Missouri Stream Team

Introduction to Volunteer Water Quality Monitoring

2019
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Missouri Stream Team

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IF YOU DISCOVER A SERIOUS WATER POLLUTION EVENT OR FISH KILL, PLEASE REPORT IMMEDIATELY TO:
MISSOURI DEPARTMENT OF NATURAL RESOURCES
EMERGENCY RESPONSE UNIT 573-634-2436

Volunteer Water Quality Monitoring Introductory Level

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Chapter 1
Welcome & Introduction

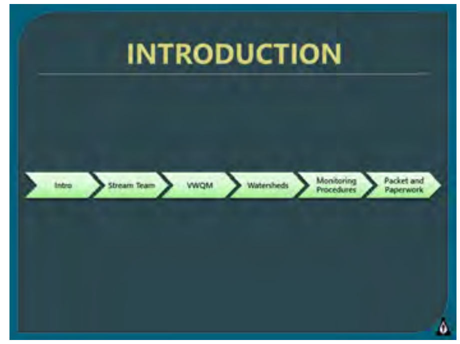
Welcome to Missouri Stream Team! This program is made possible by a strong partnership between the citizens of Missouri and the following organizations:

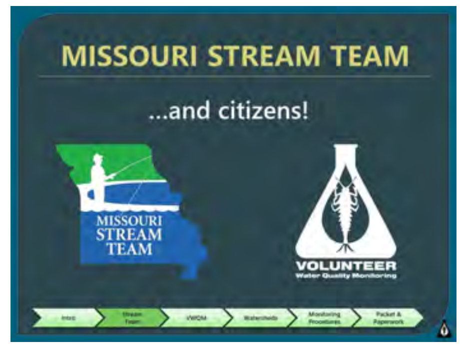
MISSOURI DEPARTMENT OF CONSERVATION — Conservation Federation MISSOURI — MISSOURI DEPARTMENT OF NATURAL RESOURCES

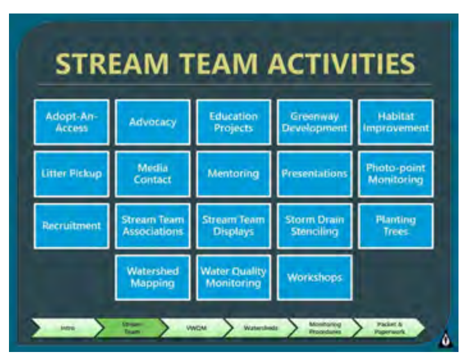
Beginning in 1989, the Missouri Stream Team provides opportunities for all citizens to get involved in river and stream conservation. The program has three main goals:

- ***Education:*** Teaching citizens about Missouri's 110,000 miles of flowing water enables people and their communities to better understand our stream systems and the challenges we face in conserving them.
- ***Stewardship:*** Becoming good stewards of our natural resources ensures future generations will enjoy the benefits of Missouri's streams. Whether you assist in litter control, streambank stabilization, streamside tree planting, water quality monitoring, or storm drain stenciling, let the Stream Team Program help you plan and support your next stewardship project.
- ***Advocacy:*** Citizens who have gained firsthand knowledge of stream needs, problems, and solutions are best equipped to speak out on behalf of Missouri's stream resources.

Whatever your talents, the Missouri Stream Team Program has many opportunities for you to get involved. We welcome your volunteer efforts and sincerely appreciate the work you do to protect and conserve Missouri's streams.







VWQM Program and Goals

One of the most popular Stream Team activities is the Volunteer Water Quality Monitoring (VWQM) Program. This activity was added in 1993 at the request of Stream Team volunteers who wanted to participate in stream monitoring.

The VWQM Program provides volunteers with training and equipment to monitor the quality of Missouri's rivers and streams. The VWQM Program was established to achieve four goals:

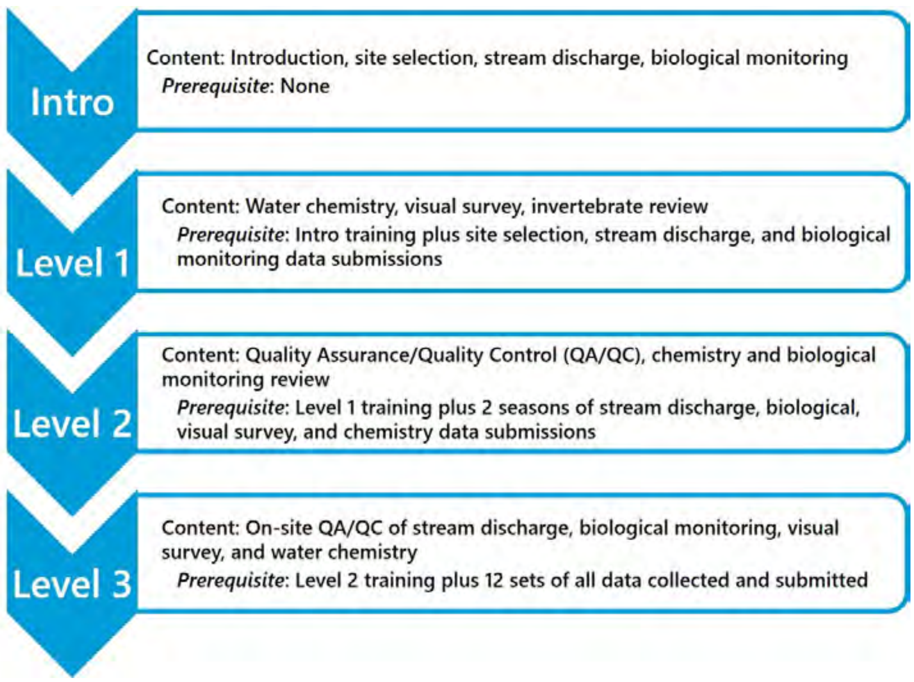
- Inform and educate yourself and others about the conditions of Missouri's rivers and streams.
- Establish a network of trained volunteers to monitor the quality of Missouri's rivers and streams.
- Enable citizens to help local, state and federal leaders make informed decisions about Missouri's waterways.
- Halt water quality degradation of Missouri's water resources.

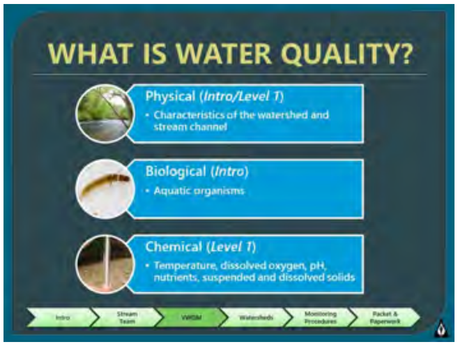
VWQM Levels of Training and Requirements

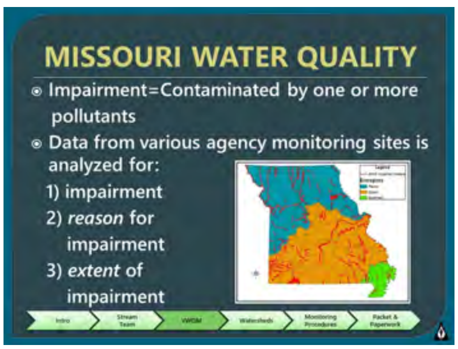
To become a water quality monitor, volunteers engage in training to acquire the knowledge and skills they need to evaluate water quality accurately. Currently, there are four levels of training. Each level of training is a prerequisite for the next. Structuring the training in this way allows volunteers to choose their own level of participation and commitment in monitoring activities.

Volunteers who wish to advance from one level to the next must meet certain requirements. The table below describes the content of each training level and the requirements that allow you to advance to the next level.

VWQM Levels of Training and Prerequisites

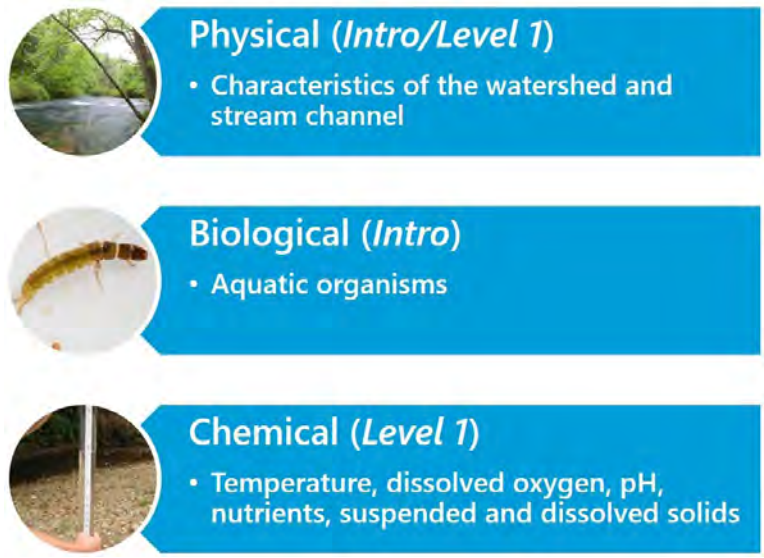






What is Water Quality?

The quality of Missouri's water resources is reflected in the physical, chemical, and biological characteristics of our rivers and streams. Today's training will introduce you to the physical and biological components of a stream. Chemical characteristics will be covered in the VWQM Level 1 training.



Missouri Water Quality

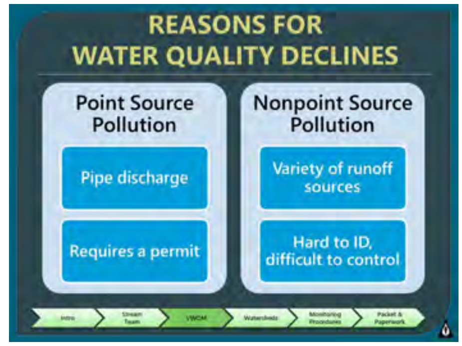
In order to compare natural properties across the state, Missouri is divided into three broad ecoregions based on topography, soils, geology, etc. The Plains ecoregion lies to the north of the state. The Ozarks ecoregion lies to the south. In Missouri's bootheel is the Mississippi Alluvial Basin ecoregion. Differences in water quality across these regions can be attributed to a combination of actual water quality differences and variations in habitat.

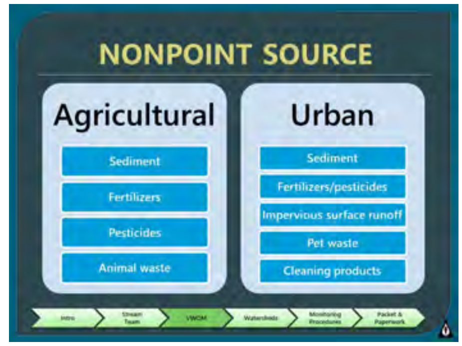
Stream Teams United published a summary of Missouri Stream Team Volunteer Water Quality Monitoring Program data collected from 1993 to 2016. This summary can be found online at www.MSTWC.org.

Reasons for Water Quality Declines

The Clean Water Act mandates how our nation must manage the two major types of water quality pollution:

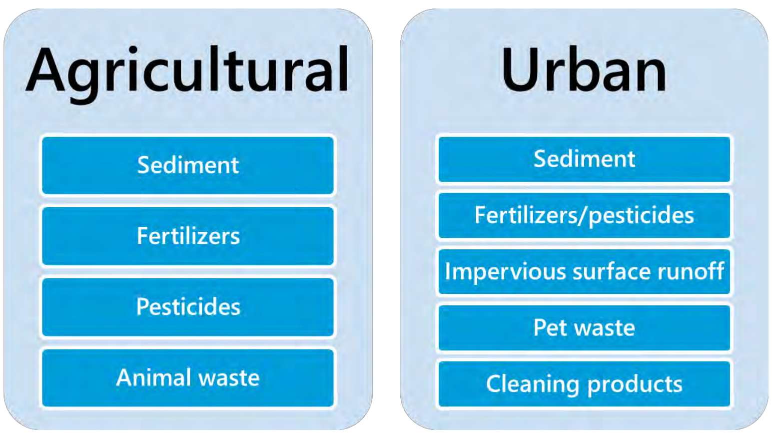
- ***Point Source Pollution*** is characterized by an entry point or source, such as a pipe. This type of pollution requires a permit, so it can usually be identified and regulated through the permitting process.
- ***Nonpoint Source Pollution*** refers to contaminants that do not come from specific conveyances, such as pipes or other permitted sources. It includes contaminants carried in runoff from fields, roads, parking lots, etc., as well as more specific sources such as improperly functioning septic systems. Nonpoint source pollution is much more challenging to identify and control than point source pollution.

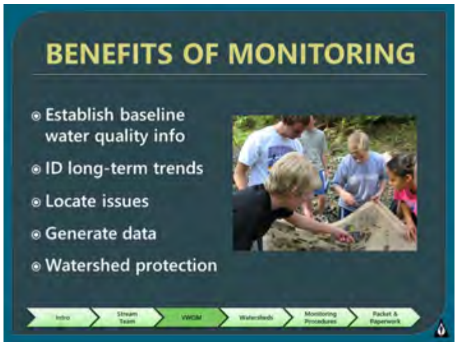


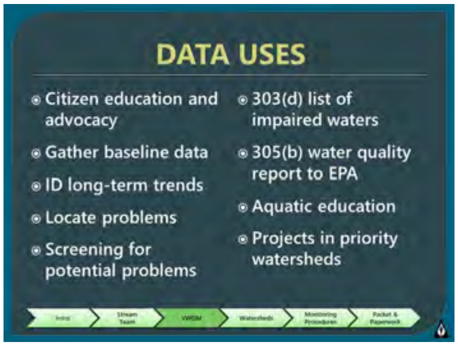


Nonpoint Source Pollution

Nonpoint Source Pollutants can be classified into two groups: Agricultural and Urban. Many of these pollutants are found in both environments, they have a substantial effect on water quality.







Benefits of Monitoring Water Quality

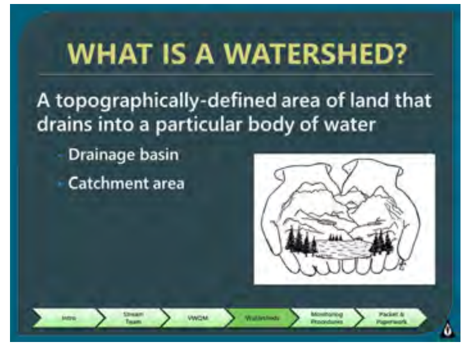
There are several benefits to monitoring the water quality of our streams:

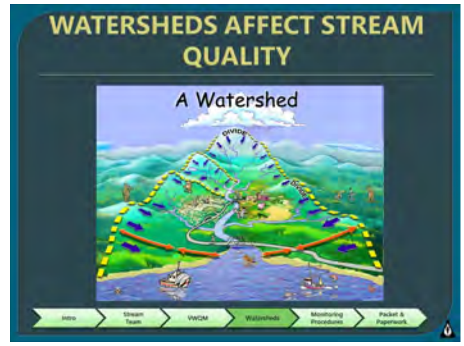
- ***Establish Baseline Water Quality Information:*** Missouri has nearly 110,000 classified streams. Many of these streams have little or no information about water quality. If a pollution event should occur, a baseline of information serves as a comparison to what conditions were like before the incident.
- ***Identify Long-Term Trends:*** Submitting consistent data over a span of many years reveals if the stream conditions are improving, declining, or staying the same.
- ***Locate Issues:*** With over 9,000 trained volunteers, there are numerous examples of volunteers who discover pollution events and alert the appropriate authorities.
- ***Watershed Protection:*** Monitoring your stream gives you a richer understanding and appreciation of our waterways. This allows for better decision making regarding the protection of your local watershed.
- ***Data Uses:*** The data collected by trained monitors is used by many state agencies and local groups to educate citizens, advocate for clean streams, locate sources of pollution, conduct scientific research, and many other applications.

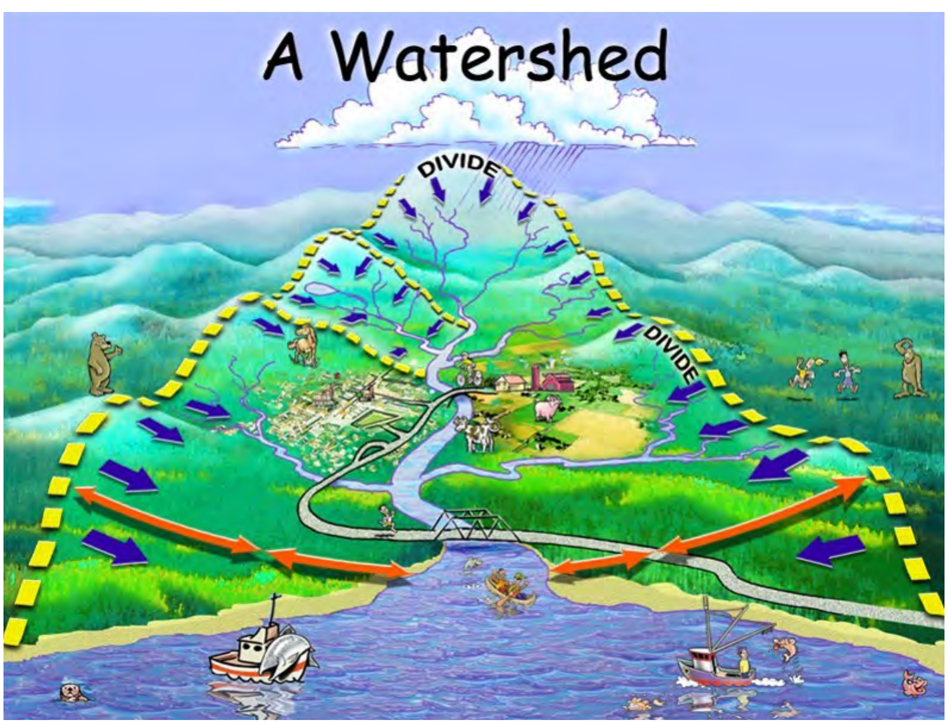
What is a Watershed?

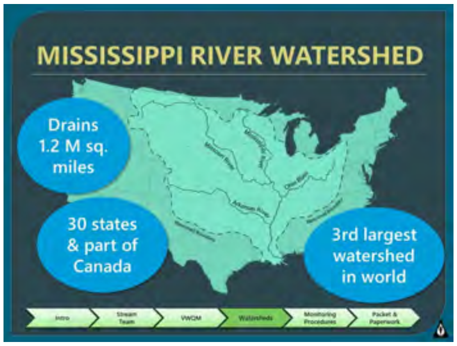
A watershed is a topographically defined area of land that drains into a particular body of water. Watersheds are interconnected. For example, the Mississippi Watershed includes the Missouri, Mississippi, Ohio, Tennessee, Arkansas, White, and Red river basins.

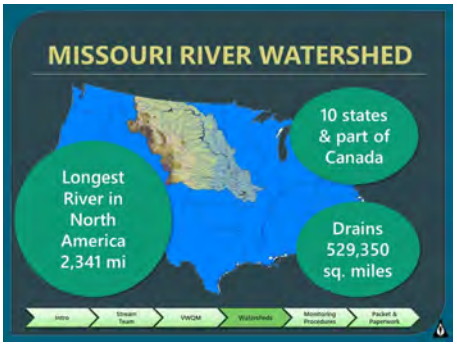
The quality of a stream is a direct reflection of its watershed. Since humans live, work, and play in watersheds, we directly and indirectly alter them and our water resources. As water flows across urban areas or pastures, it picks up sediment, pollutants, and even heat. These contaminants eventually flow into a stream or lake, impacting water quality.











Mississippi River Watershed

Watersheds range in size from less than an acre to millions of square miles. The Mississippi River watershed is the third largest, covering 1,247,000 square miles. Streams and rivers cross political boundaries, too. For example, the Mississippi River watershed includes portions of 30 states and a small part of Canada.

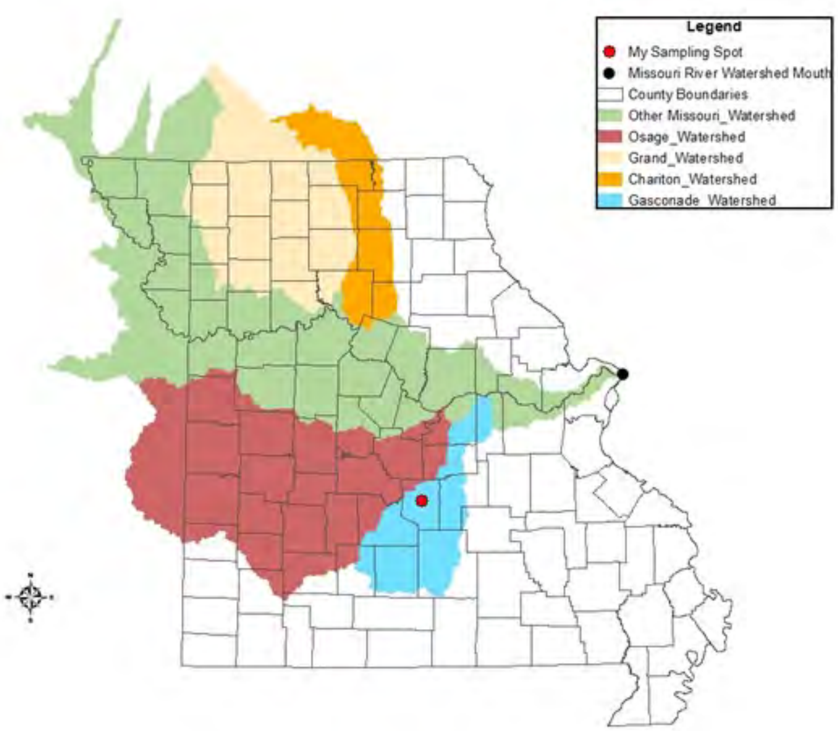
Missouri River Watershed

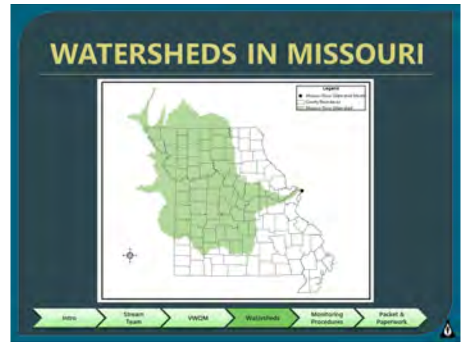
The Missouri River is the longest river in North America, stretching 2,341 miles. As the largest tributary to the Mississippi River, it has the largest reservoir system in North America. At normal water levels, this system stores approximately 55 times the amount of water stored in Truman Reservoir. With its channelization, major reservoirs, and systems of levees, it is also one of the most altered rivers in the world. More than half of Missourians get their drinking water from the river or its underground aquifer. The Missouri River watershed is actually a sub-watershed of the Mississippi. It covers 529,350 square miles, portions of 10 states, and a small part of Canada.

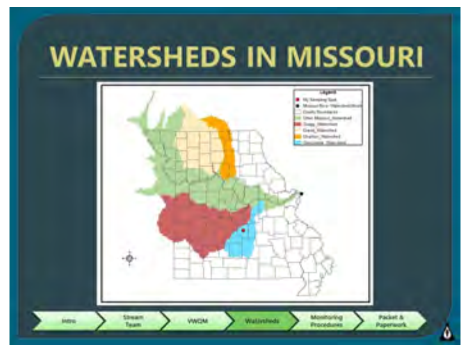
Watersheds in Missouri

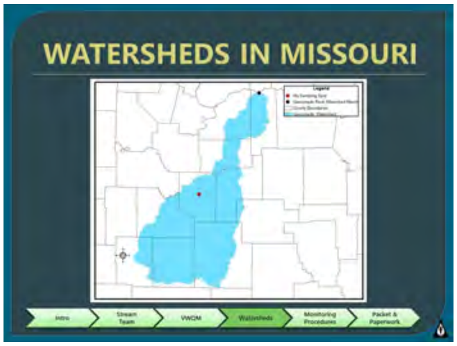
The image below depicts the portions of the Missouri River watershed in the State's boundaries. To give a point of reference, a sampling spot is indicated by the red point.

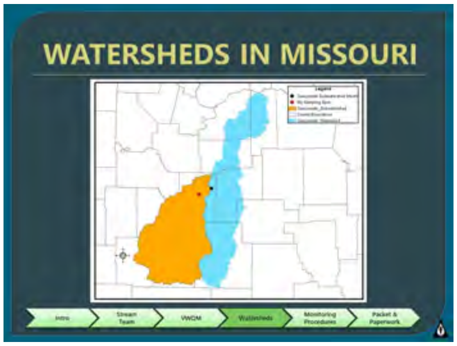
The Missouri River has many tributaries including the Gasconade, Grand, Chariton, and Osage rivers. The image below illustrates these tributaries' watersheds within the Missouri River watershed.

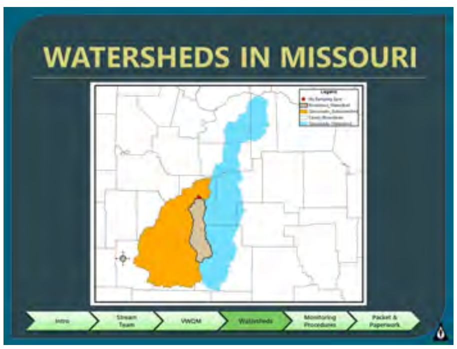


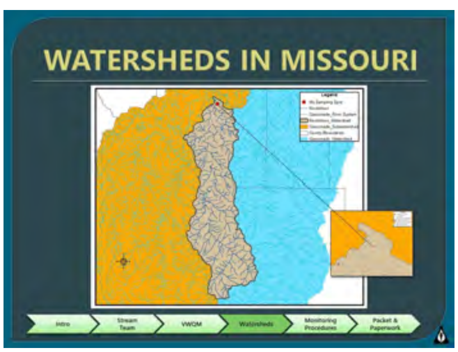








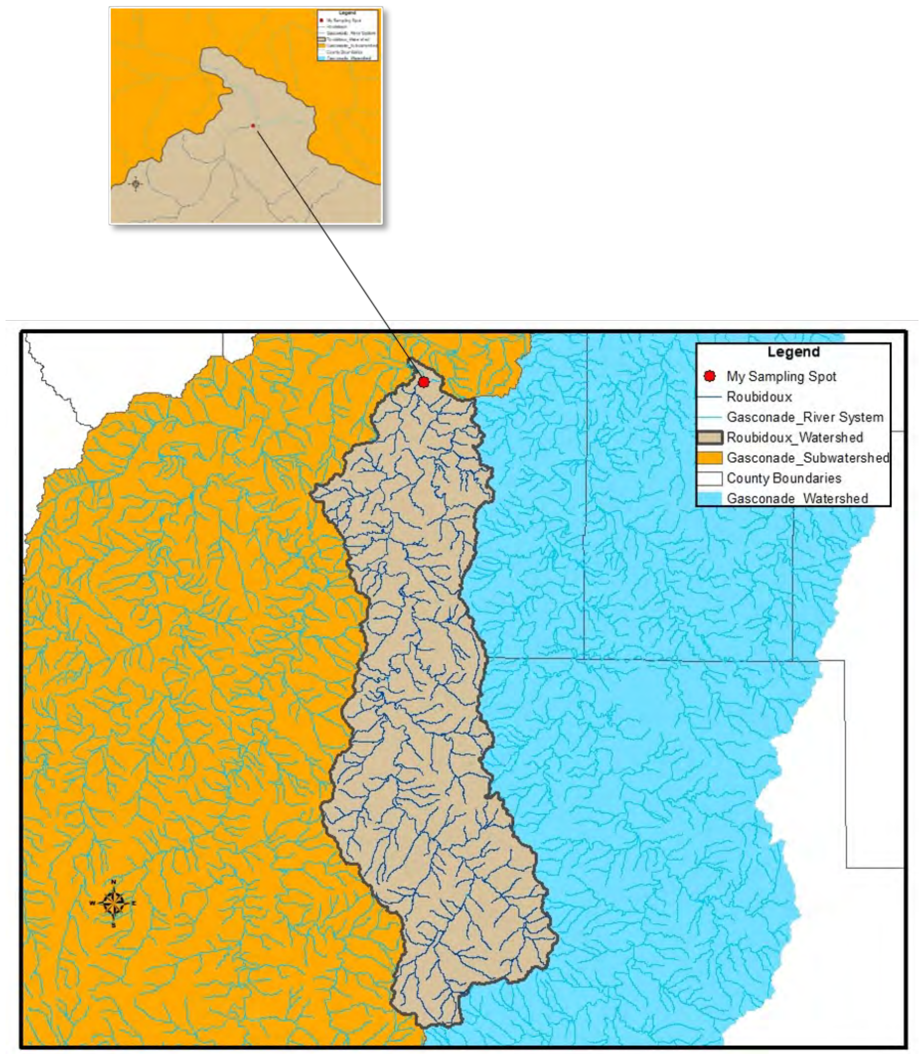




Watersheds in Missouri

The red point indicating a sampling location is along the Roubidoux Creek in Pulaski County. The Roubidoux watershed is a subwatershed of the Gasconade River watershed.

