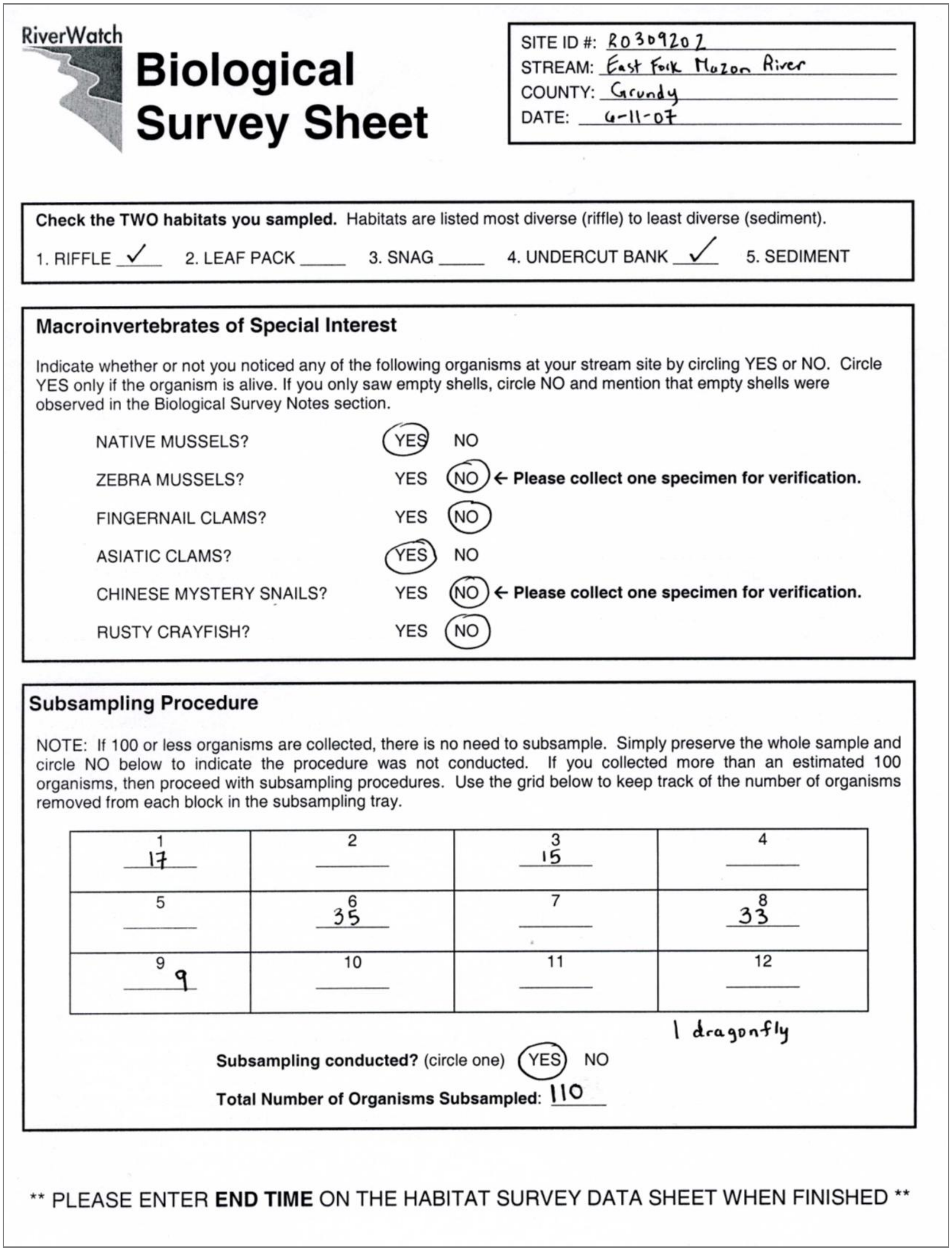
5. Transfer the macroinvertebrates from the bucket to the sub-sampling pan and determine if sub-sampling is necessary. If necessary, conduct subsampling procedure outline on page 53. If subsampling is not necessary follow the instructions outlined on page 52-53.

6. Store the sample in alcohol. Prepare a sample label and place it inside the jar so it can be read from the outside.

7. Conduct a survey for Macroinvertebrates of Special Interest and record your findings on the Biological Survey Data Sheet. If present, collect one specimen of the zebra mussel and Chinese mystery snail and preserve them in a separate jar from your sample. **DO NOT collect native mussels, fingernail clams, Asiatic clams or rusty crayfish.**

8. Within one week of monitoring, top off the sample with fresh alcohol to prevent degradation of specimens.

SAMPLE DATA SHEET: BIOLOGICAL SURVEY



RiverWatch

Biological Survey Sheet

SITE ID #: R0309202
STREAM: East Fork Mazon River
COUNTY: Grundy
DATE: 6-11-07

Check the TWO habitats you sampled. Habitats are listed most diverse (riffle) to least diverse (sediment).

1. RIFFLE ✓ 2. LEAF PACK ___ 3. SNAG ___ 4. UNDERCUT BANK ✓ 5. SEDIMENT

Macroinvertebrates of Special Interest

Indicate whether or not you noticed any of the following organisms at your stream site by circling YES or NO. Circle YES only if the organism is alive. If you only saw empty shells, circle NO and mention that empty shells were observed in the Biological Survey Notes section.

NATIVE MUSSELS? [✓ YES] NO
ZEBRA MUSSELS? YES [✓ NO] ← **Please collect one specimen for verification.**
FINGERNAIL CLAMS? YES [✓ NO]
ASIATIC CLAMS? [✓ YES] NO
CHINESE MYSTERY SNAILS? YES [✓ NO] ← **Please collect one specimen for verification.**
RUSTY CRAYFISH? YES [✓ NO]

Subsampling Procedure

NOTE: If 100 or less organisms are collected, there is no need to subsample. Simply preserve the whole sample and circle NO below to indicate the procedure was not conducted. If you collected more than an estimated 100 organisms, then proceed with subsampling procedures. Use the grid below to keep track of the number of organisms removed from each block in the subsampling tray.

1 17	2	3 15	4
5	6 35	7	8 33
9 9	10	11	12

1 dragonfly

Subsampling conducted? (circle one) [✓ YES] NO

Total Number of Organisms Subsampled: 110

** PLEASE ENTER **END TIME** ON THE HABITAT SURVEY DATA SHEET WHEN FINISHED **

Biological Survey *in the lab*

Proper sorting, counting and identification of the macroinvertebrate sample are essential to producing accurate data. These procedures are described in detail below, and should be conducted in a laboratory setting such as a classroom or other meeting place as soon as possible following field sampling.

YOU WILL NEED

- Biological Survey Sheet
- Stereoscope or dissecting microscope with magnification range of at least 10X - 30X
- Pencil
- Petri dishes
- Macroinvertebrate sample
- Forceps
- Identification Key
- Bottle of alcohol (70% ethyl or 90% isopropyl)
- Calculator

SORT AND COUNT MACROINVERTEBRATES

On a flat surface with plenty of space, place the sample specimens into an empty Petri dish. Add enough alcohol to cover the macroinvertebrates completely. Using the forceps, remove any debris that may have fallen into the dish with the sample.

Follow these steps to sort and count your sample:

1. Sort the organisms into groups with similar characteristics. For example, sort all the organisms with legs (insects and crustaceans) from leeches, worms, snails and others without legs. Next, separate the leeches, worms and snails from one another. Also sort the organisms with legs based on body shape, number of legs or number of wing pads. Continue subdividing until each group consists of only one type of organism. Use a second or third Petri dish if you need additional space as the groups are separated out.

2. Examine each organism in a group to make sure that it belongs in the group. Remove any organism that does not belong and place with another, more appropriate group (or its own, new group altogether).

3. Count the number of macroinvertebrates in each group, beginning with the least numerous group in the Petri dish. Working from the least numerous group to the most numerous group frees up space in the Petri dish. You will need this space later to count the more numerous groups of organisms in your sample. The best way to keep track of counting large groups is to divide them into subgroups of 5 or 10 organisms each. Once the larger, original group of organisms is broken down into these smaller groups, simply

count the number of smaller groups, plus any “extra” organisms. For example, a large group divided into 4 smaller groups of 10, plus 7 “extra” organisms would result in a count of 47 organisms (4 groups x 10 organisms + 7 organisms = 47 total organisms).

4. After counting a large group of organisms, count them one more time. If the total number of organisms is the same on the second try, then they have probably been counted correctly. If the total number of organisms is different on the second try, count the group again. You should count the group until you arrive at the same answer two times in a row.

Following this method of sorting may seem unnecessarily cumbersome, but will improve the accuracy of the data. Previous sampling experience shows this extra bit of organization significantly reduces counting errors and produces more accurate data. With practice, this method of sorting and counting takes relatively little time to carry out.

Tips on Counting: Shells, Caddisfly Cases and Aquatic Worms

Shells: Empty shells should not be included in the sample. Snail and clam shells often remain in a stream long after the organism inhabiting them has died. While they are a part of the stream habitat, empty shells are not a part of the stream’s living biological community. Therefore, counting them among the sample produces an inaccurate representation of the current biological community.

Caddisfly cases: Case-making caddisfly larva typically remain in their cases after being preserved in alcohol. Sometimes, however, the larva will recede into its case, making it difficult to see. Carefully pick apart cases that appear empty to see if the larva is inside. Record those found on the data sheet. As with empty shells, caddisfly cases without larva inside should not be included in the sample.

Aquatic Worms: Aquatic worms are fragile organisms that often break apart when removed from the stream and preserved. If aquatic worms contained in the sample are broken, only count the ends; ignore middle segments. Two ends should be counted as one organism.

IDENTIFY MACROINVERTEBRATES

Once the number of organisms for each group has been determined, they can be identified to the appropriate taxonomic level. Using the Illinois RiverWatch Macroinvertebrate Identification Key, identify the taxa to which each group belongs. If in doubt about an identification, double check by using another key or by asking the RiverWatch Trainer or Coordinator for help. More complex identification keys are listed in Appendix D.

Training for macroinvertebrate identification is provided at RiverWatch training workshops. Citizen Scientists not familiar or comfortable with macroinvertebrate identification should contact their RiverWatch office for assistance. Experienced Citizen Scientists are also encouraged to attend additional macroinvertebrate identification training and review sessions once per year.

Common names of macroinvertebrate indicator taxa are listed in boxes on the Biological Survey Sheet. Record the number of organisms collected for each taxon in the column labeled “N”.

The indicator taxa list only includes RiverWatch indicator organisms, and it is unlikely that all taxa on the list will be represented in your sample. Moreover, because many Illinois streams contain an abundance of different macroinvertebrates, other (non-indicator) taxa may also be part of the sample. If other macroinvertebrates are collected, write their names (if known) and how many were collected in the “NOTES” section of the data sheet. List the number of any “Unknown” organisms separately, also in the “NOTES” section.

RiverWatch Stream Reference Cards

Need extra help identifying your macroinvertebrates? The National Great Rivers Research & Education Center has RiverWatch Stream Reference Cards (8 x 11 laminated sheets). Contact the RiverWatch office to place an order or send payment to the address below.

Make check payable to *Lewis and Clark Community College* (cash not accepted).

Send payment to: Attn: Vera Bojic • Lewis & Clark Community College • 5800 Godfrey Road • Godfrey, IL 62035

PRESERVE AND PACKAGE THE SAMPLE

Once the macroinvertebrates have been sorted, counted and identified, they must be immediately preserved in a tightly sealed sample jar. Use a jar large enough for the entire sample, and fill the jar full with fresh alcohol to eliminate airspace that may dry out samples during shipment. Failure to preserve organisms immediately after sampling and identification increases the possibility they will decay. Samples showing excessive decay are rejected during the verification process and not included in the RiverWatch monitoring database.

Tips on Macroinvertebrate Preservation: Proper Alcohol Type

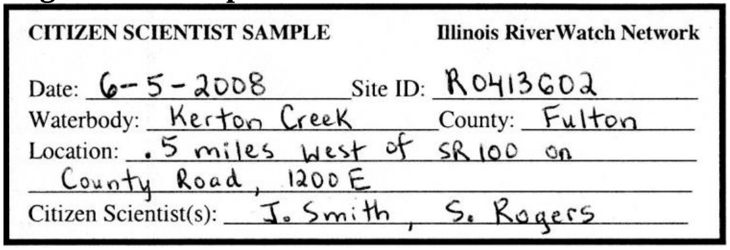
Macroinvertebrate samples should be preserved using 70% ethyl or 90% isopropyl rubbing) alcohol. Use one type or the other — DO NOT MIX. Mixing different concentrations or types of alcohol causes the alcohol to denature (break down) faster and accelerates decay of the organisms being preserved.

Label the Sample

Complete a label for the sample using permanent, non-alcohol soluble ink or pencil. Pens for this purpose can be purchased from an art or office supply store. Place the label inside the jar, with the writing facing outward so that it can be read from the outside.

All labels should contain the following information: Date, Site ID Number, Stream Name, County, Location, and Name of Identifier. The information should be formatted as shown in the example in **Figure 13** below.

Figure 13. Sample Label



CITIZEN SCIENTIST SAMPLE **Illinois RiverWatch Network**

Date: 6-5-2008 Site ID: R0413602
Waterbody: Kerton Creek County: Fulton
Location: .5 miles West of SR100 on
County Road, 1200 E
Citizen Scientist(s): J. Smith, S. Rogers

STREAM HEALTH INDEXES

As mentioned previously, environmental indexes or “metrics” are used to provide quantitative information relating to stream health. This section lists and defines various metrics used to determine trends across the state.

Organisms Collected is the total number of organisms collected before subsampling. It includes indicator and non-indicator taxa. Nutrient-enriched water has a high number of organisms, while water polluted with toxic chemicals, silt or sand usually have fewer organisms.

Organisms Sampled is the total number of indicator organisms collected or subsampled: **ΣN** (The Greek letter “sigma (Σ)” is the symbol for sum or total). If subsampling was not conducted, the organisms in the sample minus any non-indicators represent the number of organisms sampled. This index helps characterize stream health but is not necessarily a good measure of water quality, because many organisms are removed during subsampling.

The **Taxa richness** is the total number of taxa identified in the sample: **ΣTaxa**. This index measures the variety of organisms 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.

The **EPT Taxa Richness** index is the number of Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) taxa present in a sample. Higher index values indicate less organic pollution. EPT are most diverse in natural streams and decline with increasing watershed disturbance.

