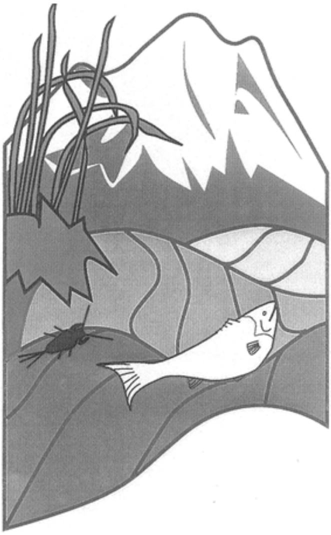
Alaska Stream Team



Educational Level
Water Quality Monitoring Field Guide

Third Edition • April 2004

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Contents

Ecosystem protection begins when friends, schools, and neighbors share a common interest in protecting the local environment.

It continues through innovative scientific methods and programs that help us find the solutions.

Acknowledgments

This manual reflects the methods stream ecologists currently use to assess the health of Alaska streams. The information is based on the Alaska Water Watch, Partners in Environmental Stewardship program. This was a cooperative effort by the Alaska Department of Environmental Conservation, Alaska Department of Fish and Game (ADFG), University of Alaska Anchorage's Environment and Natural Resources Institute (ENRI), University of Alaska Fairbanks' Alaska Cooperative Extension, U.S. Environmental Protection Agency, and the Anchorage School District.

The sampling methods used in the original version have changed. The reason for this revised approach is to present teachers with a simplified method that can be completed within class-time restrictions, is consistent with other more technical level efforts, and encourages a standardized statewide approach to monitoring at an educational level. For further information, cooperating agencies are listed below with a brief description of how they can help you.

- University of Alaska Anchorage, ENRI
  —*Rapid bioassessment methods and training*
  Dan Bogan, 257-2744
- ADFG, Sport Fish Division
  —*Salmon habitat and life history education programs*
  Anchorage, Fritz Kraus, 267-2265
  Juneau, Jon Lyman, 465-6186
- Alaska Department of Environmental Conservation
  —*Statewide water pollution prevention information*
  Kent Patrick-Riley, 269-7554
- University of Alaska Fairbanks, Cooperative Extension Service
  —*Water Quality/ Watershed Education*
  Fred Sorensen, 786-6311
- Anchorage School District—*Teacher training*
  Chugiak High School: Ralph Baldwin, 742-3051
  Elementary Science Department: Trisha Herminghaus, 742-4858
- Campbell Creek Science Center, *Educational programs,* 267-1247

Sampling with a D-net.

Alaska's Watersheds

A **watershed** is an area of land from which all of the water drains into a common water body. Streams and rivers in Alaska's watersheds serve as sources for food and drinking water, navigation, and recreation. Even the smallest of Alaska's streams represent the beginning of a network of flowing waters that connect in a long, gradual journey to the ocean. It is generally understood that human health and welfare are tied directly to our water resources and environmental quality and that human activities can affect the environment in a number of ways. Monitoring tells us not only about the health of water in our own backyard, but also about the quality of water making its way to local rivers and the Pacific Ocean.

What is Biological Monitoring?

Biological monitoring consists of collecting biological samples and then evaluating the condition of a selected stream or watershed using the results. Monitoring biological communities, specifically monitoring **benthic macroinvertebrates**, provides an integrated evaluation of water quality. These organisms show the effects of physical habitat alterations**, point source** and **nonpoint source** contaminants, and cumulative impacts over their life cycle.

There are several reasons why macroinvertebrates are used for monitoring:

- They are plentiful in most streams.
- They can be collected quickly and easily.
- They reflect cumulative impacts to an aquatic system over a relatively long period of time.
- They provide a link in the food chain between primary producers and fish.
- They are an inexpensive monitoring tool that anyone can use.

Assessment results can be used to evaluate management activities on stream and **riparian** conditions. These results also provide an excellent way to prioritize water bodies for further investigation.

Rapid bioassessment (so named because it can be completed relatively quickly) provides an excellent way for students to gain "hands-on" science experience. It provides an effective demonstration of the impacts of human activities to water resources, the interconnectedness of living components within an ecosystem, and a way for students to get involved in local monitoring efforts.