Remember, watersheds range in size from less than an acre to millions of square miles. Additionally, there are watersheds within watersheds that cross political boundaries. The health of these watersheds directly affects the quality of our water resources where we live, work, and play.



Monitoring Procedure

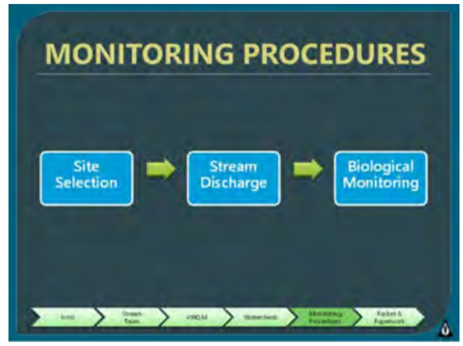
Today's Volunteer Water Quality Monitoring Introductory Level workshop will prepare you to conduct the following monitoring procedures for your chosen stream site:

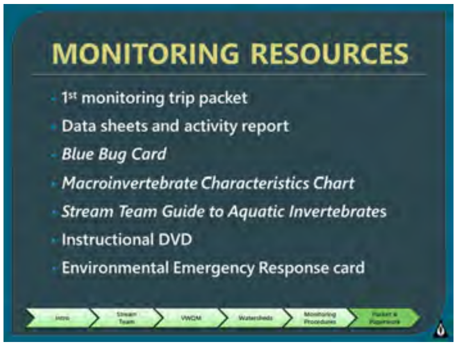
- ***Site Selection:*** In the next chapter, you will learn about how to choose an appropriate stream site to monitor, factors you should consider when selecting a site, and how to identify your site on the required data sheets and paperwork.
- ***Stream Discharge:*** In chapter 3, you will learn about factors that affect stream discharge, how stream discharge affects water quality, and a process to measure stream discharge at your chosen site.
- ***Biological Monitoring:*** In chapter 4, you will learn about benthic macroinvertebrates, the vital role they play in a stream's ecosystem, and a process to collect and identify them.

Upon leaving the workshop, you will be equipped to conduct site selection and measure stream discharge.

To receive biological monitoring equipment you must submit:

- Initial Green Site Selection form
- Map with monitoring site clearly marked
- Stream Discharge data sheet



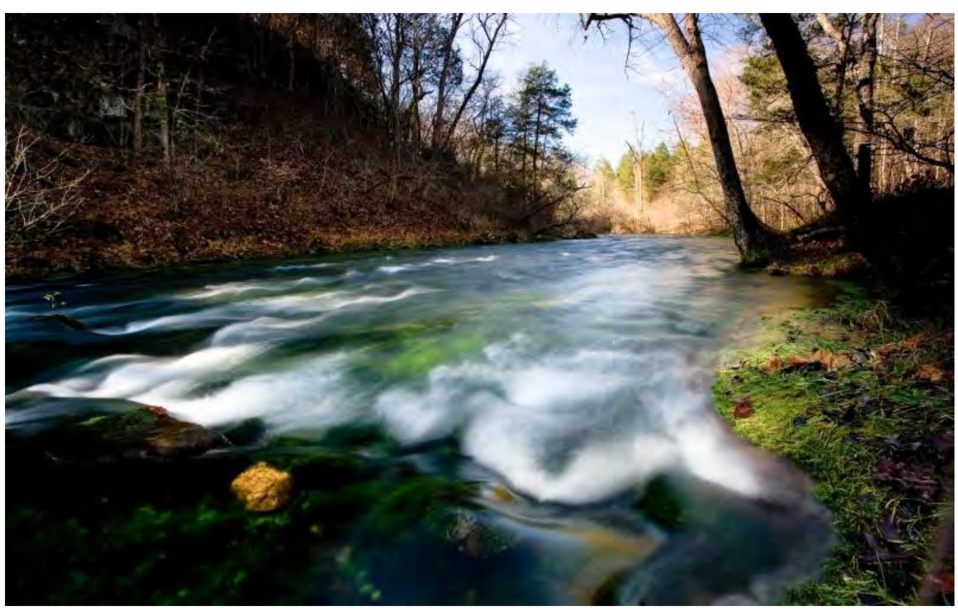


Materials and Resources

Thank you for your willingness to become a Volunteer Water Quality Monitor. The important work you do and the data you submit will help protect and conserve Missouri's water resources for future generations. To assist you in this important work, there are people and resources you can rely upon. Be sure to take a few moments to become acquainted with the many resources in your learning materials. Additionally, the Missouri Stream Team website has a wealth of information and resources for you.

Missouri Stream Team

mostreamteam.org

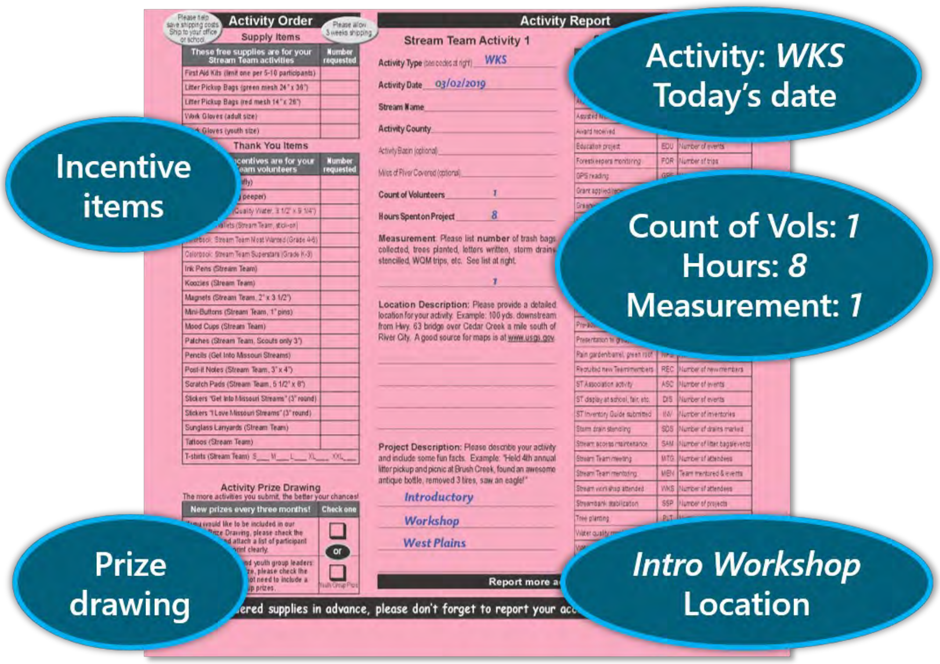


Stream Team Activity Report

Every time you participant in a Stream Team activity, please complete a *Missouri Stream Team Activity Report.* This allows program staff to track the tremendous efforts of our volunteers across the state.

- ***Contact Information:*** Record your Stream Team number and name, your name, shipping address, phone number, and email in the top section of the form.
- ***Activity Order:*** Use this section to order supplies and thank you items.
- ***Prize Drawing:*** The more activities you complete, the better your chances of winning!
- ***Activity Report:*** Use this section to describe the type of Stream Team activity completed.

For today's introductory workshop, your completed activity report should resemble the following example.

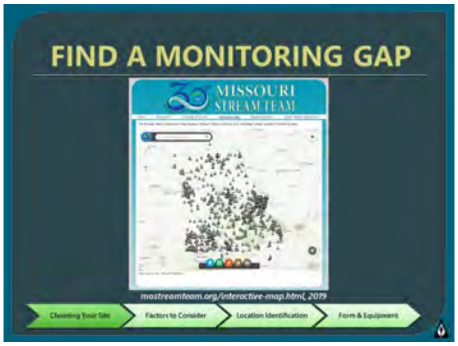


Please Complete Activity Reports Every Time You Participate in a Stream Team Activity

Chapter 2
Site Selection

Before you start monitoring water quality, you must first select a site to monitor. This chapter will explore many factors for selecting an appropriate stream site to monitor. Specifically, we will discuss:

- Varying reasons for selecting a specific site
- Factors to consider when selecting a stream site
- How to identify your site on data submissions
- How to acquire your biological monitoring equipment



Choosing a Stream Site to Monitor

When selecting a site to monitor, choose one you are invested in or that is special to you. Monitors often choose a local stream, maybe one in their own back yard or city park. Monitors are often anglers or paddlers and select their preferred recreational stream. Other volunteers may be concerned about a heavily polluted stream or may want to fill a gap in the Stream Team's current water monitoring efforts. Whatever your reasons, we appreciate your efforts in monitoring the quality of the state's water resources.

With approximately 110,000 miles of rivers and streams in Missouri, there are numerous stream sites to monitor. Do not be discouraged if the site you have in mind has already been selected by another monitor. Often, sites have been abandoned and are available for a new volunteer to begin monitoring again. To help you locate those gaps, use the Stream Team Interactive Map at:

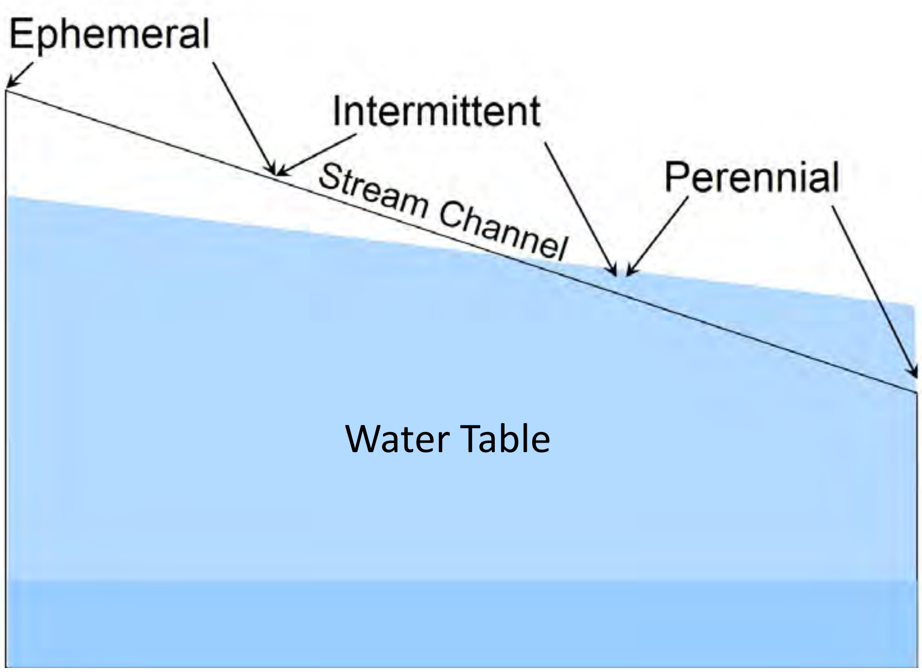
mostreamteam.org/interactive-map.html

Factors to Consider When Choosing a Site

The diagram below describes three types of streams:

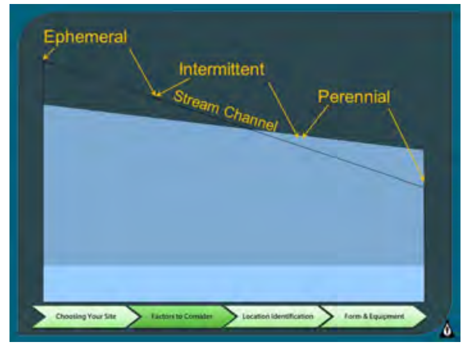
- ***Perennial Streams*** are fed continuously by a water table and will flow all year long.
- ***Ephemeral Streams*** exist above a water table. These streams only contain water after a precipitation or snow melt event. They are sometimes called wet-weather streams.
- ***Intermittent Streams*** receive groundwater flow only part of the year. The flow stops when the water table drops below the channel.

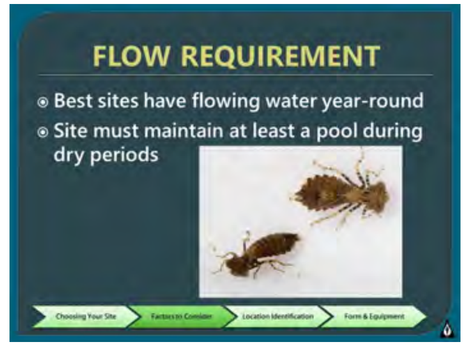
Stream Team protocol is designed for perennial streams, or streams with continuous flow.

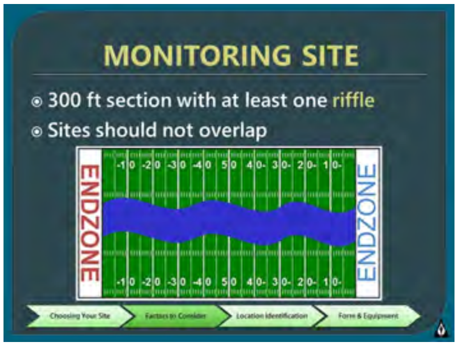


There are some important factors to consider when selecting your site:

- ***Flow Requirement:*** The best monitoring locations have permanent water flow throughout the year. However, you can still use a stream site if it maintains pools that can support aquatic life during dry periods. This is important so that you will still be able to sample macroinvertebrates during dry periods. If a stream site completely dries up at any time of the year, it will not be a suitable monitoring location.







Factors to Consider When Choosing a Site

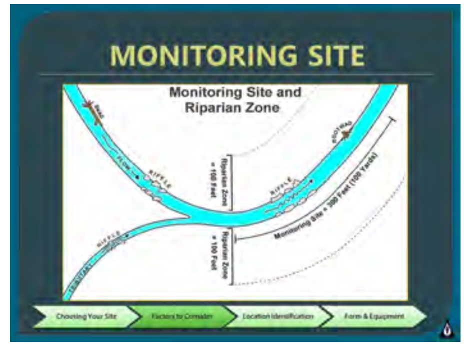
Another important factor to consider when selecting your site:

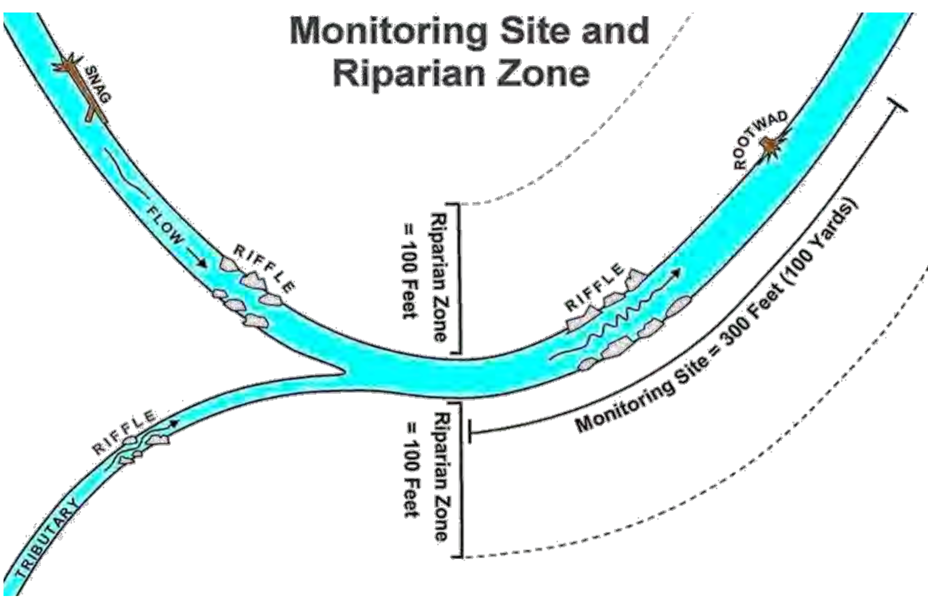
- ***300-Foot Section With at Least One Riffle:*** Your stream site should be approximately 300 feet long, about the same length as a football field, and not overlap with another stream site. If you decide to monitor two sites on the same stream, be sure the two sites do not overlap. Additionally, your proposed site should include at least one riffle. A riffle is where water breaks over rocks, indicating an elevation drop in the stream bed. Riffles provide an excellent environment when monitoring for macroinvertebrates.

Factors to Consider When Choosing a Site

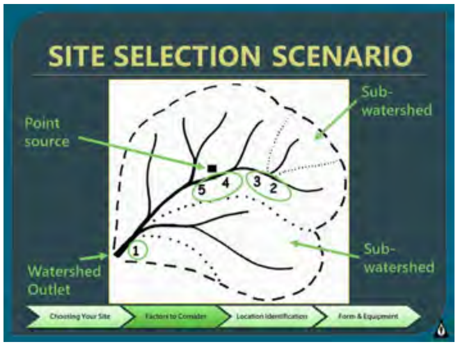
Other factors to consider when selecting your site include:

- ***Goals:*** Choose a site that best reflects your personal goals for monitoring a stream.
- ***Habitat:*** Choose a site that has suitable habitat. The best sites contain riffles. If riffles are not found, you may consider looking for alternative habitats such as a root mat or woody debris.
- ***Point and Nonpoint Sources:*** If you are concerned about a point or nonpoint source of pollution, you may consider choosing two sites. One above and one below a potential pollution source. The upstream site can be used as a reference to compare downstream data.
- ***Tributaries:*** To determine the impact of a single tributary, select sites above and/or below the confluence of the tributary. For example, consider the diagram of a proposed site below. The site sits downstream from a tributary and contains a riffle and a root wad. When monitoring your site, always use the same 300-foot stretch. By doing so, your efforts will produce reliable data.



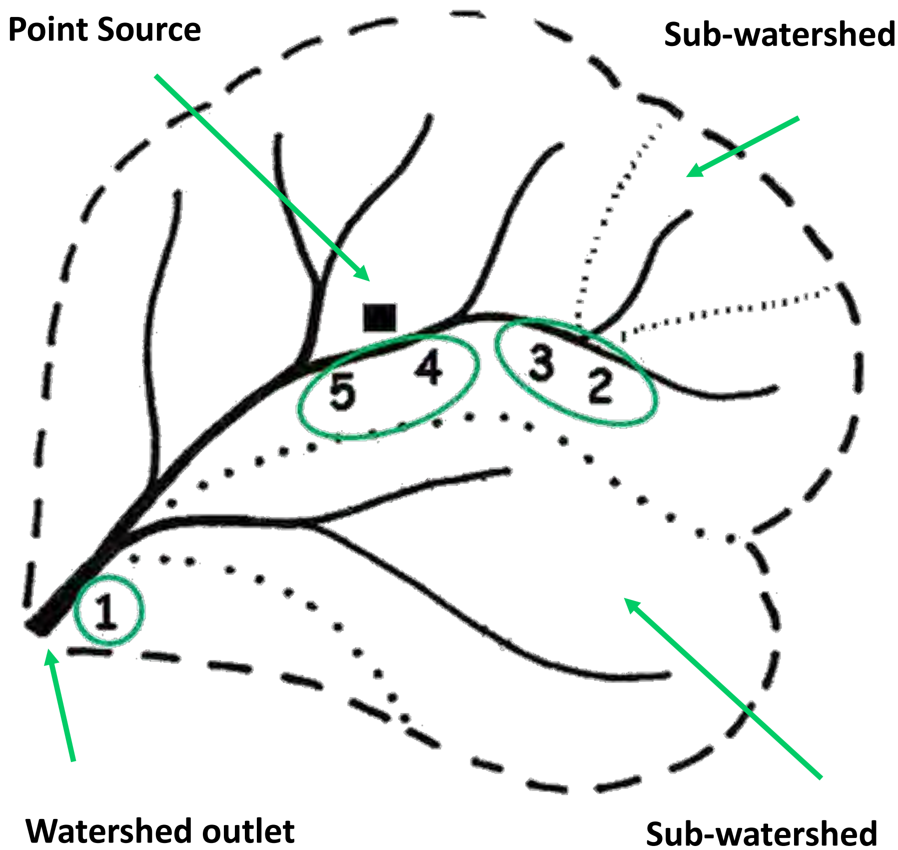


- ***Site Accessibility:*** You cannot monitor a site you cannot access. Whether your site is on private or public land, you will need to seek permission to access the stream. Use the ***Streamside Property Owner Permission Request*** (found on the stream team website at mostreamteam.org) to let a private landowner know who you are, what you are doing, and to gain permission to be on their property. To gain permission to monitor along public land, contact the area manager. Stream Team staff can facilitate communication with public land managers.



Site Selection Scenario

Consider the diagram of a watershed and the proposed sites below where the black square indicates a point source for pollution. Then, complete the table by describing the rationale for choosing each proposed site.



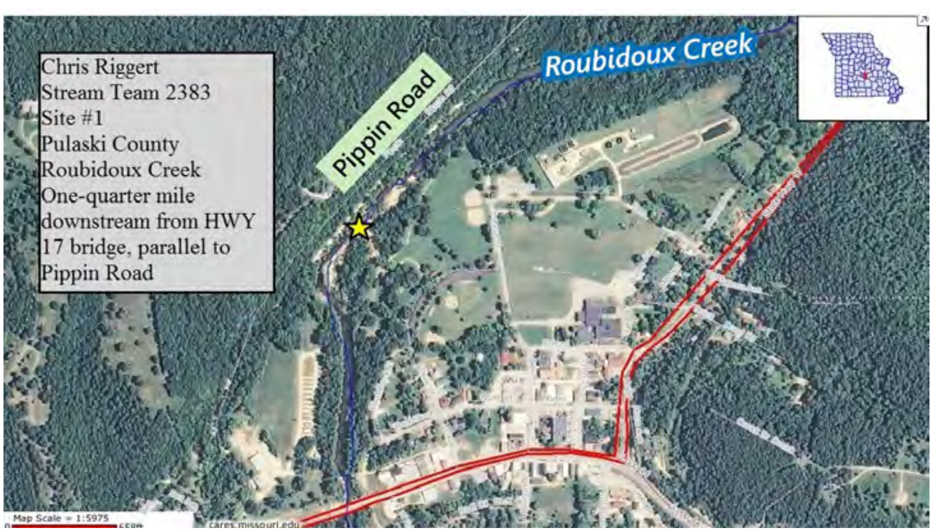
Proposed Monitoring	Rationale for Monitoring Proposed Site
Site 1	
Sites 2 & 3	
Sites 4 & 5	

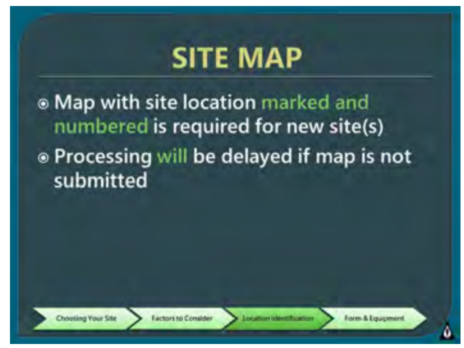
Site Number and Description

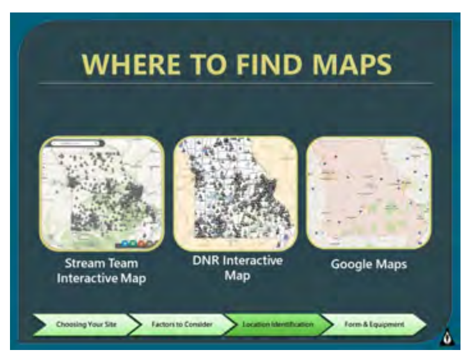
Once you have chosen an appropriate site to monitor, you will need to refer to the site each time you submit data:

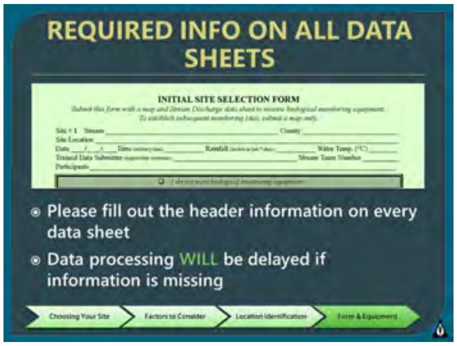
- ***Site Numbers*** are specific to each volunteer monitor. Even though the same site can be monitored by two different volunteers, each volunteer will have an independent number identifying it. For each volunteer monitor, these sites are numbered chronologically starting at Site #1. Everyone's first site will be Site #1. If you decide to monitor an additional site or abandon your first site for another, the next site will be Site #2.
- ***Site Descriptions*** enable Stream Team staff to locate your site on a map. It is important to be consistent with your site description each time you submit data. When describing your site, use the distance upstream or downstream from roadway crossings, distance and direction from major intersections, or distance and direction from permanent landmarks. For example, *300 feet downstream from Highway AA.* Avoid using physical features such as trees or buildings as these are not on maps and can change.
- **Site Map:** For each new site you monitor, please submit a site map before you begin collecting data. There are many online mapping tools to aid you:
    - Stream Team Interactive Map can be accessed at ***mostreamteam.org***
    - Department of Natural Resources Interactive Map can be found at ***dnr.mo.gov***
    - Google maps can be found at ***maps.google.com***

Below is an example of a map from the Stream Team website with the volunteer's site marked on it. The required information listed on the map will ensure program staff are able to locate your site.









Header Information

The ***Initial Site Selection Form*** and all data sheets contain a header, which need to be filled out in its entirety or else data submission will be delayed. The header consists of the following required sections:

- ***Site #:*** The site number is specific to the trained data submitter. Every monitor's first monitoring site is Site #1. Additionally sites monitored are numbered chronologically.
- ***Stream:*** State the name of the stream which is being monitored.
- ***County:*** This is the county of the stream monitoring site. Some streams cross county boundaries, so reference a map for the exact county of your site.
- ***Site Location:*** Provide a physical description of the monitoring site which would allow staff to find the site on a map.
- ***Date & Time:*** Date is required in month-day-year format. Time is required in military time.
- ***Rainfall:*** Provide amount of rainfall (in inches) for the 7 days preceding the monitoring date. This information can be measured with a rain gauge near the monitoring site or found online at:

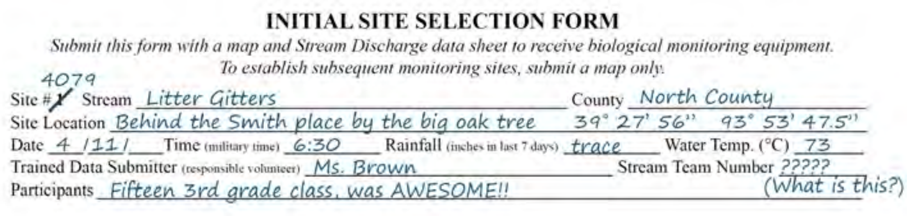
  wunderground.com

  weather.com

  noaa.gov
- ***Water Temperature:*** Record water temperature in degrees Celsius. Always take temperature measurements in the shade. Temperature is not required on the *Initial Site Selection Form* since thermometers are not issued to monitors until this form is submitted.
- ***Trained Data Submitter:*** This is the name of the person responsible for the data who has completed the appropriate level of training. Only the trained data submitter may fill out the data sheets.
- ***Participants:*** List the names of anyone who assisted in collecting the data. These individuals may be trained or untrained.
- ***Stream Team Number:*** State the Stream Team of the trained data submitter.

Header Information Scenario

Consider the header information in the Initial Site Selection Form below. Identify 11 inaccuracies of the submitted data.



INITIAL SITE SELECTION FORM

Submit this form with a map and Stream Discharge data sheet to receive biological monitoring equipment. To establish subsequent monitoring sites, submit a map only.