The **Macroinvertebrate Biotic Index** (**MBI**) was developed by the Illinois EPA to detect organic pollution such as sewage. It provides a weighted average of the pollution tolerance of indicator organisms in a sample. MBI is the total tolerance value of the total tolerance value (ΣTV) divided by the organisms sampled (ΣN). MBI = ΣTV / ΣN

Tentative Quality Ratings: Revised 2004

	Taxa Richness	**EPT Taxa Richness**	**MBI**
Excellent	**≥ 14**	**≥ 5**	**≤ 4.35**
Good	**12-13**	**4**	**≥ 4.36 - ≤ 5.00**
Fair	**9-11**	**3**	**≥ 5.01 - ≤ 5.70**
Poor	**7-8**	**2**	**≥ 5.71 - ≤ 6.25**
Very Poor	**≤ 6**	**0-1**	**≥ 6.26**

COMPLETE THE BIOLOGICAL SURVEY DATA SHEET

Before calculating the indices that measure stream health you must complete the Macroinvertebrate Identification portion of the Biological Survey data sheet. Begin by recording the results of your macroinvertebrate identification onto the data sheet.

1. Place the number of organisms identified in column “N” next to the name of the organism.

2. Multiply the “number of organisms (N)” by the “tolerance index/rating (TI).” The tolerance index is printed on the data sheet. Enter the product in the last column, titled Tolerance Value (TV).

3. Add the numbers in each column and place the results in the corresponding boxes marked “Totals.” These figures represent the total number of organisms sampled (ΣN) and the total tolerance value (ΣTV).

4. Complete the table by counting the total number of different taxa groups (ΣTaxa) collected. Enter the results in the box at the bottom of the data sheet.

5. Transfer the number of Organisms Sampled (ΣN) and Taxa Richness (ΣTaxa) values from the bottom of the chart to the spaces provided in the upper right corner of the data sheet.

6. Add the number of EPT Taxa (mayflies, caddisflies, stoneflies) and place the result in the empty box labeled ΣEPT. Note that “other mayflies” and “other caddisflies” also count as EPT taxa.

7. Calculate the Macroinvertebrate Biotic Index (MBI) by dividing the total tolerance value of the sample (ΣTV) by the number of Organisms Sampled (ΣN). This index is defined in the next section of the manual, Stream Health Indexes.

SECTION SUMMARY

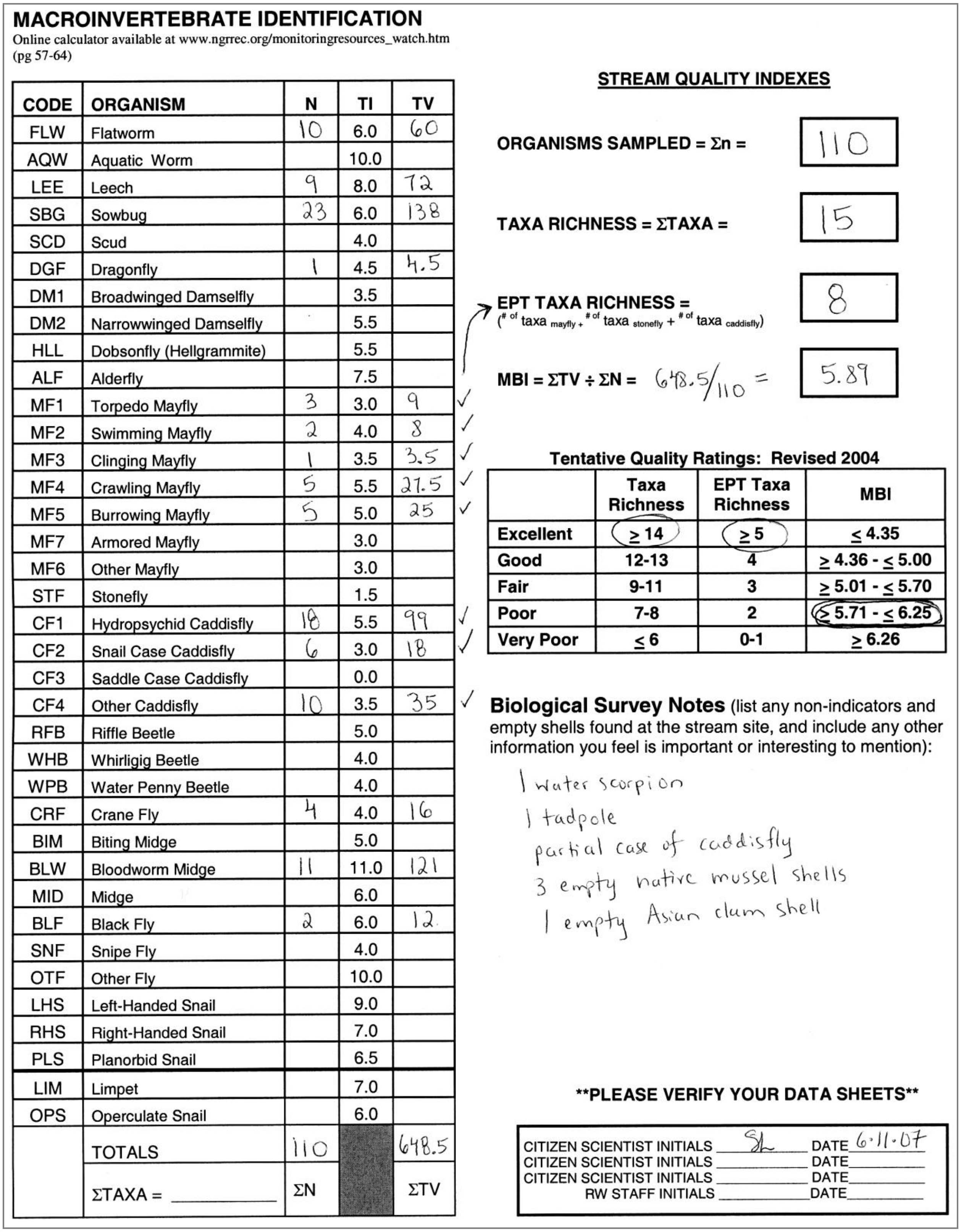
1. Contact the RiverWatch office if you need assistance identifying macroinvertebrates.

2. Sort, count and identify the macroinvertebrates in the sample. Use the Illinois RiverWatch Macroinvertebrate Identification Key or other resources provided at training sessions and on the RiverWatch website www.ngrrec.org/monitoringresources_watch.htm. If using more complex keys for identification, use the taxonomic information in the RiverWatch Indicator list to place macroinvertebrates in the appropriate taxa group.

3. Preserve the sample in fresh alcohol and place a label inside the vial.

4. Complete all calculations in the macroinvertebrate identification section of the biological survey data sheet. Add notes as needed.

SAMPLE DATA SHEET: BIOLOGICAL SURVEY



MACROINVERTEBRATE IDENTIFICATION

Online calculator available at www.ngrrec.org/monitoringresources_watch.htm
(pg 57-64)

CODE	ORGANISM	N	TI	TV	
FLW	Flatworm	10	6.0	60	
AQW	Aquatic Worm		10.0		
LEE	Leech	9	8.0	72	
SBG	Sowbug	23	6.0	138	
SCD	Scud		4.0		
DGF	Dragonfly	1	4.5	4.5	
DM1	Broadwinged Damselfly		3.5		
DM2	Narrowwinged Damselfly		5.5		
HLL	Dobsonfly (Hellgrammite)		5.5		
ALF	Alderfly		7.5		
MF1	Torpedo Mayfly	3	3.0	9	✓
MF2	Swimming Mayfly	2	4.0	8	✓
MF3	Clinging Mayfly	1	3.5	3.5	✓
MF4	Crawling Mayfly	5	5.5	27.5	✓
MF5	Burrowing Mayfly	5	5.0	25	✓
MF7	Armored Mayfly		3.0		
MF6	Other Mayfly		3.0		
STF	Stonefly		1.5		
CF1	Hydropsychid Caddisfly	18	5.5	99	✓
CF2	Snail Case Caddisfly	6	3.0	18	✓
CF3	Saddle Case Caddisfly		0.0		
CF4	Other Caddisfly	10	3.5	35	✓
RFB	Riffle Beetle		5.0		
WHB	Whirligig Beetle		4.0		
WPB	Water Penny Beetle		4.0		
CRF	Crane Fly	4	4.0	16	
BIM	Biting Midge		5.0		
BLW	Bloodworm Midge	11	11.0	121	
MID	Midge		6.0		
BLF	Black Fly	2	6.0	12	
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	110		648.5	
	ΣTAXA = ___________	ΣN		ΣTV	

STREAM QUALITY INDEXES

ORGANISMS SAMPLED = Σn = 110

TAXA RICHNESS = ΣTAXA = 15

EPT TAXA RICHNESS = (# of taxa mayfly + # of taxa stonefly + # of taxa caddisfly) 8

MBI = ΣTV ÷ ΣN = 648.5/110 = 5.89

Tentative Quality Ratings: Revised 2004

	Taxa Richness	EPT Taxa Richness	MBI
Excellent	[✓ ≥ 14]	[✓ ≥ 5]	≤ 4.35
Good	12-13	4	≥ 4.36 - ≤ 5.00
Fair	9-11	3	≥ 5.01 - ≤ 5.70
Poor	7-8	2	[✓ ≥ 5.71 - ≤ 6.25]
Very Poor	≤ 6	0-1	≥ 6.26

Biological Survey Notes (list any non-indicators and empty shells found at the stream site, and include any other information you feel is important or interesting to mention):

1 water scorpion
1 tadpole
partial case of caddisfly
3 empty native mussel shells
1 empty Asian clam shell

****PLEASE VERIFY YOUR DATA SHEETS****

CITIZEN SCIENTIST INITIALS SL DATE 6·11·07
CITIZEN SCIENTIST INITIALS __________ DATE__________
CITIZEN SCIENTIST INITIALS __________ DATE__________
RW STAFF INITIALS __________ DATE__________

Finishing Up

Although the majority of your monitoring is finished, there are several verification, data submission, and other tasks that must be completed. Careful attention to these "wrap up" activities after your monitoring session is just as important as being well prepared before visiting your site. Failure to properly complete this stage of the process is one of the most common reasons for lost or poor quality data.

This chapter outlines the steps necessary to finish your work. Completing them only takes a short time, but can make all the difference to the success of your monitoring experience.

WRAPPING UP YOUR MONITORING SESSION

Steps After Monitoring

- Verify data sheets
- Complete post-monitoring questionnaire
- Copy all forms
- Enter data on-line
- Submit data and macroinvertebrate sample
- Return borrowed equipment
- Follow-up with landowner / property manager

Verify Data Sheets

When all field work and macroinvertebrate identification is complete, spend a few minutes reviewing all data sheets for legibility and completeness. Be sure that verification boxes have been completed and calculations are correct. If monitoring was done with a group, be sure all data is entered on one set of data sheets per site. If data sheets were damaged during field or lab work, it is acceptable to copy the data over to a clean set of sheets, as long as the original data is recorded exactly as it appeared on the original sheets. When submitting data, send both the new and original (damaged) data sheets in with the sample.

Complete Post-monitoring Questionnaire

A questionnaire will be mailed to all citizen scientists at the end of the monitoring season. The feedback provided will help RiverWatch staff gauge volunteer satisfaction with the program and learn of ways to improve it.

Copy All Forms

Once the data sheets are complete, make a copy of each to retain for your files. The originals will be sent to the RiverWatch office and stored in a site file. Make extra copies for the landowner or property manager of the site and for other volunteers who may have assisted with the monitoring.

Enter Data On-line

RiverWatch Data can be entered electronically through the RiverWatch web site. This saves valuable data entry time for program staff and also helps prevent common calculation and other data entry errors.

To enter data, contact the RiverWatch office to obtain a User ID and Password if you have not already done so. Record this information in a safe place, such as on the front or back cover of this manual.

Submission of hard copy data sheets is required for all sites, even if electronic data entry is used.

Submit Data and Macroinvertebrate Sample

To submit data, mail the following items to the RiverWatch office:

- Original data sheets (one set per site)
- Sample jar containing the macroinvertebrate sample
- Site documentation (if applicable)
- Picture(s) of site (digital photos should be uploaded to online database)

Be sure that the sample jar is properly labeled and tightly sealed. Properly preserved specimens and well sealed sample jars are especially important, since the sample may be selected for verification by the RiverWatch Quality Assurance Officer. For tips on properly packaging samples, visit www.ngrrec.org/monitoringresources_watch.htm.

The data submission deadline is generally on or around September 15th. Visit the RiverWatch web site or contact the RiverWatch office to confirm the exact date.

Return Borrowed Equipment

If a RiverWatch equipment kit was used, it should promptly be returned to the local equipment loan center. Other Citizen Scientists may need it in time to complete their monitoring before the statewide annual monitoring period ends. Review the contents list to be sure that everything has been returned. Make a note of any equipment that may have been lost or damaged, and report it to the RiverWatch office. You will not be fined for lost or damaged items.

Follow Up with Landowner

If you or your group monitored a site owned or managed by someone else, please send a thank you note once monitoring is complete. You may also include a copy of the data sheets and summary of results. This helps ensure willingness on the part of the landowner or property manager to allow the site to be monitored in future years. Landowners are as important a part of our monitoring network as Citizen Scientists—be sure to acknowledge them as partners.

BEYOND MONITORING

In addition to monitoring, the RiverWatch program will provide many other opportunities for Citizen Scientists, such as stream clean-ups, habitat walks, and volunteer recognition picnics. Experienced Citizen Scientists are also invited to assist in site evaluations, training, monitoring supervision, and providing assistance to high school science teachers. Contact your RiverWatch office for details on these and other activities in your area.

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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.