Biological Assessments to Evaluate Watershed Conditions

Bioassessment results can help us evaluate the overall condition of streams and are usually reported as percent of streams in a watershed that are rated very good, good, or poor. Bioassessment is also used as an educational tool in citizen/volunteer monitoring programs to provide basic information about watershed health. Results can be used to:

- Establish **baseline** characteristics
- Identify potential stressors to water quality
- Target areas for more intensive testing efforts
- Support land use planning and zoning management decisions
- Identify areas that warrant special protection, restoration, or rehabilitation

Because environmental conditions in Alaska are different than in other areas of the United States, these sampling methodologies have been tailored for Alaska's environment. The most notable differences in Alaska include limited organism diversity and different stream types.

Using this Manual

This manual is designed to assist science educators to incorporate rapid bioassessment methods for streams into their classroom activities. The Streamkeeper's Field Guide is intended to accompany this manual and provides more in-depth information for teachers. There are three levels of bioassessment currently used in Alaska:

- Technical Level for professional biologists and scientists
- Volunteer Level for local citizens, Alaska Tribes, and volunteer groups
- Educational Level for science educators and their students.

For more information on these methods see ENRI's website:
http://enri.uaa.alaska.edu/bmap/index.html
For additional teacher resources:
http://www.state.ak.us/local/akpages/FISHGAME

The terms **bold faced** in this manual are defined in the glossary. You may photocopy this manual. The Data Sheet included should be copied for use at the stream on "Rite in the Rain"© all weather paper. This paper can be purchased in Anchorage at Surveyor's Exchange. It is recommended that the insect keys in the *Streamkeeper's Field Guide* (pages 148 to 161) be photocopied and then laminated for use at the stream.

Educational Level Biosurvey Methods

Streamside Biosurvey

Training from qualified professionals should precede the streamside biosurvey. This training ensures that data collected will be consistent and useful for evaluating the health of Alaska's streams. Data sheets will be collected by ENRI and eventually incorporated into its website. Training is conducted by representatives from a partnership of organizations committed to water quality monitoring. About 10 hours is required to complete the training. After attending the training, participants will receive:

- A copy of the *Streamkeeper's Field Guide*
- Access to sampling equipment that can be checked out
- Ongoing assistance from qualified professionals

To inquire about sampling equipment availability, email:
gillan_david@asdk12.org

Preparation

Site Considerations

You will probably want to study a stream that is of interest in your community and close to your school. Once you have chosen your site, you will need to decide the exact location or the **reach** in which you will be collecting data. The length of the reach should be 25 meters. The *Streamkeeper's Field Guide* will help you identify the best location for your reach (page 50). The beginning of a reach should be easily accessible and include a significant landmark such as a large rock or road crossing.

Once you have selected your stream reach, you will need to identify specific study sites within it where you will evaluate the stream bottom, measure flow, and collect macroinvertebrates and chemical water quality information. A topographic map may be helpful in selecting your site. If you are interested in monitoring point source discharges, contact Alaska Department of Environmental Conservation to locate the exact position of the discharge.

Water Quality Data Sheet — Education Level

Stream Habitat Walk *(Please write clearly.)*

School/group ____________________________ *Date* ___/___/___ *Time* ____________

Stream name _____________________ *Reach name/#* ___________________________

Site: *Name* _________________ *Lat:* ______________ N • *Long:* ______________W

Rvr. Mile: ___________ *Map Name* ____

Weather: ☐ *Clear* ☐ *Cloudy* ☐ *Rain* ☐ *Drizzle* ☐ *Snow* ☐ *Sleet* *Other*_____________

Driving/hiking directions ____

Comments ____

Water Quality—Qualitative Observations

Habitat types	***H_2O appearance***	***Stream bed color***	***Odor***
(write in number of samples taken from each; should total 5)	☐ *Scum/foam*	☐ *Orange to red*	☐ *Sewage*
__*Undercut bank*	☐ *Muddy/silty*	☐ *Yellowish*	☐ *Rotten egg*
__*Aquatic vegetation*	☐ *Clear*	☐ *Brown/black*	☐ *Petroleum/fuel*
__*Riffles/cobbles*	☐ *Cloudy*	☐ *Greenish*	☐ *None*
__*Snag*	☐ *Oily sheen*	☐ *None—clean bed*	☐ *Other* _________
	☐ *Other* __________	☐ *Other* ___________	
	☐ *Trash* __________		

Water Quality—Chemical Quantitative Observations

Dissolved O_2 (DO)	***pH***
1. ________*mg/L*	*1.* ____
2. ________*mg/L*	*2.* ____
3. ________*mg/L*	*3.* ____
Mean: ________*mg/L*	*Mean:* _____

