4.2 Streamside Biosurvey

The Streamside Biosurvey is based on the simple macroinvertebrate sampling approach developed and used by the Ohio Department of Natural Resources and the Izaak Walton League of America's Save Our Streams program and adapted by many volunteer monitoring programs throughout the United States.

This assessment approach has two basic components. The first is a biosurvey of aquatic organisms that involves collecting and identifying macroinvertebrates in the field and calculating an index of stream quality. The second is the habitat characterization method known as the *Streamside Biosurvey Habitat Walk.*

Two methods of macroinvertebrate sampling are detailed in this section—one for rocky-bottom streams (using a kick net) and one for muddy-bottom streams (using a dip net). Figure 4.7 illustrates and describes the nets used for these assessments. Both of these aquatic organism collection procedures have been widely tested and used successfully by many groups. You should consult with a local aquatic scientist to determine which method is appropriate for streams in your area.

Like the Stream Habitat Walk described in Section 4.1, the Streamside Biosurvey is useful as a screening tool to identify water quality problems and as an educational tool to teach volunteers about pollution and stream ecology. But instead of randomly picking up rocks or sticks and brushing off macroinvertebrates for simple observation purposes, Streamside Biosurvey volunteers are trained to use special nets and standardized sampling protocols to collect organisms from a measured area of stream habitat. Volunteers identify collected organisms, usually to the order level, and sort them into taxonomic groups based on their ability to tolerate pollution. Using this information, volunteers can then calculate a simple stream quality rating of good, fair, or poor.

Because the Streamside Biosurvey involves a standardized sampling protocol, a basic level of training, professional assistance, and a simple stream rating based on macroinvertebrate diversity and abundance, this approach is more effective than the Stream Habitat Walk in characterizing stream health and determining general water quality trends over several years. However, this method is not generally suited to determining subtle pollution impacts due, in part, to its uncomplicated level of macroinvertebrate identification

Note

The Streamside Biosurvey is based on protocols developed and widely used by programs such as the Ohio Department of Natural Resources, the Izaak Walton League of America, and others. This manual recommends some modifications to their established protocols. These include:

- A finer mesh size for the kick and dip nets used to sample for macroinvertebrates
- In rocky-bottom streams, compositing three samples into one before identifying macroinvertebrates rather than identifying macroinvertebrates in three separate samples and choosing the best result. Compositing generally provides a more representative sample of the macroinvertebrate community than a discrete sample taken from one part of the riffle. Riffle areas have what is known as a patchy distribution of organisms, meaning that different types of organisms are naturally found in different parts of the riffle. In order to more accurately assess the macroinvertebrate community in a rocky-bottom stream site, it is important to take a representative sample that includes organisms found in different microhabitats—such as in different parts of the riffle or in riffles of various flows and depths.
- A new method for calculating the stream quality rating. This modification incorporates a weighting factor to take into account the abundance of organisms in each pollution tolerance category (pollution-sensitive, somewhat tolerant, and tolerant).
- In muddy-bottom streams, varying how much each habitat type is sampled depending on its abundance at the sampling site.

and analysis. This, of course, is also one of the Streamside Biosurvey's greatest strengths, since volunteers can be easily trained in its methods.

Key features of the Streamside Biosurvey are as follows:

- It includes the Streamside Biosurvey Habitat Walk as its physical habitat characterization and visual biological characterization components. This protocol is a somewhat more detailed version of the Stream Habitat Walk described in Section 4.1.
- It centers around a macroinvertebrate survey in which organisms are collected according to specific protocols, identified in the field (generally to taxonomic order), and are then released back into the stream.
- For the identification process, volunteers group macroinvertebrates into three categories based on their pollution tolerance or sensitivity. Volunteers then calculate a water quality index by counting the specimens in each sensitivity category and determining whether they are rare, common, or dominant; multiplying the number of taxa in each category by a weighting factor; adding all the scores; and comparing results to a water quality rating scale that has been determined by a locally knowledgeable biologist/ecologist.
- The Streamside Biosurvey requires some equipment and training. Training can be conducted at the stream site, although some advance preparation is required. For example, a biologist with regional experience should assist in developing the macroinvertebrate key and the tolerance category groupings on the field data sheets. A reference collection is recommended to help volunteers identify macroinvertebrates.

Step 1—Prepare for the Streamside Biosurvey field work

Much of the preparation work for this approach is similar to that of the Stream Habitat Walk (section 4.1). Refer back to that section for relevant information on the following tasks:

- Scheduling the biosurvey
- Obtaining a USGS topographical map
- Selecting and marking monitoring locations
- Becoming familiar with safety procedures

TASK 1 Gather tools and equipment for the Streamside Biosurvey

In addition to the basic equipment listed in Section 2.4, you should collect the following equipment needed for the macroinvertebrate collection of the Streamside Biosurvey:

- Vial with tight cap filled about one-half full with 70 percent ethyl alcohol
- Buckets (2)
- Hand lens, magnifying glass, or field microscope
- Tweezers, eyedropper, or spoon
- Plastic bag
- Large, shallow, white pans, such as dishpans (2)
- Spray water bottle
- Plastic ice cube tray
- Taxonomic key to aquatic organisms
- Calculator
- *For rocky-bottom streams*—Kick net, a fine mesh (500 µm) nylon net approximately 3x3 feet with a 3-foot long supporting pole on each side is recommended—Fig.4.7).

Figure 4.7

Examples of macroinvertebrate sampling nets

Nets used by professionals and volunteers vary in overall size, design, and mesh size.

Nets recommended in this manual

Kick net

For rocky-bottom stream sampling, a kick net of 590 µm (a #30 mesh size) or 500 µm (#35 mesh size) is recommended. (Mesh size is usually measured in microns, µm. The higher the number, the coarser the mesh.)

D-frame net

For muddy-bottom stream sampling, a long-handled D-frame or dip net is recommended for reaching into vegetation that grows along stream banks or is attached to the stream bottom, and for sweeping up macroinvertebrates dislodged from woody debris. D-frame nets also come in different mesh sizes.

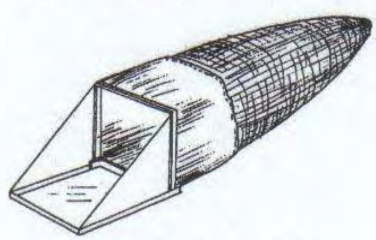
This manual recommends that volunteer programs purchase their macroinvertebrate sampling nets from scientific supply houses to ensure a standard degree of net quality and known mesh size. Some supply houses might sell the components of the net separately. Volunteer programs then buy the net material commercially, supply their own handles, and build the nets using volunteer labor.

Many programs use coarser mesh than is recommended in this manual. Coarser mesh is generally less expensive. However, smaller organisms can be lost through the mesh during sampling. If you are in doubt as to what mesh size to use, consult your technical advisor. If possible—and especially if you want your volunteer data to be used by state and local water managers—it is best to use nets of the same type and size as those which water quality professionals use in your state.

Other types of commonly used nets

Rectangular-style kick net

Used by the West Virginia Save Our Streams Program in both rocky-bottom and muddy-bottom streams.



Surber sampler

Used by professional monitoring programs, this sampler delineates an exact stream bottom area to be disturbed.

- *For muddy-bottom streams*—D-frame net (a dip net with a frame 12 inches wide with a fine nylon mesh, usually about 500 µm, attached to the frame).

Step 2—Collect and Sort Macroinvertebrates

The method you use to collect macroinvertebrates using this approach depends on the type of stream you are sampling. Rocky-bottom streams are defined as those with bottoms made up of gravel, cobbles, and boulders in any combination and usually have definite riffle areas. Riffle areas are fairly well oxygenated and, therefore, are prime habitats for benthic macroinvertebrates. In these streams, use the *rocky-bottom sampling method.*

Muddy-bottom streams have muddy, silty, or sandy bottoms and lack riffles. Generally, these are slow moving, low-gradient streams (i.e., streams that flow along relatively flat terrain). In such streams, macroinvertebrates generally attach themselves to overhanging plants, roots, logs, submerged vegetation, and stream substrate where organic particles are trapped. In these streams, use the *muddy-bottom sampling method.*

Both methods are detailed below. Regardless of which collection method is used, the process for counting, identifying, and analyzing the macroinvertebrate sample for the Streamside Biosurvey is the same.

Rocky-Bottom Sampling Method

Use the following method of macroinvertebrate sampling in streams that have riffles and gravel/cobble substrates. You will collect three samples at each site and composite (combine) them to obtain one large total sample.

The reach can be a variety of lengths depending upon your program's goals and objectives, and circumstances in the field. Most professional stream ecologist use 100-meters.

TASK 1 **Identify the sampling location**

You should already have located your site on a map along with its latitude and longitude (see Task 3, page 45).

1. You are going to sample in three different spots within a 100-yard stream reach. These spots may be three separate riffles; one large riffle with different current velocities; or, if no riffles are present, three run areas with gravel or cobble substrate. Combinations are also possible (if, for example, your site has only one small riffle and several run areas).

   Mark off your 100-yard stream reach. If possible, it should begin at least 50 yards upstream of any human-made modification of the channel, such as a bridge, dam, or pipeline crossing, Avoid walking in the stream, since this might dislodge macroinvertebrates and alter your sampling results.
2. Sketch the 100-yard sampling area. Indicate the location of your three sampling spots on the sketch. Mark the most downstream site as Site 1, the middle site as Site 2, and the upstream site as Site 3. (See Fig. 4.8.)