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Appendix A

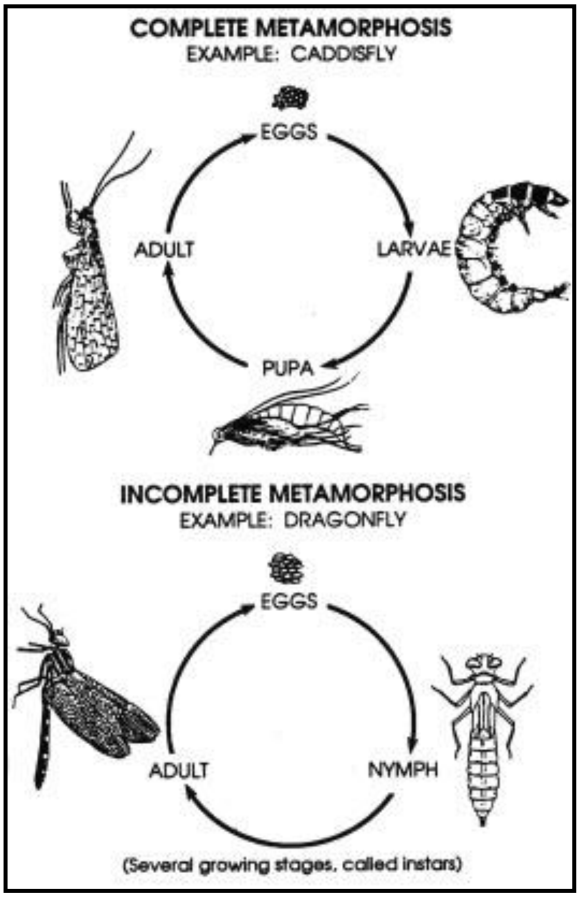
Life History of Aquatic Insects

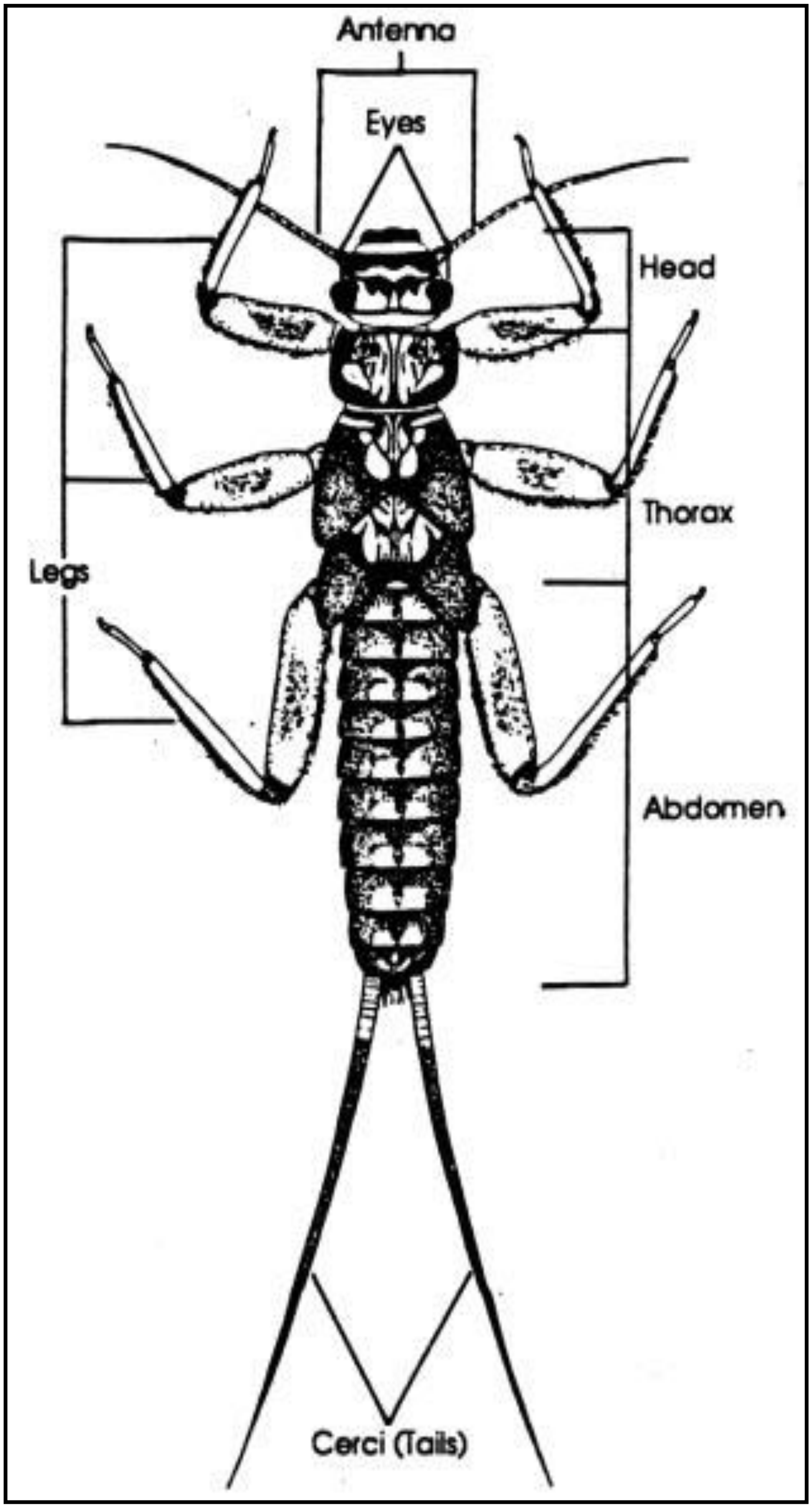
The aquatic insects comprise the bulk of benthic macroinvertebrate communities in healthy, freshwater streams. These insects are mostly in their immature form and live their adult life on land, sometimes for only a few hours. Aquatic insects can be divided into two separate groups: ones that develop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

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.





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.

Appendix B
RiverWatch Stream Quality Indicators Condensed List

Worms

Flatworm
Phylum Platyhelminthes, Order Turbellaria

Aquatic Worm
Phylum Annelida, Order Oligochaeta

Leech
Phylum Annelida, Order Hirudinea

Crustaceans

Sowbug
Phylum Arthropoda, Class Crustacea, Order Isopoda

Scud
Phylum Arthropoda, Class Crustacea, Order Amphipoda

Insects

Dragonfly Larva
Phylum Arthropoda, Class Insecta, Order Odonata, Suborder Anisoptera

Broadwinged Damselfly
Phylum Arthropoda, Class Insecta, Order Odonata, Suborder Zygoptera, Family Calopterygidae

Narrowwinged Damselfly
Phylum Arthropoda, Class Insecta, Order Odonata, Suborder Zygoptera, Family Coenagrionidae

Hellgrammite (Dobsonfly)
Phylum Arthropoda, Class Insecta, Order Megaloptera, Family Corydalidae

Alderfly
Phylum Arthropoda, Class Insecta, Order Megaloptera, Family Sialidae

Torpedo Mayfly Larva
Phylum Arthropoda, Class Insecta, Order Ephemeroptera, Family Isonychiidae

Swimming Mayfly Larva
Phylum Arthropoda, Class Insecta, Order Ephemeroptera, Families Baetidae, Siphlonuridae, Ameletidae

Clinging Mayfly Larva
Phylum Arthropoda, Class Insecta, Order Ephemeroptera, Family Heptageniidae

Crawling Mayfly Larva
Phylum Arthropoda, Class Insecta, Order Ephemeroptera, Families Tricorythidae, Caenidae

Burrowing Mayfly Larva
Phylum Arthropoda, Class Insecta, Order Ephemeroptera, Families Potamanthidae, Ephemeridae

Armored Mayfly
Phylum Arthropoda, Class Insecta, Order Ephemeroptera, Family Baetiscidae

Other Mayfly Larva
Phylum Arthropoda, Class Insecta, Order Ephemeroptera, All Other Families

Stonefly Larva
Phylum Arthropoda, Class Insecta, Order Plecoptera

Hydropsychid Caddisfly Larva
Phylum Arthropoda, Class Insecta, Order Trichoptera, Family Hydropsychidae

Saddlecase Caddisfly Larva
Phylum Arthropoda, Class Insecta, Order Trichoptera, Family Glossosomatidae

Snailcase Caddisfly Larva
Phylum Arthropoda, Class Insecta, Order Trichoptera, Family Helicopsychidae

Other Caddisfly Larva
Phylum Arthropoda, Class Insecta, Order Trichoptera, Various Families

Riffle Beetle (Adult And Larva)
Phylum Arthropoda, Class Insecta, Order Coleoptera, Families Elmidae, Dryopidae

Water Penny Beetle Larva
Phylum Arthropoda, Class Insecta, Order Coleoptera, Family Psephenidae

Whirligig Beetle (Adult and Larva)

Phylum Arthropoda, Class Insecta, Order Coleoptera, Family Gyrinidae

Crane Fly Larva
Phylum Arthropoda, Class Insecta, Order Diptera, Family Tipulidae

Biting Midge Larva
Phylum Arthropoda, Class Insecta, Order Diptera, Family Ceratopogonidae

Bloodworm Midge Larva
Phylum Arthropoda, Class Insecta, Order Diptera, Family Chironomidae

Midge Larva
Phylum Arthropoda, Class Insecta, Order Diptera, Family Chironomidae

Black Fly Larva And Pupae
Phylum Arthropoda, Class Insecta, Order Diptera, Family Simuliidae

Snipe Fly Larva
Phylum Arthropoda, Class Insecta, Order Diptera, Family Athericidae

Other Fly Larva
Phylum Arthropoda, Class Insecta, Order Diptera, Various Families (Culicidae, Tabanidae, Stratiomyidae, Empididae, Syrphidae, Ephydridae, Muscidae Etc.)

Molluscs

Left-Handed Snail
Phylum Mollusca, Class Gastropoda, Family Physidae

Right-Handed Snail
Phylum Mollusca, Class Gastropoda, Family Lymnaeidae

Planorbid Snail
Phylum Mollusca, Class Gastropoda, Family Planorbidae

Freshwater Limpet
Phylum Mollusca, Class Gastropoda, Family Ancylidae

Operculate Snail
Phylum Mollusca, Class Gastropoda, Family Viviparidae

Macroinvertebrates of Special Interest

Freshwater Mussel
Phylum Mollusca, Families Unionidae and Margaritiferidae

Fingernail Clam
Phylum Mollusca, Class Pelecypoda, Family Sphaeriidae

Asiatic Clam *Corbicula fluminea*

Zebra Mussel *Dreissena polymorpha*

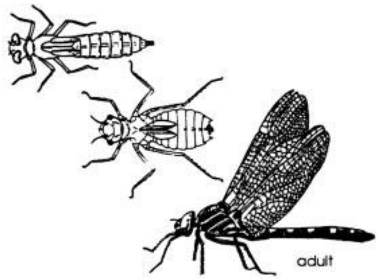
Chinese Mystery Snail *Cipangopaludina Chinensis malleata*

Rusty Crayfish *Orconectes rusticus*

Appendix C

RiverWatch Stream Quality Indicators Description

AQUATIC INSECTS



Dragonflies

Phylum Arthropoda, Class Insecta,
Order Odonata, Suborder Anisoptera
Metamorphosis: incomplete

Nymphs: • vary in shape, but most have robust, elongated, or "spiderlike" 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 developing wings on back • color varies from brown, black, but often green • length up to 2 inches

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

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

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

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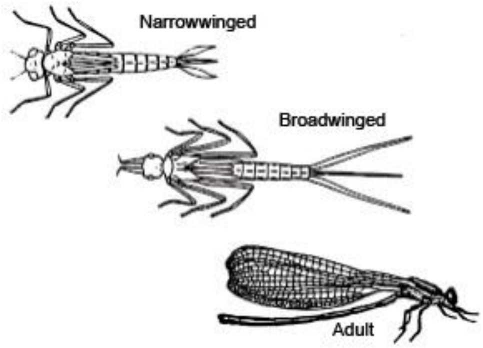
Damselflies

Order Odonata, Suborder Zygoptera, Phylum Arthropoda, Class Insecta
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

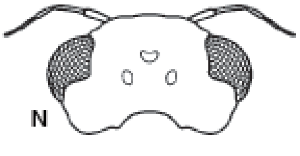
Adults: possess extremely long abdomens • two pairs of wings that are held upright at rest • very colorful in greens, blues, and reds

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

Food: predaceous, nymphs feed on other aquatic macroinvertebrates

Narrowwinged Damselfly
Family Coenagrionidae

Description: nymphs with slender bodies • 3 pairs of jointed legs, and well developed eyes • masklike labium (lower lip) hinged • distinct wingpads on the thorax • 3 leaflike gills at the end of abdomen (Caution: gills are often missing in collected specimens)



Family Calopterygidae

Description: broadwinged damselfly nymphs (B) differ from narrow-winged damselflies (N) by: elongated first segment of antennae makes antennae appear as horns and labium (lower lip) has a large, diamond-shaped, center cleft

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Alderflies

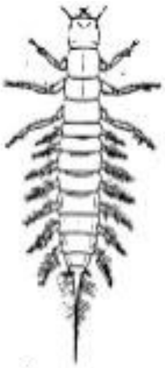
Phylum Arthropoda, Class Insecta, Order Megaloptera, Family Sialidae
Metamorphosis: complete

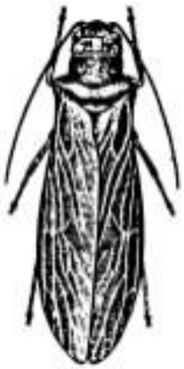
Larvae: possess a single tail filament with distinct hairs • body is thick-skinned with 6 to 8 filaments on each side of the abdomen • gills are located near the base of each filament • color brownish

Adults: dark with long wings folded back over the body

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

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


Larva


Adult

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Dobsonflies

Phylum Arthropoda, Class Insecta, Order Megaloptera, Family Corydalidae
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

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, and are used to grasp the female during copulation • females possess one pair of mandibles smaller than those of the male

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

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


Larva


Adult Male


Adult Female

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Mayflies

Phylum Arthropoda, Class Insecta, Order Ephemeroptera
Metamorphosis: incomplete

Nymphs: three distinct cerci (tails), occasionally two • cerci may be fuzzy or threadlike, but never paddle or fan-like • color varies from green, brown, gray, but usually black • total length up to 1 inch •three pairs of jointed legs, each with a single claw

Adults: resemble nymphs, but usually possess 2 pairs of long, lacy wings folded upright • adults usually have only two cerci

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

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

Torpedo Mayfly Larva
Family Isonychiidae

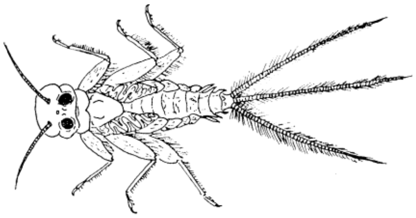
Description: one pair of wingpads apparent, flat gills with tufts along abdomen • thorax extremely hunched and head angle slightly beyond vertical • forelegs with dense comb of long, stout hairs; mouthparts hairy

Swimming Mayfly Larva
Families Baetidae, Siphlonuridae, Ameletidae

Description: one pair of wingpads apparent • flattened gills along abdomen • head vertical, with mouthparts pointing downward

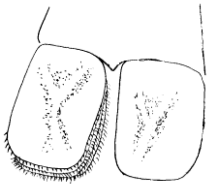
Clinging Mayfly Larva
Family Heptageniidae

Description: one pair of wingpads apparent • flattened gills on abdomen • body and head dorso-ventrally (top to bottom) flattened • large eyes on top of head



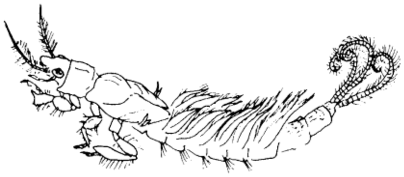
Crawling Mayfly Larva
Families Tricorythidae, Caenidae

Description: one pair of wingpads apparent • gills hidden under plate-like or triangular gill covers on abdominal segment 2 (Caution: if gill covers present on segments 3 or 4, then nymph should be identified as “other mayflies”)



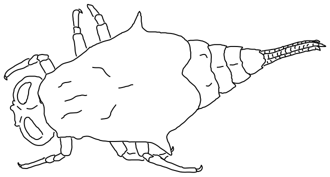
Burrowing Mayfly Larva
Families Potamanthidae, Ephemeridae

Description: one pair of wingpads apparent • forked, fringed gills along abdomen • a pair of tusks projecting forward from mouthparts and visible from above • body pale cream colored or tan with brown or white markings



Armored Mayfly
Family Baetiscidae

Description: one pair of wingpads apparent • body is stout • thorax developed into armor-like shield extending over abdominal segment 5



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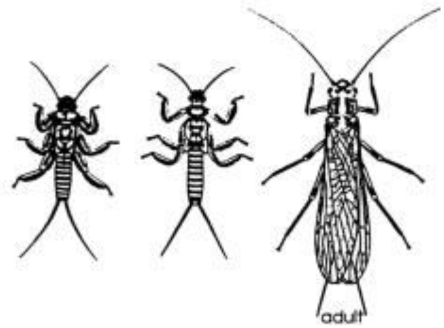
Stoneflies

Order: Plecoptera Phylum Arthropoda, Class Insecta
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.