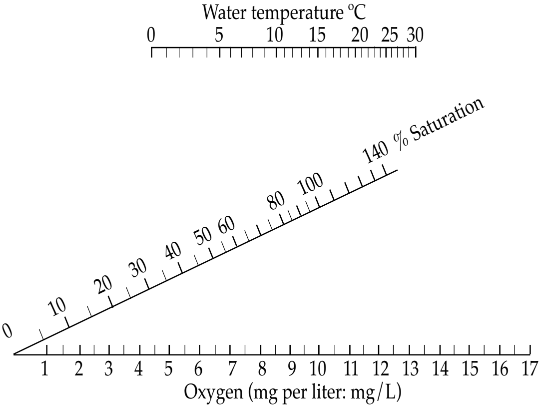
DO saturation _________*%*

Air temperature _______*ºC*

Water temperature _____*ºC*

Flow rate: _________ ***ft/sec****

DO% Saturation Chart



Discharge formula:

Average depth x average width x flow rate* (feet per second) = cubic feet per second

_______ft x ________ft x ___________ ft/sec = ________________ ◄fill in

Major group	*No. of different types*	*Est. of total no. in sample*
Mayflies (E) *Ephemeroptera*	*E=*	
Stoneflies (P) *Plecoptera*	*P=*	
Caddisflies (T) *Tricoptera*	*T=*	
EPT richness total		
Midges		
Craneflies		
Blackflies		
Aquatic mites		
Beetles		
Dragonflies		
Damselflies		
Scuds		
Snails		
Clams/mussels		
Worms		
Leeches		
Flatworms		
Other		
Non-EPT richness total		

Total no. of taxa (Taxa richness) ***Total no. of organisms***

Instructions

1. Use "***no. of diff. types***" column to record the number of different types of insects in each specified major group.
2. Estimate the total number of organisms present in your sample for **each** major group and taxa under "***Est. of total no. in sample.***"
3. Total the numbers of **E**, **P**, and **T** to calculate "***EPT richness total.***"
4. Total the numbers of all other to calculate "***Non-EPT richness total.***"
5. Add "***EPT richness total***" to "***Non-EPT richness total***" to find "***Taxa richness***" and "***Total no. of organisms.***"

Other organisms: Fish ________ Frogs ________
Signs of beaver/muskrat/otter? _______________

Send legible copies of data sheets to:

Educational level Bioassessment c/o Dan Bogan
ENRI, UAA
707 A Street, Suite 101
Anchorage AK 99501

Fax (907) 257-2707

Equipment List

Teachers will need to provide:

- Water Quality Data Sheets
- Stopwatch or watch w/second hand
- Empty milk or juice jug for waste
- Antibacterial waterless gel for washing hands
- Map of area
- Hip/chest waders
- Disposable latex gloves
- Field key

Other equipment and supplies needed:

- Chemical Kits: Dissolved Oxygen & pH
- D-frame dip net
- Long-sleeved Rubber Gloves
- Film cannister and 20 feet of string
- Bucket
- 2 white trays
- 4 ice cube trays
- Hand lens/magnifying glass
- Clipboard
- Kick-Net (Optional)
- Thermometer (ºC)
- Tape measure
- 10 forceps
- Aquatic pipette or eyedropper
- Compass
- Goggles

Suggested Sampling Schedule

The best time to sample is during the fall or spring when the greatest number of stream bugs should be present. If fish are present or a biologist believes fish use your site to spawn, plan on sampling only in the spring or early summer after the young salmon have emerged up through the gravel. If you do enter the stream in the fall or winter, you may kill these young fish without ever knowing they were there.

Safety & Stream Etiquette

Please consider the following suggestions:

- Keep open cuts or sores from contacting the water.
- Avoid sampling during high-water flow periods. Strong currents can be dangerous.
- Protect yourself and your students from injuries such as hypothermia during cold, windy, and wet conditions.
- Always work in groups of two or more.
- Do not drink the water.
- Do not dispose of chemicals or anything else near the water.
- Wash your hands and exposed skin after you have finished sampling.

Conducting the Biosurvey

There are three parts to the biosurvey:

1. Stream Habitat Walk
2. Water Quality—Qualitative and Quantitative Observations
3. Rapid Bioassessment Using Macroinvertebrates

1. Stream Habitat Walk

The first step to conduct a biosurvey is completing the Stream Habitat Walk section of the data sheet. It consists of walking your 25 meter stream reach, observing general characteristics, taking measurements, and noting them on the data sheet. When entering your "reach name" your students might enjoy naming the reach and the site themselves. For "site location" you can either use a GPS unit or a map to identify the latitude and longitude of your section. The river mile can be estimated by using a string, marked to represent miles, on a topographic map to calculate how many miles your site is upstream from the mouth.