TASK 2 **Get into place**

1. **Always approach your sampling locations from the downstream end and sample the site farthest downstream first (Site 1)** (see Fig. 4.9, Panel #1). This minimizes the possibility of biasing your second and third collections with dislodged sediment or macroinvertebrates.

   Always use a clean kick net, relatively free of mud and debris from previous uses. Fill a bucket about one third full with stream water and fill your spray bottle.

2. Select a 3-foot by 3-foot riffle area for sampling at Site 1. One member of the team, the net holder, should position the net at the downstream end of this sampling area. Hold the net handles at a 45 degree angle to the water's surface (see Fig. 4.9, Panel #2). Be sure that the bottom of the net fits tightly against the streambed so no macroinvertebrates escape under the net. You may use rocks from the sampling area to anchor the net against the stream bottom. Don't allow any water to flow over the net.

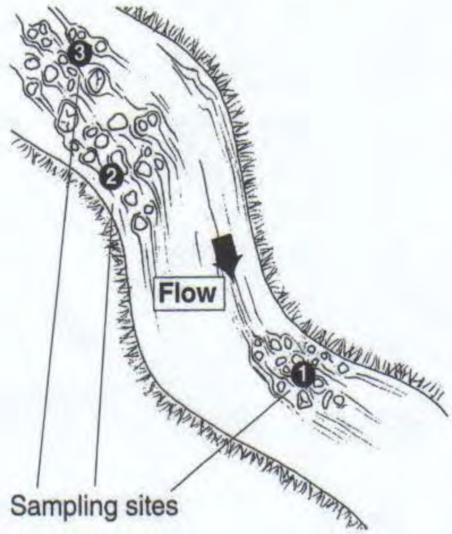


Figure 4.8

Location of sample sites in a rocky-bottom stream with riffles

Within a 100 yard reach volunteers begin their sampling at the most downstream site and then work their way upstream.

TASK 3 **Dislodge the macroinvertebrates**

1. Pick up any large rocks in the 3-foot by 3-foot sampling area and rub them thoroughly over the partially-filled bucket so that any macroinvertebrates clinging to the rocks will be dislodged into the bucket (see Fig. 4.9, Panel #3). Then place each cleaned rock outside of the sampling area. After sampling is completed, rocks can be returned to the stretch of stream they came from.
2. The member of the team designated as the "kicker" should thoroughly stir up the sampling area with their feet, starting at the upstream edge of the 3-foot by 3-foot sampling area and working downstream, moving toward the net. All dislodged organisms will be carried by the stream flow into the net (see Fig. 4.9, Panel #4). Be sure to disturb the first few inches of stream sediment to dislodge burrowing organisms. As a guide, disturb the sampling area for about 3 minutes, or until the area is thoroughly worked over.
3. Any large rocks used to anchor the net should be thoroughly rubbed into the bucket as above.

TASK 4 **Remove the net**

1. Next, remove the net without allowing any of the organisms it contains to wash away. While the net holder grabs the top of the net handles, the kicker grabs the bottom of the net handles and the net's bottom edge. Remove the net from the stream with a forward scooping motion (see Fig. 4.9, Panel #5).
2. Roll the kick net into a cylinder shape and place it vertically in the partially filled bucket. Pour or spray water down the net to flush its contents into the bucket (see Fig. 4.9, Panel #6). If necessary, pick debris and organisms from the net by hand. Release back into the stream any fish, amphibians, or reptiles caught in the net.

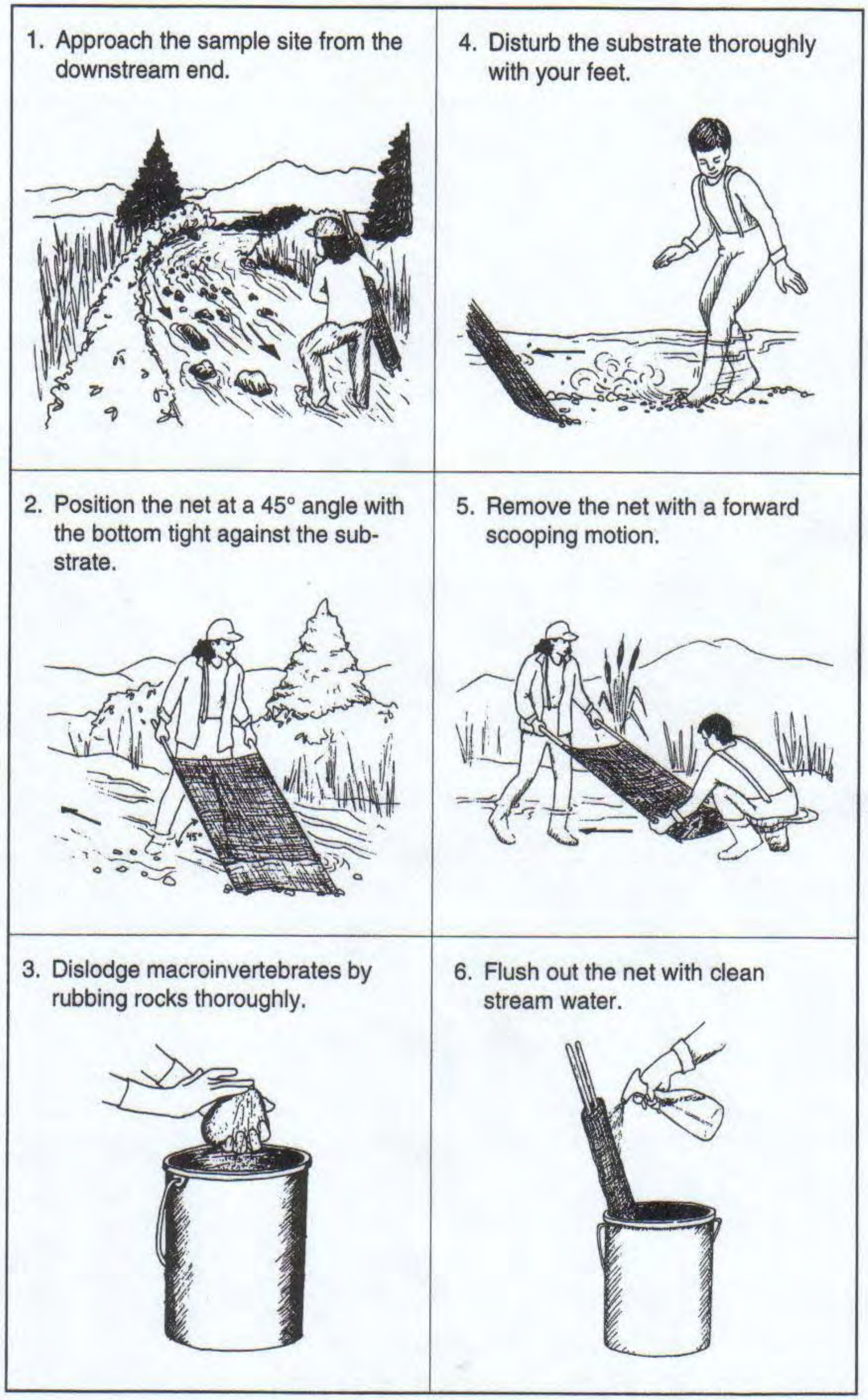
TASK 5 **Collect the second and third samples**

Once you have removed all the organisms from the net repeat these tasks at Sites 2 and 3. Put the samples from all three sites into the same bucket. Combining the debris and organisms from all three sites into the same bucket is called *compositing*.

Figure 4.9

Procedures for collecting a macroinvertebrate sample in a rocky-bottom stream

Volunteers must follow set protocol to collect an unbiased sample.



Rock rubbing is often done in the stream directly in front of the net. Only cobble size and larger rocks are rubbed.

It is often more effective to rinse the net using water from another bucket instead of a spray bottle. Also, expand the net around the bucket to better facilitate rinsing.

Hint: If your bucket is nearly full of water after you have washed the net clean, let the debris and organisms settle to the bottom of the bucket. Then cup the net over the bucket and pour the water through the net into a second bucket. Inspect the water in the second bucket to be sure no organisms came through.

TASK 6 **Sort macroinvertebrates**

Pour the contents of the bucket into a large, shallow, white pan. Add some stream water to the pan, and fill the ice cube tray with stream water. Using tweezers, eye dropper, or spoon, pick through the leaf litter and organic material looking for anything that swims, crawls, or seems to be hiding in a shell, like a snail. Look carefully; many of these creatures are quite small and fast-swimming. Sort similar organisms into the ice cube tray.

Note: Instructions for counting, identifying, and analyzing the macroinvertebrate sample follow the muddy-bottom sampling method. (See page 70, Step 3)

Muddy-Bottom Sampling Method

In muddy-bottom streams, as in rocky-bottom streams, the goal is to sample the most productive habitats available and look for the widest variety of organisms. The most productive habitats are the ones that harbor a diverse population of pollution sensitive-macroinvertebrates. Volunteers should sample by using a D-frame net to jab at the habitat and scoop up the organisms that are dislodged. The objective is to collect a combined sample from 20 jabs taken from a variety of habitats.

TASK 1 **Determine which habitats are present**

Picking Bugs

Some monitoring programs find it easier to collect organisms from the net by hand-picking them rather than washing the sample into a pan and then trying to pick through the floating debris. The advantage to placing the organisms in a pan is that they are more likely to survive while in the pan and their characteristic movements will help in organism identification.