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

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

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

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Caddisflies

Phylum Arthropoda, Class Insecta, Order Trichoptera
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

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

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

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

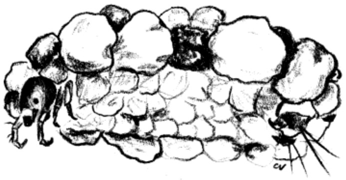
Hydropsychid Caddisfly Larva

Family Hydropsychidae

Description: caddisfly larvae with no case, except when ready to pupate. Thorax with 3 hardened plates. Feathery gills on ventral side of abdomen

Saddle Case Caddisfly Larva

Family Glossosomatidae



Description: caddisfly larvae with case resembling a tortoiseshell (arched at top, flat on bottom) • case is made of rock material • head protrudes from anterior end of case • end of abdomen protrudes from posterior end of case • if larvae are not attached to case, it will have a dorsal plate on first segment of thorax and on abdominal segment 9 • EXTREMELY RARE in Illinois

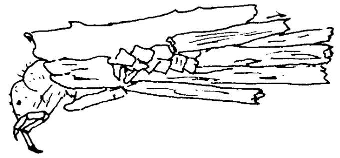
Snail Case Caddisfly Larva

Family Helicopsychidae

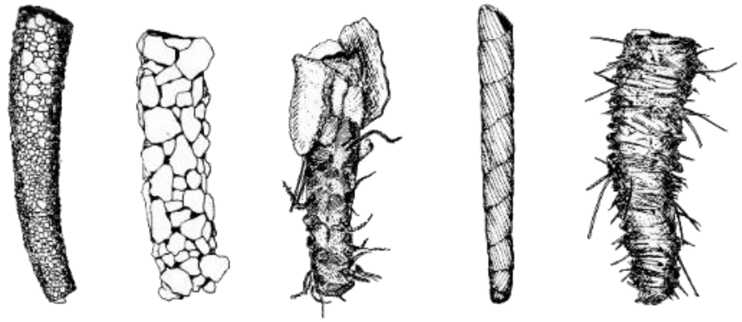
Description: caddisfly larvae with snail shell-shaped case made of sand particles • head and legs usually protrude from a single opening in the case

Other Caddisfly Larva
Various Families

Description: head is well-developed and enveloped by a hard exoskeleton • abdomen fleshy; ends with a pair of prolegs, each with one claw • 3 pairs of jointed legs • free-living or builds cases of sand, stone, sticks, or leaves



Examples of Caddisfly Cases



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Riffle Beetles

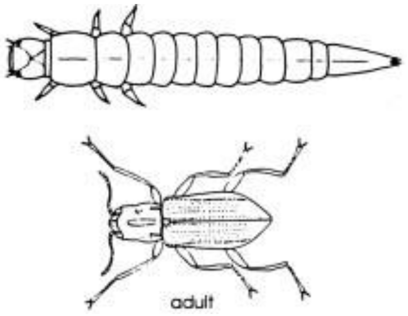
Phylum Arthropoda, Class Insecta, Order Coleoptera, Families Elmidae, Dryopidae
Metamorphosis: complete

Larvae: resemble small “torpedoes” with circular stripes or rings around body • pointed at both ends with a “fuzzy” mass at one end • color usually copper; length less than 1/2 inch

Adults: unique in that they are also aquatic and are found more often than the larvae • adults are tiny, hard-shelled beetles, and usually black

Reproduction: females deposit eggs on plant materials under water

Food: primarily plant material such as diatoms and algae



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Water Penny Beetles

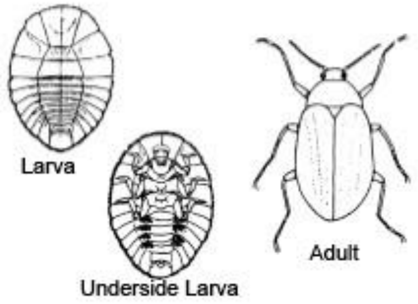
Phylum Arthropoda, Class Insecta, Order Coleoptera, Family Psephenidae
Metamorphosis: complete

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

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

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

Food: primarily plant debris such as algae and diatoms



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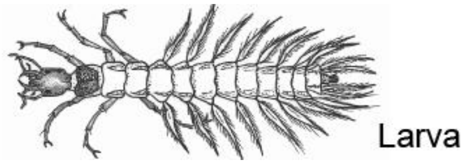
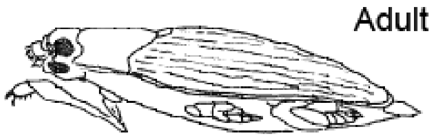
Whirligig Beetles (Adult and Larvae)

Phylum Arthropoda, Class Insecta, Order Coleoptera, Family Gyrinidae
Metamorphosis: complete



Larvae: long, slender, pale-colored • 3 pairs of segmented legs • long, lateral, unsegmented filaments on abdominal segments • end of abdomen bears 2 pairs of sickle-shaped hooks

Adults: shiny, black, oval-shaped beetles with the abdomen projecting beyond the elytra (wing covers) • eyes divided so that they appear to have 2 pairs of eyes, one looking up and one looking down



Reproduction: eggs are laid under the surface of the water

Food: adults feed primarily by preying on small organisms, or by scavenging on small bits of floating material; larvae are predaceous

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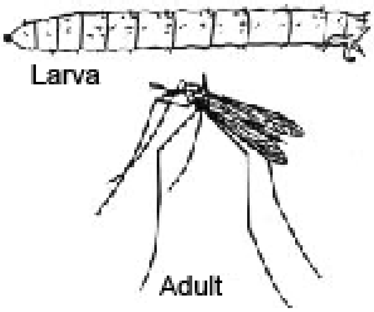
Crane Flies

Phylum Arthropoda, Class Insecta, Order Diptera, Family Tipulidae
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



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

Reproduction: female deposits eggs on submerged vegetation or other debris

Food: mostly plants and plant debris; some are predaceous

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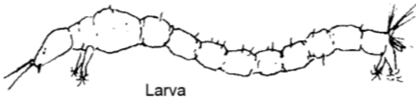
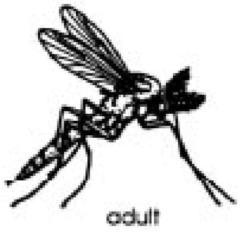
Midges

Phylum Arthropoda, Class Insecta, Order Diptera, Family Chironomidae
Metamorphosis: complete



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

Adults: resemble small mosquitoes with fuzzy antennae on males



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

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

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Biting Midges

Phylum Arthropoda, Class Insecta, Order Diptera, Family Ceratopogonidae
Metamorphosis: complete

Larvae: most are thin and needlelike with no prolegs • prolegs, if present, unpaired on first thoracic segment and paired on the last abdominal segment • those species with prolegs have long, conspicuous spines on the body segment

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

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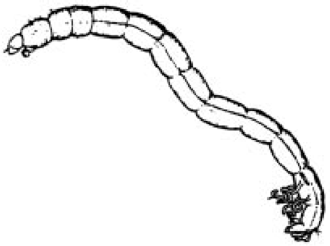
Bloodworm Midges

Phylum Arthropoda, Class Insecta, Order Diptera, Family Chironomidae
Metamorphosis: complete



Larvae: similar to other midges, but are larger, robust, usually red in color when alive • four ventral tubules present on next to last segment • length up to 1 inch

Adults: resemble small mosquitoes with fuzzy antennae on males

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

Food: primarily algae and other organic debris

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Black Flies

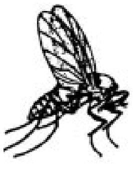
Phylum Arthropoda, Class Insecta, Order Diptera, Family Simuliidae
Metamorphosis: complete

Larva

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

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

Pupa



adult

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

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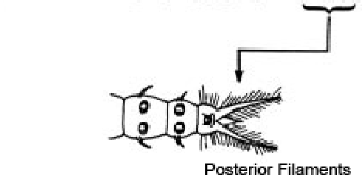
Snipe Flies

Phylum Arthropoda, Class Insecta, Order Diptera, Family Athericidae
Metamorphosis: complete

Larvae: elongated, cylindrical, slightly flattened • two long, fringed filaments at end of abdomen; color varies • length up to 1/2 inch



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

Food: larvae are predaceous, adults mostly feed on blood

Other Fly Larvae

Phylum Arthropoda, Class Insecta, Order Diptera, Various Families (Culicidae, Tabanidae, Stratiomyidae, Empididae, Syrphidae, Ephydridae, Muscidae Etc.)

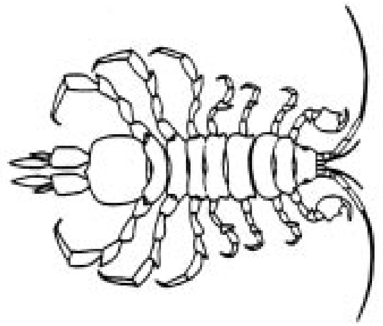
Larvae: usually elongate, wormlike, soft bodies with 12 segments (3 thoracic, 9 abdominal) • no jointed thoracic legs • may have unjointed prolegs • may be naked and smooth, or have tubercles, bristles, spines, or scales • head may be well-developed or vestigial mouthparts either parallel and hooked, or opposed

NON-INSECT MACROINVERTEBRATES:

CRUSTACEA

Sowbugs or Aquatic Pill Bugs

Phylum Arthropoda, Class Crustacea, Order Isopoda



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 plants, and animal debris

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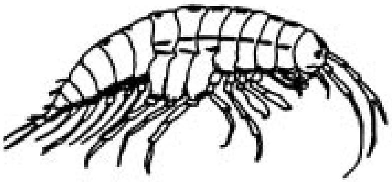
Scuds or Sideswimmers

Phylum Arthropoda, Class Crustacea, Order Amphipoda



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

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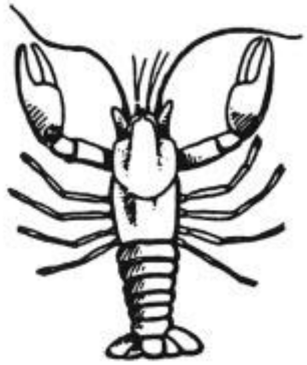
Crayfishes

Order Decapoda



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 (which resembles a raspberry) underneath their tail

Food: omnivorous, eating plants and animals; pinchers are used for tearing food into edible chunks

MOLLUSCA

Right-handed Snails

Phylum Mollusca, Class Gastropoda, Family Lymnaeidae

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 gray, often covered with algae • length is up to 1 inch

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

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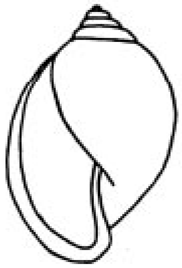
Pouch or Left-handed Snails

Phylum Mollusca, Class Gastropoda, Family Physidae



Description: distinguished from the right-handed snails by the fact that the shell opening is on the left-handed side as the point of the shell is straight up and the opening faces you • does not possess gills, but a sac-like lung with which they can breath air • color is brown, gray, or black, often with algae growing on the shell • length is up to 1/2 inch

Reproduction: gelatinous egg masses are deposited under rocks or other debris

Food: algae, other aquatic plants, and sometimes dead animals; preyed upon by fish, birds, and some turtles

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Limpets

Family Ancylidae

Description: shell is not coiled, but resembles a cap or an inverted cone

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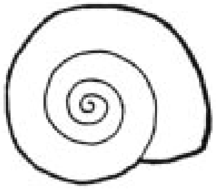
Ramshorn or Planorbid Snails

Family Planoribidae



Description: coiled shell that does not form a spire, but is flat and spiral shaped

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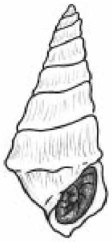
Operculate Snails

Family Viviparidae



Description: resemble right-handed snails but have a hard plate, called an operculum that can seal off the shell opening, protecting the soft-bodied snail inside

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Freshwater Clams and Mussels*

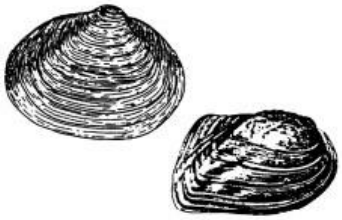
Class Bivalvia

Reproduction: fingernail and Asian 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

Freshwater Mussels

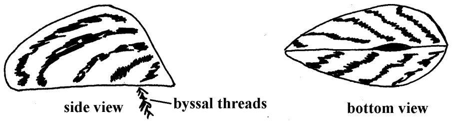
Families Unionidae and Margaritiferidae



Description: often large (up to 9 inches in diameter), robust, thick or thin shelled, and usually dark in color.