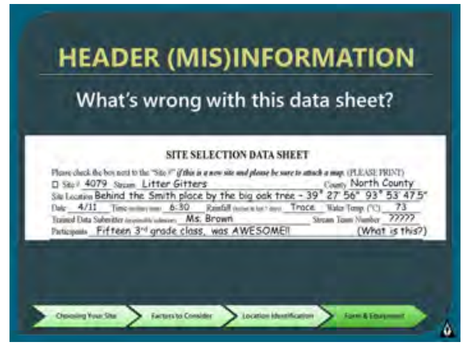
Site # ~~X~~ 4079 Stream Litter Gitters County North County

Site Location Behind the Smith place by the big oak tree 39° 27' 56'' 93° 53' 47.5''

Date 4 /11 / Time (military time) 6:30 Rainfall (inches in last 7 days) trace Water Temp. (°C) 73

Trained Data Submitter (responsible volunteer) Ms. Brown Stream Team Number ?????

Participants Fifteen 3rd grade class, was AWESOME!! (What is this?)



1.

2.

3.

4.

5.

6.

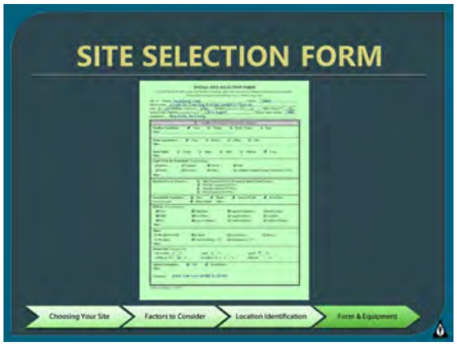
7.

8.

9.

10.

11.



Initial Site Selection Form

The ***Initial Site Selection Form*** is the first set of data you will submit. You will only submit this one time and only for your Site #1. This is a basic visual assessment of your site and provides program staff with the information they will need to add your location to the statewide database. ***You will not receive your biological monitoring equipment until you have submitted this form.*** The form consists of the following sections:

- ***Header:*** This section includes required information such as stream name, site number, site description, date and time monitored, name of trained volunteer, and Stream Team number. Additionally, it asks for the amount of rainfall in the last seven days, water temperature (in Celsius), and the name of any other participants assisting you.
- ***Weather Conditions:*** Record the weather conditions on the date you monitored your stream. You will also need to take an air temperature reading (in Celsius). Be sure to take the air temperature reading in the shade and before taking a water temperature reading.
- ***Water Appearance and Odor:*** Scoop some stream water in a clear plastic container and document the visual appearance of the water. Smell the sample of the water and note the odor.
- ***Land Use in the Watershed:*** Select how the watershed surrounding your stream site is used.
- ***Riparian Cover:*** Riparian cover refers to the vegetation along the streambank. Select the appropriate description for your site. If you are sampling during early spring or winter, imagine the cover during full foliage.
- ***Streambank Vegetation:*** Note all the kinds of vegetation along the streambank.
- ***Habitat:*** Document the habitat in the stream at your site by selecting all stream features that apply.
- ***Algae:*** Note if algae is present and if it is close growing (less than two inches) or if it is filamentous (longer than 2 inches).
- ***Stream Bed:*** Estimate the percentage of streambed that is covered by the various sized sediments listed. Your percentages should add up to 100%. This may require you to get into the water. You may also want to scoop up a little sediment to determine if there is any silt or sand.
- ***Aquatic Organisms:*** Note the types of aquatic organisms you find.

INITIAL SITE SELECTION FORM

Submit this form with a map and Stream Discharge data sheet to receive biological monitoring equipment. To establish subsequent monitoring sites, submit a map only.

Site # 1 Stream Roubidoux Creek County Pulaski
Site Location 1/4 mile DS from Hwy 17 bridge, parallel to Pippin Rd.
Date 9 / 24/2014 Time (military time) 0930 Rainfall (inches in last 7 days) 0 Water Temp. (°C) NA
Trained Data Submitter (responsible volunteer) Chris Riggert Stream Team Number 2383
Participants Alicia Burke, April Sevy

☐ *I do **not** want biological monitoring equipment*

Weather Conditions: ☒ Clear ☐ Cloudy ☐ Partly Cloudy ☐ Rain
Other:

Water Appearance: ☒ Clear ☐ Brown ☐ Milky ☐ Oily
Other:

Water Odor: ☐ Rotten ☐ Musty ☐ Fishy ☐ Chlorine ☒ None
Other:

Land Use in the Watershed: (Check all that apply)
☐ Pasture ☐ Cropland ☒ Woods ☒ Park
☐ Homes ☐ Factories ☐ Stores ☐ Confined Animal Feeding Operation (CAFO)
Other:

Riparian Cover: Stream is ...
☐ Fully Exposed (0-25% of stream is shaded from the sun)
☒ Partially Exposed (25-50%)
☐ Partially Shaded (50-75%)
☐ Fully Shaded (75-100%)

Streambank Vegetation: (Check all that apply)
☒ Trees ☒ Shrubs ☒ Grasses/Weeds ☒ Root Mats
☒ Bare Ground Other:

Habitat: (Check all that apply)
☒ Pool ☒ Backwater ☒ Aquatic Vegetation ☐ Rock Ledges
☒ Riffle ☒ Root Wads ☐ Large Boulders ☐ Log Piles
☒ Run ☒ Logs or Stumps ☐ Undercut Banks ☐ Artificial Objects
Other:

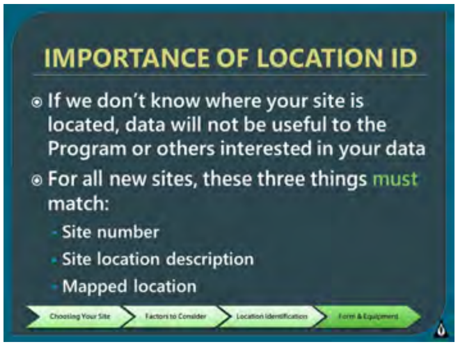
Algae:
Is the algae located: ☒ In Spots ☐ Everywhere ☐ Absent
Is the algae: ☒ Close-Growing (< 2") ☐ Filamentous (> 2")
Other:

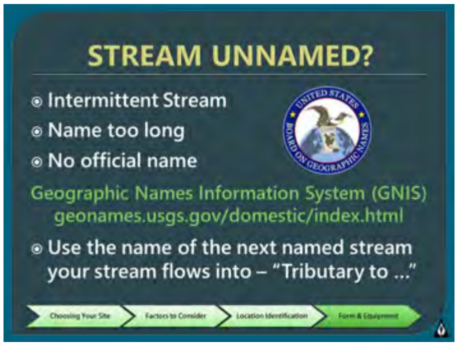
Stream Bed: (Must equal 100%)
silt or mud 5 % sand 5 % gravel 15 %
cobble (2-10") 70 % boulder (>10") 5 % bedrock %

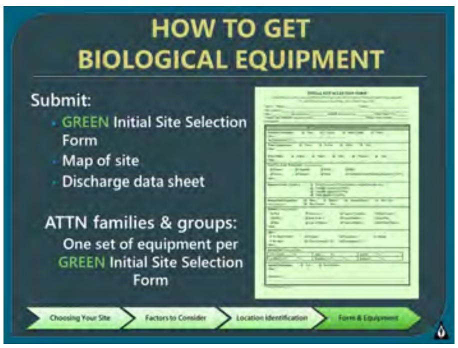
Aquatic Organisms: ☒ Fish ☒ Invertebrates
Other:

Comments: gravel road runs parallel to stream

Volunteer Monitoring - 05/2018







Required Information on All Data Sheets

Each time you submit any data sheet, be sure to include the following required information. Data processing will be delayed if any information is missing from the data sheet header:

- Stream Name
- Site Number
- Verbal Site Description
- Date Monitored
- Name of Trained Data Submitter
- Stream Team number

Unnamed Streams

The sampling protocol for Missouri Stream Team is designed for perennial streams that have permanent flow throughout the year, but it is possible your stream may not have an official name. In this case, your stream is a tributary to the nearest named stream into which it flows. Most intermittent streams are not officially named on a map, even though it may be known to a local community by a certain name. If this is the case, you may want to research your proposed site online with:

Geological Names Information System (GNIS)
geonames.usgs.gov/domestic/index.html

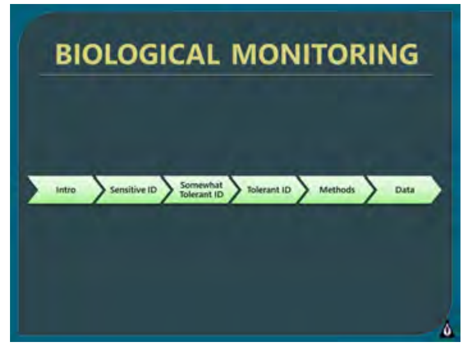
Importance of Location Identification

It is extremely important to the validity of the data you collect that the location of your site is accurately identified. If your site cannot be located, data will not be useful to the program or other interested parties. All new sites must accurately match their site number, site description, and mapped location. Remember to always submit a map with each new site you adopt.

How to Receive Your Biological Equipment

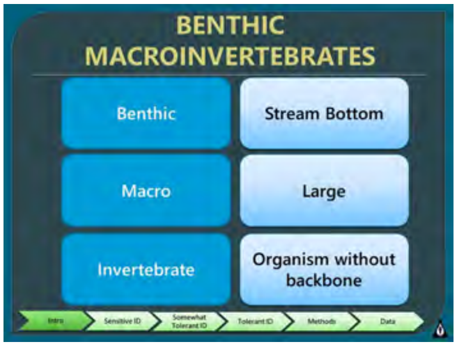
To receive your biological monitoring equipment, please submit the green *Initial Site Selection Form,* a map of your site, and the *Stream Discharge Data Sheet*. If you represent a group, family, or spouse, you will receive one set of equipment for each person that submits their own Green Initial Site Selection form, map, and Stream Discharge data sheet.

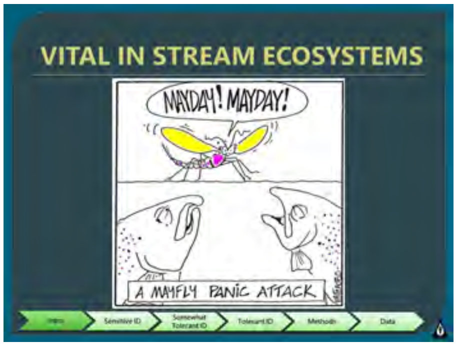
Chapter 3
Biological Monitoring

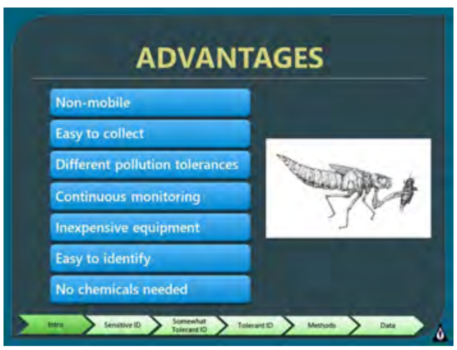


A good way to monitor the water quality of a stream is to closely examine the biological diversity of its habitat. This chapter will introduce you to benthic macroinvertebrates and the important role they play in helping us understand the water quality of Missouri's rivers and streams. Specifically, you will:

- Understand the importance of biological monitoring
- Identify pollution sensitive, somewhat tolerant, and tolerant macroinvertebrates
- Identify the methods and processes to monitor the biological diversity of your stream
- Analyze the data of benthic macroinvertebrates in your stream







Benthic Macroinvertebrates

What are benthic macroinvertebrates? By definition, macroinvertebrates are organisms without backbones which are visible to the human eye without the aid of a microscope. Aquatic macroinvertebrates are often regarded as benthic, which means they live on, under, and around rocks and sediment at the bottoms of lakes, rivers, and streams. Freshwater benthic communities may consist of fly and beetle larvae, mayflies, caddisflies, stoneflies, dragonflies, aquatic worms, snails, leeches, and numerous other organisms.

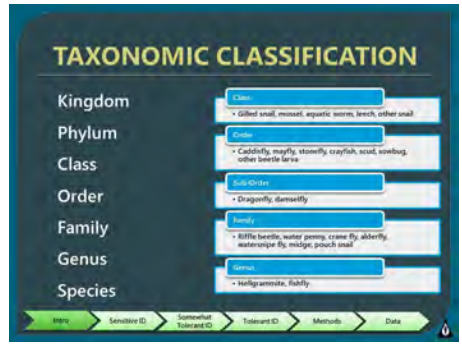
Since these macroinvertebrates are important to the food chain in our rivers and streams, they play a vital role in a stream's ecosystem. Their presence in a stream, or lack there of, is a good indicator of water quality and health of these ecosystems. There are many advantages to using macroinvertebrates as an indicator of water quality:

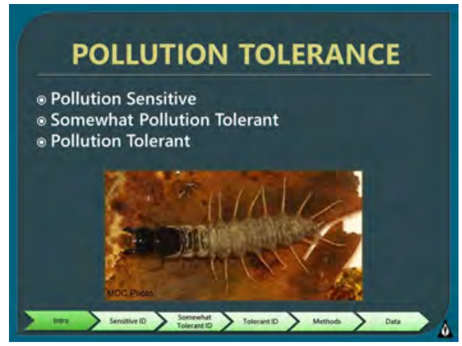
- ***Non-Mobile:*** While fish will move if their habitats start to deteriorate, invertebrates are much more limited in their mobility.
- ***Taxa with Different Pollution Tolerances:*** Invertebrates have different levels of sensitivity to pollution. They can be assigned to three categories: pollution sensitive, somewhat tolerant, and tolerant. This allows us to determine the condition of a stream based on their presence or absence.
- ***Continuous Monitoring:*** Invertebrates are permanent residents of a stream. This makes them susceptible to pollutants present in the water and can reveal the impact pollutants have on the health of a stream over time.
- ***Easy to Collect:*** Invertebrates are easy to collect.
- ***Inexpensive Equipment:*** Chemical monitoring requires expensive and sometimes highly sophisticated equipment to analyze water samples. Biological monitoring only requires a kick net, forceps, and a small tray.
- ***Easy to Identify:*** Although it seems difficult at first, with a little practice, people become very adept at identifying these organisms.
- ***No Chemicals Needed:*** No chemicals are needed to conduct this type of monitoring.

Taxonomic Classification

Taxonomic classification is a hierarchical system for classifying organisms. The broadest classifications are by kingdom; the most specific classification is by genus and species.

Taxonomic Classification	**How to Remember the Taxonomy**
Kingdom	King
Phylum	Phillip
Class	Came
Order	Over
Family	For
Genus	Great
Species	Salmon





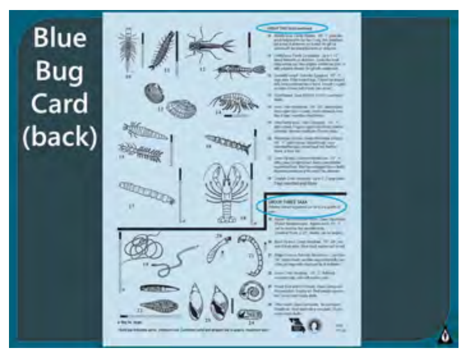
With the exception of a few taxa, volunteers will generally identify organisms to the level of Order when conducting their biological monitoring. This is the typical taxa level that can be identified easily in the field without magnification.

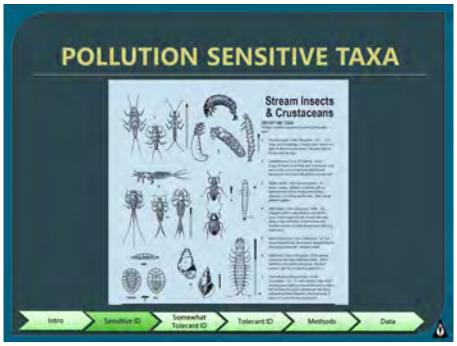
Pollution Tolerance

The invertebrates you will be looking for can be categorized into three main groups:

- ***Pollution Sensitive:*** These organisms are very sensitive to pollutants and will only be present in streams that have excellent water quality.
- ***Somewhat Pollution Tolerant:*** These invertebrates can survive in streams with moderate impairment.
- ***Pollution Tolerant:*** Organisms in this category are very tolerant of pollution and are the only organisms you will find in streams with severe impairment. Pollution tolerant organisms can be present in all streams, including those with excellent water quality.

A useful resource for aiding in macroinvertebrate identification is *Stream Insects & Crustaceans*, or Blue Bug Card, adapted from the Izaak Walton League. Taxa are placed in three groups: Group One is pollution sensitive, Group Two is somewhat pollution tolerant, and Group Three is pollution tolerant.

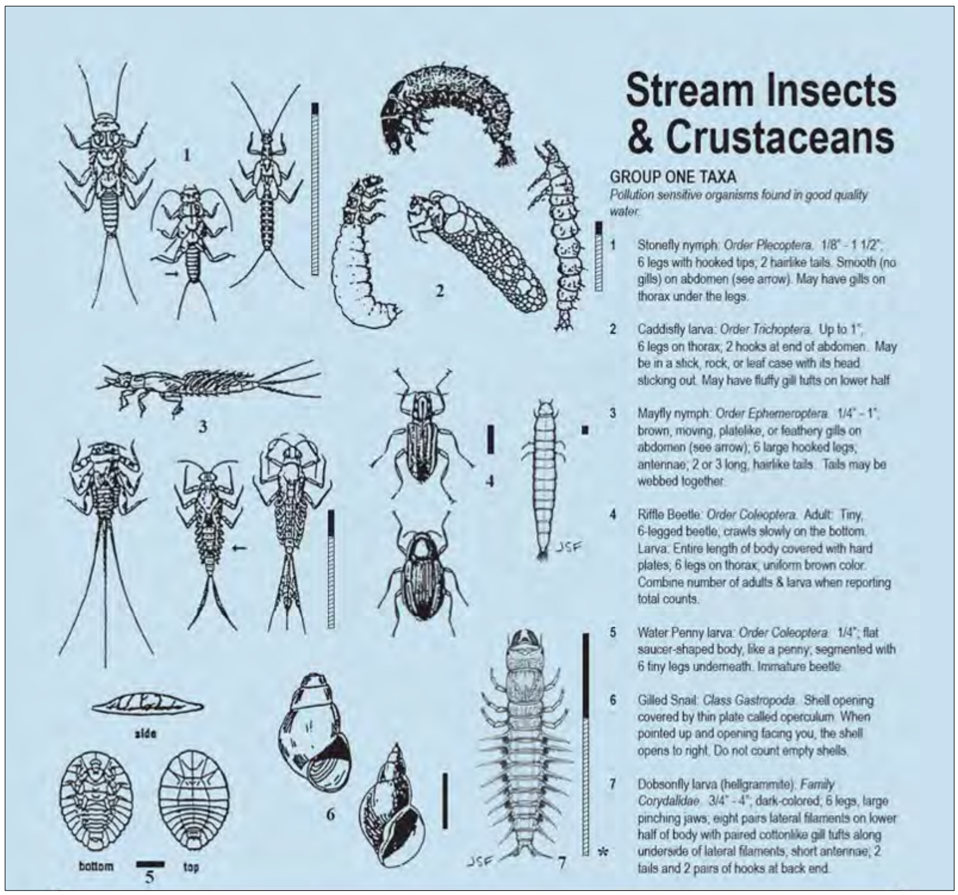




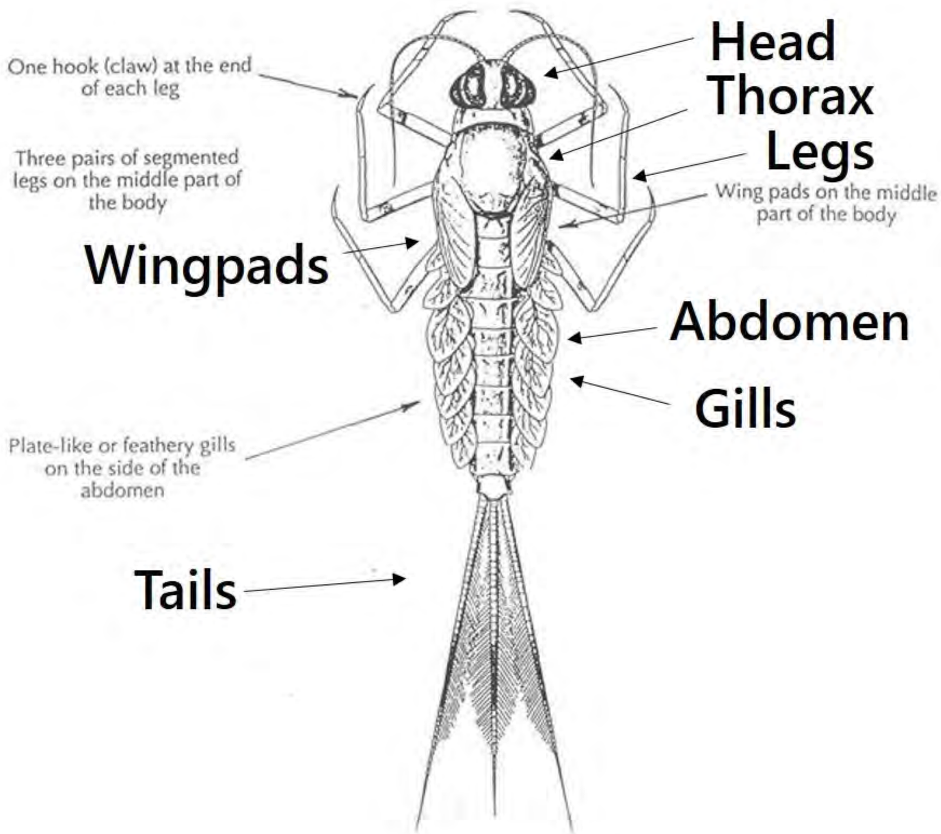
Pollution Sensitive Taxa

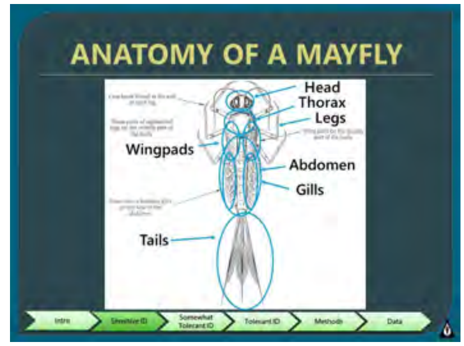
Pollution sensitive invertebrates are organisms that are very sensitive to pollutants and will only be present in streams with excellent water quality. Invertebrates that belong to this group include:

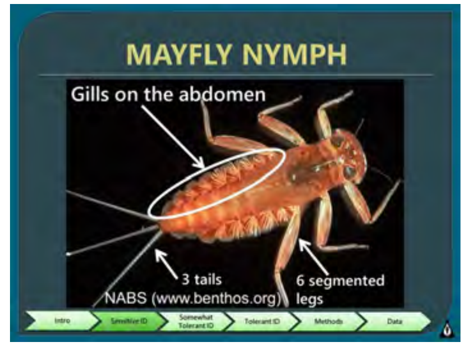
- Mayfly Nymph
- Stonefly Nymph
- Caddisfly Larva
- Riffle Beetle Larva and Adult
- Water Penny Larva
- Gilled Snail
- Dobsonfly Larva (Hellgrammite)

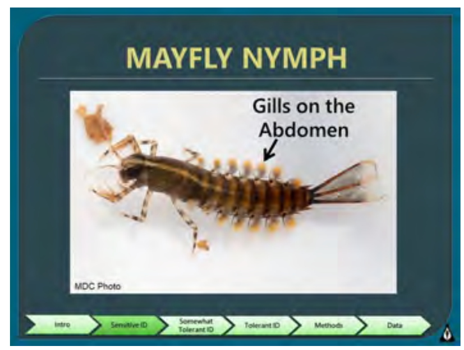


Pollution Sensitive: Mayfly Nymph





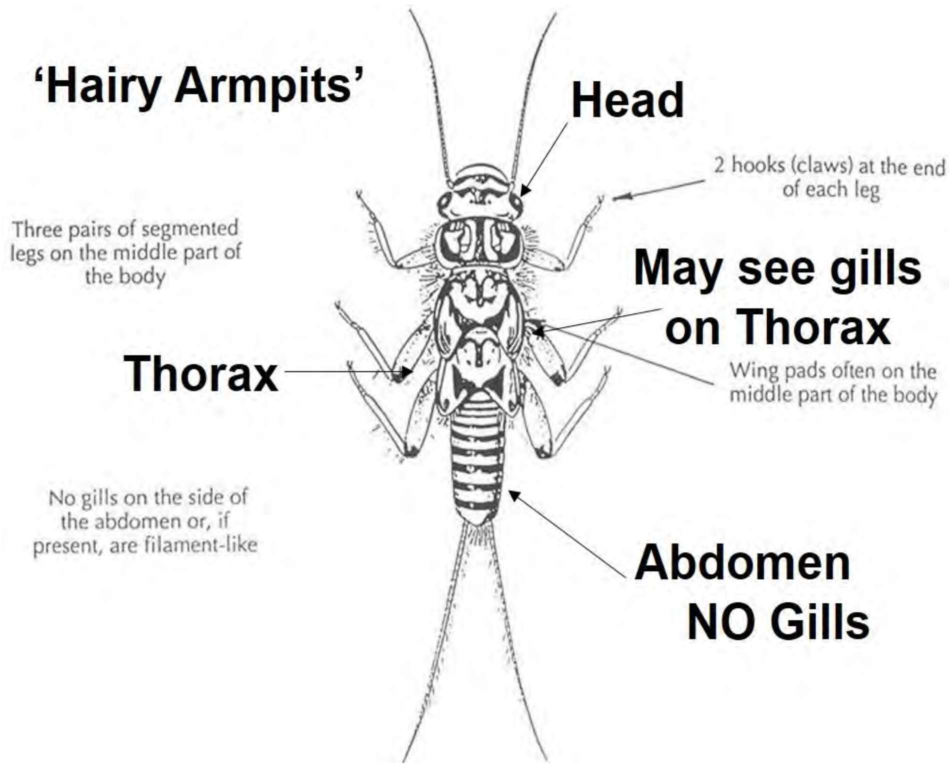




Distinguishing Features:

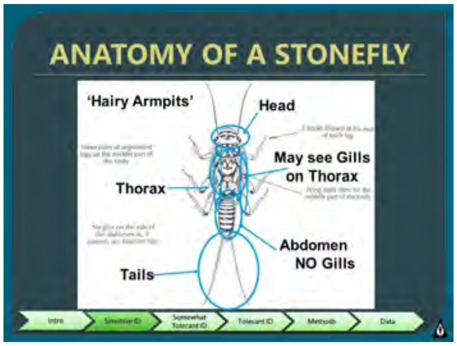
- Plate-like, elongate, or feather-shaped gills located on the sides of the abdomen.
- One hook (claw) at the end of each leg.
- Most mayflies have three filament-like tails; some may have only two.