If you prefer to pick bugs directly off the net, a white background, such as a white plastic trash bag under the net, will help you see the bugs more clearly. In addition, periodically wetting the net with a water bottle will help keep the bugs alive and moving.

Identification can be made easier if you sort the organisms into groups based on physical similarities and place them together in sections of an ice cube tray as you pick them from the pan or net.

Muddy-bottom streams usually have four habitats (Fig. 4.10). It is generally best to concentrate sampling efforts on the most productive habitat available, yet to sample other principal habitats if they are present. This ensures that you will secure as wide a variety of organisms as possible. Not all habitats are present in all streams or present in significant amounts. If your sampling areas have not been preselected, try to determine which of the following habitats are present. (Avoid standing in the stream while making your habitat determinations.)

- *Vegetated bank margins.* This habitat consists of overhanging bank vegetation and submerged root mats attached to banks. The bank margins may also contain submerged, decomposing leaf packs trapped in root wads or lining the streambanks. This is generally a highly productive habitat in a muddy–bottom stream, and it is often the most abundant type of habitat.
- *Snags and logs.* This habitat consists of submerged wood, primarily dead trees, logs, branches, roots, cypress knees and leaf packs lodged between rocks or logs. This is also a very productive muddy-bottom stream habitat.

Ice-cube trays are effective tools for sorting; however, WV Save Our Streams recommends using large white trays with squares drawn inside with indelible ink. These squares make it easier to sort/count the macro- invertebrates. As they are counted/sorted they can be removed and placed back into the another tray or container for preservation or released back into the stream. Another option is a plastic craft organizer.

- *Aquatic vegetation beds and decaying organic matter.* This habitat consists of beds of submerged, green/leafy plants that are attached to the stream bottom. This habitat can be as productive as vegetated bank margins, and snags and logs.
- *Silt/sand/gravel substrate.* This habitat includes sandy, silty, or muddy stream bottoms; rocks along the stream bottom; and/or wetted gravel bars. This habitat may also contains algae-covered rocks (sometimes called Aufwuchs). This is the least productive of the four muddy-bottom stream habitats, and it is always present in one form or another (e.g., silt, sand, mud, or gravel might predominate).

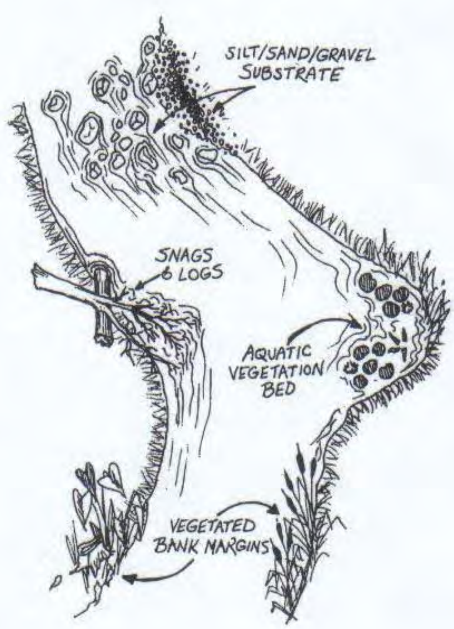
TASK 2 **Determine how many times to jab in each habitat type**

Your goal is to jab a total of 20 times. The D-frame net is 1 foot wide, and a jab should be approximately 1 foot in length. Thus, 20 jabs equals 20 square feet of combined habitat.

Figure 4.10

Four habitats found in muddy-bottom streams

Volunteers will likely find the most macroinvertebrates in vegetated habitats and snags and logs.



- If all four habitats are present in plentiful amounts, jab the vegetated banks 10 times and divide the remaining 10 jabs among the remaining 3 habitats.
- If three habitats are present in plentiful amounts and one is absent, jab the silt/sand/gravel substrate—the least productive habitat—5 times and divide the remaining 15 jabs among the other two more productive habitats.
- If only two habitats are present in plentiful amounts, the silt/sand/gravel substrate will most likely be one of those habitats. Jab the silt/sand/gravel substrate 5 times and the more productive habitat 15 times.
- If some habitats are plentiful and others are sparse, sample the sparse habitats to the extent possible, even if you can take only one or two jabs. Take the remaining jabs from the plentiful habitat(s). This rule also applies if you cannot reach a habitat because of unsafe stream conditions. Jab a total of 20 times.

Because you might need to make an educated guess to decide how many jabs to take in each habitat type, it is critical that you note, on the field data sheet, how many jabs you took in each habitat. This information can be used to help characterize your findings.

TASK 3 **Get into place**

Outside and downstream of your first sampling location (1st habitat), rinse the dip net and check to make sure it does not contain any macroinvertebrates or debris from the last time it was used. Fill a bucket approximately one-third full with clean stream water. Also, fill the spray bottle with clean stream water. This bottle will be used to wash down the net between jabs and after sampling is completed.

This method of sampling requires only one person to disturb the stream habitats. While one person is sampling, a second person should stand outside the sampling area, holding the bucket and spray bottle. After every few jabs, the sampler should hand the net to the second person, who then can rinse the contents of the net into the bucket.

TASK 4 Dislodge the macroinvertebrates

Approach the first sample site from downstream, and sample as you walk upstream. Here is how to sample in the four habitat types:

- Sample vegetated bank margins by jabbing vigorously, with an upward motion, brushing the net against vegetation and roots along the bank. The entire jab motion should occur underwater.
- To sample snags and logs, hold the net with one hand under the section of submerged wood you are sampling. With the other hand (which should be gloved), rub about 1 square foot of area on the snag or log. Scoop organisms, bark, twigs, or other organic matter you dislodge into your net. Each combination of log rubbing and net scooping is one jab (Fig. 4.11).
- To sample aquatic vegetation beds, jab vigorously, with an upward motion, against or through the plant bed. The entire jab motion should occur underwater.
- To sample a silt/sand/gravel substrate, place the net with one edge against the stream bottom and push it forward about a foot (in an upstream direction) to dislodge the first few inches of silt, sand, gravel, or rocks. To avoid gathering a netful of mud, periodically sweep the mesh bottom of the net back and forth in the water, making sure that water does not run over the top of the net. This will allow fine silt to rinse out of the net.

When you have completed all 20 jabs, rinse the net thoroughly into the bucket. If necessary, pick any clinging organisms from the net by hand and put them in the bucket.

Figure 4.11

Collecting a sample from a log

Volunteer rubs the log with one hand and catches dislodged organisms and other material in the net.

TASK 5 **Sort the macroinvertebrates**

Pour the contents of the bucket (water, organisms, and organic material) into a large, shallow, white pan and fill the ice cube tray with clean stream water. Using tweezers, eye dropper, or spoon, pick through the leaf litter and organic material looking for anything that swims, crawls, or seems to be hiding in a shell (like a snail). Look carefully; many of these creatures are quite small and fast-swimming. Sort similar organisms into the plastic ice cube tray.

Step 3—Identify Macroinvertebrates and Calculate Stream Rating

The following methods are used for both the rocky- and muddy-bottom assessments.

Task 1 **Identify Macroinvertebrates**

1. Identify the collected macroinvertebrates. Using the hand lens or magnifying glass and the aquatic organism identification key, carefully observe the collected macroinvertebrates. Refine your initial sort so that like individuals are placed in the same section(s) of the ice cube tray. If you cannot identify an organism, place one or two specimens in the alcohol-filled vial and forward it to your program coordinator for identification.
2. On your field data sheet, note the number of individuals of each type of organism you have identified (Section 3 of the field data sheet—See Fig. 4.12.).

Note: When you feel that you have identified all the organisms to the best of your ability, return the macroinvertebrates to the stream.

3. Assign one of the following abundance codes to each type of organism. Record the code next to the actual count on the field data sheet.

R (rare)	=	if 1-9 organisms are found in the sample
C (common)	=	if 10-99 organisms are found in the sample
D (dominant)	=	if 100 or more organisms are found in the sample

Your field data sheet should be organized to help you sort macroinvertebrates into three groups based on their ability to tolerate pollution. **A local authority (such as a state biologist or entomologist) should determine which organisms belong in each pollution tolerance category for your region.**

Generally, the three tolerance groups are as follows:

- *Group I* (sensitive organisms) includes pollution- sensitive organisms such as mayflies, stoneflies, and non net-spinning caddisflies, which are typically found in good-quality water.
- *Group II* (somewhat sensitive organisms) includes somewhat pollution-tolerant organisms such as net-spinning caddisflies, crayfish, sowbugs, and clams, found in fair-quality water.
- *Group III* (tolerant organisms) includes pollution-tolerant organisms such as worms, leeches, and midges, found in poor-quality water.

TASK 2 **Calculate the stream quality rating**

The stream water quality rating takes into account the pollution sensitivity of the organisms and their relative abundance. This is accomplished through use of a weighting system.

MACROINVERTEBRATE COUNT

Identify the macroinvertebrates in your sample and assign them letter codes based on their abundance: R (rare) = 1-9 organisms; C (common) = 10-99 organisms; and D (dominant) = 100 plus organisms.