Zebra Mussels

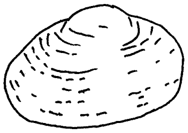
Dreissena polymorpha



Description: small (under 1 inch), triangular shaped shells with alternating cream and brown colored bands; the color and shape of the stripes can vary, hence the name polymorpha

Fingernail Clams

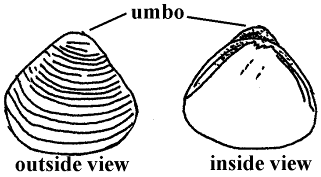
Family Sphaeriidae



Description: small (no more than 1/2 inch in diameter), fragile, cream to tan in color with smooth striations or lines that look like growth rings; about the size of a fingernail

Asiatic Clams

Family Corbiculidae, *Corbicula fluminea*



Description: rounded to slightly triangular shell (2 inches in diameter), yellowish brown to black in color with evenly spaced, elevated growth rings; inside of shell is white with occasionally purple in the region close to the umbo

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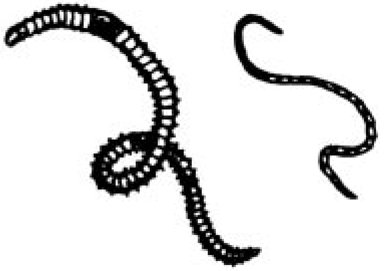
WORMS

Aquatic Worms

Phylum Annelida, Order Oligochaeta



Description: resemble earthworms, but more slender, segmented, color is reddish, brown or gray • reach lengths of up to 3 inches

Reproduction: hermaphroditic, similar to earthworms; fertilization and development of embryos occur in a cocoon

Food: like earthworms, they ingest large quantities of mud and filter out organic debris; fed upon by bottom feeders of fish

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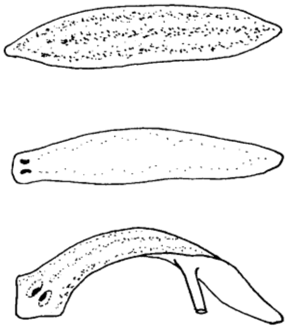
Flatworms or Planarians

Phylum Platyhelminthes, Order Turbellaria



Description: soft bodied, flat and non-segmented worms • gray, brown or black, often mottled, striped or spotted, ventral sides gray • may have two dark eyespots on dorsal side of head

Reproduction: hermaphroditic, although flatworms do not usually fertilize their own eggs

Food: most are carnivores and scavengers that feed on a variety of soft invertebrates

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Leeches

Phylum Annelida, Class Hirudinea

Description: worms that are flattened lengthwise and possess a sucker at each end; color is green, black, brown, or gray, some with patterns of bright colors of yellow and red; length up to 5 inches

Reproduction: similar to aquatic worms

Food: some species feed on blood, others eat detritus, decaying plant and animal debris; not an important food source for fish.

*Denotes Macroinvertebrate of Special Interest

Appendix D

RiverWatch Water Quality Indicators Key

Introduction

Illinois RiverWatch uses biological monitoring to estimate stream health. As indicators of the quality of a stream's biotic community, the benthic macroinvertebrates collected during the biological survey provide useful information for estimating water quality, habitat conditions and overall stream health. Accurate identification of these organisms is essential to producing reliable information for estimating stream health.

This macroinvertebrate identification key is intended for use by RiverWatch Citizen Scientists as a tool for accurate identification of benthic macroinvertebrates. Organisms featured in the key are specific to Illinois streams. Macroinvertebrates commonly found elsewhere in the Midwest may also be identified using this key, since most organisms listed are common to the region.

Learning the Lingo

Aquatic organisms are identified based on their physical characteristics. Most aquatic organisms share common features that allow them to survive in aquatic habitats. As they evolved, each species also developed unique structures and body shapes well suited for survival in a particular microhabitat. For instance, the adult whirligig beetle is a predator that swims at the water surface. Its eyes are divided so that it has one pair of eyes that can see above the water and one that can see underwater. Some have chewing mouthparts while others have piercing or sucking mouthparts; some have gills while others have siphons or breathing tubes; some have short, flattened bodies while others are slender or curved. These distinctive features are used to separate one group of organisms from another until each can be identified based on its unique physical characteristics.

A firm grasp of the vocabulary used to distinguish these features is essential to identifying benthic macroinvertebrates. Basic terms describe orientation, body divisions, body structures and other aspects of the organism. *Orientation* refers to the direction or location (top, bottom, front, back, etc.) of a particular structure on the body of the organism being identified. *Body divisions* are the parts or sections (head, thorax, abdomen, etc.) of the organism. Common orientation and body division terms are introduced in the following section. *Body structure* terms describe specific parts of the organism, such as legs, claws, wings or gills. *Other descriptive terms* are also used to further describe particular structures of the organism. Terms used in this key are defined in the glossary.

From Top to Bottom and Head to Tail: Some Basic Terms

Several common orientation terms are used to indicate the position of a specific structure. These terms are usually variations on top, bottom, front and back. Figure 1 illustrates where some of these terms are referring to in reference to a generic aquatic insect.

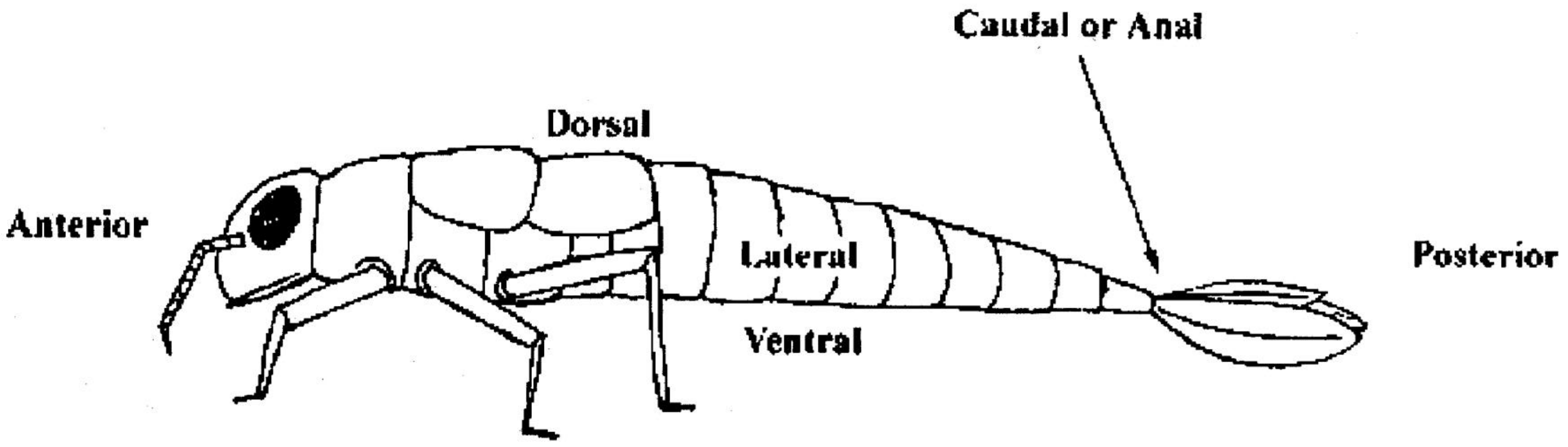


Figure 1: Aquatic Insect Orientations

Most aquatic insect bodies are divided into three regions: the *head*, *thorax* and *abdomen*. The head usually appears as a single segment, although it actually consists of six or seven fused segments. It includes the mouthparts and sensory structures such as the eyes and antennae.

The second region, or thorax, is located immediately behind the head. It consists of three segments: the *prothorax* (first segment), *mesothorax* (second or middle segment), and *metathorax* (third or last segment). Legs or wings are attached to the thorax. The feet of an insect are referred to as *tarsal segments* or *tarsi*.

The third region is called the abdomen. It is located immediately behind the thorax and is often the longest region of the body. The abdomen typically consists of 8 to 11 segments, and may have various hairs, filaments or gills attached. Many insect larvae also have structures attached to the end of the abdomen, such as hooks, prolegs or respiratory structures.

The thorax and abdomen are often difficult to distinguish in some insects (members of the *Diptera* family, for example), and are sometimes referred to together as the *trunk*. The three body divisions are illustrated using a diagram of a generic aquatic insect in Figure 2.

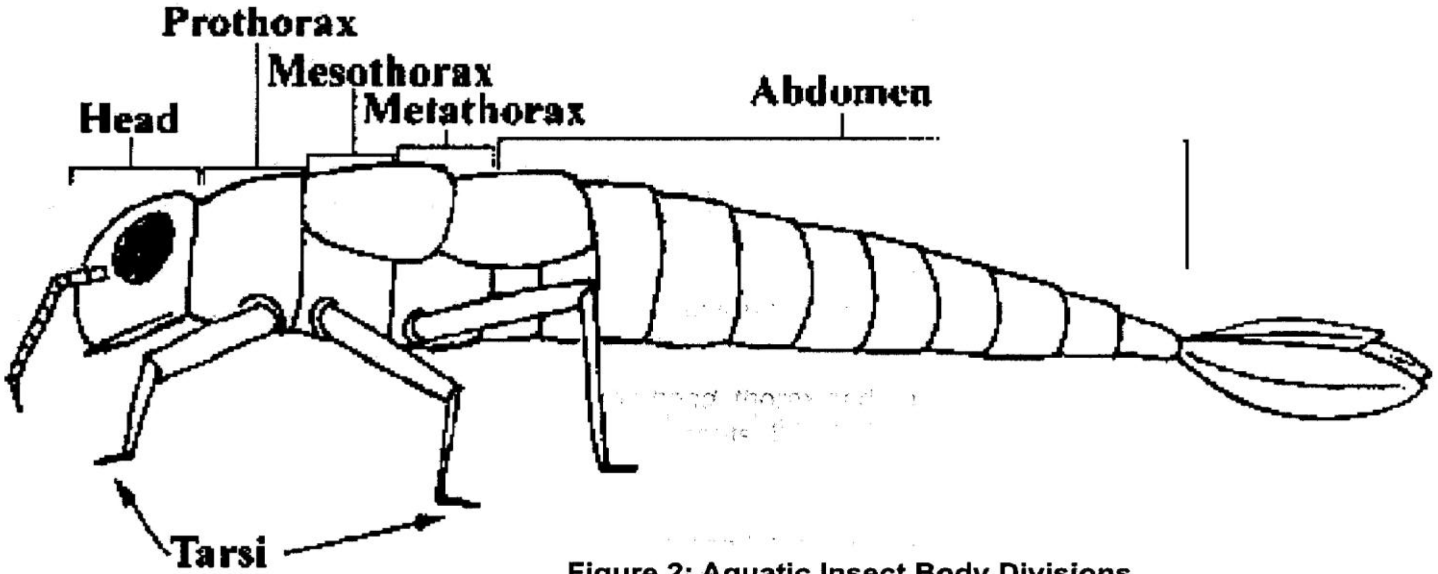


Figure 2: Aquatic Insect Body Divisions

How to Use This Key

This key is designed for those with little or no previous experience identifying benthic macroinvertebrates. Using detailed illustrations and simple descriptions of key structures, aquatic insects can be identified through a simple process of elimination. Each pair of choices, or couplets, represents a branch in the “family tree” of Illinois RiverWatch Stream Quality Indicators.

To use the key, read each choice and select the one which best describes the organism being identified. Once a choice is selected, follow the arrow to the next pair of choices. Continue making choices and following arrows until no further choices or arrows are offered. When this “dead end” is reached, the name of the organism is listed.

All Illinois RiverWatch indicator organisms are listed in the key. Other (non-indicator) organisms commonly found in Illinois streams are also included. These non-indicator organisms are noted where they appear.

This key should be used as the primary tool for identifying benthic macroinvertebrate samples collected for RiverWatch. Once a positive identification is made, it should be cross-checked using RiverWatch field reference cards (*Stream Quality Indicators of Illinois*) or one of the other identification keys recommended in the Illinois RiverWatch Stream Monitoring Manual.

Text adapted in part from *Aquatic Entomology: The Fishermen’s and Ecologists’ Illustrated Guide to Insects and Their Relatives (W. Patrick McCafferty, 1981)*

Glossary

ORIENTATION

Anterior — forward; refers to the head end of the body or that part of a structure located nearest the head of the body

Basal — origin; refers to the origin of a structure, generally closest to the point of attachment to the body

Distal — end; refers to that part of a structure furthermost from its point of attachment to the body

Dorsal — top, upper or back; refers to the upper or top part of the body or structure

Lateral — side; refers to the site of the body or structure

Medial — middle; refers to the longitudinal midline of the body

Posterior — rear; refers to the tail end of the body or that part of a structure located nearest the tail of the body

Ventral — lower, bottom or front; refers to the lower or bottom part of the body or structure

BODY DIVISIONS

Abdomen — the third major body region of an insect, typically divided into 8 to 11 individual segments

Head — the first major body region of an insect, including mouthparts and sensory structures such as the eyes and antennae.

Mesothorax — the second or middle segment of the thorax

Metathorax — the third, most posterior segment of the thorax

Prothorax — the first, most anterior segment of the thorax

Thorax — the second (middle) major body region of an insect, often divided into three parts or segments

BODY STRUCTURES

Antennae — a variously shaped appendage of the head, occurring in pairs, commonly located between the eyes

Beak — hard, cone-shaped mouthparts

Cephalothorax — a single body region consisting of a head and thorax that are little differentiated from each other

Compound eyes — multifaceted eyes, usually situated laterally on the head of some aquatic insects (dragonflies, damselflies,

Mouthparts — any of several various structures which form the mouth of an insect; typical structures include the labrum, labium, madibles, maxilla

Exoskeleton — external, rigid body wall of arthropods

Eyespots — single eye or eye-like structure found on the head

beetles, etc.)