2. Water Quality

Qualitative Observations

You will be selecting five areas of the stream to sample where macroinvertebrates live (habitat). From the habitat types identified below, select the areas that are the most predominant in the stream. Then you will be collecting a sample that is composed of kicks or jabs from these habitats. (For example, depending upon the stream you may collect 3 from the riffle/cobble and 2 from snag habitat in one stream and 3 from undercut banks and 2 from riffle/cobble in another stream.) The following descriptions can help you make your decision about the predominant habitat types:

- Riffle/Cobble Habitat—fist-sized rocks on the bottom of a fast flowing stream.
- Undercut banks/roots or vegetated bank margins—overhanging bank vegetation or submerged roots attached to the stream banks.
- Snags—sticks or logs submerged underwater that are not recent downfall.
- Aquatic vegetation beds—areas of submerged vegetation.

Encourage your students to use their best judgement in assessing the other qualitative characteristics in this section of the data sheet.

Quantitative Observations

D.O. Measurements

Follow the instructions in the kit to measure D.O. The D.O. scale provided on the data sheet is to calculate percent saturation. Streams with a saturation value of 90% or greater (or greater than 9mg/L) are considered healthy. It is recommended to take three readings of each; this is an excellent way to ensure the accuracy of your results. If you intend to anlayze your sample for D.O. later, you must "fix" your water sample before you leave the stream site. (See water chemistry instruction sheets.)

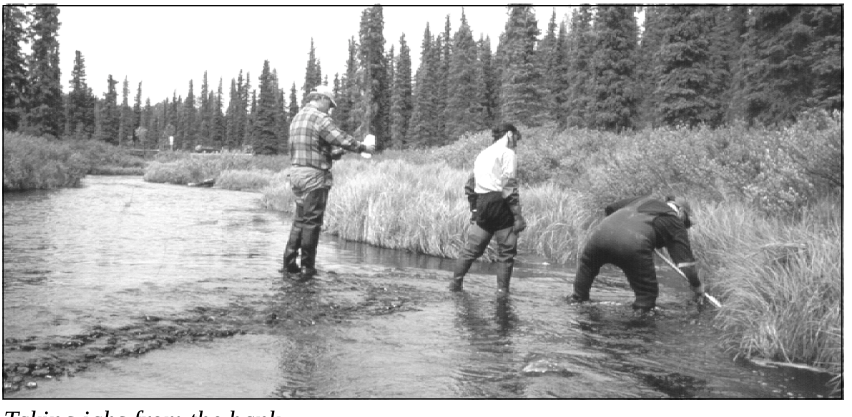
To calculate the % D.O., use a straight edge to connect your mg/L measurement with the water temperature reading. The point where the straight edge crosses the % saturation scale is the % D.O. reading. Also, refer to pages 172–176 of *The Streamkeeper's Field Guide*.

pH Measurements

Follow the instructions in the kit to measure pH. The pH tells us about the acidity or alkalinity of a solution. A healthy stream should have a pH of between 6.5 and 8.0. If available, an electronic meter can also be used; make sure it is calibrated often. Litmus paper can also be used for younger students to get them familiar with the concept. Refer to pages 165–169 of *The Streamkeeper's Field Guide* for more information.

Flow Rate

Choose a fairly straight **reach** of the stream approximately 20 feet long where water flow is unobstructed. Have your students estimate the average <u>depth</u> of this section by wading in the stream and noting the water level on their boots. They can also estimate the stream <u>width</u> by



Taking jabs from the bank.

averaging the estimated width at three different locations in the 20 foot reach. Both depth and width measurements should be made in feet. To estimate the velocity of the water, fill the film cannister with water and, with a 20-foot string attached, drop into the water at the upstream boundary of the reach. Have another student start a timer when the ball or orange is dropped into the water. When it reaches the end of the string, note the elapsed time on the data sheet (how much time it took to travel 20 feet). Use this flow rate number to calculate the discharge rate using the formula provided.

3. Rapid Bioassessment using Macroinvertebrates

Sample Collection

A word of caution: Do not sample when the water is running high and fast. It may be dangerous and strong currents disrupt benthic organisms. Your results may not accurately reflect the quality of your site.