Group I Sensitive	Group II Somewhat-Sensitive	Group III Tolerant
C (50) Water penny larvae	*R (4)* Beetle larvae	*R (5)* Aquatic worms
R (2) Hellgrammites	____ Clams	____ Blackfly larvae
____ Mayfly nymphs	____ Crane fly larvae	____ Leeches
____ Gilled snails	*R (6)* Crayfish	____ Midge larvae
____ Riffle beetle adult	____ Damselfly nymphs	*C (50)* Snails
C (25) Stonefly nymphs	*D (100)* Scuds	
____ Non net-spinning caddisfly larvae	*D (150)* Sowbugs	
	R (8) Fishfly larvae	
	____ Alderfly larvae	
	C (27) Net-spinning caddisfly larvae	

Figure 4.12

Sample macro-invertebrate count for (hypothetical) Volunteer Creek

The weighting system acknowledges the most desirable combinations of pollution sensitivity and abundance by assigning these extra weights within a 5, 3, and 1 point scale. Pollution-sensitive organisms receive a weighting factor based on a 5-point scale. Somewhat sensitive organisms are weighted on a 3-point scale, and tolerant organisms are weighted on a 1-point scale. As can be seen in Table 4.2, a sample's ideal combination of organisms would be "sensitive" and "somewhat sensitive" organisms in common abundance (10-99 organisms), and pollution "tolerant" organisms in rare abundance (less than 10 organisms). This is because it is never ideal for any given type of organism to dominate a sample, and because it is best to have a wide variety of organisms including a few pollution-tolerant individuals.

1. Add the number of R's, C's and D's in each of the 3 pollution tolerance groupings. Then, for each grouping, multiply the total number of R's, C's and D's by the relevant weighting factor. Table 4.3 illustrates sample calculations for determining the water quality rating for (hypothetical) Volunteer Creek.

Note: The tolerance category groupings shown on the Biosurvey Data Sheet were developed for streams in the mid-Atlantic (Maryland, Virginia, West Virginia, District of Columbia, Pennsylvania). These groupings may not totally apply in other regions of the United States. **It is important that a local aquatic biologist take a look at these categories and make any changes necessary for your region.**

In addition, depending on the level of taxonomic training volunteers receive, you might consider separating out some other families of organisms. For instance, the tolerance groupings given here separate caddisflies into net-spinning and non net-spinning families. Mayflies might also be separated into different tolerance groupings. It is not recommended here, however, because of the difficulty in distinguishing mayfly families in the field without a microscope.

Some volunteer programs, like the one coordinated by the Audubon Naturalist Society in Maryland, conduct intensive field identification training workshops and teach volunteers to distinguish several families in the field. Creating more specific tolerance groupings may be an option for your program if you have the resources and expertise to conduct more intensive taxonomic field training.

Note: WV Save Our Streams level-one volunteers assess their macroinvertebrate collections using an estimate of diversity (number of different kinds, also called taxa), and relative abundance (RA) rating. The RA rating is based upon the scale below.

A (abundant) > 50
C (common) 5 - 50
R (rare) < 5

Table 4.2

Weighting factors used in calculating stream water quality ratings

Abundance	Weighting Factor		
	Group I Sensitive	Group II Somewhat Sensitive	Group III Tolerant
Rare (R)	5.0	3.2	1.2
Common (C)	5.6	3.4	1.1
Dominant (D)	5.3	3.0	1.0

Table 4.3

Sample calculations of index values for Volunteer Creek

Group I Sensitive	Group II Somewhat Sensitive	Group III Tolerant
1 (No. of R's) x 5.0 = 5.0	3 (No. of R's) x 3.2 = 9.6	1 (No. of R's) x 1.2 = 1.2
2 (No. of C's) x 5.6 = 11.2	1 (No. of C's) x 3.4 = 3.4	1 (No. of C's) x 1.1 = 1.1
	2 (No. of D's) x 3.0 = 6.0	
Index Value for Group I = 16.2	Index Value for Group II = 19.0	Index Value for Group III = 2.3

Table 4.4

Tentative rating scale for streams in Maryland

Score	Rating
>40	Good
20-40	Fair
< 20	Poor

Level-one metrics are calculated either by the volunteers or the program coordinator. Three different metrics are used.

(1) Total Taxa; (2) EPT Taxa; and (3) Biotic Index. The results are combined using reference formulas and an overall stream index score is determined.

Note: In addition to adjusting the rating scale according to regional location, it might also need to be adjusted for muddy-bottom vs. rocky-bottom streams. An experienced stream biologist can calculate the best rating system for your area's streams by examining data from several streams.

2. To obtain a water quality rating for the site, total the values for each group and add them together. The total score for the sample stream site is: 16.2 (Group I) + 19.0 (Group II) + 2.3 (Group III) = 37.5.
3. The final step is to compare the score to water quality ratings (good to poor) established by a trained biologist familiar with local stream fauna. Table 4.4 presents a tentative rating scale for streams in Maryland. Assuming Volunteer Creek is located in Maryland, the stream would receive a rating of "Fair."

In a healthy stream, the sensitive (Group I) organisms will be well represented in a sample. It is important to remember that macroinvertebrate populations can fluctuate seasonally and that these natural fluctuations can affect your results. Therefore, it is best to compare the results by season from year to year. (Compare your spring sampling results to each other, not to fall results.)

Step 4—Conduct the Streamside Biosurvey: Habitat Walk

You will conduct a habitat assessment (which will include measuring general characteristics and local land use) in a 100-yard section of stream that includes the riffles from which organisms were collected.

TASK 1 **Delineate the habitat assessment boundaries**

1. Begin by identifying the most downstream riffle that was sampled for macroinvertebrates. Using your tape measure or twine, mark off a 100-yard section extending 25 yards below the downstream riffle and about 75 yards upstream.
2. Complete the identifying information on your field data sheet for your habitat assessment site. On your stream sketch, be as detailed as possible, and be sure to note which riffles were sampled.

TASK 2 **Complete the Physical Characteristics, Local Watershed Characteristics, and Visual Biological Survey sections of the field sheet**

For safety reasons as well as to protect the stream habitat, it is best to estimate these characteristics rather than actually wading into the stream to measure them.

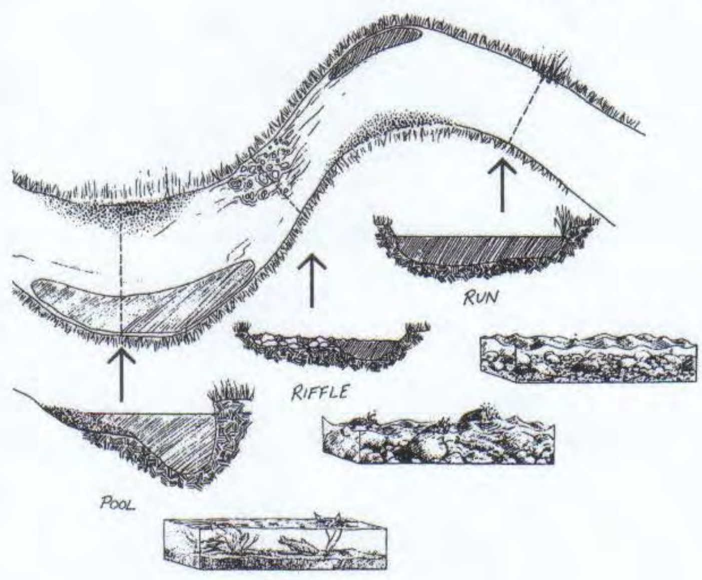
In-stream Characteristics

1. *Pools, riffles, and runs* create a mixture of flows and depths and provide a variety of habitats to support fish and invertebrate life. Pools are deep with slow water. Riffles are shallow with fast, turbulent water running over rocks. Runs are deep with fast water and little or no turbulence.
2. *Stream bottom (substrate)* is the material on the stream bottom. Identify what substrate types are present. Substrate types include:
   - *Silt/clay/mud*—This substrate has a sticky, cohesive feeling. The particles are fine. The spaces between the particles hold a lot of water, making the sediments behave like ooze.
   - *Sand (up to 0.1 inch)*—A sandy bottom is made up of tiny, gritty particles of rock that are smaller than gravel but coarser than silt (gritty, up to pea size).
   - *Gravel (0.1-2 inches)*—A gravel bottom is made up of stones ranging from tiny quarter-inch pebbles to rocks of about 2 inches (fine gravel - pea size to marble size; coarse gravel - marble to tennis ball size).
   - *Cobbles (2-10 inches)*—Most rocks on this type of stream bottom are between 2 and 10 inches (between a tennis ball and a basketball).

Figure 4.13

Overview and cross sections of a pool, riffle, and run

Varying flows and depths create a variety of habitats for macroinvertebrates.



- *Boulders (greater than 10 inches)*—Most of the rocks on the bottom are greater than 10 inches (between a basketball and a car in size).
- *Bedrock*—is solid rock (or rocks bigger than a car).

Estimate the percentage of substrate types at your site.