Filaments — slender, finger- or thread-like appendage such as antennae or gills

Gills — structures used for absorption of oxygen from the water

Labium — lower lip or most posterior whole mouthpart of the insect head

Labrum — upper lip or most anterior, unpaired mouthpart of the insect head
Lobe — a rounded projection
Operculum — a covering of a chamber (ex.: the disc-like structure covering the opening of the shell in an operculate snail)
Plate-like gills — broad, flattened gills
Prolegs — a fleshy, unsegmented, leglike or lobelike structure; usually occurring in pairs and located on the thorax of some fly larva and on the abdomen of various other insect larva
Protuberance — a projection or bulge; a rounded projection
Simple eyes — non-faceted eyes, usually smaller than compound eyes
Spiracle — an external opening along the body wall of insects used for air intake
Tubules — long, filamentous, tube-shaped structures
Wingpad — a developing wing or sheath of a developing wing

OTHER DESCRIPTIVE TERMS

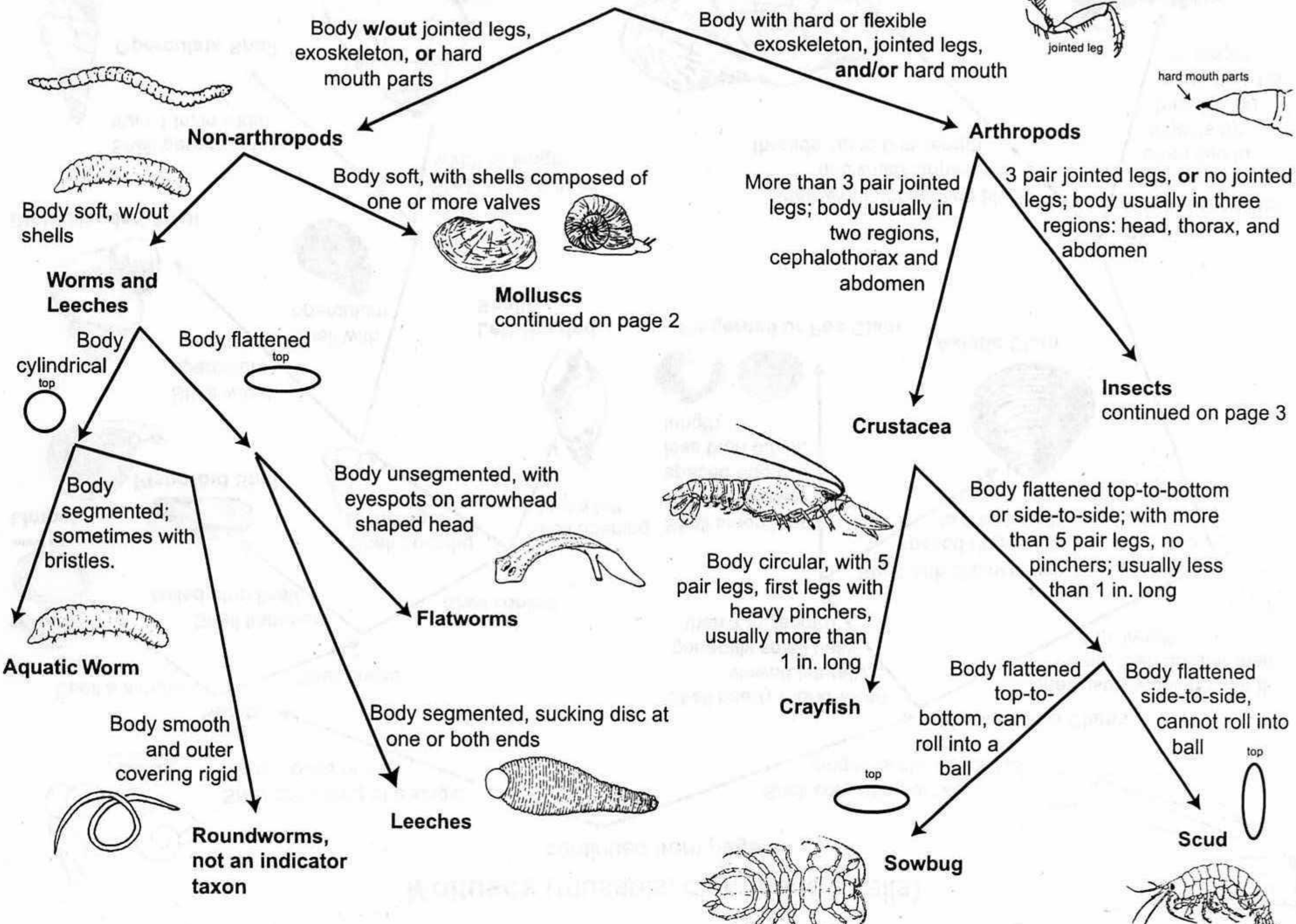
Apex — tip or point of a structure
Caudal (or Anal) — a structure that is located on the very end, or near the anus of an organism
Elongated — long and thin; extended and lengthened
Membranous — consisting of or resembling a thin, pliable skin-like tissue serving to line or connect various body structures
Operculate — functioning as a covering for other structures (ex.: the triangular, rectangular or oval shaped gill coverings on the abdominal segments of various mayfly larvae)
Segmented — divided into sections, often of similar size, and joined in a linear fashion (ex.: leeches, aquatic worms and the abdominal regions of many aquatic insects)
Terminal — forming or located at the end of a structure

Definitions adapted in part from *Aquatic Entomology: The Fishermen's and Ecologists' Illustrated Guide to Insects and Their Relatives (W. Patrick McCafferty, 1981)*

Key prepared by Dr. R. Edward DeWalt and Carolyn Peet Nixon of the Illinois Natural History Survey, 607 E. Peabody Drive, Champaign, Illinois 61820.

Drawings in the key by C. Nixon or from The Mayflies of Illinois (B.D. Burks, Illinois Natural History Survey); The Caddis Flies, or Trichoptera, of Illinois (Herbert H. Ross, Illinois Natural History Survey); The Taxonmoy and Bionomics of the Aquatic Hermiptera of Illinois (David Robert Lauck, unpublished Masters Thesis from the University of Illinois); or Freshwater Sphaeriacean Clams (Mollusca: Pelecypoda) of North America (J.B. Burch, US EPA)

Aquatic Macroinvertebrates



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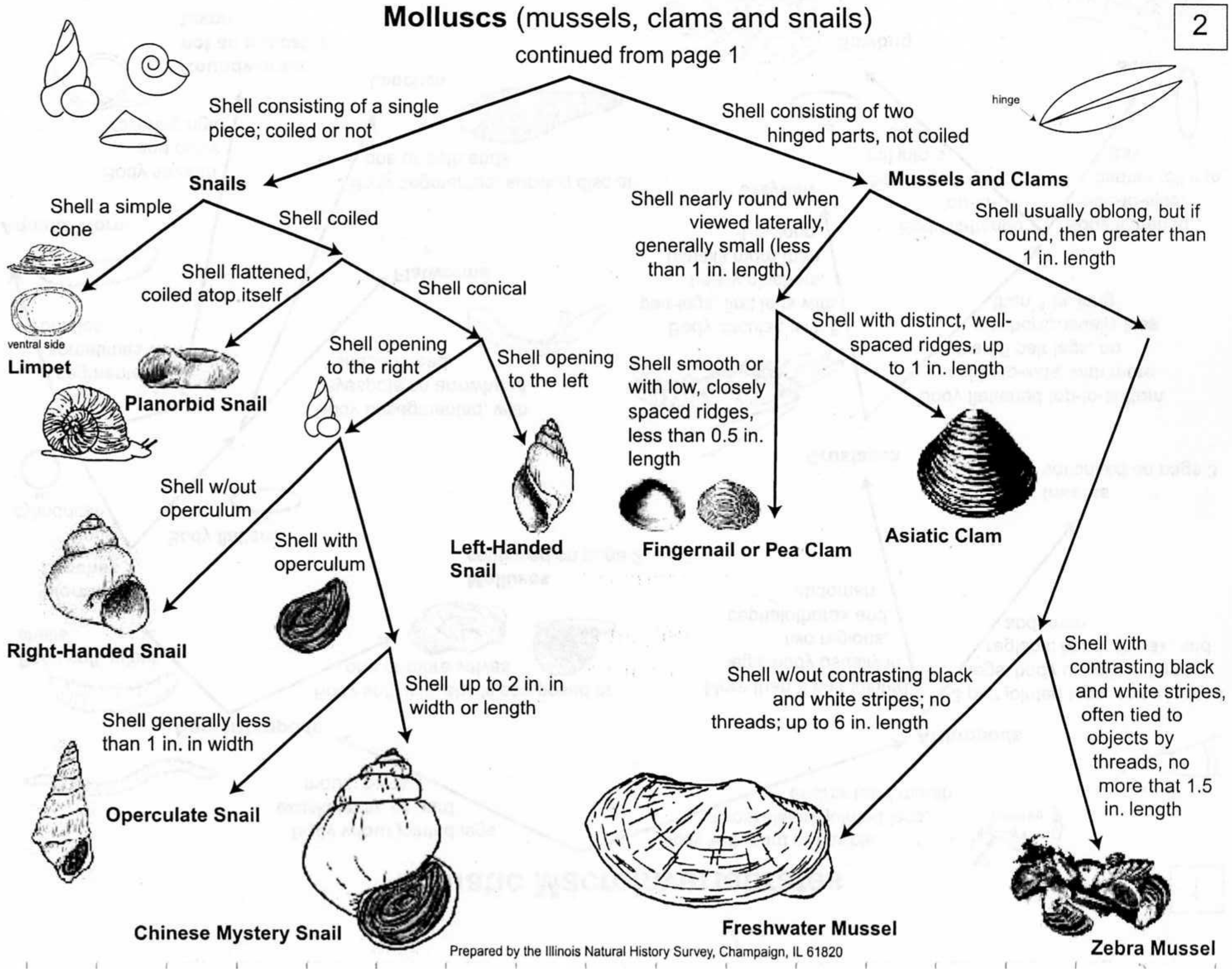
Molluscs (mussels, clams and snails)



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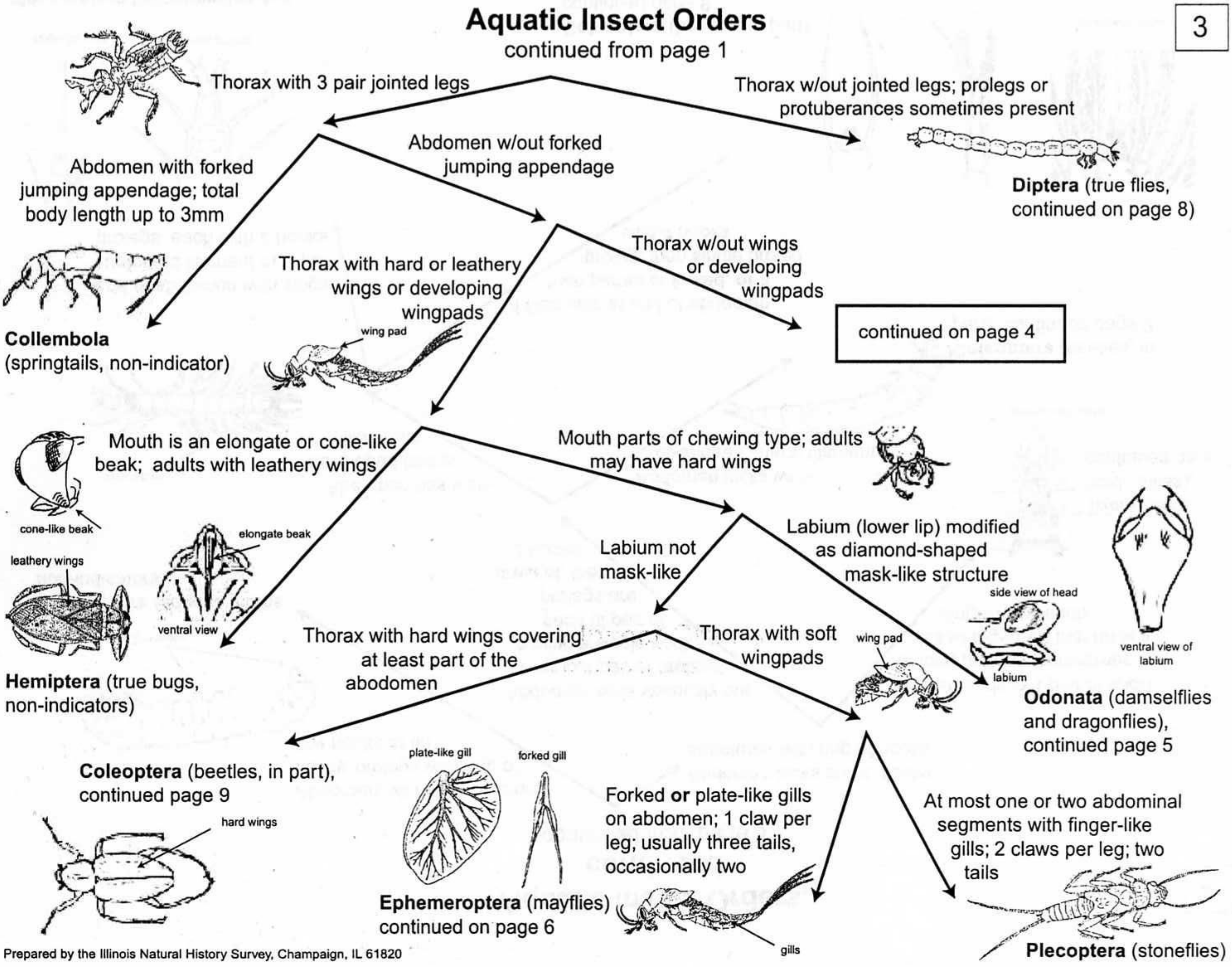
Aquatic Insect Orders

continued from page 1



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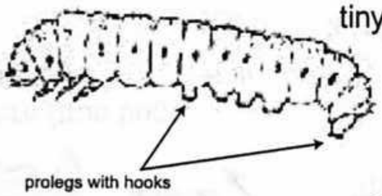
Aquatic Insect Orders, continued

continued from page 3

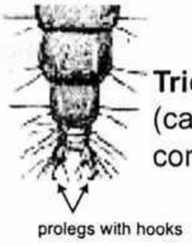
Abdomen with pairs of short, fleshy, prolegs with ring of tiny hooks at tip



Lepidoptera (aquatic moths, non-indicators)

Abdomen lacks short, fleshy, structures with ring of hooks

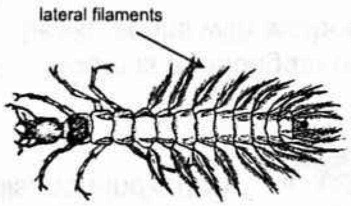
Abdomen ends in 1 pair of short or long prolegs (sometimes fused together) that have a single hook each.