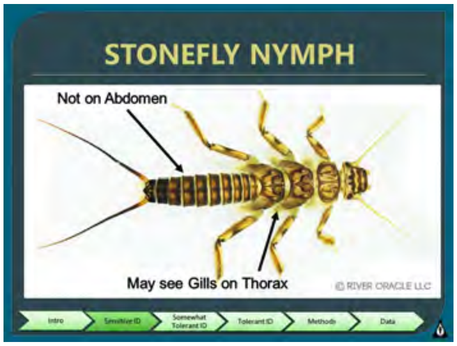
Pollution Sensitive: Stonefly Nymph

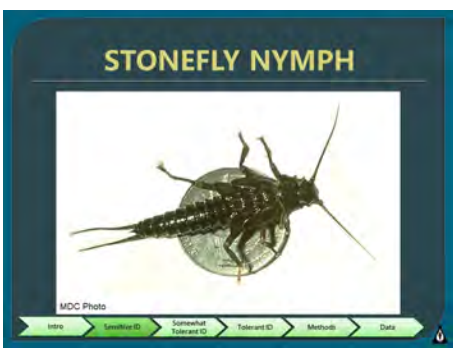


<u>**Distinguishing Features:**</u>

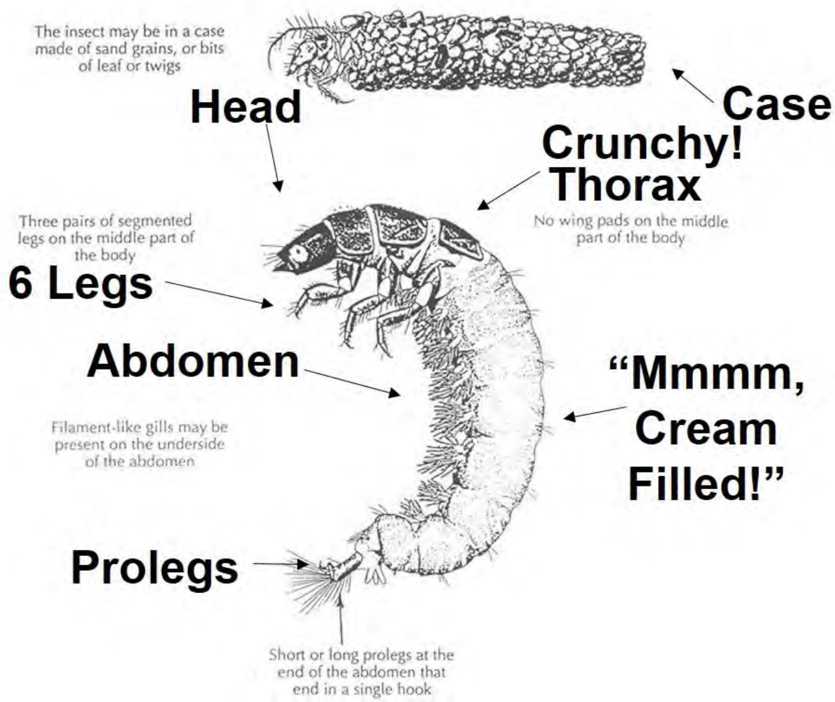
- No gills on the abdomen.
- “Hairy armpits.” Stonefly gills may look like hairs and are located under the legs on the thorax.
- Two hooks (claws) at the end of each leg.
- Stonefly nymphs have 2 tails.

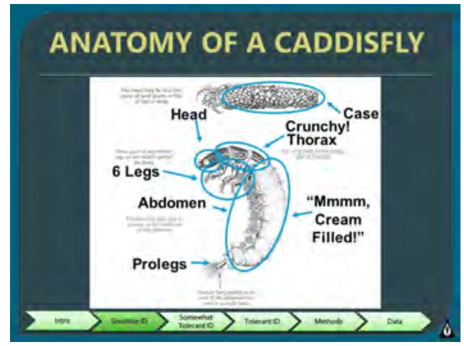


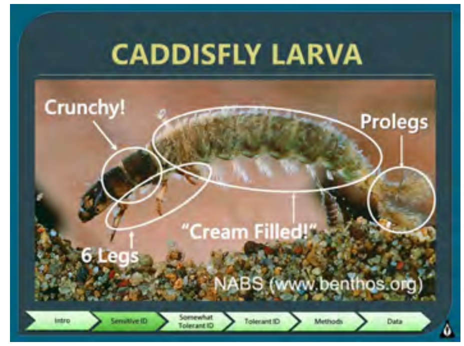


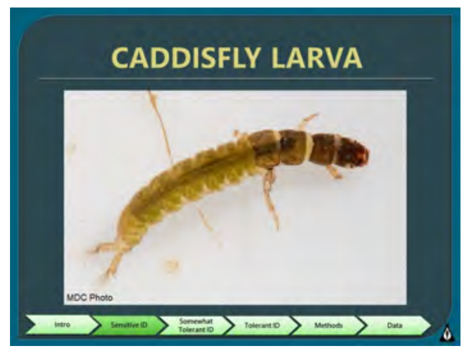


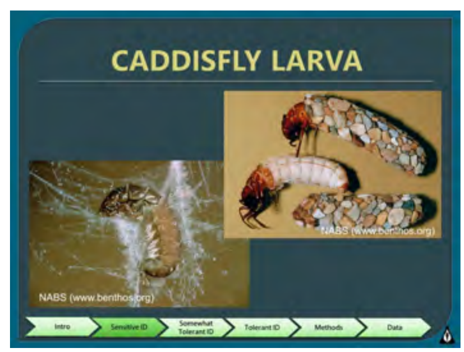
Pollution Sensitive: Caddisfly Larva

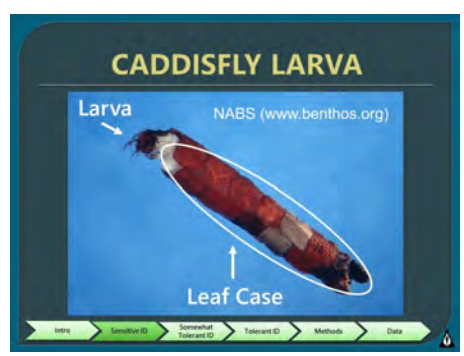






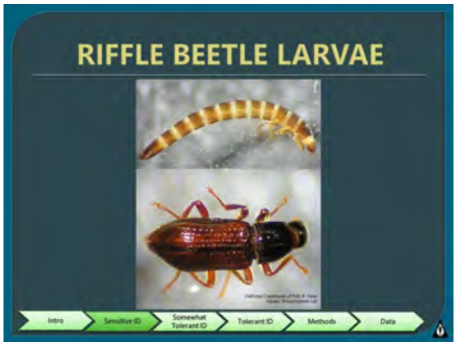






<u>Distinguishing Features:</u>

- No tails; instead they have hook-like features called prolegs.
- No wing pads.
- Crunchy thorax; soft abdomen.
- May build their own case made of sand grains or bits of leaves or twigs.
- Filament-like gills may be present on the underside of the abdomen.

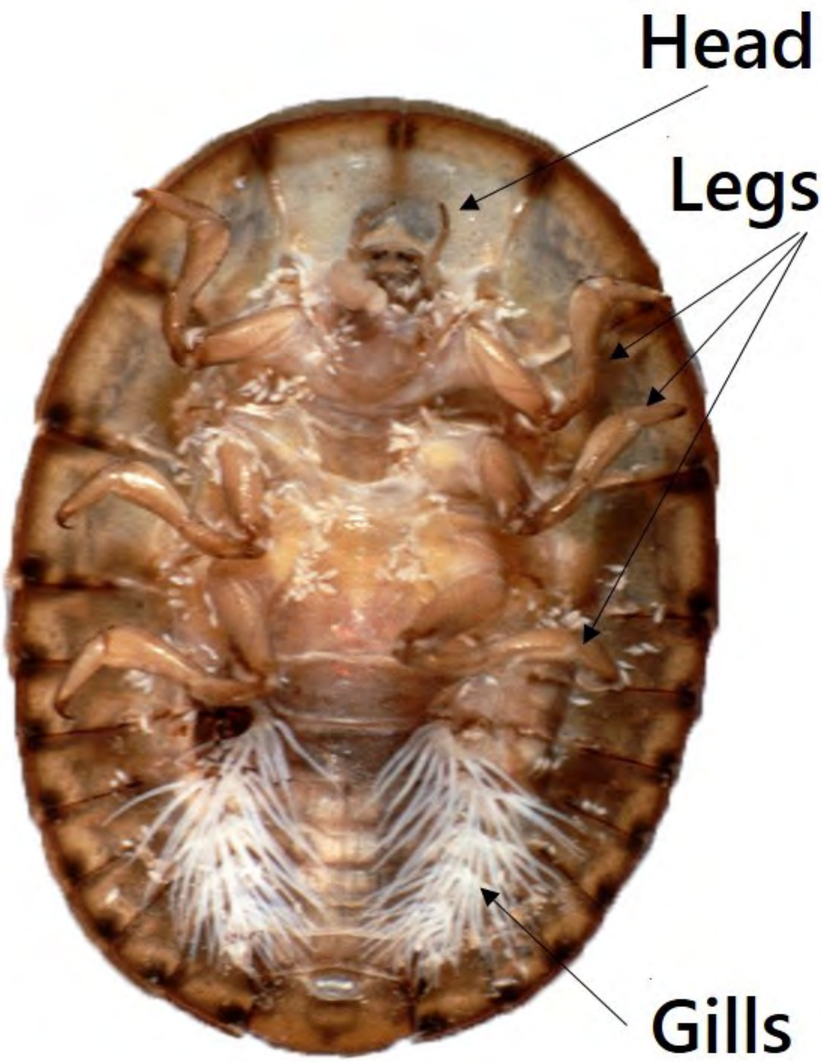


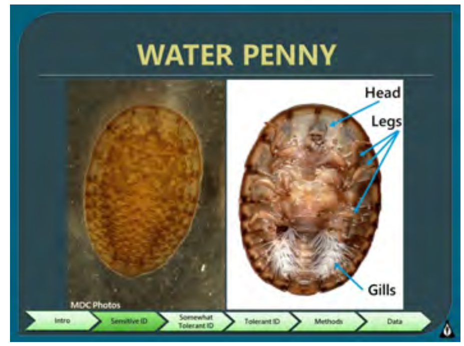
Pollution Sensitive - Riffle Beetle

Distinguishing Features:

- Riffle beetles spend both their larval and adult life cycle in water. It is not uncommon to collect adults and larvae in net sets. Both are counted on the data sheet.
- Riffle beetle larvae are tiny and elongate. The head and 3 pairs of legs are visible; filamentous gills may emerge from the tip of the abdomen. The entire body is covered in hard plates.
- Adult riffle beetles are very small, dark, and hard-bodied. They have relatively long legs and tarsal claws.

Pollution Sensitive: Water Penny





<u>Distinguishing Features:</u>

- Described as looking like a fish scale.
- Body is covered with a hard, oval carapace
- The head, legs, and gills are clearly visible on the underside of a water penny.

Pollution Sensitive: Gilled Snail

<u>Distinguishing Features:</u>

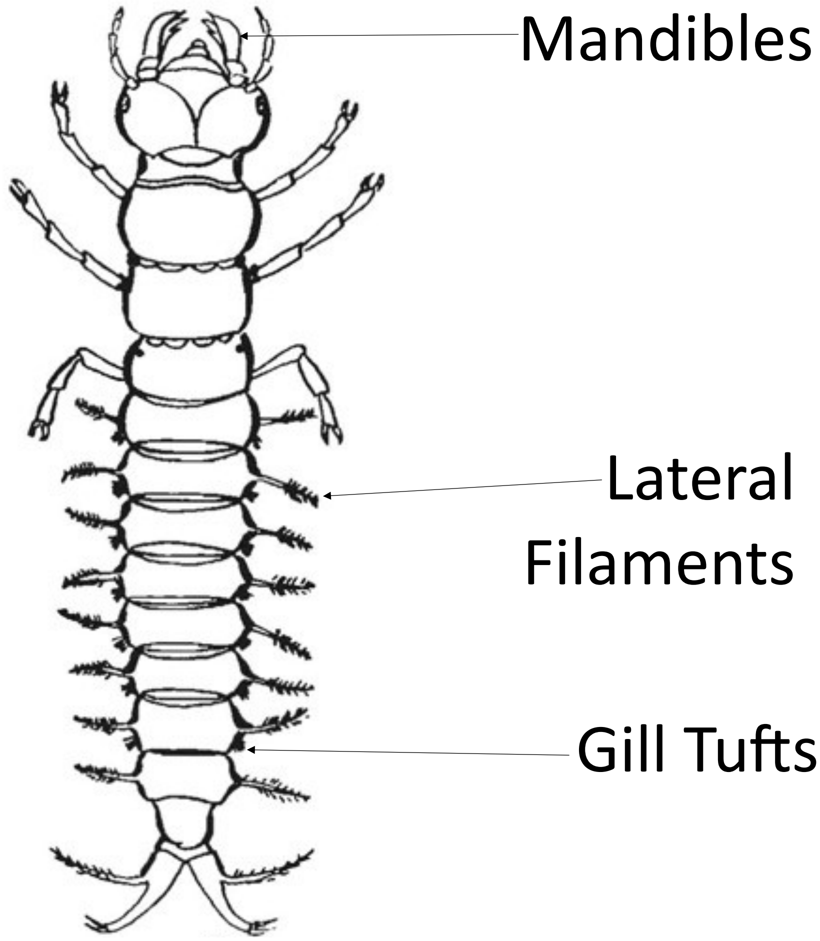
- When the snail is held point up, the opening is on the right side.
- The opening is often covered by a hard, plate-like operculum.
- Do not count empty shells on the data sheet

Dichotomous Key

Many resources are available to aid in identifying macroinvertebrates. The Key to Macroinvertebrate Life in the River is a simple dichotomous key with photos. Use the Key to identify the invertebrate below.

1. Is there a shell?
2. Does this organism have legs?
3. How many pairs of legs does this organism have?
4. Are wings present?
5. Does this organism have an obvious tail?
6. Use description and photo to identify this organism.

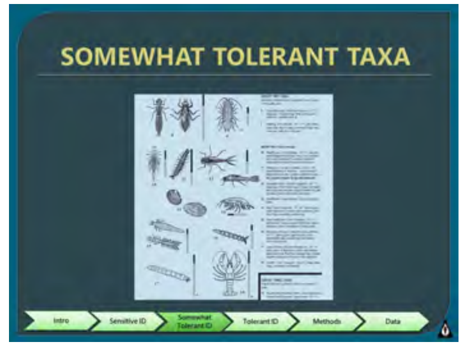
Pollution Sensitive: Hellgrammite



Distinguishing Features:

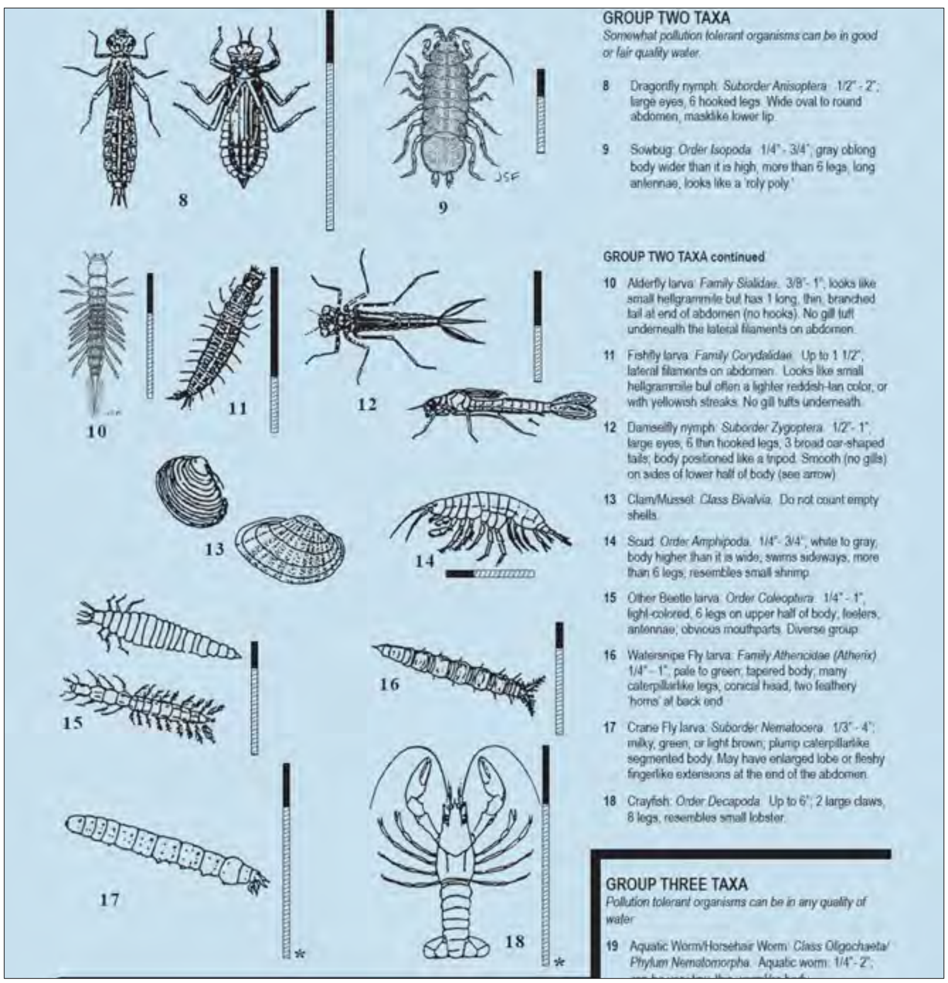
- Hellgrammites, the larval stage of the dobsonfly, are one of the largest invertebrates.
- Large mandibles or pinchers used for feeding and mating.
- Gill tufts located under the lateral filaments.

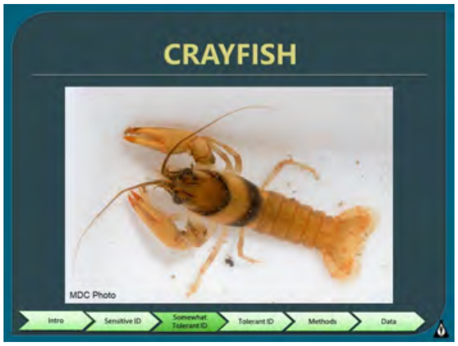
Somewhat Pollution Tolerant Taxa



Somewhat pollution tolerant invertebrates can survive in streams with moderate pollution impairment. Invertebrates that belong to this group include:

- Crayfish
- Sowbug
- Scud
- Alderfly Larva
- Fishfly Larva
- Damselfly Nymph
- Dragonfly Nymph
- Watersnipe Fly Larva
- Crane Fly Larva
- Other Beetle Larva
- Freshwater Clam or Mussel



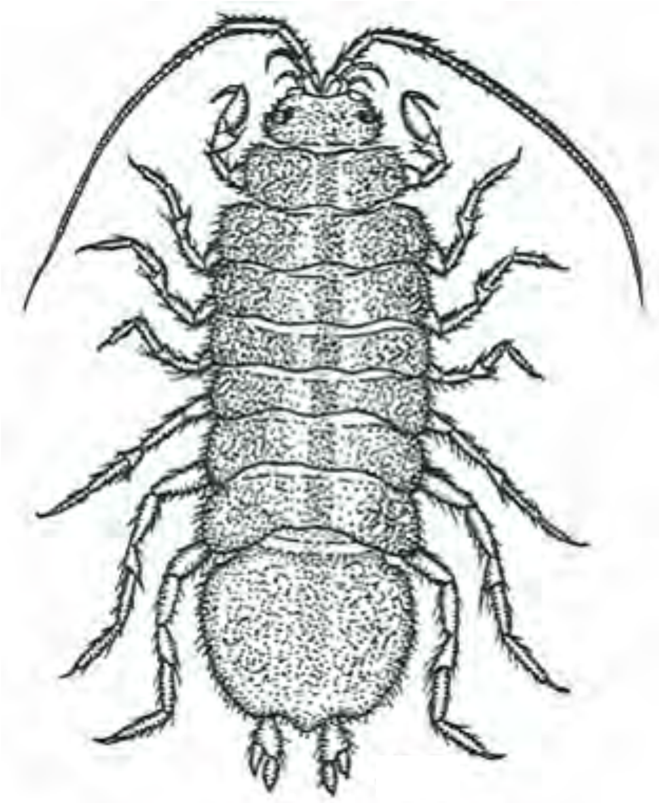


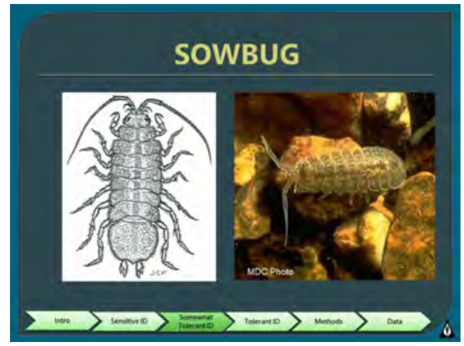
Somewhat Pollution Tolerant: Crayfish

Distinguishing Features:

- One of the most recognizable macroinvertebrates.
- There are 36 species of crayfish in Missouri.
- If you find crayfish in your net, immediately record the number on your data sheet and return them to the water as this predator will consume other organisms on the net or in the sorting tray.

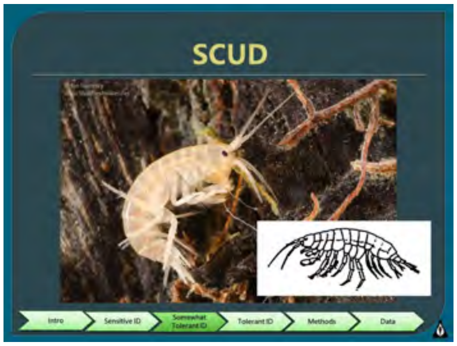
Somewhat Pollution Tolerant: Sowbug

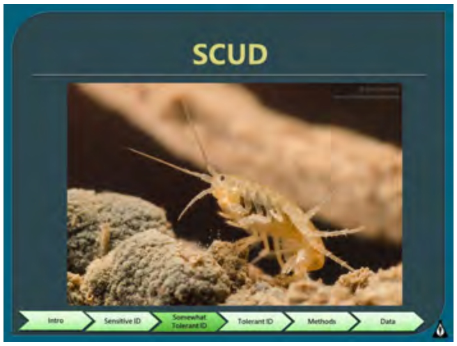




Distinguishing Features:

- A crustacean, similar to the crayfish.
- Resembles its terrestrial cousin, the roly-poly or pill bug.
- Flattened dorsoventrally from top to bottom.
- Seven pairs of legs



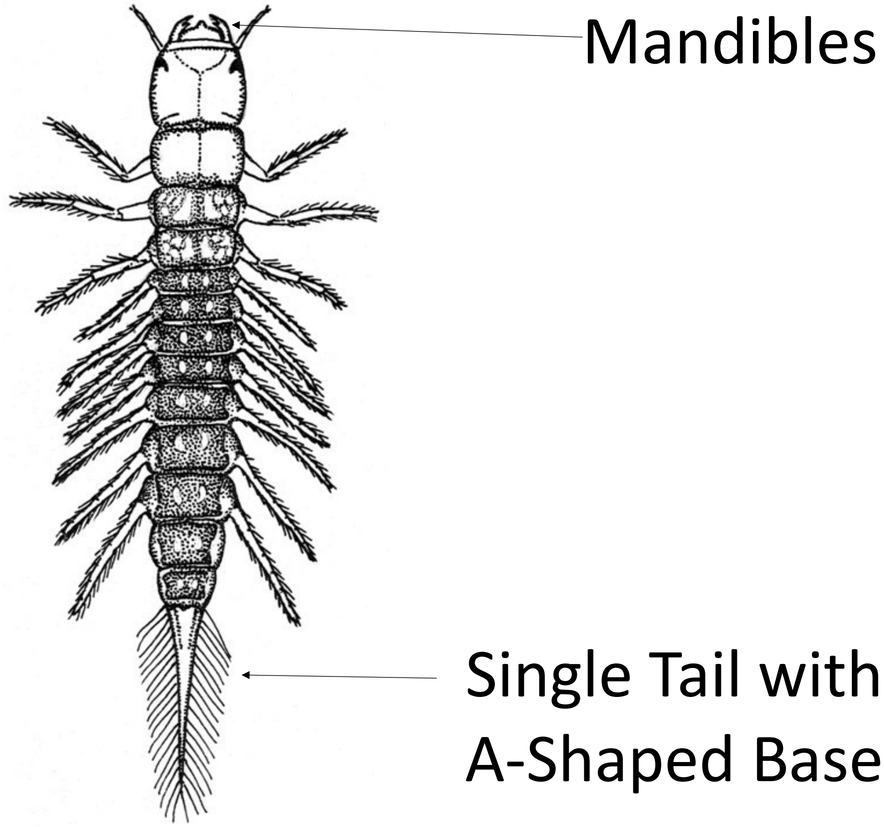


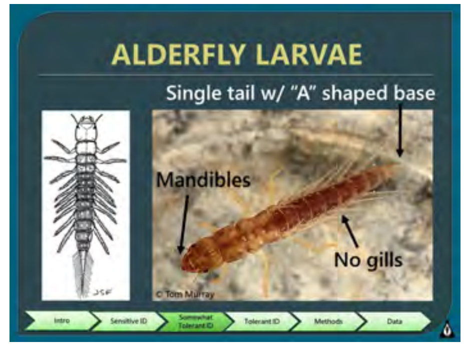
Somewhat Pollution Tolerant: Scud

Distinguishing Features:

- Many appendages on their abdomen.
- Seven pairs of legs.
- Several pairs of pinchers.
- Segmented body.
- Flattened laterally from side to side.
- Also referred to as side swimmers.

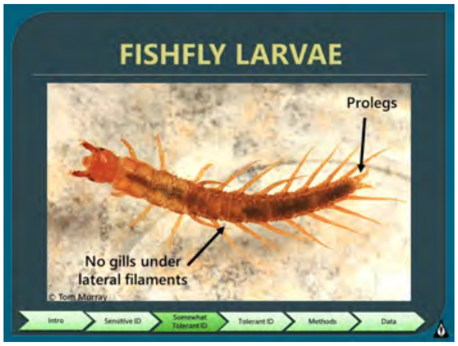
Somewhat Pollution Tolerant: Alderfly Larvae

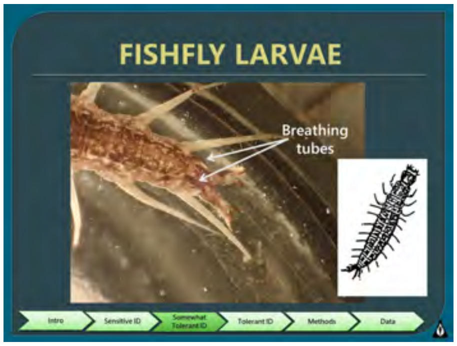




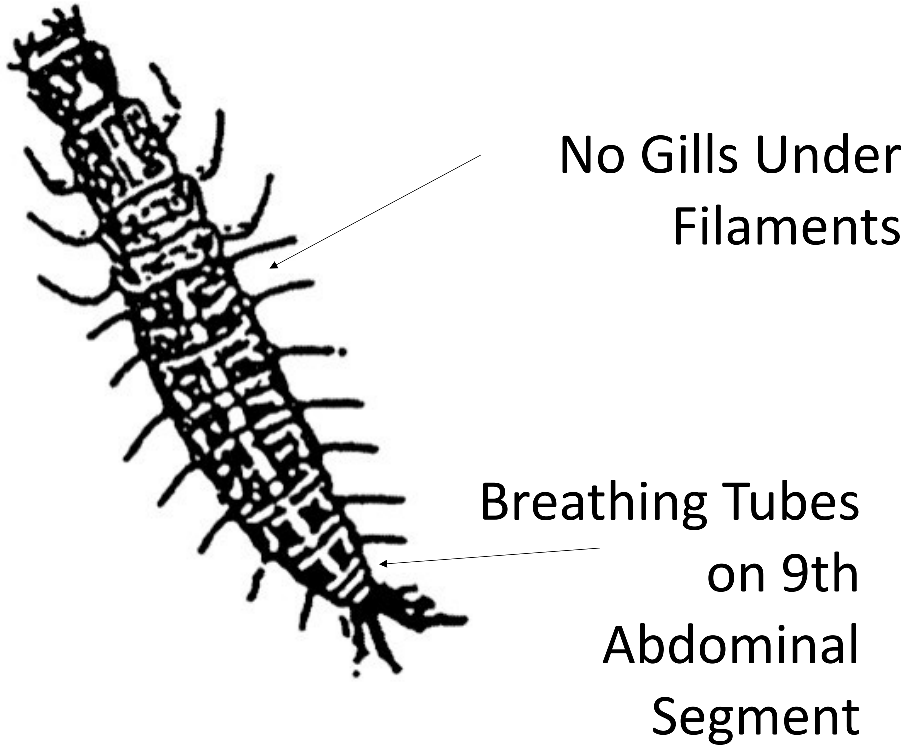
Distinguishing Features:

- Although similar to the hellgrammite, an alderfly is much smaller.
- Mandibles or pinching mouthparts.
- No gills under lateral filaments.
- Abdomen ends in a single filament that looks like a tail in the shape of a capital letter "A."