3. *Embeddedness* is the extent to which rocks (gravel, cobbles, and boulders) are sunken into the silt, sand, or mud of the stream bottom (Fig. 4.14). Generally, the more rocks are embedded, the less rock surface or space between rocks is available as habitat for aquatic macroinvertebrates and for fish spawning. Excessive silty runoff from erosion can increase the embeddedness in a stream. To estimate the embeddedness, observe the amount of silt or finer sediments overlying, in between, and surrounding the rocks.
4. *Streambed stability* can provide additional clues to the amount of siltation in a stream. When you walk in the stream, note whether your feet sink significantly into sand or mud.
5. *Presence of logs or woody debris (not twigs and leaves) in stream* can slow or divert water to provide important fish habitat such as pools and hiding places. Mark the box that describes the general amount of woody debris in the stream.
6. *Naturally occurring organic material in stream.* This material includes leaves and twigs. Mark the box that describes the general amount of organic matter in the stream.
7. *Water appearance* can be a physical indicator of water pollution.
   - *Clear* - colorless, transparent
   - *Milky* - cloudy-white or grey, not transparent; might be natural or due to pollution
   - *Foamy* - might be natural or due to pollution, generally detergents or nutrients (foam that is several inches high and does not brush apart easily is generally due to some sort of pollution)
   - *Turbid* - cloudy brown due to suspended silt or organic material
   - *Dark brown* - might indicate that acids are being released into the stream due to decaying plants
   - *Oily sheen* - multicolored reflection might indicate oil floating in the stream, although some sheens are natural
   - *Orange* - might indicate acid drainage
   - *Green* - might indicate excess nutrients being released into the stream
8. *Water odor* can be a physical indicator of water pollution
   - *No smell or a natural odor*
   - *Sewage* - might indicate the release of human waste material
   - *Chlorine* - might indicate over-chlorinated sewage treatment/ water treatment plant or swimming pool discharges
   - *Fishy* - might indicate the presence of excessive algal growth or dead fish
   - *Rotten eggs* - might indicate sewage pollution (the presence of methane from anaerobic conditions)
9. *Water temperature* can be particularly important for determining the suitability of the stream as aquatic habitat for some species of fish and macroinvertebrates that have distinct

temperature requirements. Temperature also has a direct effect on the amount of dissolved oxygen available to the aquatic organisms. Measure temperature by submerging a thermometer for at least 2 minutes in a typical stream run. Repeat once and average the results.

Stream Bank and Channel Characteristics

10. *Depth of runs and pools* should be determined by estimating the vertical distance from the surface to the stream bottom at a representative depth at each of the two habitats.
11. *The width of the stream channel* can be determined by estimating the width of the streambed that is covered by water from bank to bank. If it varies widely, estimate an average width.
12. *Stream velocity* can have a direct influence on the health, variety, and abundance of aquatic communities. If water flows too quickly, insects might be unable to maintain their hold on rocks and vegetation and be washed downstream; if water flows too slowly, it might provide insufficient aeration for species needing high levels of dissolved oxygen. Stream velocity can be affected by dams, channelization, terrain, runoff, and other factors. To measure stream velocity, mark off a 20-foot section of stream run and measure the time it takes a stick, leaf, or other floating biodegradable object to float the 20 feet. Repeat 5 times and pick the average time. Divide the distance (20 feet) by the average time (seconds) to determine the velocity in feet per second. (See Chapter 5, Section 1 on flow for a more in-depth discussion on using floats to estimate velocity.)

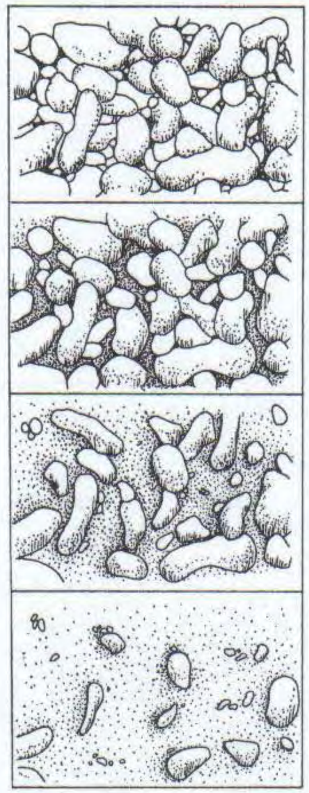


Figure 4.14

A representation of a rocky-bottom stream becoming embedded with sand and silt

As silt settles on the streambed, spaces between the rocks are filled in and the stream becomes more embedded.

13. *The shape of the stream bank, the extent of artificial modifications, and the shape of the stream channel* are determined by standing at the downstream end of the 25-yard section and looking upstream.

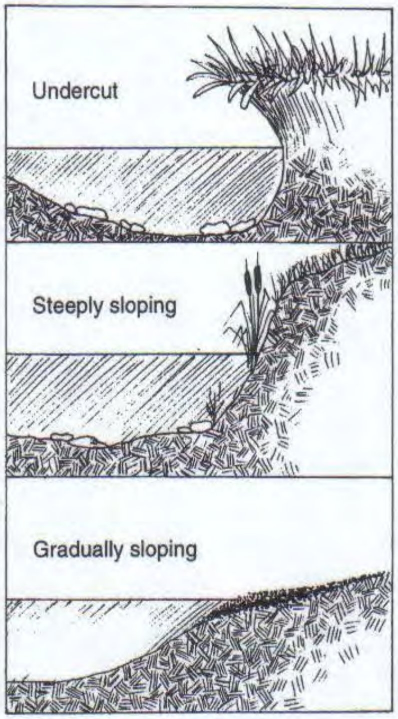
(a) The *shape of the stream bank* (Fig. 4.15) may include.

- *Vertical or undercut bank* - a bank that rises vertically or overhangs the stream. This type of bank generally provides good cover for macroinvertebrates and fish and is resistant to erosion. However, if seriously undercut, it might be vulnerable to collapse.
- *Steeply sloping* - a bank that slopes at more than a 30 degree angle. This type of bank is very vulnerable to erosion.

Figure 4.15

Types of streambank shapes

Undercut banks provide good cover for fish and macroinvertebrates.



- *Gradual sloping* - a bank that has a slope of 30 degrees or less. Although this type of stream bank is highly resistant to erosion, it does not provide much streamside cover.

(b) *Artificial bank modifications* include all structural changes to the stream bank such as riprap (broken rock, cobbles, or boulders placed on earth surfaces such as the face of a dam or the bank of a stream, for protection against the action of the water) and bulkheads. Determine the approximate percentage of each bank (both the left and right) that is artificially covered by the placement of rocks, wood, or concrete.

(c) *The shape of the stream channel* can be described as narrow (less than 6 feet wide from bank to bank), wide (more than 6 feet from bank to bank), shallow (less than 3 feet deep from the stream substrate to the top of the banks) or deep (more than 3 feet from the stream substrate to the top of the banks). Choose the category that best describes the channel.

- Narrow, deep
- Narrow, shallow
- Wide, deep
- Wide, shallow

14. *Streamside cover* information helps determine the quality and extent of the stream's riparian zone. This information is important at the stream bank itself and for a distance away from the stream bank. For example, trees, bushes, and tall grass can contribute shade and cover for fish and wildlife and can provide the stream with needed organic material such as leaves and twigs. Lawns indicate that the stream's riparian zone has been altered, that pesticides and grass clippings are a possible problem, and that little habitat and shading are available. Bare soil and pavement might indicate problems with erosion and runoff. Looking upstream, provide an estimate of the percentage of the stream bank (left and right stream banks) covered by the following:

- *Trees*
- *Bushes, shrubs* - conifers or deciduous bushes less than 15 feet high
- *Tall grass, ferns, etc.* - includes tall natural grasses, ferns, vines, and mosses
- *Lawn* - cultivated and maintained short grass
- *Boulders* - rocks larger than 10 inches
- *Gravel/cobbles/sand* - rocks smaller than 10 inches; sand

- *Bare soil*
- *Pavement, structure* - any man-made structures or paved areas, including paths, roads, bridges, houses, etc.

15. *Stream shading* is a measurement of the extent to which the stream itself is overhung and shaded by the cover identified in 14 above. This shade (or *overhead canopy*) provides several important functions in the stream habitat. It cools the water; offers habitat, protection, and refuge for aquatic organisms; and provides a direct source of beneficial organic matter and insects to the stream. Determine the extent that vegetation shades the stream at the site.

16. *General conditions of the stream bank and stream channel, and other conditions* that might be affecting the stream are determined by standing at the downstream end of the 25-yard site and looking upstream. Provide observations for the right and left banks of the stream.

(a) *Stream bank conditions* that might be affecting the stream.

- *Natural plant cover degraded*—note whether streamside vegetation is trampled or missing or has been replaced by landscaping, cultivation, or pavement. (These conditions could lead to erosion.)
- *Banks collapsed/eroded*—note whether banks or parts of banks have been washed away or worn down. (These conditions could limit habitats in the area.)
- *Garbage/junk* adjacent to the stream—note the presence of litter, tires, appliances, car bodies, shopping carts, and garbage dumps.
- *Foam or sheen on bank*—note whether there is foam or an oily sheen on the stream bank. Sheen may indicate an oil spill or leak, and foam may indicate the presence of detergent.

(b) *Stream channel conditions* that might be affecting the stream.

- *Mud/silt/sand on bottom/entering stream*—can interfere with the ability of fish to sight potential prey. It can clog fish gills and smother fish eggs in spawning areas in the stream bottom. It can be an indication of poor construction practices, urban area runoff, silviculture (forestry-related activities), or agriculture in the watershed. It can also be a normal condition, especially in a slow-moving, muddy-bottom stream.
- *Garbage or junk in stream*—note the presence of litter, tires, appliances, car bodies, shopping carts, and garbage.

(c) *Other general conditions* that might be affecting the stream.