A team of two samplers outfitted with hip boots, long rubber gloves, and the D-net will collect a **composite sample** from five separate locations of the predominant habitats identified during the stream walk. (If riffle/cobble is your predominant habitat type and snag is your second most predominant habitat type, then you will collect three samples from the riffle/cobble habitat and two from snag habitat for a total of five.) A **jab** type of motion is used to collect the sample. The entire composite sample from the five sample locations is emptied into the bucket and is processed as one sample to represent your stream reach. (If you have collected a lot of debris, the net may need to be cleaned out in between the 5 samples.

The following describes how each habitat type is sampled using the D-frame net.

- *Riffle/Cobble:* Place the net in the stream with the water flowing into the net. One person should hold the net firmly in place on the stream bottom while the other person stands in front of the net. The person in front of the net dislodges the organisms from the rocks and substrate by picking up and rubbing the large rocks and moving these to the side and then stirring the smaller substrate underneath. Disturb the area 18 inches in front of the net and about 1.5 inches into the streambed for approximately 3 minutes.
- *Snag:* Place the section of submerged wood into or in front of the net and rub off organisms from about 18 inches of the material for about 2 minutes.
- *Undercut Banks:* Approach the bank from downstream and jab the net vigorously along about 18 inches of the bank with an upward

motion to dislodge any organisms. The entire jab motion should occur underwater. Approximately 5 passes should be used to complete this jab.

- *Aquatic Vegetation Beds:* Jab vigorously along about 18 inches of any vegetative beds with an upward motion of the net against or through the plant bed. This entire motion should occur underwater. Approximately 5 passes should be used to complete this jab.

For younger groups, you may choose to use the kick net for sample collection. It is recommended that one sample be taken from two different riffle/cobble areas, preferably from the middle and edge of the stream. For variation, the kick net can be used to sample other habitats, such as the margins of weed-beds and undercut banks. You will find the community of bugs in each of these habitats may be quite different than the other areas in the stream.

Sample Processing

Samples should be processed in the field at the end of the sample collection. Some may contain a lot of leaves and rocks. A stir-and-pour technique is used to separate the insects and organic matter from the inorganic sand and rocks. After the entire composite sample is emptied into the bucket, stir it until the leaves and organic matter are suspended in the water. The floating organic matter can be visually inspected for insects and then placed back into the stream.

Sorting, Identifying, and Counting

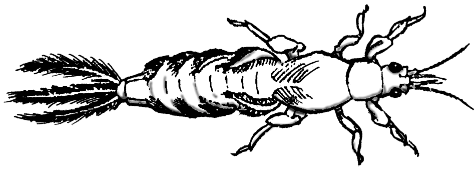
Begin by removing the remaining leaves, twigs, and rocks from your sample. Look closely for bugs that are on stems of leaves, on twigs, and in cracks of rocks. Pick out all of the different types of organisms in the sample using the hand lens and forceps and transfer them to the ice cube trays. Group bugs that look alike by looking at the body shape and number of legs and tails. You may have several different types of each of the mayflies, caddisflies, and stoneflies. To assist in sorting into groups, you may also want to look carefully at the type of movement the bugs make. Many of these organisms are small and quick! The eyedropper or pipette may be useful to catch very small organisms. If you are having trouble catching some of the faster insects, try pouring some extra water into the pan.

Using the hand lens (and taxonomic key if desired for upper grade levels), separate the specimens by their physical differences. The three most sensitive **orders** include mayflies (Ephemeroptera), stoneflies

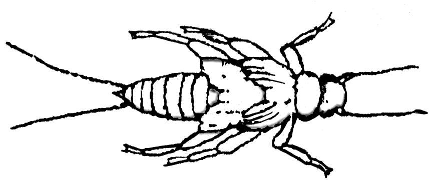
(Plecoptera), and caddisflies (Trichoptera). These are commonly referred to as **EPT taxa**. Each EPT group contains many species. These three groups are often considered the **indicator species** of stream health. Also separate other organisms into groups using physical characteristics (blackflies, worms, leeches, etc.)

Use the following general guidelines to differentiate the three main groups:

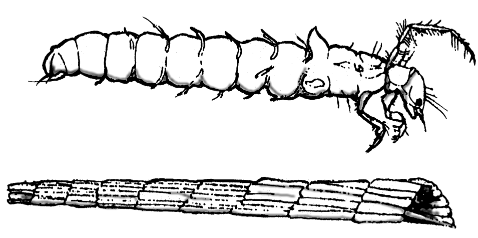
- Mayfly **nymphs** wiggle back and forth when they move and have either two or three **cerci** or “tails.” They also have distinct gills on the lower abdomen.