Somewhat Pollution Tolerant: Fishfly Larvae

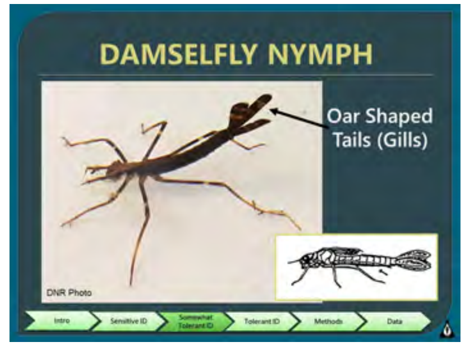


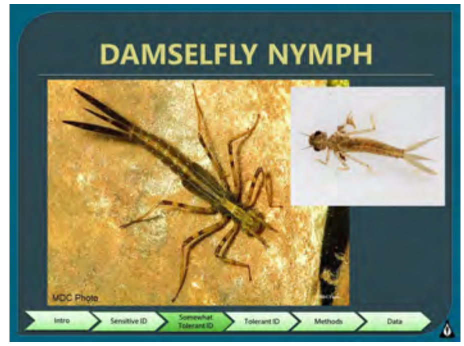
Distinguishing Features:

- Presence of breathing tubes at the end of the abdomen.
- No gills under lateral filaments.
- Fishfly larvae are relatively smaller in size than the hellgrammite.
- Fishfly larvae look similar to the hellgrammite, except gills are not present under the lateral filaments and they are smaller in size than the hellgrammite.

Somewhat Pollution Tolerant: Damselfly

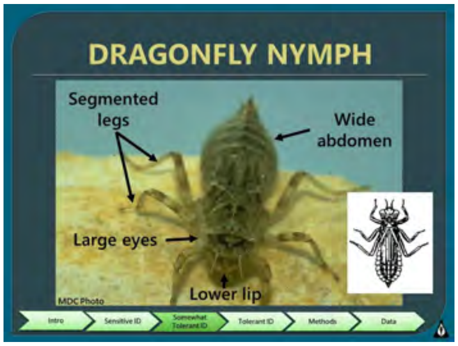
Oar Shaped Tails (Gills)

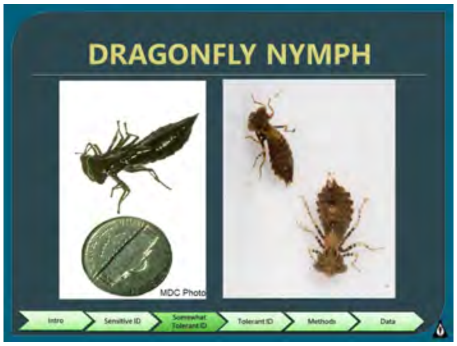




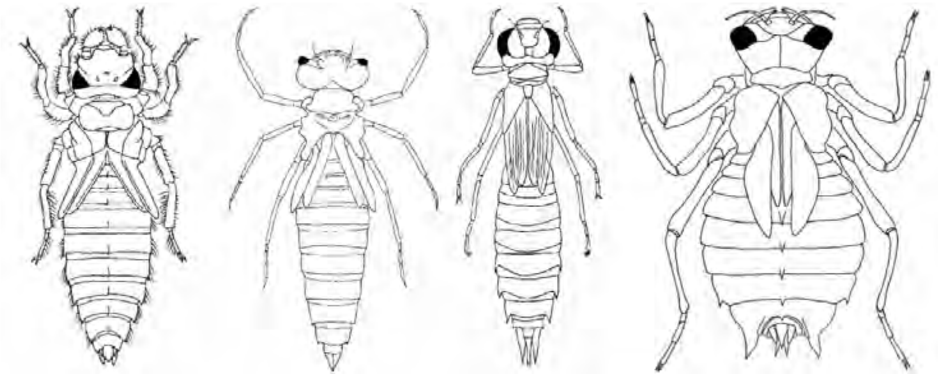
<u>Distinguishing Features:</u>

- Three broad oar or paddle-shaped gills at end of abdomen which look like tails.
- Body shape is elongate and legs are tall and spindly.
- Extendible lower lip, or labium, for grasping prey.





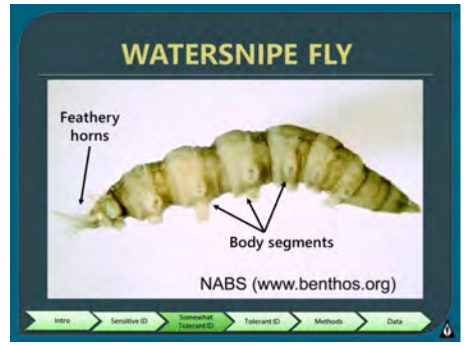
Somewhat Pollution Tolerant: Dragonfly

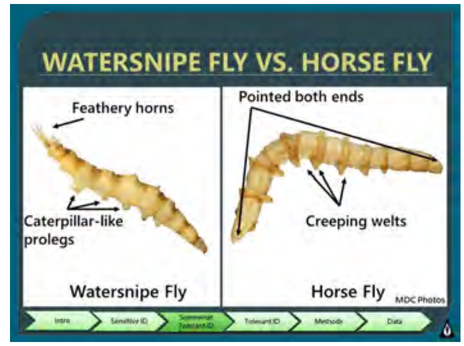


Distinguishing Features:

- Dragonfly nymphs can have a wide range of body shapes based on species.
- Long, segmented legs.
- Long, folded lower labium or lip used for capturing prey.
- Large eyes located on the front of their head.
- Abdomen is wide and has an oval or round shape.
- Abdomen may have a flat, leaf-like appearance.

Somewhat Pollution Tolerant: Watersnipe Fly

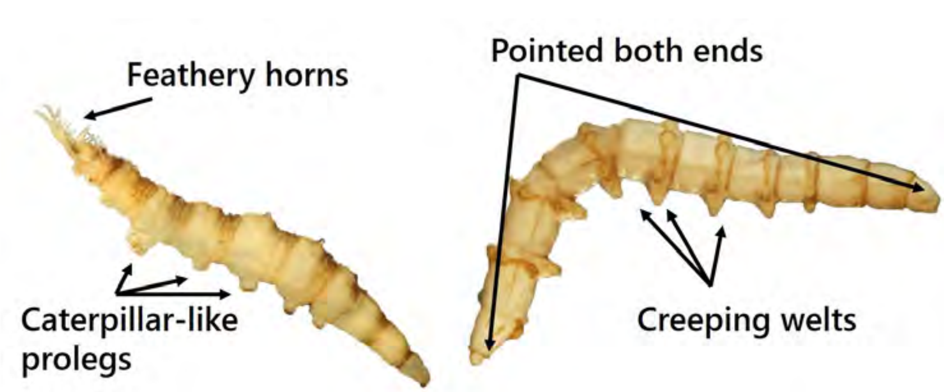


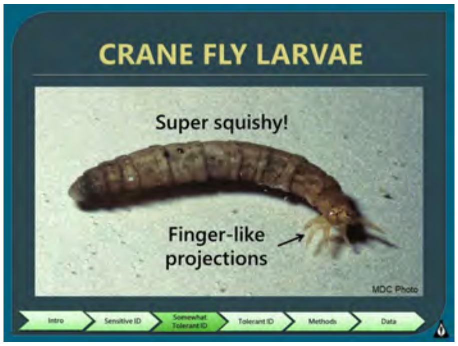


Distinguishing Features:

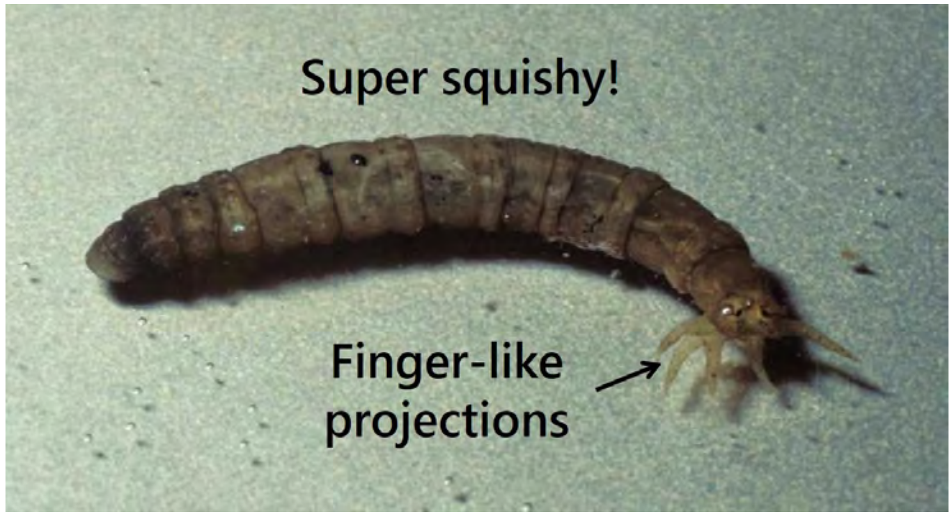
- Watersnipe fly larvae can be identified by caterpillar-like prolegs on each body segment and two feathery horns at the end of the abdomen.
- Medium size, about half an inch.
- Worm-like appearance with distinct body segments.
- Can be difficult to distinguish from other organisms such as horse flies and crane flies from the order Diptera.

Watersnipe Fly **Horse Fly**





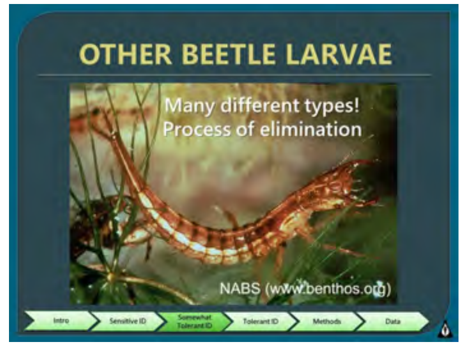
Somewhat Pollution Tolerant: Crane Fly



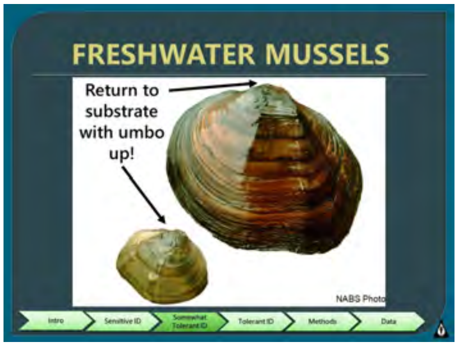
Distinguishing Features:

- Very squishy.
- Often appear transparent.
- Common species found are quite large, up to several inches.
- Abdomen ends in several finger-like lobes. A smaller species of crane fly has an abdomen that ends in an enlarged lobe resembling a turnip shape.

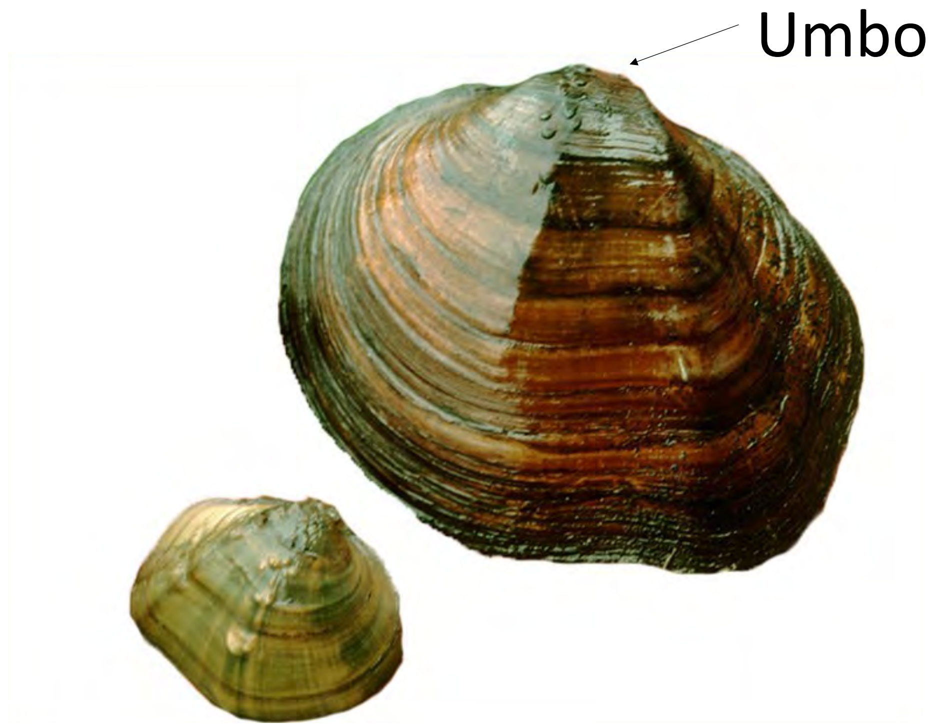
Somewhat Pollution Tolerant: Other Beetles



Besides riffle beetles and water pennies, volunteers may find the larvae of other aquatic beetles. If a volunteer finds something they cannot easily identify, use the Blue Bug Card or a dichotomous key. It may be identified as an other beetle larva in a process of elimination. Beetles are a diverse group and have features similar to other taxa counted on the data sheet. When reporting these, simply lump them together under the ***"Other Beetle"*** category on your data sheet.



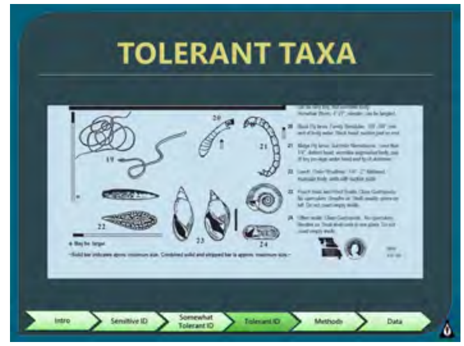
Somewhat Pollution Tolerant:
Freshwater Mussels and Clams



Nationwide, it is estimated that over 70% of native mussels are either threatened or endangered. This is true for Missouri. Native mussels and clams in Missouri include the maple leaf mussel and fingernail clam, so named because of its small, fingernail-like shape. The Asiatic clam is a foreign species to Missouri, although it has become very abundant in some watersheds. The Asiatic clam can typically be distinguished from native mussels by their symmetrical shape, centered umbo, and strong shell with many ridges.

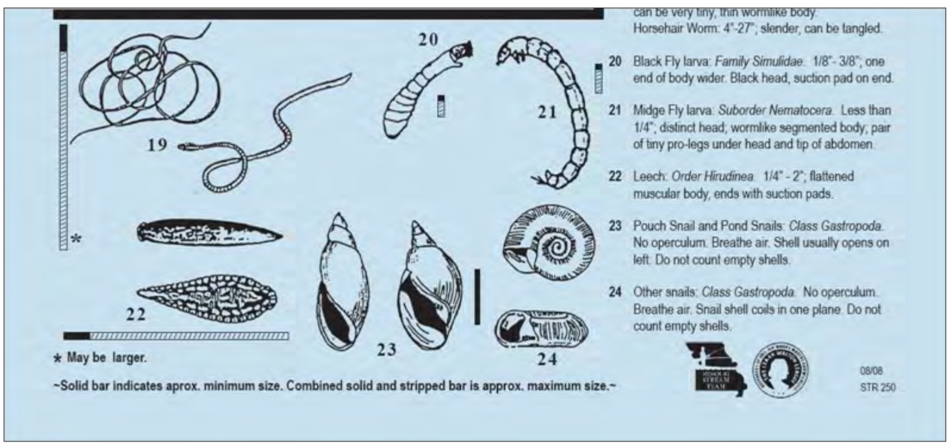
Volunteers are strongly encouraged to return all clams and mussels to the stream as quickly as possible. Mussels must be placed upright in the substrate with the umbo pointed up. ***If you find an empty shell, do not count it on your Macroinvertebrate Data Sheet.***

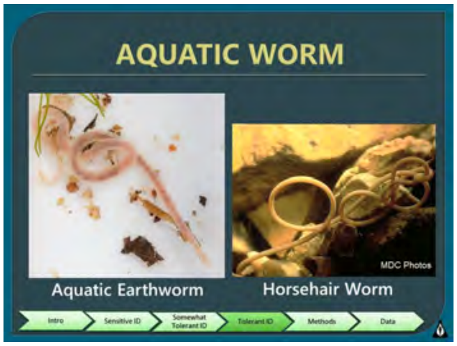
Pollution Tolerant Taxa



The following set of macroinvertebrates are pollution tolerant organisms. These organisms can be found in all river systems, both healthy and impaired. The abundance of tolerant invertebrates compared to the abundance of sensitive invertebrates is an important observation when determining the health of a stream:

- Aquatic Worm
- Midge Fly Larva
- Black Fly Larva
- Leech
- Pouch Snail
- Other Snail



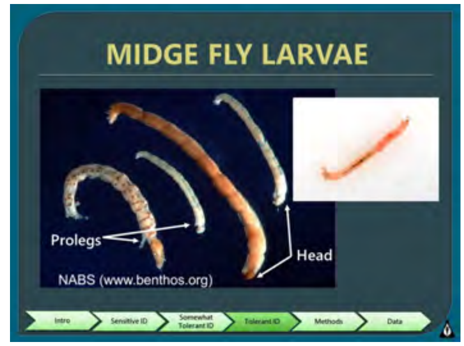


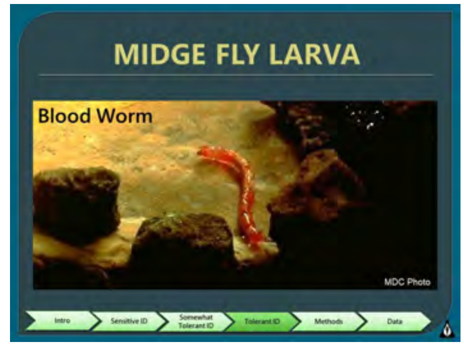
Pollution Tolerant: Aquatic Worm

Distinguishing Features:

- Segmented or unsegmented (horsehair worm).
- Long and thin.
- Often curl back around on themselves.
- Aquatic worms are longer than midge fly larvae.
- Count worms while picking from the net as they will become entangled and difficult to count from the tray.

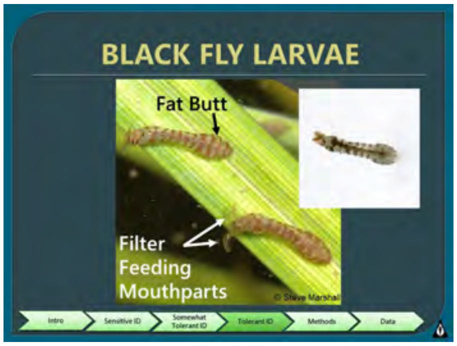
Pollution Tolerant: Midge Fly Larvae

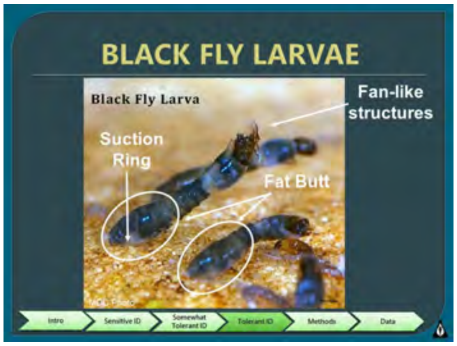




Distinguishing Features:

- Very small larvae, usually less than 1/4 inch in length.
- Head is visible when viewed with magnification.
- Presence of two small prolegs located by the head and at the end of the abdomen. Prolegs are not segmented.
- Slightly curved, segmented body.



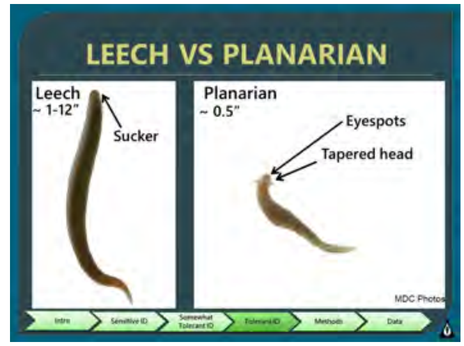


Pollution Tolerant: Black Fly Larvae

Distinguishing Features:

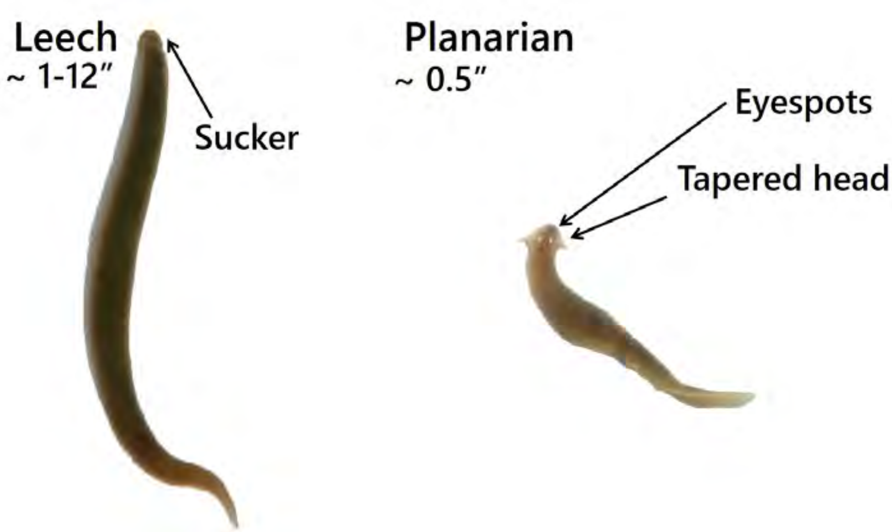
- Very small in size.
- Will readily attach to side of sorting tray or other objects in water.
- Wider on one end than the other, due to a ring on the posterior end of the animal used to attach itself to debris or rocks.
- Filter feeder with two fan-like structures on the head used to collect food out of the water.

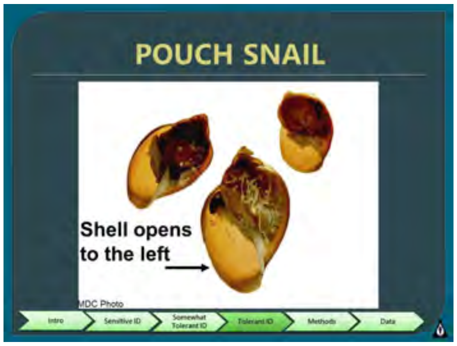
Pollution Tolerant: Leech



Distinguishing Features:

- Suction cup-shaped mouth.
- Long, flattened, muscular body 1-12 inches in length.
- Often brown, black, or mottled in color.
- Can be misidentified as a planarian. Planarians will have a tapered head, two eyespots, and have a gliding locomotion. The average length of a planarian is .5 inches while leeches can grow to several inches.





Pollution Tolerant: Pouch Snail

Distinguishing Features:

- Pouch snails are sometimes referred to as left-handed snails since the shell opens to the left when the point of the snail is held upwards.
- Also called lunged snails because they have a rudimentary lung to breathe air.
- No operculum.
- Do not count empty shells on data sheet.

Ethyl alcohol (Denatured alcohol)

- Dilute to 80% alcohol solution.
- Best method for long-term storage.
- More expensive than isopropyl and may be more difficult to find at retailers.
- Located with painting supplies and may contain high percentage of methanol so check label or SDS for a product that is mostly ethyl alcohol.

Isopropyl alcohol

- Dilute to 40% alcohol solution; buffer with a drop or two of glycerin or a pinch of calcium carbonate antacid tablets.
- Inexpensive and can be found easily at most general retailers.
- Often harsh on invertebrates and can make them brittle over time.
- Remember isopropyl alcohol comes in 70% or 90% concentrations.

Hand sanitizer

- Fill vial part way with sanitizer, insert specimen, then fill completely to top to

Pollution Tolerant: Other Snails

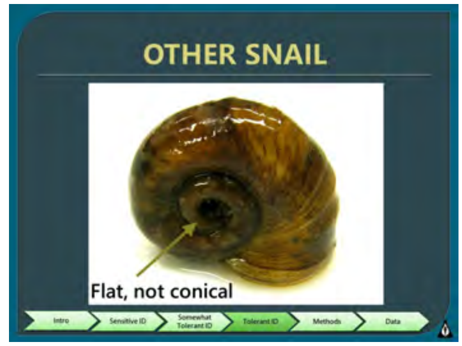
Distinguishing Features:

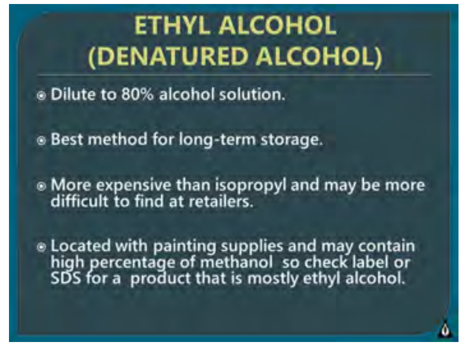
- Snails that are ***not*** conical-shaped with an opening to the left or right.
- Shell will be coiled or look like a ram's horn.

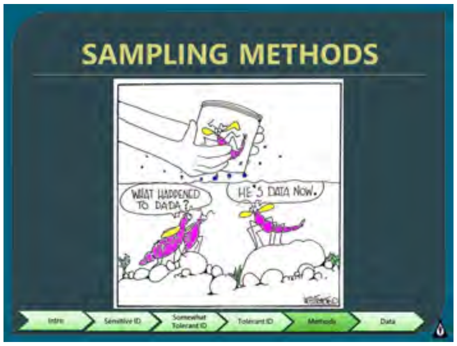
Invertebrate Species Preservation

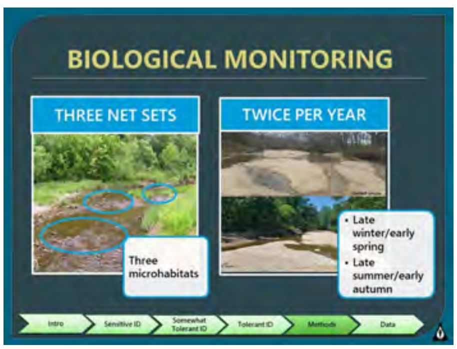
Monitors may preserve specimens for aid in identification or as a reference collection. The preferred method of preservation is using ethyl alcohol (ethanol). Denatured alcohol with a high ethyl alcohol content may be used. See the Safety Data Sheet to determine alcohol content. If ethyl alcohol is not available, isopropyl alcohol (rubbing alcohol) may be used but is harsher on specimens.

1. Euthanize specimen in jar of 100% ethyl alcohol.
2. Place specimen in vial with 80% ethyl alcohol and 20% water.
3. Specimen may be placed in vial of hand sanitizer for easy viewing. This is best for small specimens.









Equipment Needed

To collect, sort, and analyze the invertebrates in your stream, you will need the following equipment:

- 3' X 3' Net*
- Forceps*
- Magnifying Lens*
- Sorting Pan or Tray
- Squirt Bottle
- Macroinvertebrate Data Sheet*

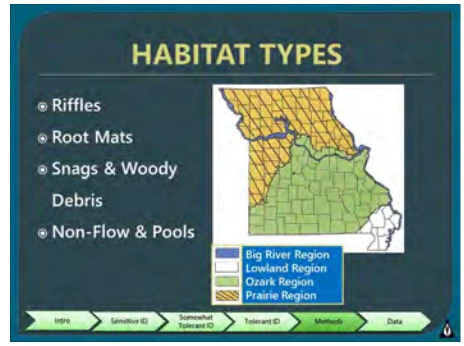
** Indicates equipment provided by the Stream Team Program.*

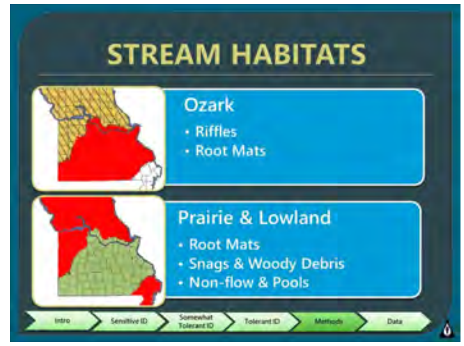
Biological Monitoring

Macroinvertebrates should be sampled twice a year, once in the spring before the leaves appear and once in the fall before leaves drop. Sampling more often may destroy stream habitats.

When conducting your biological sampling, you will collect three net sets for replication within your 300-foot site. It is preferable that each net set is collected from three different microhabitats. For example, if you are sampling from riffles, choose three different microhabitats: the bottom of a riffle, a riffle area with vegetation, and a riffle area with leaf packs.