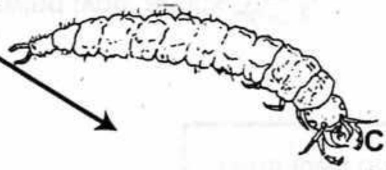
Trichoptera (caddisflies), continued page 7

Abdomen ends variously but never in 1 pair of prolegs having a single hook each (if pair of prolegs are present, then 2 hooks

Abdomen has well-developed lateral filaments

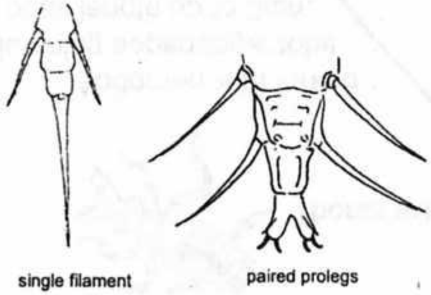


Abdomen lacks well-developed lateral filaments



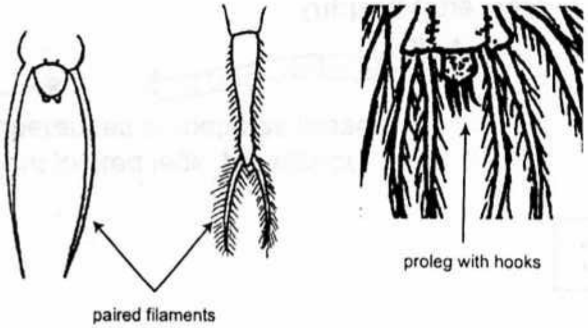
Coleoptera (beetles, in part), continued page 9

End of abdomen with single, unforked filament **or** 1 pair prolegs, each with 2 hooks



Megaloptera hellgrammites and alderflies), continued page 5

If filaments at end of abdomen, then paired or forked, **or** if proleg, then single proleg with 4 hooks



Coleoptera (beetles, in part) continued page 9

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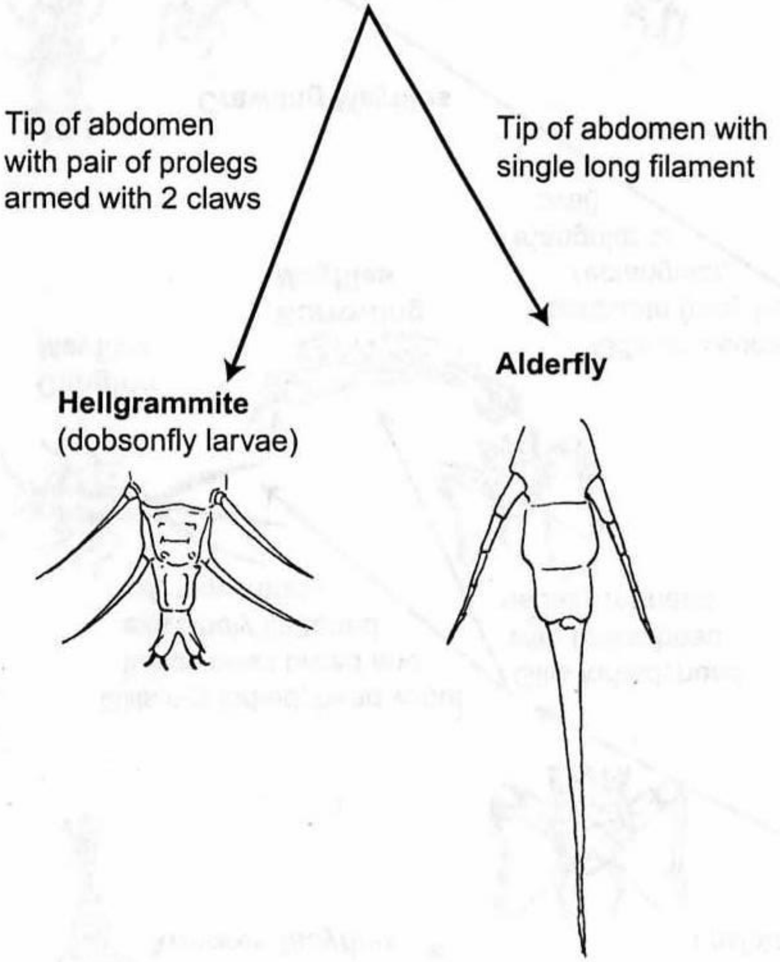
5

Megaloptera (dobson flies and alderflies)

continued from page 4



Tip of abdomen with pair of prolegs armed with 2 claws

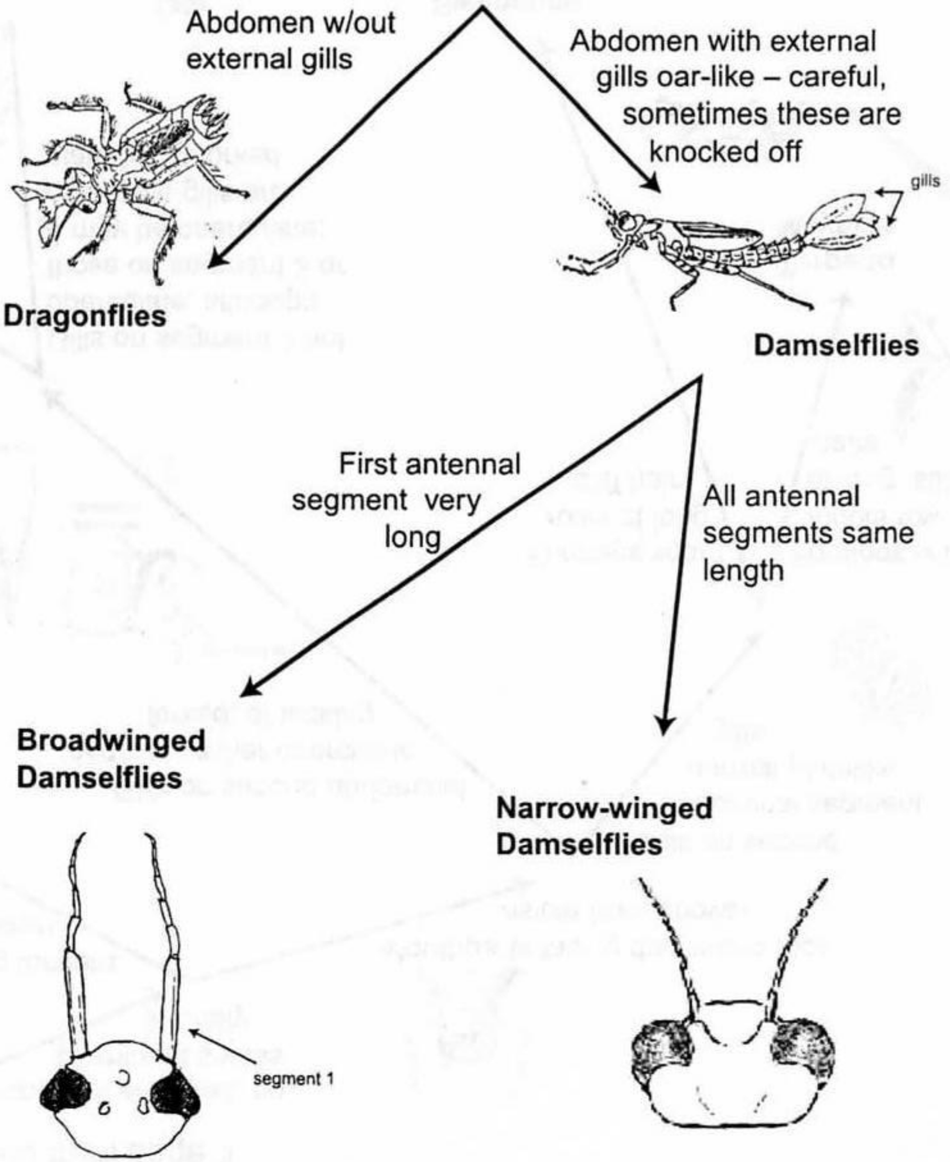
Hellgrammite
(dobsonfly larvae)

Tip of abdomen with single long filament

Alderfly

Odonata (dragonflies and damselflies)

continued from page 3



Abdomen w/out external gills

Dragonflies

Abdomen with external gills oar-like – careful, sometimes these are knocked off

Damselflies

First antennal segment very long

Broadwinged Damselflies

All antennal segments same length

Narrow-winged Damselflies

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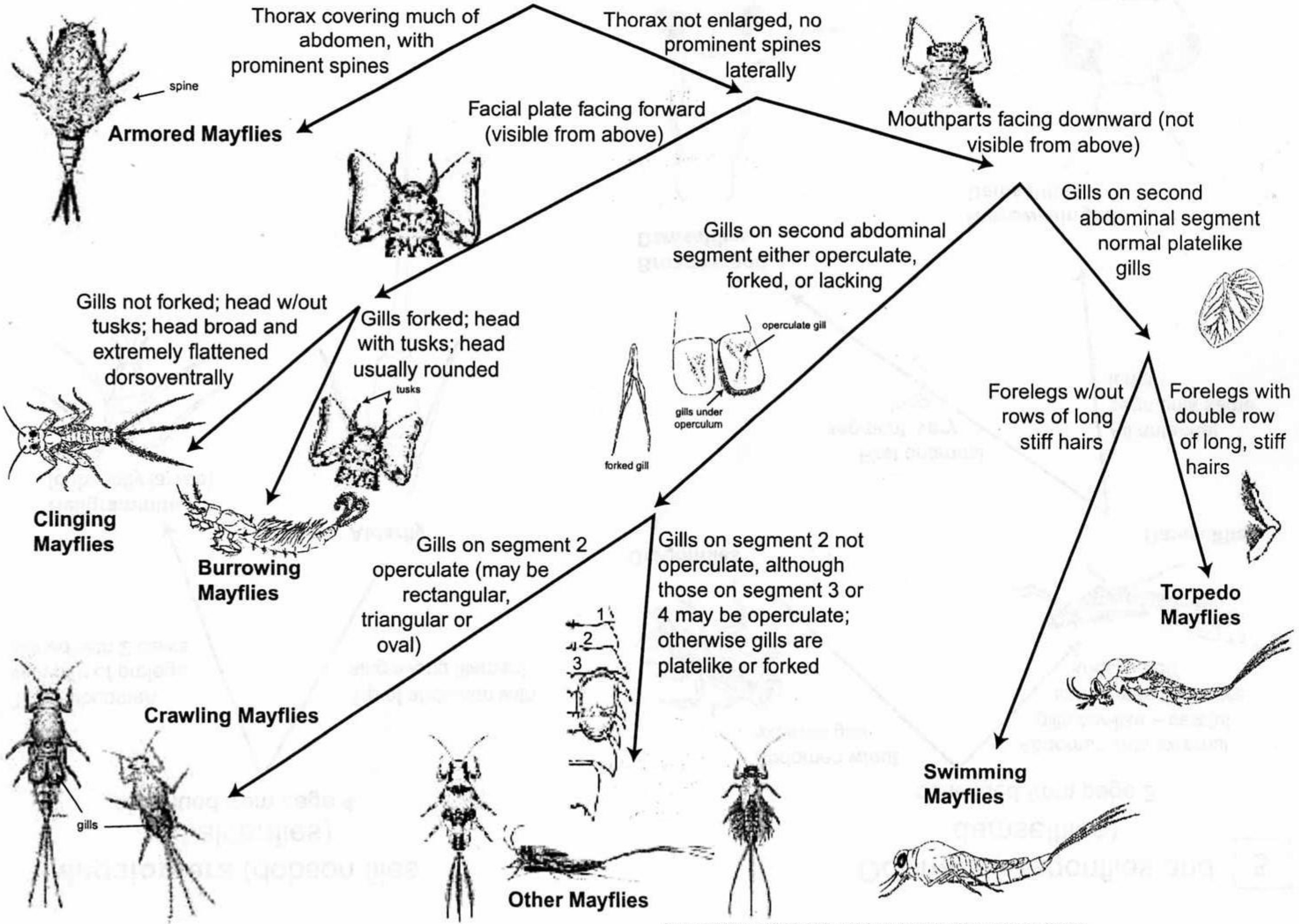
Ephemeroptera (mayflies)

continued from page 3



Thorax covering much of abdomen, with prominent spines

Armored Mayflies

Thorax not enlarged, no prominent spines laterally

Facial plate facing forward (visible from above)

Gills not forked; head w/out tusks; head broad and extremely flattened dorsoventrally

Clinging Mayflies

Gills forked; head with tusks; head usually rounded

Burrowing Mayflies

Mouthparts facing downward (not visible from above)

Gills on second abdominal segment either operculate, forked, or lacking

Gills on segment 2 operculate (may be rectangular, triangular or oval)

Crawling Mayflies

Gills on segment 2 not operculate, although those on segment 3 or 4 may be operculate; otherwise gills are platelike or forked

Other Mayflies

Gills on second abdominal segment normal platelike gills

Forelegs w/out rows of long stiff hairs

Swimming Mayflies

Forelegs with double row of long, stiff hairs

Torpedo Mayflies

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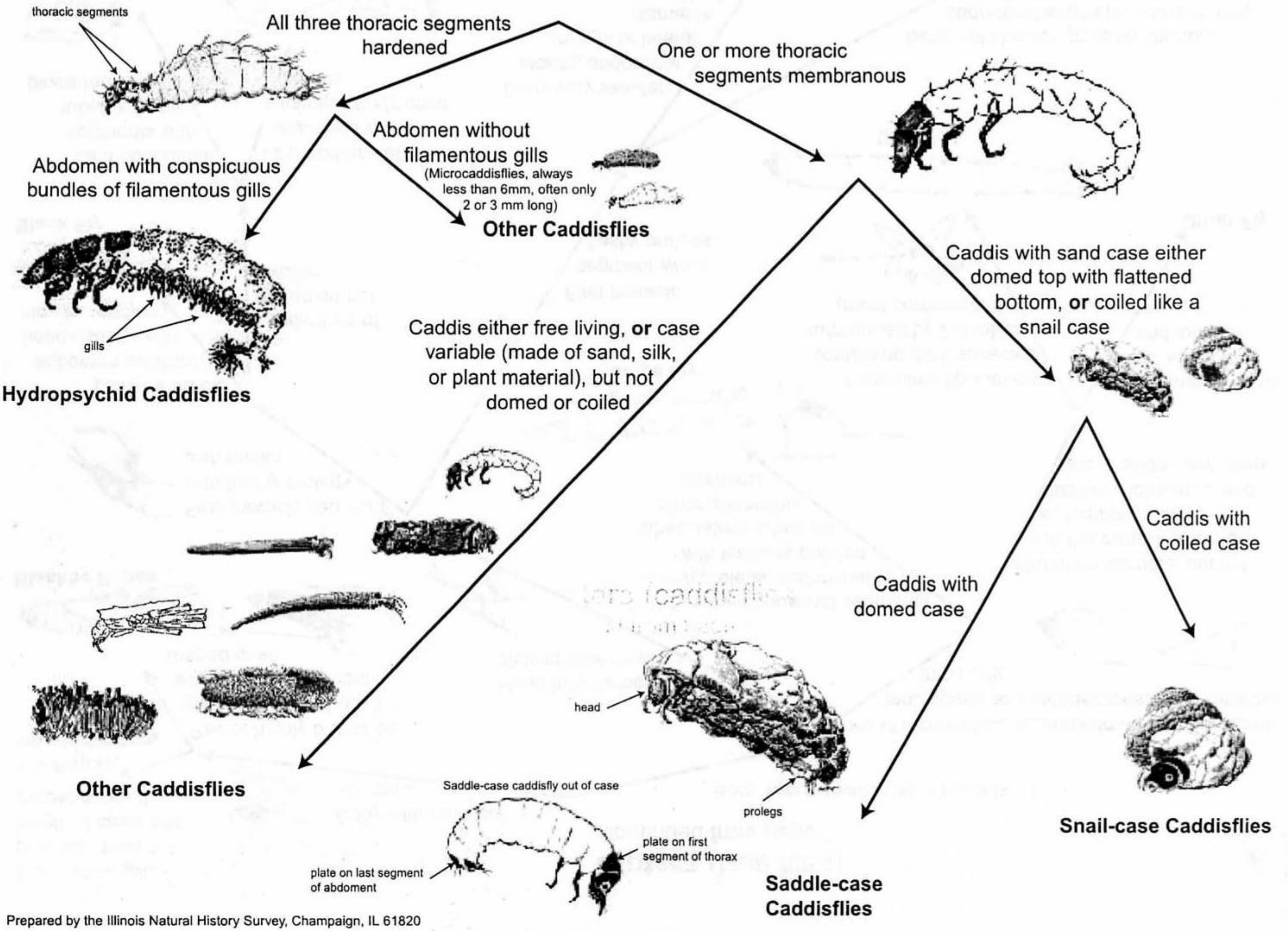
7