- Stonefly nymphs travel in a straight line, have only two cerci, have a smaller “neck” than mayflies, and generally have longer antennae.



- Caddisfly larvae are either in their little tube-shaped houses of leaves, twigs, or stone or they look like worms with heads and six jointed legs.



If you have all three types of EPT bugs at your site, you probably have a very healthy site! It is important that you note the other organisms you discover in your sample. A key may help you to note these on your data sheet.

Completing the Data Sheet

1. It is very important to document who collected the information and where it was collected. Please make sure that all of the location information is clearly filled out on the data sheet. Weather conditions may also influence your results, so it is important to complete this section too.
2. Complete the water quality–qualitative observations section next. The two predominant habitat types sampled should be checked. The appearance of the water, stream bed, and odors should also be noted.
3. Complete the water quality–quantitative observations for D.O. and pH Include the air and water temperature.
4. To record the flow rate, use the film cannister and determine how fast it travels over 20 feet. Repeat three times. Divide 20 (feet) by the average time (sec) to get velocity (feet per sec). Use the estimates for stream depth and width (feet) to complete the first two parts of the discharge formula. Use the flow rate recorded to calculate the estimated discharge.
5. To calculate the number of different types of organisms present at your site, first calculate the EPT richness by counting the number of different types of mayflies, stoneflies, and caddisflies present in the ice cube trays. Write the numbers in the first column next to what types you have. Total the first three rows in the first column to determine the EPT Richness. Next, write the types of other organisms you have in the first column that are not in the EPT groups and total that number to determine the Non-EPT richness total. Combine the EPT and non-EPT richness totals to determine the **Taxa** richness. The higher the number, the more diverse the community your site supports. If you have only a few types present, you should report this to one of the agencies listed in the acknowledgments for a more in-depth evaluation of the site. You can also compare the percentage of total number of taxa for both EPT and non-EPT organisms; having mostly EPT indicates good habitat and water quality.
6. Next, calculate the estimated number of each type of macroinvertebrate in your sample. Start by counting organisms of each type in the ice cube trays. Visually estimate the numbers of each type of organism remaining in the sorting trays. Add these two numbers to get estimated number of each type of organism present. Enter the estimates in the boxes (in the second column) next to the appropriate type. Total these in the bottom box (marked *Total no. organisms)*.
7. Note any other types of wildlife and fish on your form.
8. Send legible copies of the data sheets to ENRI (address on Water Quality Data Sheet).

Baseline: The basic standard or level to be used as a comparison or control for future studies (background information). Often refers to scientific data collected prior to human disturbance.

Benthic: Bottom-dwelling. Organisms that live on or in the stream bed.

Biosurvey (biological survey): Survey of living organisms in a defined area.

Bioassessment (biological assessment): Using living organisms, in addition to physical and chemical information, to evaluate water quality.

Cerci: The slender tails of a mayfly or stonefly.

Composite Sample: A sample composed of several jabs or kicks from each of the predominant habitat types identified during the stream walk. (A composite sample for the educational-level effort is taken from five different sampling spots within the 20 foot reach – 3 from the most predominant habitat type and 2 from the next most abundant habitat type.)

EPT: The three orders of insects (Ephemeroptera, Plecoptera, and Trichoptera) that are commonly used as indicators of stream health.

Indicator Species: An organism whose presence is used to measure ecological changes in the environment.

Jab: Jabbing motion used with a D-net to collect macroinvertebrate samples from various habitat types, such as undercut banks or aquatic vegetation.

Kick: Motion sometimes used with a D-net to collect a macroinvertebrate sample from bottom substrate

Macroinvertebrate: Organisms that are visible with the naked eye (macroscopic) and have no backbones, such as insects and snails.

Non-point Source: Diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet).

Nymphs: The young of an insect that undergoes incomplete metamorphosis.

Orders: Broad groupings of organisms that display similar physical or structural characteristics.

Point Source: A stationary location of fixed facility from which pollutants are discharged or emitted or any single identifiable source of pollution.

Reach: Specific area of a stream identified for a study, often 25 to 100 meters in length.

Riparian: Areas along the banks (or corridor) of a stream or a river.

Taxa: Plural term for taxon, a taxonomic level of classification within a scientific system that categorizes living organisms based on physical characteristics.

Watershed: An area of land from which all of the water drains to one common water body.

Other Information Sources

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