Habitat Types





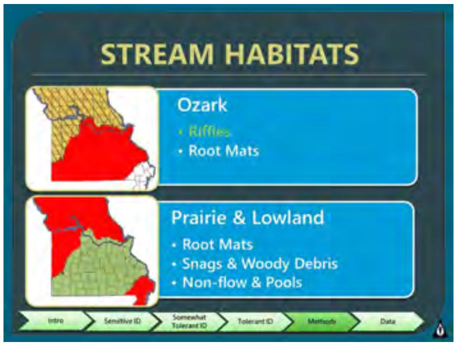
Missouri can be divided into four principle aquatic faunal regions: Big River, Lowland, Ozark, and Prairie. Each region is characterized by different habitats and fauna. Streams in the Ozark Region have many riffles, but they are less common in the Prairie Region due to the gradient of the land.

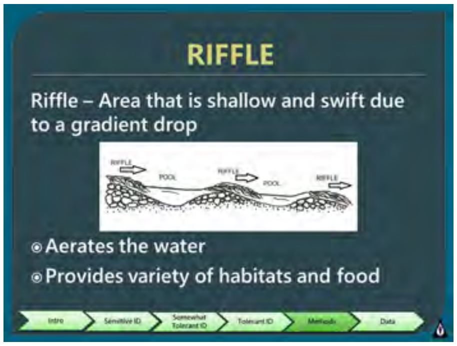
When sampling for macroinvertebrates, you will find different habitat types in different regions. You will commonly find riffles and root mats in the Ozark region. In the Prairie and lowland regions, you will characteristically have root mats, snags, and pools, but very few, if any, riffles.

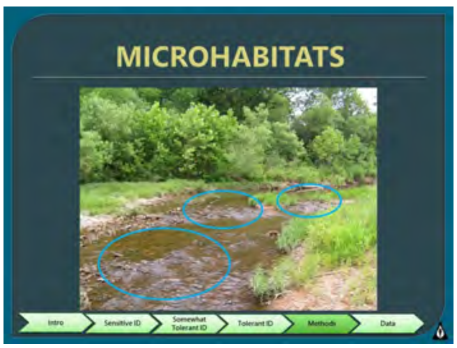
Stream Team protocol prefers you to sample the habitats in the following order. If you do not have a riffle, then look for a root mat next. If you fail to find one, then you can sample a snag or woody debris. Sample a non-flow or pool only as a last resort.

Priority Order for Sample Habitats

1. Riffles
2. Root Mats
3. Snags and Woody Debris
4. Non-Flow and Pools







Sampling Riffles

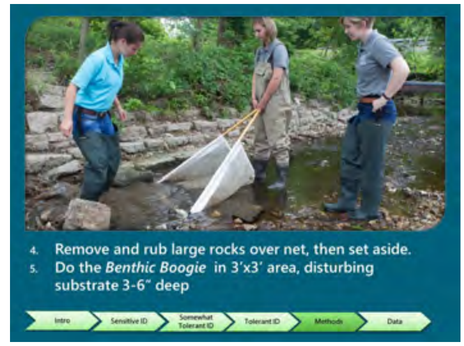
A riffle is an area in your stream where water breaks over the rocks due to a gradient drop in the stream bed. This action incorporates atmospheric oxygen into the water which results in higher dissolved oxygen levels needed for invertebrates to thrive. A riffle provides a variety of microhabitats for a diverse community of organisms.

Since Stream Team protocol requires samples from three microhabitats, start with the most downstream microhabitat and work your way upstream. This prevents disturbing the other locations you will be sampling.

Sampling Riffles

Follow the process to collect samples of invertebrates in a riffle:

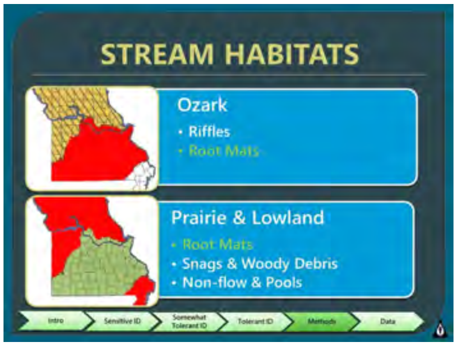
1. Place net in riffle.
2. Ensure bottom of net is on stream bottom.
3. Weigh down the bottom of the net with large rocks.
4. Rub any large rocks in the sample area over the net, then set aside.
5. Agitate the stream bottom directly in front of the net in a 3’ X 3’ area, disturbing the substrate 3 to 6 inches deep. (Benthic Boogie!)
6. Remove and rub rocks weighing down the net.
7. Slowly lift the net from the stream, ensuring water does not pour over the sides.
8. Move the net to land to pick, sort, and identify invertebrates.



Sampling Root Mats

Root mats are the fibrous roots from vegetation that hang over a stream bank and into the water. Damselflies, dragonflies, mayflies, caddisflies, and midges are common in root mats. Use the following process to sample macroinvertebrates from root mats:

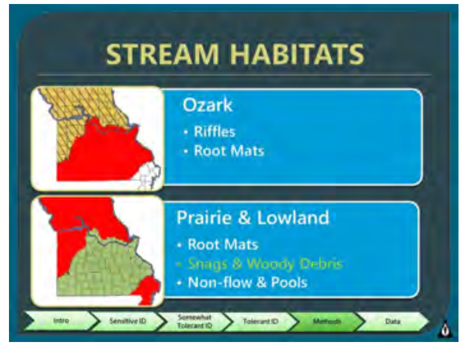
1. Place net downstream of root mat.
2. Kick and swirl water through roots into the net.
3. Slowly lift the net from the stream, ensuring water does not pour over sides.
4. Move the net to land to pick, sort, and identify invertebrates.

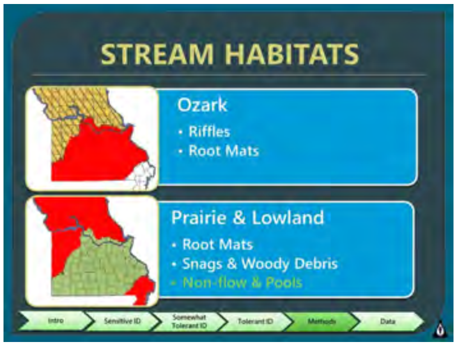


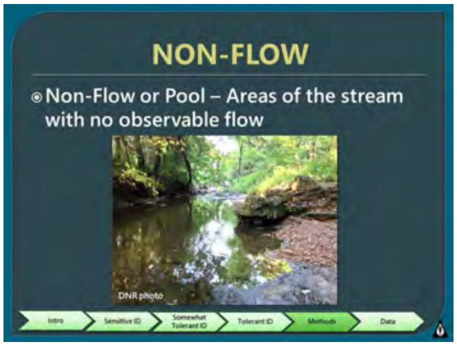
Sampling Snags and Woody Debris

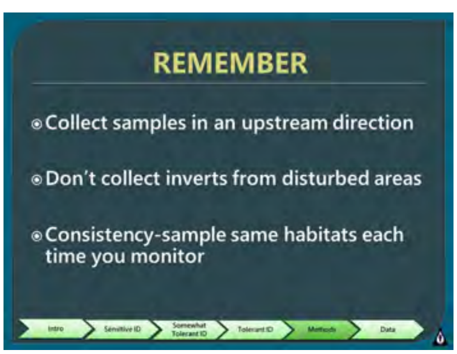
If your site has no riffles or root mats, you can sample snags or woody debris. When tree limbs, logs, and sticks fall into a stream and begin to decompose, the material becomes soft and provides a microhabitat for invertebrates. Follow the process below when sampling snags or woody debris:

1. Place net below the woody debris.
2. Scrub the debris using a brush.
3. Slowly lift the net from the water.
4. Move the net to land to pick, sort, and identify invertebrates.
5. Repeat steps 1 to 4 to sample three to five snags for one net set.









Sampling Non-Flow

If no other habitats exist at your monitoring site, you can sample in pools or non-flow areas. Use a D-net and the following process to collect your samples from these microhabitats:

1. Hold D-frame net in front of you in the water.
2. Shuffle feet to disturb substrate.
3. Sweep net side to side or in a circular motion just above substrate .
4. Move the net to land to pick, sort, and identify invertebrates.

Sampling Tips

- Prioritize habitats to monitor according to stream team protocol:

    1. Riffles
    2. Root Mats
    3. Snags and Woody Debris
    4. Non-flow or pools

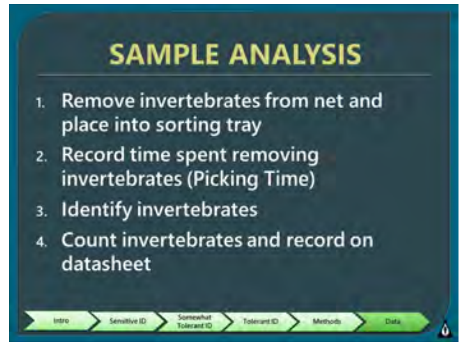
- Collect samples in an upstream direction.
- Do not collect invertebrates from disturbed areas.
- Be consistent in the habitats you sample.
- Sample macroinvertebrates twice a year; once in the spring and once in the fall.

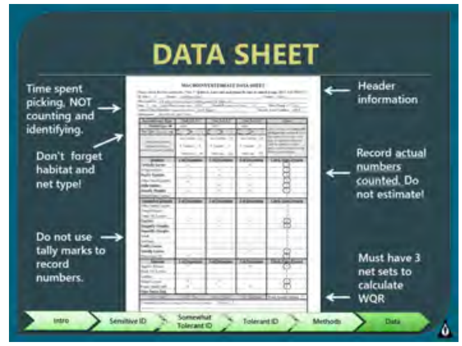
Completing the Macroinvertebrate Data Sheet

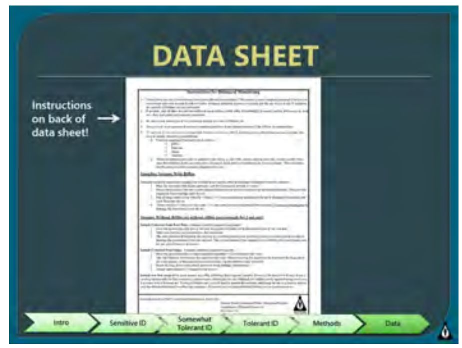
After you have collected a sample, begin the process of sorting, identifying, and counting each type of invertebrate. Record your findings on the Macroinvertebrate Data Sheet. This process will be repeated for each of the three net sets:

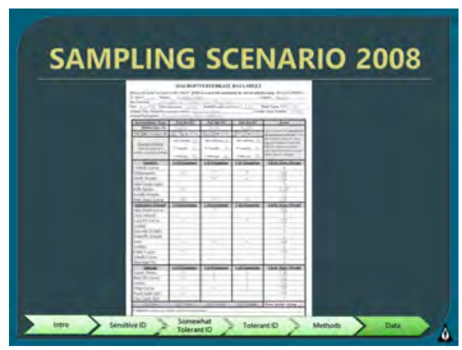
1. Remove invertebrates from the net and place them into your sorting tray.
2. Record the time spent removing invertebrates.
3. Identify invertebrates.
4. Count invertebrates and record your findings on the data sheet.

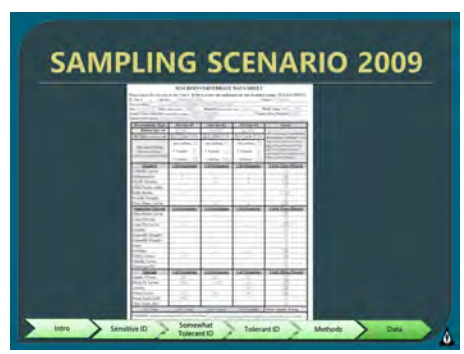
As with every data sheet you submit, be sure the header information is filled out entirely. For each of the three net sets, you will record the ***Habitat Type*** and select the ***Net Type*** you used. Record the amount of time it took to pick invertebrates from the net and the number of people that helped. Identify the organisms in the sorting tray and record the quantity of each variety found. After all three net sets have been completed, circle the number in the far right column called ***Score.*** If the taxa was present in any of the three net sets, circle the corresponding number. Once all data has been recorded, add up the scores to get the final water quality rating.











MACROINVERTEBRATE DATA SHEET

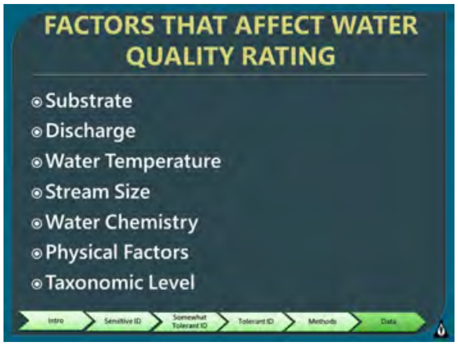
Please check the box next to the "Site #" *if this is a new site and please be sure to attach a map.* (PLEASE PRINT)
☐ Site # 1 Stream Roubidoux Creek County Pulaski
Site Location 1/4 mile DS from Hwy 17 bridge, parallel to Pippin Rd.
Date 9 /24 /2014 Time (military time) 0900 Rainfall (inches in last 7 days) 0 Water Temp. (°C) 20
Trained Data Submitter (responsible volunteer) Chris Riggert Stream Team Number 2583
Participants Alicia Burke, April Perry

Invertebrate Type	*Net Set #1*	*Net Set #2*	*Net Set #3*	*Score*
Habitat type →	Riffle	Riffle	Riffle	*After entering the **number(s) of organisms collected**, circle the number below for every type of organism collected. Add the numbers circled and record the totals as your Water Quality Rating.*
Net Type (circle type) →	Kick Net or D-Net	Kick Net or D-Net	Kick Net or D-Net	
Time Spent Picking (*Minutes picking x number of people picking*)	min. picking 12 × # people 3 = total min. 36	min. picking 15 × # people 3 = total min. 45	min. picking 14 × # people 3 = total min. 42	
Sensitive	**# of Organisms**	**# of Organisms**	**# of Organisms**	**Circle Types Present**
Caddisfly Larvae	4		2	3
Hellgrammites		1		3
Mayfly Nymphs	1	2	4	3
Gilled Snails (right)	2			3
Riffle Beetles		2	1	3
Stonefly Nymphs	2	1	2	3
Water Penny Larvae				3
Somewhat Tolerant	**# of Organisms**	**# of Organisms**	**# of Organisms**	**Circle Types Present**
Other Beetle Larvae				2
Clams/Mussels				2
Crane Fly Larvae				2
Crayfish	3	1	1	2
Dragonfly Nymphs		1		2
Damselfly Nymphs				2
Scuds				2
Sowbugs				2
Fishfly Larvae				2
Alderfly Larvae			1	2
Watersnipe Fly	1			2
Tolerant	**# of Organisms**	**# of Organisms**	**# of Organisms**	**Circle Types Present**
Aquatic Worms	1		3	1
Black Fly Larvae				1
Leeches				1
Midge Larvae	3	1		1
Pouch Snails (left)	3	4	4	1
Other Snails (flat)				1
<12 = Poor	12-17 = Fair	18-23 = Good	>23 = Excellent	**Water Quality Rating** 24

Comments (mention any changes from your usual readings) Planaria - 2

Fish Present (Please Mark) **Yes**☑ or **No**☐

Volunteer Monitoring - 12/15



Factors Affecting Biological Water Quality Rating

There are many factors that affect the biological water quality rating. Some of these include:

- ***Substrate:*** The type of habitat the stream provides will affect the rating. Silt and sand-bottomed streams will generally have lower ratings than cobble-bottomed Ozark streams due to poor habitat availability.
- ***Discharge, Depth and Velocity:*** Sensitive organisms prefer water with some velocity because it helps to keep oxygen levels high. Too much velocity though, can result in a lower water quality rating. An example of would be when rain events generate deep, fast flows in which organisms can be swept away.
- ***Season:*** Many invertebrates are insect larvae and emerge at varying times of the year. If you conduct your biological monitoring when they are in the adult stage, your rating will be lowered.
- ***Water Temperature:*** Very warm streams, like those with no riparian corridor or those in urban areas that are partially paved, will not hold much oxygen and will not support aquatic life.
- ***Stream Size:*** Invertebrate communities are dependent on the characteristics associated with stream size.
- ***Water Chemistry:*** A balance of chemical constituents must be maintained to support aquatic life. Imbalances will result in changes in the stream that will alter what organisms can live there. Certain chemicals are toxic and if present in large enough quantities, will kill all life in a stream.
- ***Physical Factors:*** Habitat, flow, and rates of soil erosion are all physical factors that affect aquatic life. Poor ratings can often be attributed to physical problems in the stream rather poor water quality conditions.
- ***Level of Taxonomy:*** Our program identifies many macroinvertebrates to class, order, and family based on ability to identify stream-side. A general pollution sensitivity is assigned to this level. A given taxa may have a genus or species more tolerant than others. For example, mayflies are considered pollution sensitive on the data sheet, but there are some species of mayfly that are actually somewhat pollution tolerant.

Biological Monitoring Analysis

How does the collection and identification of macroinvertebrates aid in determining overall water quality of a stream? The four scenarios below illustrate how density and diversity of macroinvertebrates in a stream can aid in determining the health or impairment of a stream.

Scenario 1

Observations of Macroinvertebrates	Water Quality Analysis
• High density • High diversity • Many sensitive taxa (stoneflies, caddisflies, mayflies)	

Scenario 2

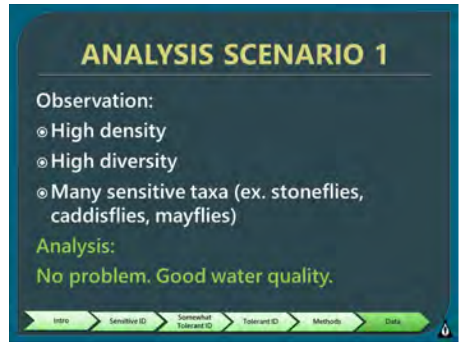
Observations of Macroinvertebrates	Water Quality Analysis
• Low density • High diversity	

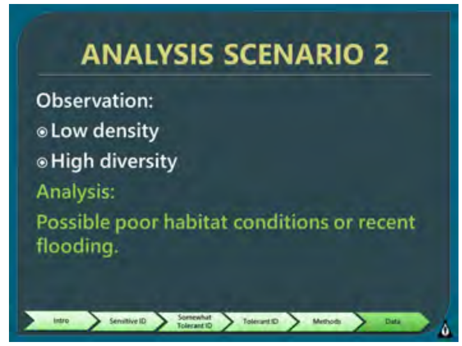
Scenario 3

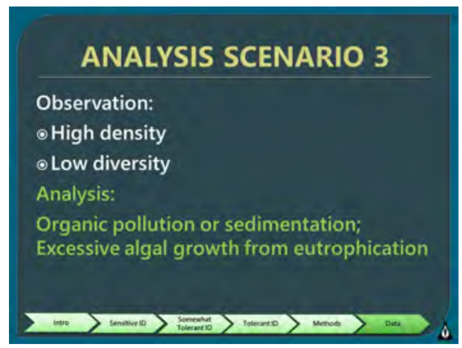
Observations of Macroinvertebrates	Water Quality Analysis
• High density • Low diversity	

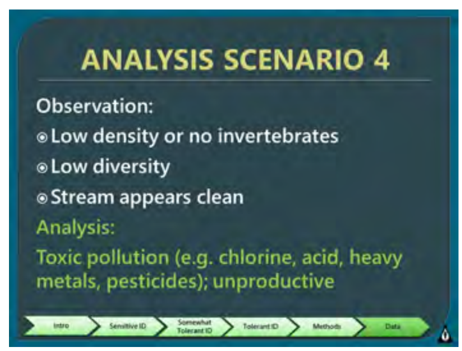
Scenario 4

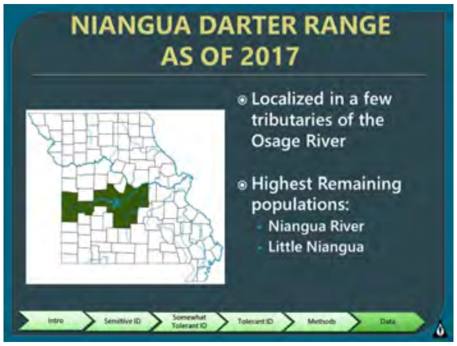
Observations of Macroinvertebrates	Water Quality Analysis
• Low density or no invertebrates • Low diversity • Stream appears clean	











Other Organisms to Consider

As you begin your monitoring efforts, there are a few additional organisms for you to consider. Niangua Darters are small fish that are endangered in Missouri and federally threatened. Located in a few tributaries along the Osage River, their highest remaining populations can be found in the Niangua and Little Niangua rivers. Because the Niangua Darter spawns in riffles, kicking up macroinvertebrates can be detrimental to spawning and future populations. Consequently, do not conduct macroinvertebrate monitoring in the following streams from March 15 through June 15.

<u>Niangua River Watershed</u>

- Niangua River
- Greasy Creek
- Little Niangua River

<u>Little Niangua River Watershed</u>

- Macks Creek
- Starks Creek
- Thomas Creek
- Cahoochie Creek

<u>Sac River Watershed</u>

- Sac River
- Bear Creek
- Brush Creek
- Panther Creek
- North Dry Sac River

<u>Tavern Creek Watershed</u>

- Tavern Creek
- Barren Fork
- Brushy Fork
- Kenser Creek
- Little Tavern Creek

<u>Other Streams</u>

- Pomme de Terre River
- South Fork Pomme de Terre River
- Little Pomme de Terre River
- Maries River
- Little Maries Creek

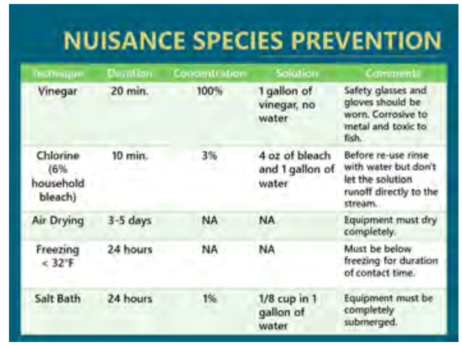
Other Organisms to Consider

Please be mindful of nuisance species, too. Some of the invasive species in Missouri's streams include:

- Zebra mussel
- Chinese mystery snail
- Rusty crayfish
- Hydrilla

To prevent spreading these species to even more streams, be sure to clean and dry your equipment, boots, and boats after being in the water. This is especially true if you monitor more than one stream. The table below provides guidelines on how to prevent the spread of these species from one stream to another.

Technique	Duration	Concentration	Solution	Comments
Vinegar	20 min.	100%	I gallon of vinegar, no water	Safety glasses and gloves should be worn. Corrosive to metal and toxic to fish
Chlorine (6% household bleach)	10 min.	3%	4 oz of bleach and 1 gallon of water	Before re-use, rinse with water but do not let the solution runoff directly to a stream
Air Drying	3-5 days	NA	NA	Equipment must dry completely
Freezing <32° F	24 hours	NA	NA	Must be below freezing for duration of contact time
Salt Bath	24 hours	1%	1/8 cup in 1 gallon of water	Equipment must be completely submerged


NUISANCE SPECIES PREVENTION

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Aquatic Macroinvertebrates Characteristics Chart

This chart was designed to aid in the identification of aquatic macroinvertebrates and is a supplement to the dichotomous key in Chapter 4 of your Introductory Notebook, Stream Insects & Crustaceans "blue bug card" and the Key to Macroinvertebrate Life in the River.

Key:
× = present
✓ = sometimes present

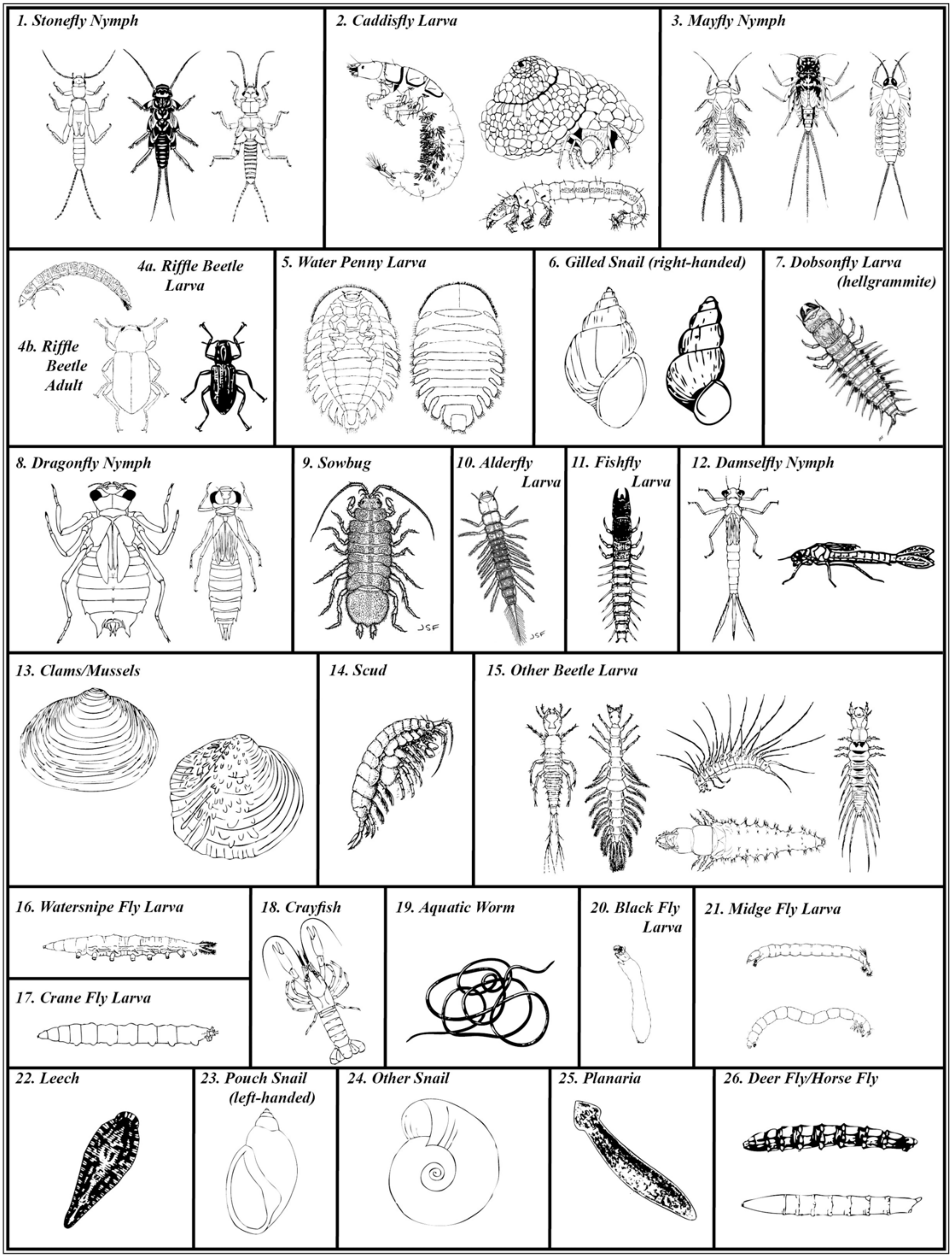
				Head					Thorax							Abdomen						
	Flattened body	Shell	Caterpillar-like	Distinct head	Large eyes	Obvious antennae	Obvious mouth parts	Mask-like lower lip	No legs	Prolegs	Six segmented legs	More than six segmented legs	Gills	Hard plate(s)	Wings/Wing pads	Gills	Hard plate(s)	Lateral filaments	Prolegs	Hooked prolegs	Suction pad(s)	Tail(s)
1. Stonefly Nymph	✓			×		×					×		✓		×							×
2. Caddisfly Larva				×							×			×		✓				×		
3. Mayfly Nymph	✓			×		✓					×				×	×						×
4a. Riffle Beetle Larva				×							×			×			×					
4b. Riffle Beetle Adult				×		×					×			×								
5. Water Penny Larva	×			×							×			×		✓	×					
6. Gilled Snail (right-handed)		×							×													
7. Dobsonfly Larva (hellgrammite)	✓			×			×				×			×		×		×		×		
8. Dragonfly Nymph	✓			×	×	×	×	×			×				×							
9. Sowbug	×					×						×		×			×					
10. Alderfly Larva	✓			×			×				×			×				×				×
11. Fishfly Larva	✓			×			×				×			×				×		×		
12. Damselfly Nymph				×	×	×	×	×			×				×							×
13. Clam/Mussel		×							×													
14. Scud	×			×		×						×		×			×					
15. Other Beetle Larva	✓			×		✓	×				×			✓			✓	✓				✓
16. Watersnipe Fly Larva			×						×										×			
17. Crane Fly Larva			×						×													
18. Crayfish					×	×						×		×			×					×
19. Aquatic Worm									×													
20. Black Fly Larva				×					×	×											×	
21. Midge Fly Larva				×					×	×									×			
22. Leech	×								×												×	
23. Pouch Snail (left-handed)		×							×													
24. Other Snails		×							×													

Other macroinvertebrates you may encounter that are not included in our count/protocol.