- *Yard waste* (e.g., grass clippings)—is there evidence that grass clippings, cut branches, and other types of yard waste have been dumped into the stream?
- *Livestock in or with unrestricted access to stream*—are livestock present, or is there an obvious path that livestock use to get to the water from adjacent fields? Is there streamside degradation caused by livestock?
- *Actively discharging pipes*—are there pipes with visible openings discharging fluids or water into the stream? Note such pipes even though you may not be able to tell where they come from or what they are discharging.

- *Other pipes*—are there pipes near or entering the stream? Note such pipes even if you cannot find an opening or see matter being discharged.
- *Ditches*—are there ditches, draining the surrounding land and leading into the stream?

Local watershed characteristics

17. *Adjacent land uses* can potentially have a great impact on the quality and state of the stream and riparian areas. Determine the land uses, based on your own judgment of the activities in the watershed surrounding your site within a quarter of a mile. Enter a "1" if a land use is present and a "2" if it is clearly having a negative impact on the stream.

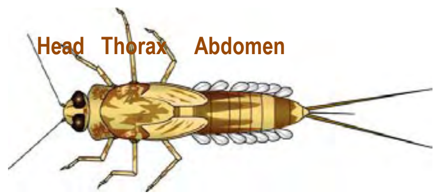
Visual biological survey

18. Are *fish* present in the stream? Fish can indicate that the stream is of sufficient quality for other organisms.
19. *Barriers to the movement of fish* in the stream are obstructions that would keep fish from moving freely upstream or downstream.
20. *Aquatic plants* provide food and cover for aquatic organisms. Plants also might provide very general indications of stream quality. For example, streams that are overgrown with plants could be over enriched by nutrients. Streams devoid of plants could be affected by extreme acidity or toxic pollutants. Aquatic plants may also be an indicator of stream velocity because plants cannot take root in fast-flowing streams.
21. *Algae* are simple plants that do not grow true roots, stems, or leaves and that mainly live in water, providing food for the food chain. Algae may grow on rocks, twigs, or other submerged materials, or float on the surface of the water. It naturally occurs in green and brown colors. Excessive algal growth may indicate excessive nutrients (organic matter or a pollutant such as fertilizer) in the stream.

Step 4—Complete all the field data sheets

After you have completed macroinvertebrate sampling, analysis of findings, and the habitat characterization, make sure you have completed the field data sheet to the extent possible and that the recorded data are legible. If you are not able to determine how to answer a question on the field data sheet, just leave the space blank. Return all completed forms to your program coordinator.

WV Save Our Streams’ Benthic Macroinvertebrate Field Guide

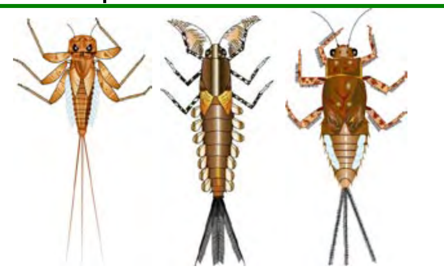


Small minnow mayfly

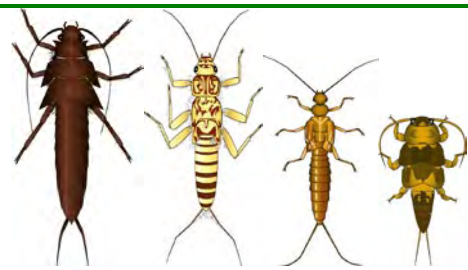
What is an insect? An insect is an invertebrate (an animal with no spine) that has three-pairs of legs (except Diptera) and three body divisions; the head is the location of the mouth, antenna and eyes; the thorax is the attachment site for the legs and wing pads; and the abdomen, which often has a variety of structures attached including filaments gills and tails. Gills are usually leaf-like, plate-like, or thin filaments. Tails can be long and thin, hairy, webbed or paddle-like. Most of the **benthic macro-invertebrates** you will encounter during stream surveys are aquatic larva or nymphs of insects. Most adult stages are not aquatic but the beetles are the exception. The majority of the insects are described and illustrated on page one and the top of page two; non-insect group descriptions and Illustrations begin on page two.

Insect Groups

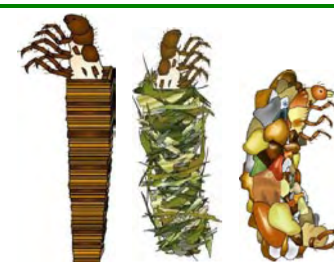
Instructions provided at the bottom of page two



Mayflies (Order **Ephemeroptera**): Three-pairs of legs with a single hook at the end; three some-times two tail filaments; gills attached to the abdomen, which may sometimes be covered and difficult to see. Mayflies exhibit several types of movements (or habits); swimmers, clingers, crawlers and burrowers. (**VS-M**) (**M**)

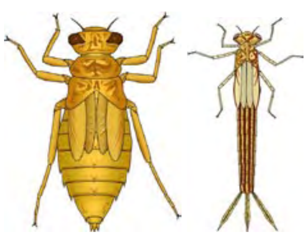


Stoneflies (Order **Plecoptera**): Three-pairs of legs with two-hooks at the end; two tail filaments; no gills attached to the abdomen but some kinds may have gills near the top of the abdomen; gills if visible, mostly on the legs and thorax. (**S-VL**) (**M**)



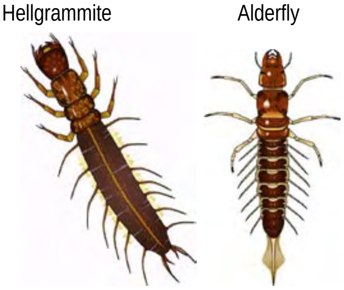
Case-building caddisflies (Order **Trichoptera**): Grub-like soft body and a hard head; Three-pairs of legs located on the upper third of the body; tail is small and usually forked, sometimes fringed with hairs; gills are scattered on the underside of the abdomen. The case (retreat) is a relatively solid structure made of a variety of stream-bed materials held together by silk. (**VS-L**) (**M**)

Dragonfly Damselfly



Dragonflies and **Damselflies** (Order **Odonata**): Three-pairs of legs; large eyes; long spoon-like jaws; no tails on the abdomen. Dragonflies have a broad shaped abdomen, while the Damselfly abdomen is much narrower. Damselfly gills are attached to the end of the abdomen, they look like tails. (**M-VL**) (**M**)

Hellgrammite Alderfly

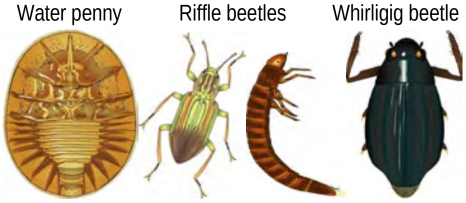


Fishflies and **Alderflies** (Order **Megaloptera**): Three-pairs of legs; large pinching jaws; eight-pairs of filaments attached to the sides of the abdomen. Fishflies also called **hellgrammites** have a two-hooked tail, whereas Alderflies have a single tapered tail and are usually much smaller and lighter in color. (**M-VL**)

Common netspinner Finger-net Free-living

Net-spinning caddisflies (Order **Trichoptera**): Similar characteristics as above but the abdomen usually has more abundant gills, especially the **common netspinner** (family **Hydropsychidae**). The net-spinner’s retreat is also made of a variety of streambed materials, which are held together more loosely by fine strands of silk. The **free-living caddisfly** (right) does not build a case or net. (**S-L**) (**M**)

Water penny Riffle beetles Whirligig beetle



Beetles (Order **Coleoptera**): Three-pairs of legs; body usually covered by a hard exoskeleton. The Most common kinds collected are the **water penny** and **riffle beetles** (left-right), but others kinds are also found. (**VS-L**) (**M**)

True flies (Order **Diptera**): Usually the body is segmented with some type of visible features either along the body, or at the head or tail regions (i.e. head, tails, prolegs, whelps etc.). **This order contains aquatic insects without legs in their larval stages**. Diptera is a very diverse order with many aquatic families (kinds). Several commonly encountered kinds are described here. (**M**)

Non-biting midge (Order **Diptera**; family **Chironomidae**): Segmented body with a visible head; two leg-like projections at the front and rear. Sometimes they are bright **red** in color. (**VS-M**)

Crane fly (Order **Diptera**; family **Tipulidae**): No legs, no visible head; plump body with lobes along the segments; may have structures that look like tentacles, lobes or one bulb at the end of the body. (**S**-**VL**)

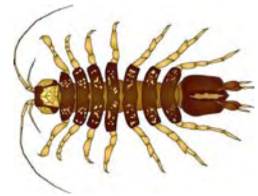
Black fly (Order **Diptera**; family **Simuliidae**): Body has a bowling-pen shape (lower is wider than the upper); there are multiple brushes/fans on the head and a ring of hooks on the abdomen. (**VS**-**M**)

Watersnipe fly (Order **Diptera**; family **Athericidae**): Plump body, looks very much like a caterpillar; on the underside there are structures that look similar to legs but are not segmented; the tail is forked and fringed with hairs. (**S**-**L**)

Non-Insect Groups

Crayfish (Order **Decapoda**): Five pairs of legs, the first two usually have large claws; large flipper-like structure at the end of the abdomen. (**M**-**VL**)

Scud/**Sideswimmer** (Order **Amphipoda**): Seven pairs of legs, the first two may be claw-like; body is somewhat higher than it is wide. Usually swims with a sideways motion. (**S**-**M**)



Aquatic sowbug (Order **Isopoda**): Seven pairs of legs, the first two may be claw-like; very long antenna; body is wider than it is high, giving the animal a fairly flattened appearance. (**S**-**M**)