Trichoptera (caddisflies)

continued from page 4



All three thoracic segments hardened

One or more thoracic segments membranous

Abdomen with conspicuous bundles of filamentous gills

Hydropsychid Caddisflies

Abdomen without filamentous gills (Microcaddisflies, always less than 6mm, often only 2 or 3 mm long)

Other Caddisflies

Caddis either free living, **or** case variable (made of sand, silk, or plant material), but not domed or coiled

Other Caddisflies

Caddis with sand case either domed top with flattened bottom, **or** coiled like a snail case

Caddis with domed case

Saddle-case Caddisflies

Caddis with coiled case

Snail-case Caddisflies

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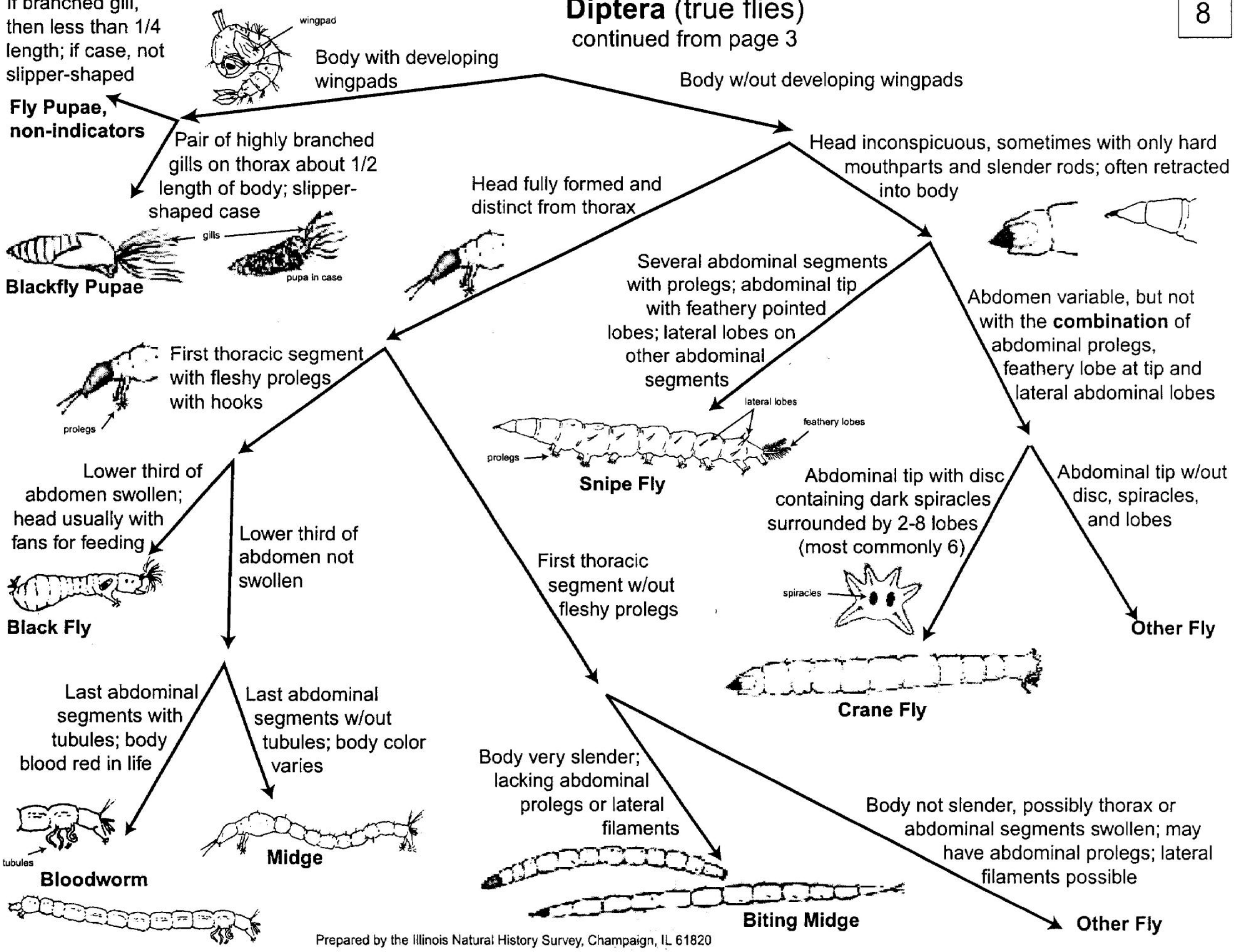
8

Diptera (true flies)

continued from page 3



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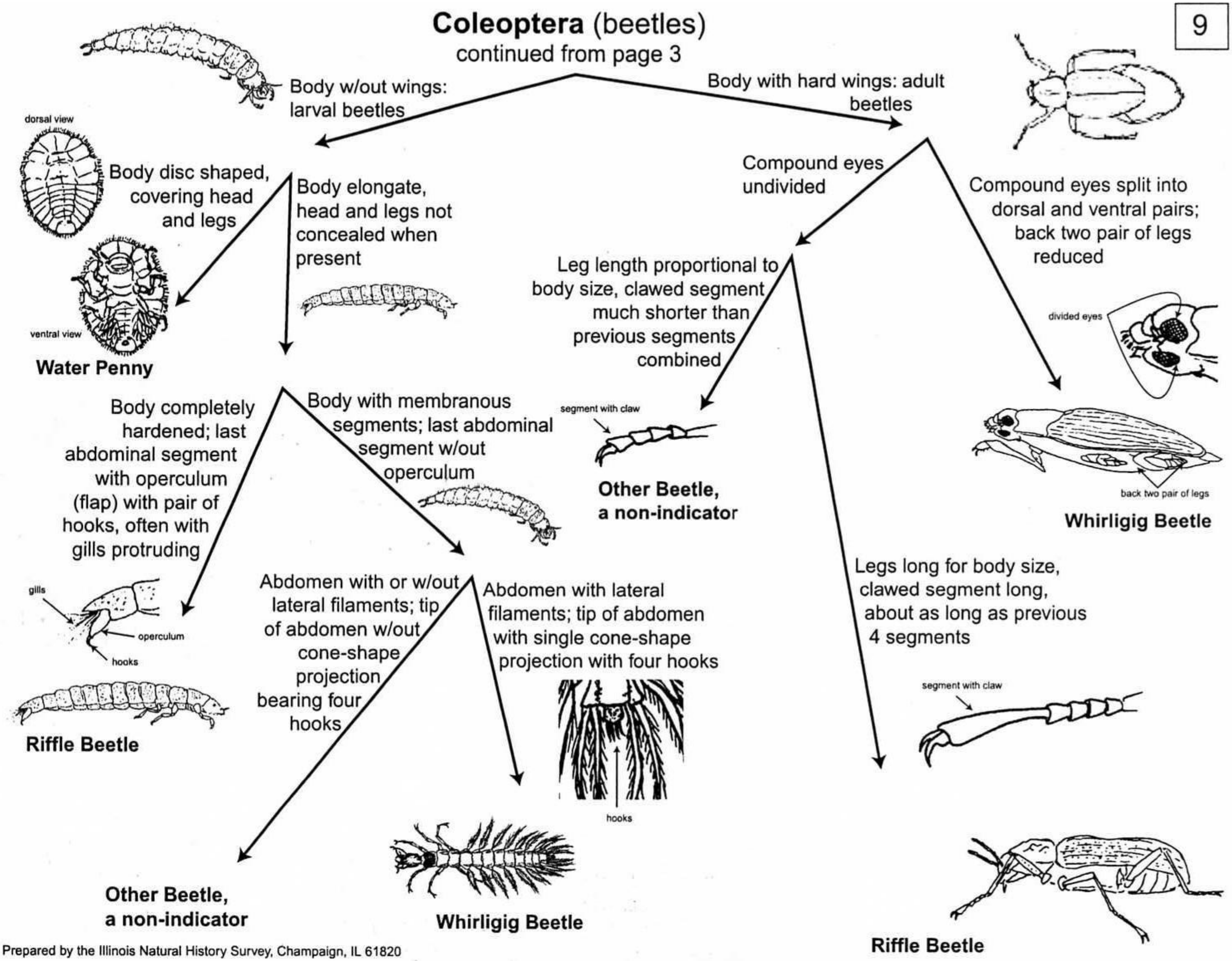
Coleoptera (beetles)

continued from page 3

9



Body w/out wings: larval beetles

Body disc shaped, covering head and legs

Water Penny

Body elongate, head and legs not concealed when present

Body completely hardened; last abdominal segment with operculum (flap) with pair of hooks, often with gills protruding

Riffle Beetle

Body with membranous segments; last abdominal segment w/out operculum

Abdomen with or w/out lateral filaments; tip of abdomen w/out cone-shape projection bearing four hooks

Other Beetle, a non-indicator

Abdomen with lateral filaments; tip of abdomen with single cone-shape projection with four hooks

Whirligig Beetle

Body with hard wings: adult beetles

Compound eyes undivided

Leg length proportional to body size, clawed segment much shorter than previous segments combined

Other Beetle, a non-indicator

Legs long for body size, clawed segment long, about as long as previous 4 segments

Riffle Beetle

Compound eyes split into dorsal and ventral pairs; back two pair of legs reduced

Whirligig Beetle

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Appendix E
Loaner Monitoring Kit Contents

RiverWatch monitoring kits are available for you to check out from various locations around the state. To locate the nearest kit location, visit: www.ngrrec.org/monitoringresources_watch.htm.

Each monitoring kit includes the following items:

1	3-5 gallon bucket
10	site markers (flags)
1	50’ measuring tape, marked off in decimal feet (tenths of a foot)
1	thermometer
1	practice golf (whiffle) ball
1	dip net
1	subsampling pan
1	wash bottle
2	forceps
2	water droppers/pipettes
2	pocket magnifiers
1	random number cup

If any of the above items are missing or damaged, please let the staff at the loaner kit location know and contact the RiverWatch Coordinator at 618-468-4870 or vbojic@lc.edu.

Monitors should supply:

- copy of data sheets and pencil
- small calculator
- small bottle of 90% isopropyl (rubbing) alcohol or 70% ethyl alcohol
- clean glass jar with secure lid (no larger than 8 oz)
- vial label
- digital or regular camera for documenting changes to your site
- knee-high boots or waders, or an old pair of gym shoes
- drinking water
- cell phone (for emergencies)
- first aid kit and flashlight
- towel or change of clothes suitable for the season
- insect repellent, sunscreen, sunglasses
- stopwatch or secondhand watch
- soda water (club soda) to slow down macroinvertebrates in tray

Appendix F
Equipment Suppliers

The equipment needed to conduct RiverWatch monitoring is listed in the Getting Started section of this manual. Several monitoring kits are available on short term loan from various facilities around the state. The complete list of loaner kit locations is available on the RiverWatch website. Volunteers who wish to purchase their own equipment can use this list of suggested scientific suppliers to locate what they need. Please keep in mind that some pieces of equipment, such as the dip net, thermometer and measuring tape have specific requirements.

NOTE — The listing of any commercial scientific/education supplier does not imply an official endorsement by the National Great Rivers Research and Education Center for the products or the supplier. The list is provided to help Citizen Scientists purchase good monitoring equipment at a reasonable cost. Additional suppliers may be added to the list as they are identified.

Equipment	**Supplier**
Compasses	Cynmar, Forestry Suppliers
Dip nets	BioQuip, Forestry Suppliers, NASCO
Dissecting forceps	BioQuip, Cynmar, NASCO, Forestry Suppliers
Dissecting microscopes	Cynmar
Engineering rule measuring tapes	Forestry Suppliers
Entomological forceps	Forestry Suppliers
Glass jars/vials	Cynmar, BioQuip
Magnifiers (pocket)	BioQuip, Cynmar, Forestry Suppliers, Wildco
Petri plates	Cynmar
Pipettes (disposable)	Ward’s
Rite-N-Rain paper	NASCO, Forestry Suppliers
Stopwatches	Cynmar
Subsampling/larval trays	BioQuip
Thermometers	BioQuip, Cynmar, NASCO, Forestry Suppliers, Wildco

Supplier Contact Information

BioQuip Products, Inc.
17803 LaSalle Avenue
Gardena, CA 90248-3502
Phone: 310-324-0620
Fax: 310-324-7931
www.bioquip.com/default.asp

Cynmar Corporation
131 North Broad Street
PO Box 530
Carlinville, IL 62626
Phone: 800-223-3517
Fax: 800-754-5154
www.cynmar.com

NASCO - Fort Atkinson
901 Janesville Avenue
Fort Atkinson, WI 53538-0901
Phone: 800-558-9595
Fax: 414-563-8296
www.nascofa.com

Forestry Suppliers, Inc.
PO Box 8397
Jackson, MS 39284-8397
Phone: 800-647-5368
Fax: 800-543-4203
www.Forestry-Suppliers.com

Ward's Natural Science
PO Box 92912
Rochester, NY 14692-9012
Phone: 800-962-2660
Fax: 585-334-6174
www.wardsci.com

Wildco
PO Box 8397
Jackson, MS 39284-8397
Phone: 800-647-5368
Fax: 800-543-4203
www.Forestry-Suppliers.com

Appendix G
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 biosensors, 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. 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 µg/m3) 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 whose 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.

Invertebrate — Organism lacking a backbone.

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.

Nymph — Immature form of some insect species.

-O-

Order — A scientific rank between class and family.

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.

Phylum — A scientific rank between kingdom and class.

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.

Submergent Plant — A plant that is completely beneath the surface of water.

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.

Streambed---The channel bottom of a stream, river or creek.

-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.

Notes