25. Planaria	×			×					×													
26. Deer Fly/Horse Fly			×						×													

Images by Bouchard, R.W., Jr. 2004. Guide to Aquatic Macroinvertebrates of the Upper Midwest, except where otherwise noted.

02/10
STR 423



1. Stonefly Nymph
2. Caddisfly Larva
3. Mayfly Nymph
4a. Riffle Beetle Larva
4b. Riffle Beetle Adult
5. Water Penny Larva
6. Gilled Snail (right-handed)
7. Dobsonfly Larva (hellgrammite)
8. Dragonfly Nymph
9. Sowbug
JSF
10. Alderfly Larva
JSF
11. Fishfly Larva
12. Damselfly Nymph
13. Clams/Mussels
14. Scud
15. Other Beetle Larva
16. Watersnipe Fly Larva
17. Crane Fly Larva
18. Crayfish
19. Aquatic Worm
20. Black Fly Larva
21. Midge Fly Larva
22. Leech
23. Pouch Snail (left-handed)
24. Other Snail
25. Planaria
26. Deer Fly/Horse Fly

Stream Insects & Crustaceans

GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

1 Stonefly nymph: *Order Plecoptera.* 1/8" - 1 1/2"; 6 legs with hooked tips; 2 hairlike tails. Smooth (no gills) on abdomen (see arrow). May have gills on thorax under the legs.

2 Caddisfly larva: *Order Trichoptera.* Up to 1"; 6 legs on thorax; 2 hooks at end of abdomen. May be in a stick, rock, or leaf case with its head sticking out. May have fluffy gill tufts on lower half.

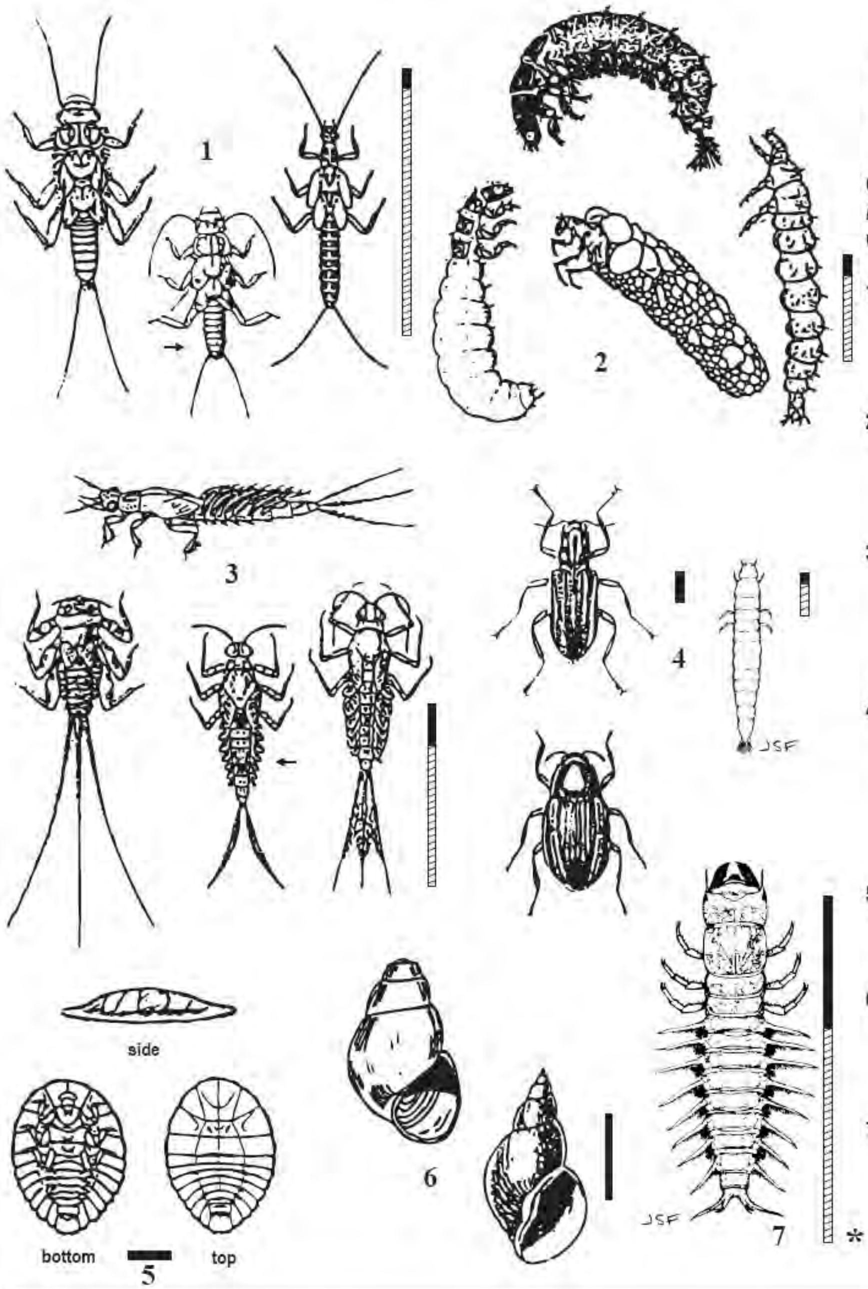
3 Mayfly nymph: *Order Ephemeroptera.* 1/4" - 1"; moving, platelike, or feathery gills on abdomen (see arrow); 6 large hooked legs; antennae; 2 or 3 long, hairlike tails. Tails may be webbed together.

4 Riffle Beetle: *Order Coleoptera.* Adult: Tiny, 6-legged beetle; crawls slowly on the bottom. Larva: Entire length of body covered with hard plates; 6 legs on thorax; uniform brown or black color. Combine number of adults & larvae when reporting total counts.

5 Water Penny larva: *Order Coleoptera.* 1/4"; flat saucer-shaped body, like a penny; segmented with 6 tiny legs underneath. Immature beetle.

6 Gilled Snail: *Class Gastropoda.* Shell opening covered by thin plate called operculum. When pointed up and opening facing you, the shell opens to right. Do not count empty shells.

7 Dobsonfly larva (hellgrammite): *Family Corydalidae.* 3/4" - 4"; dark-colored; 6 legs, large pinching jaws; eight pairs lateral filaments on lower half of body with paired cottonlike gill tufts along underside of lateral filaments; short antennae; 2 pairs of hooks at back end.

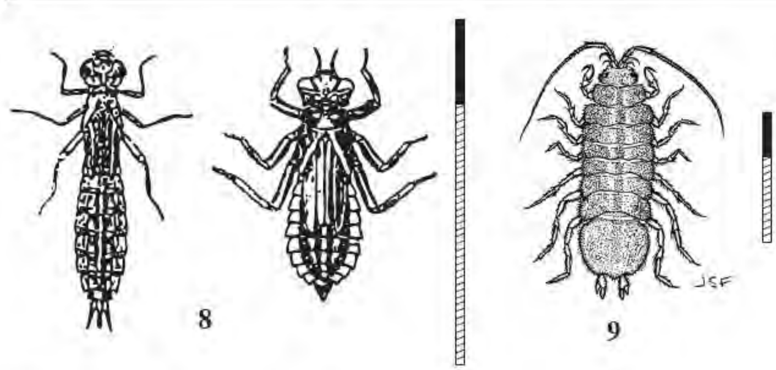


GROUP TWO TAXA

Somewhat pollution tolerant organisms can be in good or fair quality water.

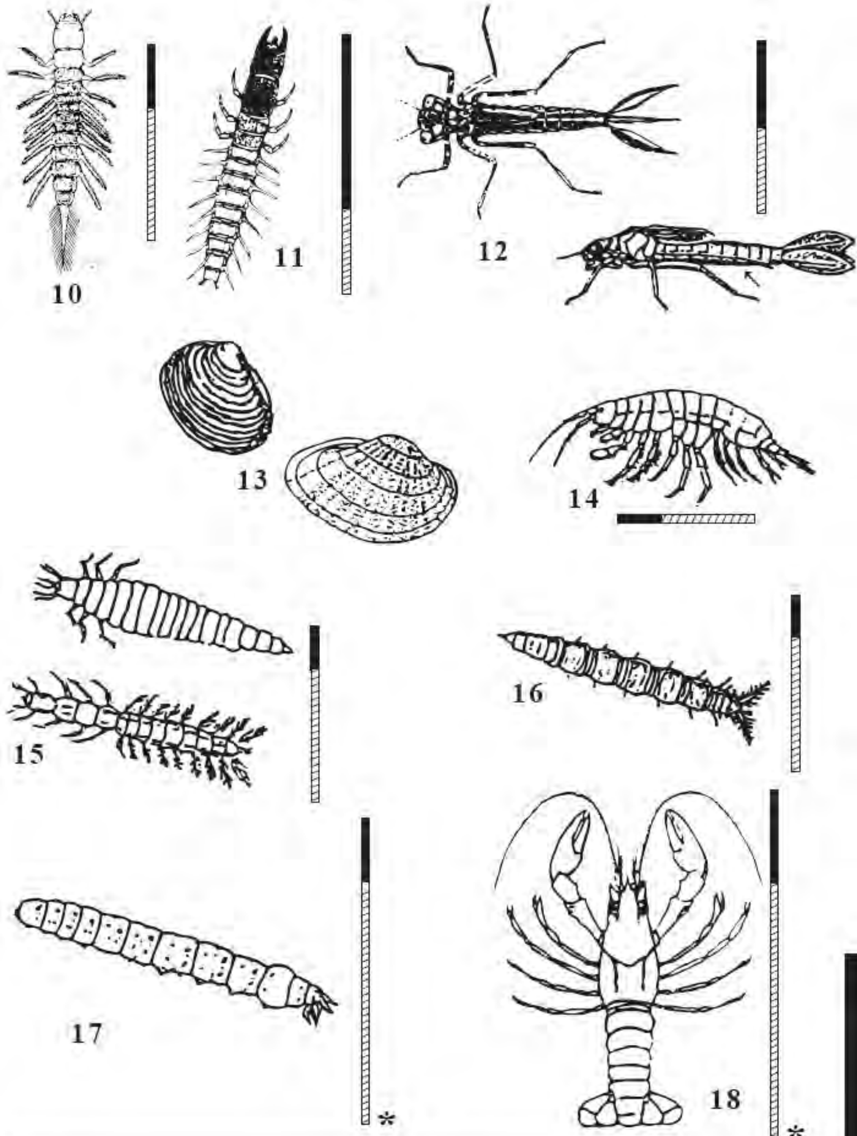
8 Dragonfly nymph: *Suborder Anisoptera.* 1/2" - 2"; large eyes, 6 hooked legs. Wide oval to round abdomen, masklike lower lip.

9 Sowbug: *Order Isopoda.* 1/4" - 3/4"; gray oblong body wider than it is high, more than 6 legs, long antennae, looks like a 'roly poly.'



*** May be larger.**
~Solid bar indicates approx. minimum size. Combined solid and striped bar is approx. maximum size.~

Save Our Streams



GROUP TWO TAXA continued

10 Alderfly larva: *Family Sialidae*. 3/8"- 1"; looks like small hellgrammite but has 1 long, thin, branched tail at end of abdomen (no hooks). No gill tuft underneath the lateral filaments on abdomen.

11 Fishfly larva: *Family Corydalidae*. Up to 1 1/2"; lateral filaments on abdomen. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

12 Damselfly nymph: *Suborder Zygoptera*. 1/2"- 1"; large eyes; 6 thin hooked legs; 3 broad oar-shaped tails (gills); body positioned like a tripod. Smooth (no gills) on sides of lower half of body (see arrow).

13 Clam/Mussel: *Class Bivalvia*. Do not count empty shells.

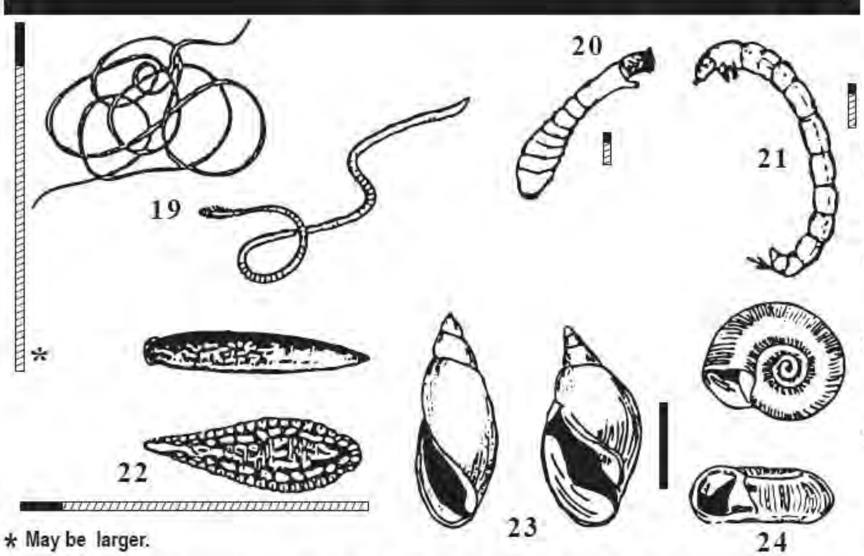
14 Scud: *Order Amphipoda*. 1/4"- 3/4"; white to gray, body higher than it is wide; swims sideways; more than 6 legs; resembles small shrimp.

15 Other Beetle larva: *Order Coleoptera*. 1/4" - 1"; light-colored; 6 legs on upper half of body; feelers; antennae; obvious mouthparts. Diverse group.

16 Watersnipe Fly larva: *Family Athericidae (Atherix)*. 1/4" - 1"; pale to green; tapered body; many caterpillar-like legs; conical head; two feathery 'horns' at back end.

17 Crane Fly larva: *Suborder Nematocera*. 1/3" - 4"; milky, green, or light brown; plump caterpillar-like segmented body. May have enlarged lobe or fleshy fingerlike extensions at the end of the abdomen.

18 Crayfish: *Order Decapoda*. Up to 6"; 2 large claws, 8 walking legs, resembles small lobster.



GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

19 Aquatic Worm/Horsehair Worm: *Class Oligochaeta/ Phylum Nematomorpha*. Aquatic worm: 1/4"- 2"; can be very tiny, thin wormlike body. Horsehair Worm: 4"-27"; slender, can be tangled.

20 Black Fly larva: *Family Simulidae*. 1/8"- 3/8"; one end of body wider. Black head, suction pad on end.

21 Midge Fly larva: *Suborder Nematocera*. Less than 1/4"; distinct head; wormlike segmented body; pair of tiny prolegs under head and tip of abdomen.

22 Leech: *Order Hirudinea*. 1/4" - 6"; flattened muscular body, ends with suction pads.

23 Pouch Snail and Pond Snails: *Class Gastropoda*. No operculum. Breathe air. Shell usually opens on left. Do not count empty shells.

24 Other snails: *Class Gastropoda*. No operculum. Breathe air. Snail shell coils in one plane. Do not count empty shells.

*** May be larger.**

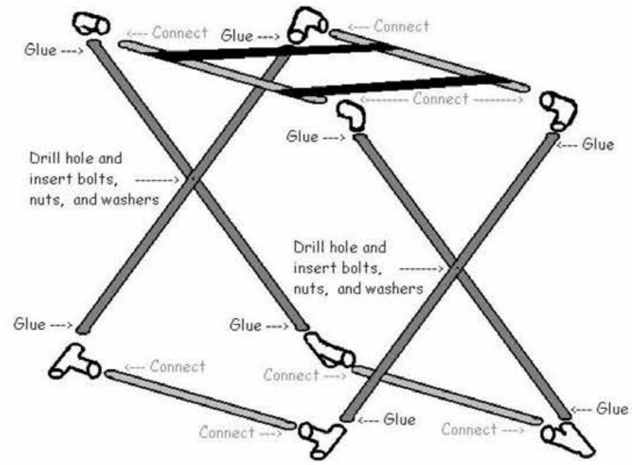
~Solid bar indicates approx. minimum size. Combined solid and striped bar is approx. maximum size.~

01/10
STR 250

PVC Net Rack

Materials

- Three 10 foot sections of 1 inch PVC pipe
- Four PVC elbows (1 inch - 90°)
- Four PVC 'T' connectors (1 inch - 90°)
- Two bolts (3 X 1/4 inch)
- Three lock nuts (1/4 inch)
- Four washers (1/4 inch)
- Canvas
- Heavy duty thread / twine
- Needle
- PVC cleaner and glue
- Tape measure
- Hacksaw and scissors
- Pliers
- Drill and 3/8 inch bit

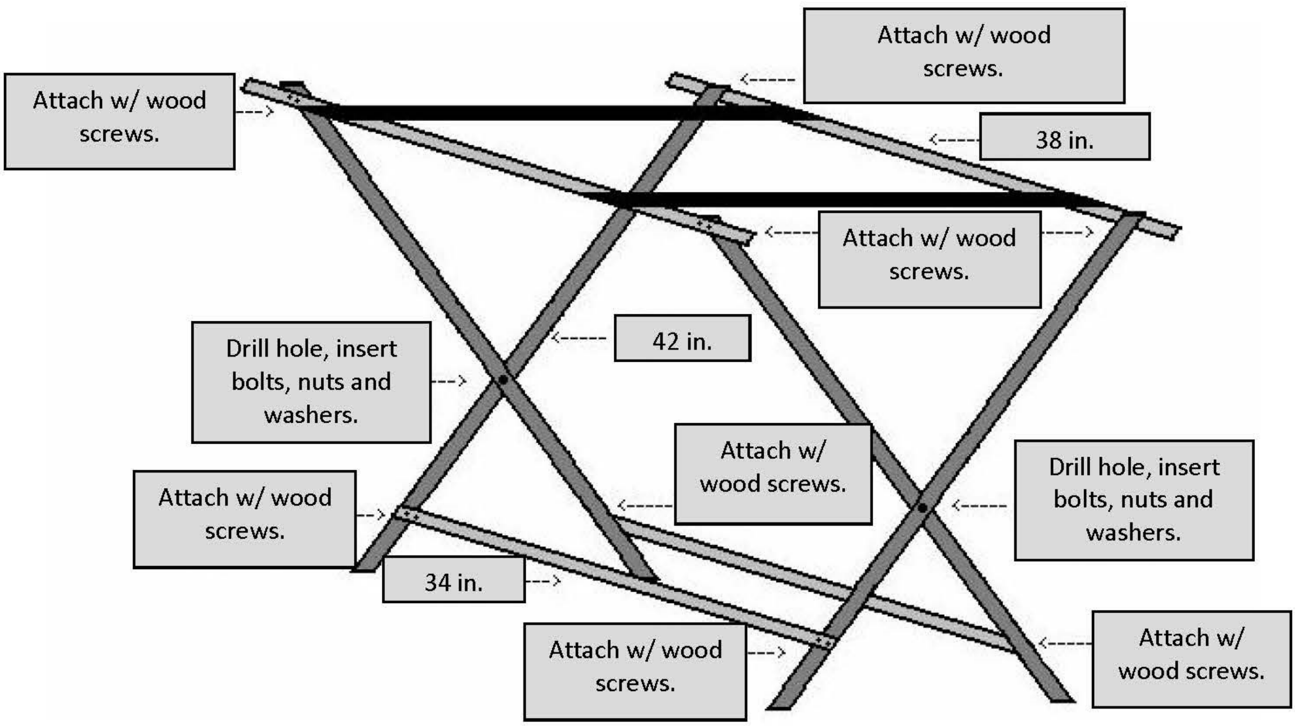


Procedure

1. Cut two 10ft. PVC pipes into one 4ft. section and two 3 ft. sections.
2. Cut the third 10ft. PVC pipe into two 4 ft. sections.
3. Steps 1-3 will give you the legs (4ft. sections) and the cross supports (3 ft. sections).
4. Drill a hole in the 4ft pieces (2 ft. from the end).
5. Connect the legs (4 ft. sections) with a bolt, washer and lock nut.
6. Clean the ends of the legs and inside the 'T' connector with pipe cleaner and wipe off.
7. Put the 'T' sections (bottom of the 'T') onto either end of two cross pieces and make sure the 'T's" are lined up the same way. **Note: Do not glue these together. This allows you to dissemble the rack for transport.**
8. Apply PVC glue to both ends of the legs and inside the 'T' sections.
9. Attach the 90° elbows to the other end of the legs.
10. Cut the canvas to a length that will allow you to work off your bug rack at a comfortable height. **Note: The shorter the canvas the taller the rack.**
11. Loop the ends of the canvas around the top cross bar to the desired length and sew canvas loop closed.
12. Let the glue cure before use.

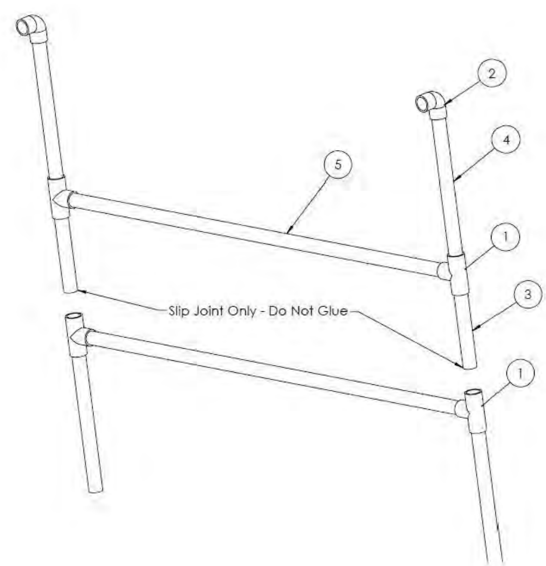
Wooden Net Rack

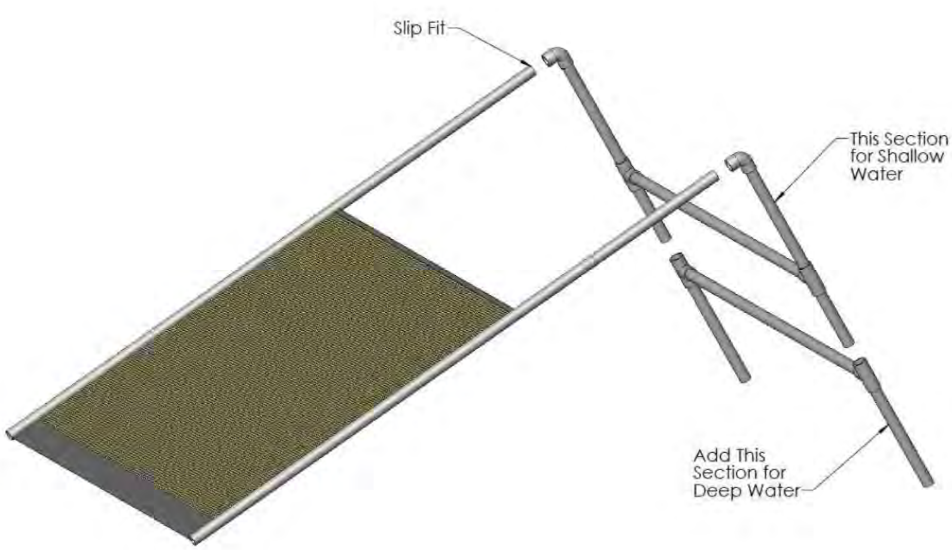
Part	Length
Lumber 1x2	42"
Lumber 1x2	1-34", 1-36" and 2-38"
Drywall Screws	1 3/4"
Bolts wit lock nuts	3"
Canvas strips	6" wide x 40" long



Free Standing Net

Item Number	Part	Length	Quantity
1	PVC 3/4" Tee		4
2	PVC 3/4" Elbow		2
3	PVC 3/4" Upright	8"	2
4	PVC 3/4" Upright	13"	4
5	Cross Bar	43" using 1 inch PVC	2





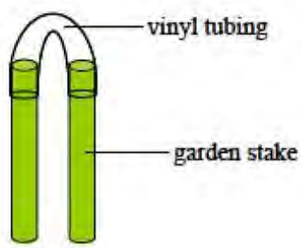
Plans for Freestanding Kicknet Support

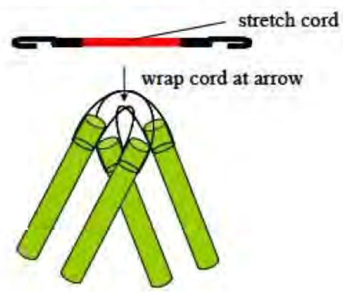
Materials

Quantity	Part	Length	Diameter
4	Steel core, plastic-coated garden stakes	4ft	3/8"
1	Clear vinyl tubing soft	6"	7/16" outside, 5/16" inside
1	Long stretch bungee cord with hooked ends or rope	10"	

Procedure

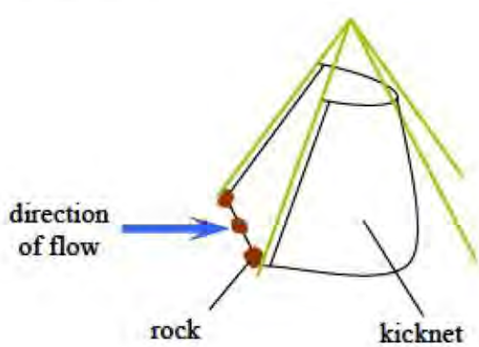
- Place a 3-inch piece of vinyl tubing onto the end of the garden stakes.
- Wrap the stretch cord around both pieces of vinyl tubing and interlock the hooks to create a flexible joint.





Practical Use

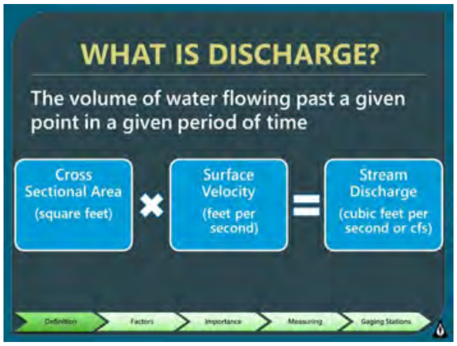
- Guide the looped edges on opposite sides of the kicknet onto tow supports.
- Lower the kicknet into the stream and step on the bottom edge to hold it in place in the flowing water.
- Place large rocks on the submerged edge of the kicknet to hold it firmly on the stream bottom.
- Position downstream supports to make a stable structure.
- When removing the kicknet from the stream, grab the bottom edge as you remove the rocks to prevent the loss of the sample.

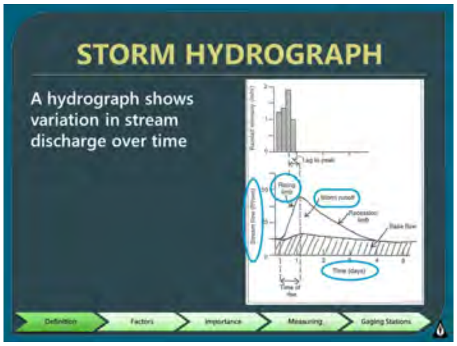


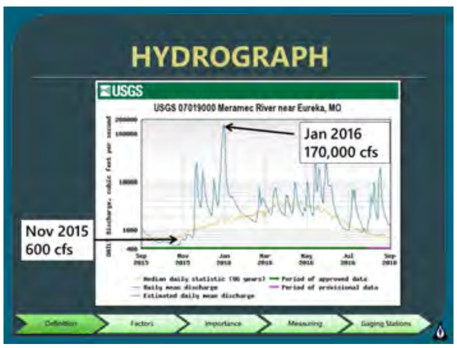
Chapter 4
Stream Discharge

Once a site has been determined, the next step in monitoring is to determine the volume and velocity of water flowing in your stream. This is called stream discharge. In this chapter, you will:

- Define stream discharge
- Understand the factors affecting discharge
- Understand the importance of discharge
- Measure stream discharge
- Know how to use United States Geological Survey (USGS) Gage Stations







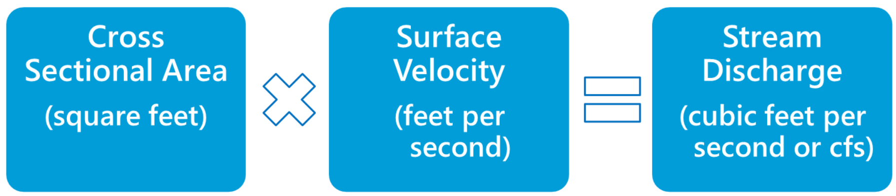
What is Stream Discharge?