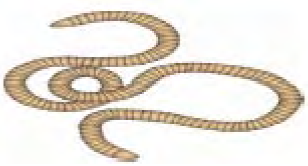
Mussel

Clams

Clams and **Mussels** (Class **Bivalvia**): Fleshy body enclosed between two-hinged shells; the shape and ridge spacing of the shells is used used to destinguish different kinds. **Mussels** are usually larger than clams and have dark colored oblong shells. (**VS**-**VL**) (**M**)

Operculate snails (Class **Gastropoda**; sub-class **Prosobranchia**): Fleshy body enclosed by a single shell, which is usually coiled in an upward spiral. The opening of the shell is covered by an operculum (door). (**VS**-**L**) (**M**)

Non-operculate snails (Class **Gastropoda**; sub-class **Pulmonata**): Fleshy body enclosed by a single shell, which is sometimes coiled upward but also may lie flat or have a conical shape. The opening of the shell is not covered by an operculum. (**VS**-**L**) (**M**)



Aquatic worms (Class **Oligochaeta**): Body is long with numerous segments along its entire length; has no visible head or tail. (**VS**-**VL**)

Leeches (Class **Hirudinea**): Body is long and thin or slightly widened; 34–segments along its length, but there appears to be many more. (**S**-**VL**)

Flatworms (Class **Turbellaria**): Soft elongate body without segment; head triangular shaped with eyes on top, which give the animal a cross-eyed appearance. (**VS**-**L**)

http://www.dep.wv.gov/sos

Sizes illustrated not proportional

dep

WV Save Our Streams
601 57th Street, SE
Charleston, WV 25304

Instructions: Identification is easier when the organism is viewed in the same orientation as its illustration. Illustrations are drawn mostly in top and side views; the water penny is shown in underside view. The (**M**) symbol indicates that multiple kinds may be collected from the group (Order or Class). Use **morphological** features as your basis for identification; the size and color are often variable and influenced by environmental factors. Only a few of the many kinds possible are illustrated. (**Size range in mm**)

Size categories: > 50 Very large (**VL**); 50 - 30 Large (**L**); 29 -10 Medium (**M**); 10 - 5 Small (**S**); < 5 Very small (**VS**)

Note: This field guide will help you identify common aquatic invertebrate classes and orders, and a few families. You should always refer to a more complete guide for verification of family level identification. Eventually, you will be able to identify a wide variety of families in the field.

Illustrations courtesy of the Cacapon Institute (http://www.cacaponinstitute.org/) and artist Jennifer Gillies; used with permission

Save Our Streams

A citizens volunteer stream monitoring program

(**1**) Determine your stream-reach boundary; this is a stream length up to 100-meters, which may be more or less under certain circumstances. (**2**) Near the lower end of the reach (in the deepest portion of the run), collect water samples and analyze using the chemical tests you have available. You may use your collection container to observe watercolor and clarity and to determine water odors. (**3**) Measure the width-depth and velocity, and estimate the water level. (**4**) Using a **kick-net**, collect a minimum of three benthic macro-invertebrate samples from the best riffles or runs within your stream reach. Use the tally sheet on page three to record information about your collections. (**5**) Evaluate the physical and habitat conditions, and record information about known land use activities. (**6**) Sketch your reach or submit photographs with the survey, and add any other comments that you feel are important for evaluating the conditions of your study site.

Stream name ______________________ Survey date ____________

Watershed ______________________ County ____________

Latitude ____________ Longitude ____________ Directions ____________

______________________ Start/end times ____________

Survey completed by ______________________ Station code ____________

Affiliation ______________________ E-mail ____________

Mailing address ______________________ Phone number ____________

____

Water chemistry: Use the boxes below to record the results of your water chemistry analysis; attach additional sheets if necessary.

	Result	units		Result	units		Result	units
Temperature (C/F)			Conductivity			Alkalinity		
Dissolved oxygen			Nitrate/Nitrite			Metals (describe)		
pH			Phosphate			Fecal/E-coli		

Additional tests (describe and record results) ______________________

____

____

Physical conditions: Use the check boxes below to describe the conditions that closely resemble those of your stream. The extra lines are provided to write in any additional comments. You may see more than one type of condition; if so, be sure to indicate these on your survey (check all that apply). If multiple conditions are observed, always indicate the most dominant condition. Note: If the condition you observe is not listed, describe it in the comment section.

Water clarity		Water color		Water odor		Surface foam	
Clear		None		None		None	
Murky		Brown		Fishy		Slight	
Milky		Black		Musky		Moderate	
Muddy		Orange/red		Rotten egg		High	
Other (describe)		Gray/White		Sewage			
		Green		Chemical			

Algae color		Algae abundance		Algae growth habit		Streambed color	
Light green		None		Even coating		Brown	
Dark green		Scattered		Hairy		Black	
Brown		Moderate		Matted		Green	
Other (describe)		Heavy		Floating		White/gray	
						Orange/red	

Physical condition comments: ______________________

____

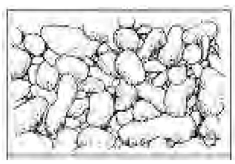
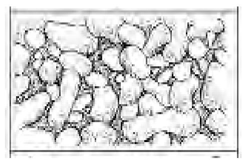
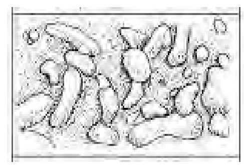
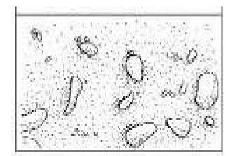
Estimate the % of your reach that is shaded	> 80	80 - 60	60 - 40	< 40
	Excellent	Good	Fair	Poor

Circle your estimate

Width and depth measurements: Record the wetted width and average depth from at least one of the channel's habitats (riffle, run or pool). Record the average depth from a minimum of five measurements (one of these should be from the deepest part of the habitat). The width should be measured from the widest section of the feature. Be sure to indicate the type(s) of habitat that you have chosen. **It is best to complete this task during your discharge measurements**.

				Riffle	Run	Pool
1. Width (feet)	____________	Depth (feet)	____________	[ ]	[ ]	[ ]
2. Width (feet)	____________	Depth (feet)	____________			

Habitat conditions: Rate the habitat conditions by choosing the best description for the reach. Bank stability and riparian buffer width are assessed on both the **left** and **right** side of the stream. Indicate your choice by writing **O**, **S**, **M** or **P** in the spaces provided.

Point values	8	6	4	2
Embeddedness	 Fine sediments surrounds <10% of the spaces between the gravel, cobble and boulders.	 Fine sediment surrounds 10-30% of the spaces between the gravel, cobble and boulders.	 Fine sediment surrounds 30-60% of the spaces between the gravel, cobble and boulders.	 Fine sediment surrounds > 60% of the spaces between the gravel, cobble and boulders.
	Optimal	**S**uboptimal	**M**arginal	**P**oor

Embeddedness should be evaluated in riffles/runs prior to or during your macroinvertebrate collections.

Sediment deposition	Little or no formation of depositional features; < 20% of the reach affected. **See below for examples**	Some increase in depositional features; 20-40% of the reach affected.	Moderate amounts of depositional features; 40-60% of the reach affected.	Heavy amounts of deposition; > 60% of the reach affected.
	Optimal	**S**uboptimal	**M**arginal	**P**oor

The next two conditions are evaluated on both the left and the right sides of the stream.

Point values	4	3	2	1
Bank stability	Banks are stable; no evidence of erosion or bank failure; little or no potential for future problems; < 10% of the reach affected.	Banks are moderately stable; infrequent areas of erosion occur, mostly shown by banks healed over or a few bare spots; 10-30 % of the reach affected.	Banks are moderately unstable; 30-50% of the reach has some areas of erosion; high potential for erosion during flooding events.	Banks are unstable; many have eroded areas (bare soils) along straight sections or bends; obvious bank collapse or failure; > 50% affected.
	Optimal	**S**uboptimal	**M**arginal	**P**oor
Riparian buffer width	Mainly undisturbed vegetation > 60 ft; no evidence of human impacts such as parking lots, road beds, clear-cuts, mowed areas, crops, lawns etc.	Zone of undisturbed vegetation 40-60 ft; some areas of disturbance evident.	Zone of undisturbed vegetation 20-40 ft; disturbed areas common throughout the reach.	Zone of undisturbed vegetation < 20 ft; disturbed areas common throughout the entire reach.
	Optimal	**S**uboptimal	**M**arginal	**P**oor
Totals	> 26	26 – 20	19 – 13	< 13
	Optimal	Suboptimal	Marginal	Poor

Habitat condition comments: ______________________________

Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. Usually deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends.

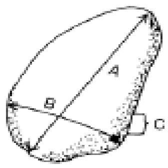
Station code ____________ Date(s) ____________

Streambed composition: You should always collect information about the composition of your reach. You can either estimate the proportions or you use a **pebble count** for a more accurate measure of composition. At a minimum you should estimate composition of the riffles within your reach. The size categories are determined by the (B) axis measured in millimeters. Did you estimate [ ] or count [ ] ? Use the table below to record your data.

Woody debris
Includes sticks, leaves etc. [ ]

Silt/clay < 0.06	Sand 0.06 – 2	Fine gravel 2 - 24	Coarse gravel 25 - 64	Cobble 65 - 255	Boulder 256 - 1096	Bedrock > 1096
Very small; having a smooth slick feel	Very small; having a grainy feel	Pea to tennis ball		Tennis ball to basketball	Basketball to car size	Usually larger than a car; solid surface

Riffle only [ ] Entire reach [ ]



(A) Long axis (**Length**)
(B) Intermediate axis (**Width**)
(C) Short axis (**Height**)

Pebble counts require two people, one in the stream and one on shore. The person in the stream walks upstream from bank to bank using a zigzag pattern. After each step the person reaches down without looking, picks up the first particle touched, and measures the intermediate axis with a ruler. The on-shore partner records the measurement. The process continues until **100** pebbles have been measured or the reach has been walked. For a quick estimate, the coordinator recommends that **50** be collected from the entire reach and **20** if collecting from riffles only.

Land use: Indicate the land uses that you believe may be having an impact on your stream station. Use the letters (**S**) streamside, (**M**) within ¼ mile and (**W**) somewhere in the watershed, to indicate the approximate location of the disturbance and the numbers (**1**) slight, (**2**) moderate or (**3**) high, to represent the level of disturbance.

Active construction			Pastureland			Single-family residences		
Mountaintop mining			Cropland			Sub-urban developments		
Deep mining			Intensive feedlots			Parking lots, strip-malls etc.		
Abandoned mining			Unpaved Roads			Paved Roads		
Logging			Trash dumps			Bridges		
Oil and gas wells			Landfills			Other (describe)		
Recreation (parks, trails etc.)			Industrial areas					

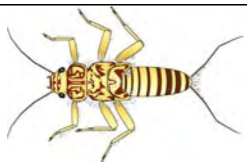
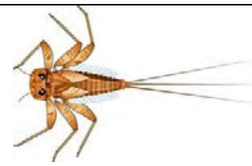
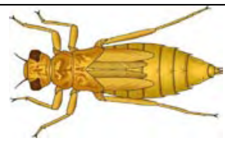
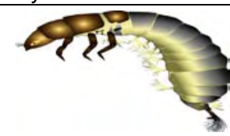
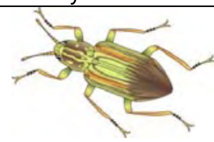
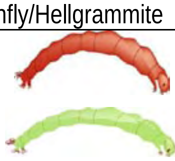
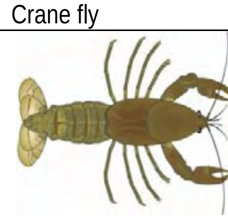
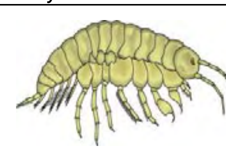
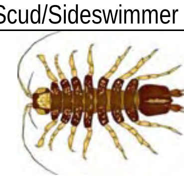
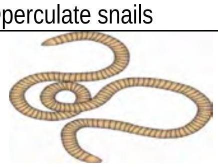
Pipes? [Yes] [No]

Describe the types of pipes observed and indicate if there is any discharge from the pipes. Also describe the colors and odors of the discharge, and provide any other land-use comments. ______________________________

____

Photograph and **sketch your study reach**: Use the space below to draw your study reach. Indicate the direction of flow, sample locations and important features of the reach. Photographs are an excellent method for tracking changes, especially changes related to the condition of the habitat. Choose at least two locations from which to take your photos and submit your photos with your survey data sheet.

Benthic macroinvertebrates: Use the table below to record information about your collections. Record their abundance using these codes: (**A**) > **50**, (**C**) **5** – **50** and (**R**) < **5** and also record the number of different kinds. The **# of kind's** box indicates groups in which multiple kinds (families) are possible. If collected, include the free-living caddisfly with the other net-spinners. Illustrations courtesy of the Cacapon Institute; Jennifer Gillies, artist

 Stoneflies	# of kinds	 Mayflies	# of kinds	 Caddisflies	**Case-builders** # of kinds
 Dragonflies	# of kinds	 Caddisfly	**Common netspinner**	 Caddisflies	**Other net-spinners** # of kinds
 Damselflies	# of kinds	 Riffle beetle		 Water penny	
 Fishfly/Hellgrammite		 Alderfly		 Other beetles	# of kinds
 Midges		 Black fly		 Crane fly	
 Watersnipe fly		 Other flies	# of kinds	 Crayfish	
 Clams	# of kinds	 Mussel		 Scud/Sideswimmer	
 Operculate snails	# of kinds	 Non-operculate snails	# of kinds	 Aquatic sowbug	
 Aquatic worm		 Leech		 Flatworm	

Other aquatic life observed or collected: ______________________________

Station code ____________________ Date(s) ______________________

Stream Score

After the sorting and identifications is complete, the macroinvertebrates are assessed using four metrics. First, transform your abundance rating into numbers using this code (**A** = **6; C** = **3**; **R** = **1**) and follow the instructions below to complete all calculations. The light gray shading indicates that multiple kinds are possible.

1. **Biotic Index**: Multiply the abundance number by the tolerance value to calculate the tolerance score. Add the entire tolerance score column and the abundance column. Divide the tolerance total by the abundance total.
2. **Total Taxa**: Calculate the total number of kinds.
3. **EPT Taxa**: Calculate the total number of kinds from the stoneflies, mayflies, and all caddisflies.

The final step is to determine a **point value** for each metric. These points are added together to determine your overall **stream score** and integrity rating.

Benthic macroinvertebrates	Abundance	Tolerance Value	Tolerance Score	Number of Kinds
Stoneflies (Order Plecoptera)		2		
Mayflies (Order Ephemeroptera)		3		
Case-building caddisflies (Order Trichoptera)		3		
Net-spinning caddisflies (Order Trichoptera)		4		
Common netspinner (Family Hydropsychidae)		5		
Dragonflies (Sub-order Anisoptera)		4		
Damselflies (Sub-order Zygoptera)		7		
Riffle beetle (Family Elmidae)		4		
Water penny (Family Psephenidae)		3		
Other beetles (Order Coleoptera)		6		
Hellgrammite (Family Corydalidae)		3		
Alderfly (Family Sialidae)		6		
Non-biting midge (Family Chironomidae)		8		
Black fly (Family Simuliidae)		6		
Crane fly (Family Tipulidae)		4		
Watersnipe fly (Family Athericidae)		3		
Other true flies (Order Diptera)		7		
Water mite (Order Hydrachnida)		6		
Crayfish (Order Decapoda)		5		
Sideswimmer (Order Amphipoda)		5		
Aquatic sowbug (Order Isopoda)		7		
Operculate snails (Sub-class Prosobranchia)		4		
Non-operculate snails (Sub-class Pulmonata)		7		
Clams (Order Veneroida)		6		
Mussel (Family Unionidae)		4		
Aquatic worm (Class Oligochaeta)		10		
Leech (Class Hirudinea)		10		
Flatworm (Class Turbellaria)		7		
Other invertebrates (describe)	Total Abundance		Total Tolerance	Total Taxa (Kinds)

Metrics	Results	**Points**	**10**	**7**	**5**	**3**
1. Total Taxa			> 18	18 - 13	12 - 8	< 8
2. EPT Taxa			> 10	10 - 7	6 - 4	< 4
3. Biotic Index			< 4.0	4.0 – 5.0	5.1 – 6.0	> 6.0

Stream Score

Integrity Rating

> 24	24 - 19	18 - 12	< 12
Optimal	Suboptimal	Marginal	Poor

Station code ____________________ Date(s) ____________________

Discharge: Determine the discharge by using a flow meter (if available) or other methods such as the float method or the velocity head rod method (VHR). Discharge should always be measured from a **run**. The more measurements collected the more accurate your discharge results will be. To convert inches into feet divide by 12. For example, if your depth measurement was 6-inches the result in feet would be 0.5. Indicate the method and use the tables to record your results.

Discharge method used

☐ Float ☐ Velocity Head Rod ☐ Flow meter

Water Level

☐ Low ☐ Normal ☐ High ☐ Dry

Channel width ______________ feet

Tape distance (ft)	Depth (ft)	Velocity (ft/sec)	VHR (Rise-inches)	Float (sec)	Discharge (cfs)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
Totals/Averages					

Cross Sectional Area (CSA) ______________ ft^2

(CSA = Average Depth x Width)

Discharge = CSA x Velocity

= ______________ x ______________

= ______________ cfs (ft^3/sec)

If you use a float record your distance below and the number of seconds it took to travel the distance in the column indicated.

Float distance (feet) ___________

VHR rises and velocities.

Rise (R)	Velocity	Rise (R)	Velocity
¼	1.2	3 ¼	4.2
½	1.6	3 ½	4.3
¾	2.0	3 ¾	4.5
1	2.3	4	4.6
1 ¼	2.6	4 ¼	4.8
1 ½	2.8	4 ½	4.9
1 ¾	3.1	4 ¾	5.0
2	3.3	5	5.2
2 ¼	3.5	5 ¼	5.3
2 ½	3.7	5 ½	5.4
2 ¾	3.8	5 ¾	5.5
3	4.0	6	5.7

Submit a clear copy or the original data sheet to the coordinator at address below. If you submit the original, always keep a copy for your records.

West Virginia Dept. of Environmental Protection
Save Our Streams Program
601 57th Street, SE
Charleston, WV 25304

If you have questions or comments contact the program coordinator by E-mail at: timothy.d.craddock@wv.gov, call (304) 926-0499 Ext. 1040 or visit the program's web page at: http://www.dep.wv.gov/sos.