Stream discharge is also referred to as flow. It measures the volume of water flowing past a given point in a given period of time. Stream discharge is expressed as a rate with two components:

- Volume of water, expressed in cubic feet.
- Time, expressed in seconds.

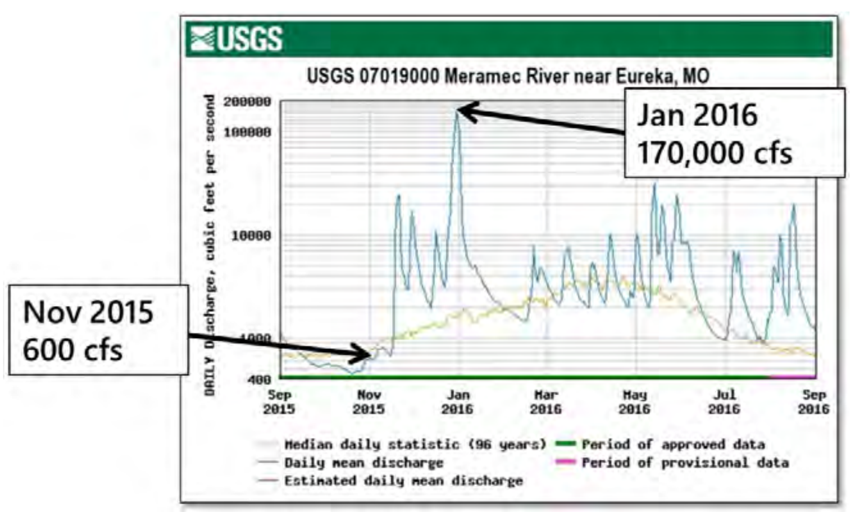
For example, one cfs refers to one cubic foot of water flowing past a given point every second.

Although it sounds difficult, calculating stream discharge is easy. The mathematical formula can be articulated as the cross-sectional area of a stream multiplied by the surface velocity of the water.

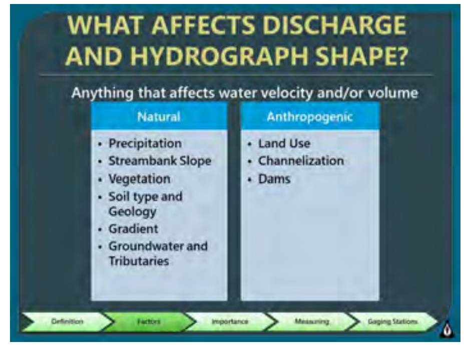


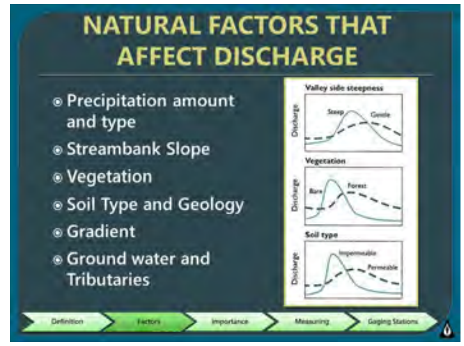
Hydrographs

A stream's discharge changes over time. When stream discharge measurements are collected over time, they can be used to create a hydrograph. In the example below, time is represented on the X axis of the graph. The discharge is represented on the Y axis and is measured in cubic feet per second (cfs). This hydrograph shows the variation in discharges for different seasons of the year for the Meramec River near Eureka, MO. As you can see, the daily mean discharge in November of 2015 was 600 cfs, while the discharge in January was much higher at 170,000 cfs.



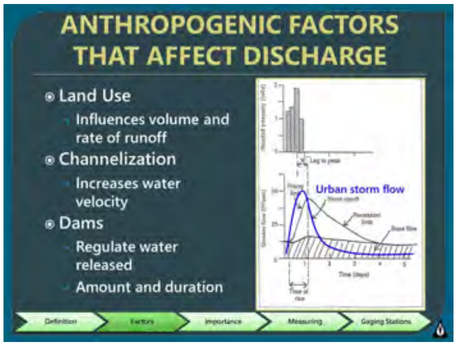
Natural Factors Affecting Stream Discharge





There are many natural factors that can affect the stream discharge:

- ***Precipitation:*** The type and amount of precipitation determines how much water is introduced into the system and how quickly it is released over time. A downpour of rain will introduce a lot of water flowing into the system very quickly, whereas snow or ice will release the moisture more slowly into the system.
- ***Streambank Slope:*** If the streambanks are steep, water will be confined to a smaller stream channel and will travel faster through the channel, resulting in an increased stream discharge after a storm event. With gently sloping streambanks, the influx of water after a storm event has more room to spread out. This slows the stream's discharge.
- ***Vegetation:*** Vegetation absorbs water and releases it to the atmosphere through evapotranspiration. It increases the water storage capacity of soil, making it like a sponge. This allows the soil to store water during dry periods and will increase your flow. Vegetation also adds surface roughness to the stream channel, streambanks, and flood plain, which will slow down the stream discharge. Removing vegetation from the land or replacing it with concrete removes that surface roughness and the absorption of water into the soil, allowing a dramatic increase in discharge in a short period of time.
- ***Soil Type:*** Permeable soils, such as gravel and sand, allow greater absorption of water into the ground, regulating increased stream discharges and smoothing out the shape of a hydrograph. Impermeable soils, such as clay or bedrock, do not allow for absorption and act more like concrete, increasing stream discharge.
- ***Channel gradient:*** High-gradient streams occur in steep topography, such as in areas of the Ozarks. Lower gradient streams tend to move water more slowly, while higher gradient streams move water faster.
- ***Other Factors:*** Groundwater, springs, adjacent wetlands, and tributaries contribute to portions of the total flow of a stream and can be crucial during dry times.



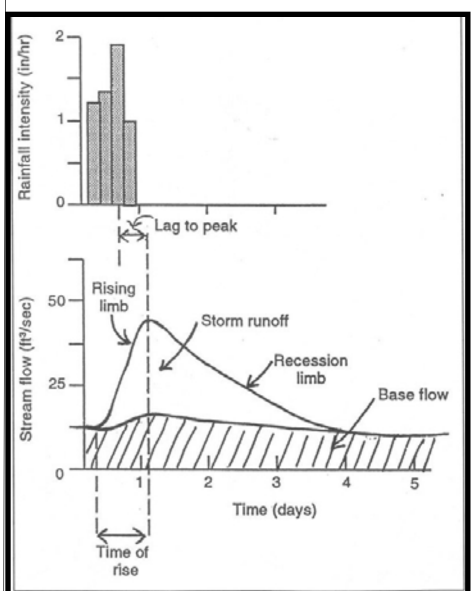
Anthropogenic Factors Affecting Stream Discharge

Anthropogenic or man-made factors affect stream discharge. Land use, channelization, and dams can have a tremendous effect on water velocity and volume.

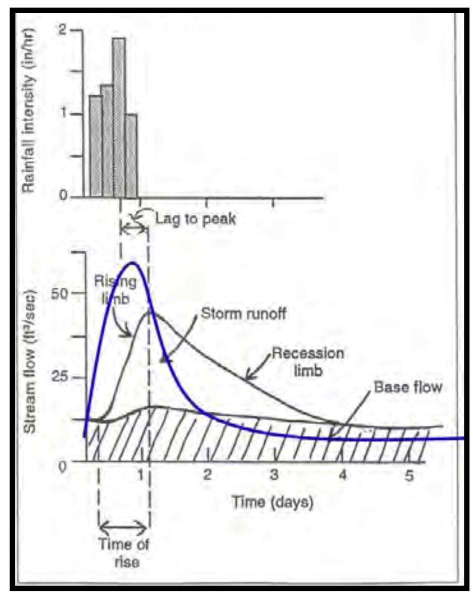
For example, compare the two graphs below. The first one represents the normal storm flow for a stream in a natural, well-vegetated landscape, as it responds to a precipitation event.

However, in an urban setting, vegetation is usually converted to streets, parking lots, and concrete. The second graph shows a blue line, which represents how an urban stream typically responds to a storm event. This type of hydrograph is referred to as “flashy” because water enters and exits the stream much faster than streams in more vegetated areas.

Normal Storm Flow



Urban Storm Flow



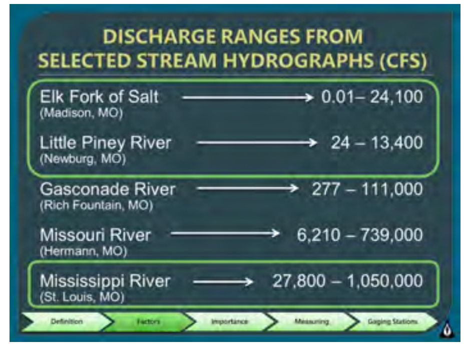
- ***Land Use:*** When vegetated areas and wetlands are converted to bare soil or impervious surfaces, the volume and rate of runoff and stream discharge dramatically increases during storm events. This leads to flashy streams.
- ***Channelization:*** The straightening of a stream channel and removal of woody debris results in increased water velocity and erosional force.
- ***Dams:*** These man-made (or beaver made) structures change the flow of water by slowing or detaining it. The release of water can fluctuate, dramatically altering the physical and chemical conditions both upstream and downstream of a dam.

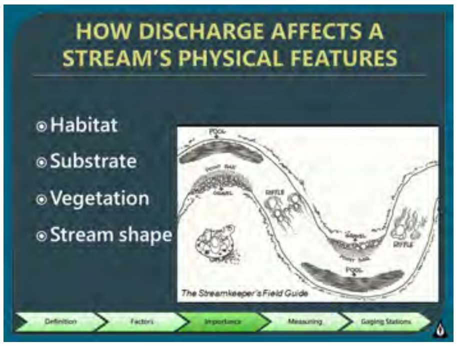
Stream Discharge Ranges of Missouri's Streams

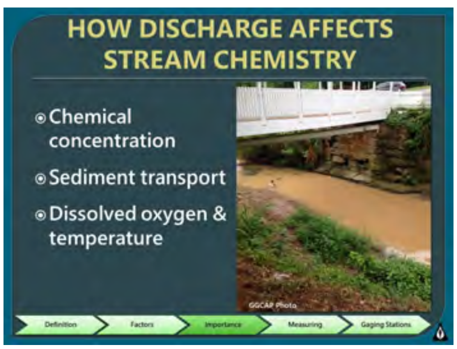
The table below describes the ranges of discharge of a few selected Missouri streams:

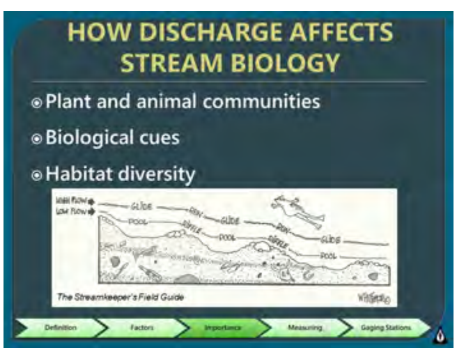
Stream	Range of Discharge (cfs)
Elk Fork of Salt River *Madison, MO*	0.01—24,100
Little Piney River *Newburg, MO*	24—13,400
Gasconade River *Rich Fountain, MO*	277—111,000
Missouri River *Herman, MO*	6,210—739,000
Mississippi River *St. Louis, MO*	27,800—1,050,000

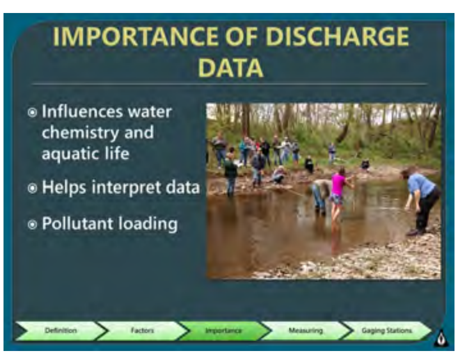
Notice how stream flow varies ***between*** streams and ***within*** them. The differences in discharge between these streams are mainly due to stream and watershed size. The range of flow within each stream can vary due to seasonality. Compare the Elk Fork of the Salt River with the Little Piney River. Both of these watersheds are approximately the same size but have very different flow ranges. The Elk Fork in Northern Missouri receives no groundwater recharge. Additionally, the land use around it is mostly agricultural, so runoff from cleared, non-forested land is higher and contributes to a higher stream discharge. The Little Piney is situated in a karst area and receives groundwater recharge from natural springs. The maximum discharge is lower in the Little Piney because it is located in a heavily forested watershed. This reduces overland flow to the river.











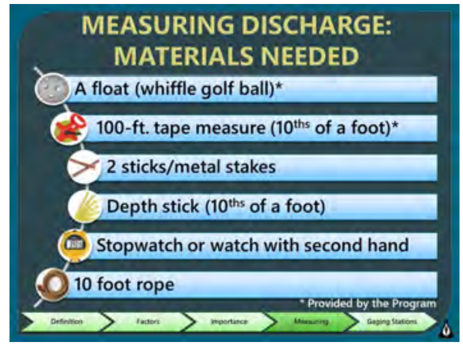
Stream Discharge and Stream Quality

Stream discharge has a large effect on the physical, chemical, and biological characteristics of a stream:

- ***Physical Features:*** The flow of water and other material changes the shape of the stream channel, the size of substrate in the streambed, and the types of riparian vegetation that are able to grow in or near the stream. These characteristics, in turn, influence the types of habitat available for aquatic life.
- As water moves substrate in the streambed, it erodes streambanks and deposits material downstream, shaping the stream channel. Variability in a stream's discharge influences the migration of the stream channel over time.
- ***Stream Chemistry:*** Stream discharge also affects water chemistry. The flow transports sediment and debris. A large volume of fast moving water carries more sediment and larger debris than a small volume of slow moving water. High volume flows have greater erosional energy, while smaller and slower flows allow sediment to be deposited. The concentration of chemicals and sediment is also affected. Larger volumes of water will dilute chemical and sediment pollutants. Stream discharge can also affect dissolved oxygen and water temperature. Fast moving water will tumble over substrate, introduce atmospheric oxygen into the water, and raise the dissolved oxygen of the water. Smaller volumes are influenced more by temperature. Streams with smaller volumes of slow-moving water warm up faster in the sun. Hot water holds less oxygen than cold water.
- ***Stream Biology:*** Stream discharge determines the types of habitat available for aquatic plants and animals. Streams with a variety of velocities can support a more diverse aquatic community. Additionally, fish like trout and salmon and pollution-sensitive macroinvertebrates require high concentrations of dissolved oxygen, low water temperatures, and gravel substrates to lay their eggs. Fish such as carp and catfish and pollution-tolerant macroinvertebrates can survive in warmer water and softer substrates. Variations in stream discharge also provide biological cues for aquatic life to complete their life cycles, including reproduction.

Because of its effect on water quality, stream discharge is an important characteristic of any stream. It influences water chemistry and aquatic life, helps us to interpret other kinds of data collected at the stream, and can aide in determining the severity and extent of a pollutant entering a stream. For these reasons, we encourage monitors to measure stream discharge every time they visit a stream to collect data!

Preparation for Measuring Discharge



In order to calculate stream discharge for your site, you will need to gather some materials:

- A Float (Wiffle Golf Ball)*
- 100-Foot Tape Measure (10ths of a Foot)*
- 2 Sticks or Metal Stakes
- Depth Stick, Marked in 10ths of a Foot
- Stopwatch or Watch with a Second Hand
- 10-Foot Rope
- Stream Discharge Data Sheet

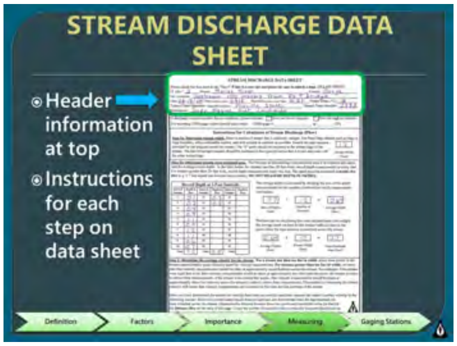
** Items Provided by Missouri Stream Team*

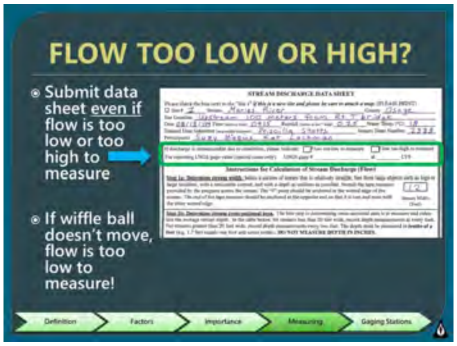
Select a safe and appropriate location within your stream site. Find a spot that is:

- Straight and free of obstacles like sandbars, large rocks or trees
- Has a noticeable current
- Has a uniform depth across the streambed, if possible

If you cannot find such a location in your 300-foot stream site, you can choose a location outside of your designated site in order to measure discharge. However, be sure there are no inputs or outputs such as tributaries or intake pipes between the site location and the discharge measurement location.

Stay safe! If the stream flow is high (over your knees), with a noticeable current, do not risk taking discharge measurements.





Stream Discharge Data Sheet

The ***Stream Discharge Data Sheet*** is a valuable tool when calculating stream discharge. Double check that you have filled out the header information accurately. Incorrect information in the header can delay processing for the data you collect.

Instructions for calculating stream discharge can be found on this form. Follow these instructions when measuring your stream's discharge.

STREAM DISCHARGE DATA SHEET

Please check the box next to the "Site #" ***if this is a new site and please be sure to attach a map.*** (PLEASE PRINT)

☐ Site # 2 Stream Maries River County Osage

Site Location Upstream 100 meters from Rt. T bridge

Date 08/13/04 Time (military time) 0915 Rainfall (inches in last 7 days) 0.25 Water Temp. (°C) 18

Trained Data Submitter (responsible volunteer) Priscilla Stotts Stream Team Number 2383

Participants Suzy Higgins, Kat Lackman

If discharge is unmeasurable due to conditions, please indicate: ☐ Flow too low to measure ☐ Flow too high to measure

For reporting USGS gage value (special cases only): USGS gage # ________ at ______ cfs

Instructions for Calculation of Stream Discharge (Flow)

Step 1a: Determine stream width. Select a section of stream that is relatively straight, free from large objects such as logs or large boulders, with a noticeable current, and with a depth as uniform as possible. Stretch the tape measure provided by the program across the stream. The "0" point should be anchored at the flowing edge of the stream. The end of the tape measure should be anchored at the opposite end so that it is taut and even with the other flowing edge. Do not measure nonflowing water.

Stream Width (Feet): 12

Step 1b: Determine stream cross-sectional area. The first step in determining cross-sectional area is to measure and calculate the average stream depth. In the table below, for streams less than 20 feet wide, record depth measurements at every foot. For streams greater than 20 feet wide, record depth measurements every two feet. The depth must be measured in **tenths of a foot** (e.g. 1.7 feet equals one foot and seven tenths). **DO NOT MEASURE DEPTH IN INCHES.**

Record Depth at 1-Foot Intervals

Interval Number	Depth in Feet	Interval Number	Depth in Feet	Interval Number	Depth in Feet
1	0.1	11	0.3	21	
2	0.2	12	0.2	22	
3	0.4	13		23	
4	0.9	14		24	
5	1.1	15		25	
6	0.9	16		26	
7	1.2	17		27	
8	1.1	18		28	
9	0.6	19		29	
10	0.7	20		30	
Sum	7.2	Sum	0.5	Sum	

The average depth is calculated by dividing the sum of the depth measurements by the number of intervals at which measurements were taken.

7.7 (Sum of Depths (feet)) ÷ 12 (Number of Intervals) = 0.64 (Average Depth (feet))

The final step in calculating the cross-sectional area is multiply the average depth (in feet) by the stream width (in feet) at the point where the tape measure is stretched across the stream.

0.64 (Average Depths (feet)) x 12 (Stream Width (feet)) = 7.7 (Cross Sectional Area (feet)²)

Step 2: Determine the average velocity for the stream. A minimum of four velocity measurements should be taken from equal intervals across the stream's width. For example, if the stream is eight feet wide, then velocity measurements should be taken at approximately every foot and a half across the stream in order to derive four measurements. For a stream width of 16 feet, velocity measurements should be taken at approximately three feet increments across the stream to derive four measurements. This method of measuring the stream velocity will ensure that velocity measurements are recorded for the slow and fast portions of the stream. For greater accuracy, more than four measurements are recommended for wider streams.

To measure the water's surface velocity, the first step is to select two points located equal distance upstream and downstream from the tape measure you have stretched across the stream. Determine the distance between these two points and record this value (in feet) in the **Distance Box** on the back of this page. A 10-foot total float distance is a recommended starting point. This distance can be lenghtened or shortened depending on stream swiftness. Count the number of seconds it takes a neutrally buoyant object (such as a wiffle practice golf ball) to float this distance. Record this time (in seconds) in the table on the back of this page for each float trial you complete.

Water Quality Volunteer

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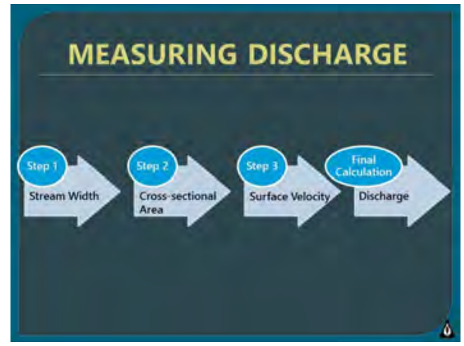
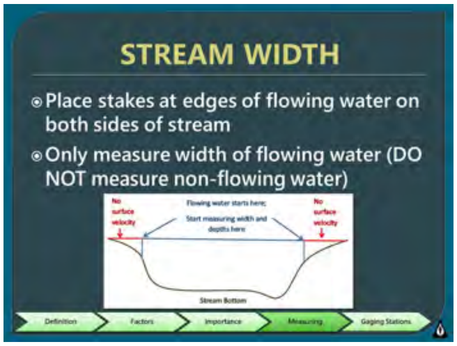
Please submit discharge data sheet even if the flow is too high or too low to measure. Use your wiffle golf balls to determine if the flow is too low to measure (i.e. if you drop the wiffle ball and it doesn't move, it's too low.) Just check the box at the top of the form and send it in to us!

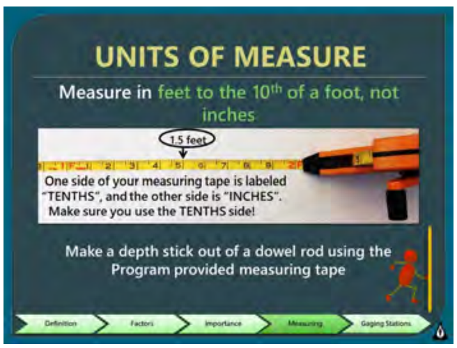
Measuring Stream Discharge

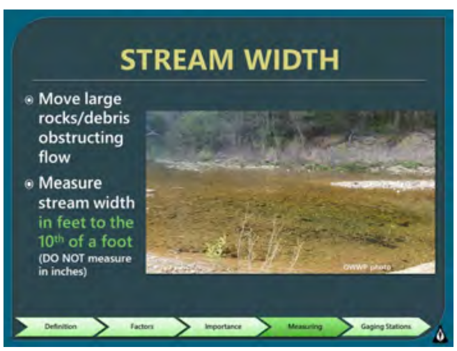
Stream discharge can be measured in just four basic steps:

1. Determine Stream Width
2. Determine Cross-Sectional Area
3. Measure Surface Velocity
4. Calculate Stream Discharge









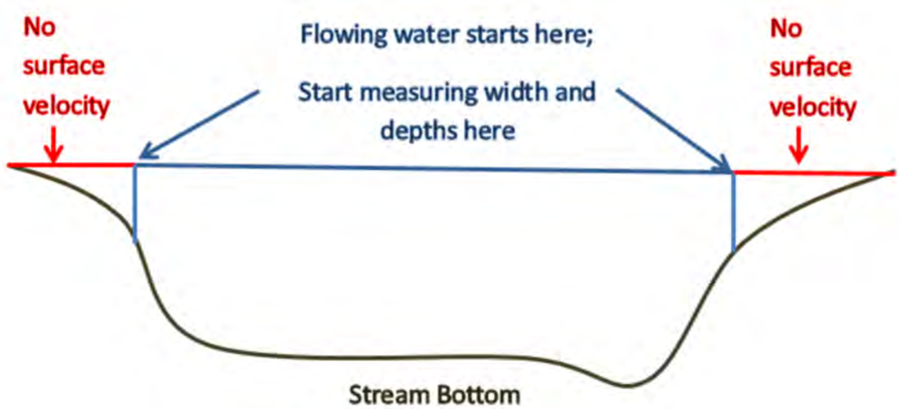
Stream Width

The first step in calculating discharge is to determine the width of your stream. To do this, place two stakes at the edges of the flowing water on each side of the stream. Stretch and anchor the tape measure between the stakes so that it is taut and perpendicular to the flow.

Sometimes, the flowing water is several inches from the edge of a streambank. Dead water, water that is not flowing, or eddies at the edge of a stream should not be counted when determining your stream width. Be sure to measure only where water is flowing. You may want to drop your wiffle ball on the water to determine if the water is flowing.

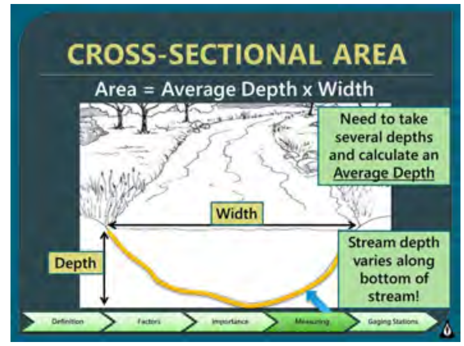
You should move obstacles obstructing the flow in your stream, if you are able. If you do, be sure to move them downstream from where you are taking your measurement.

Measure the stream width in feet to the 10th of a foot, not inches. To do this, be sure to use the correct side of your tape measure and record the width on the Stream Discharge Data Sheet.

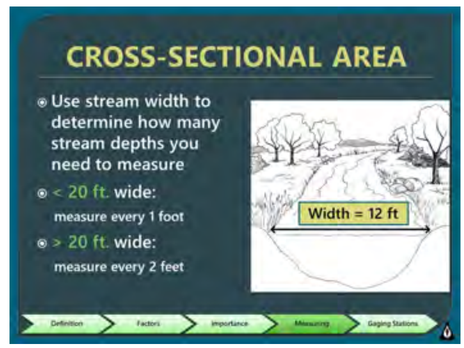


Cross-Sectional Area

The next step is to determine the cross-sectional area of your stream. To do this, the depth of the stream is multiplied by the width of the stream: ***Area = Depth X Width.*** Unfortunately, stream beds are not flat and even. The depth of a stream varies along the bottom; often being shallower at the edges and deeper in the middle. Consequently, you will take several depth readings across the stream and calculate an average depth in order to determine the cross-sectional area. Use the following guidelines to determine the number of depth readings needed.



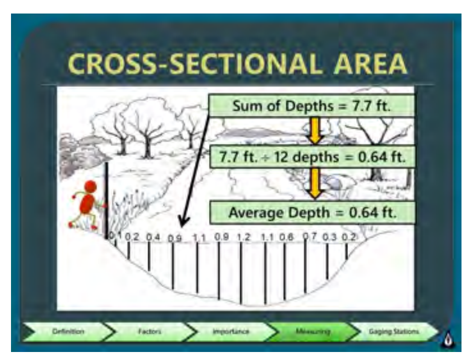
Stream Width	Depths Measurements
< 20 feet	Depth every 1 foot
20 feet to 60 feet	Depth every 2 feet
60 feet to 90 feet	Depth every 3 feet
> 90 feet	Depth every 4 feet

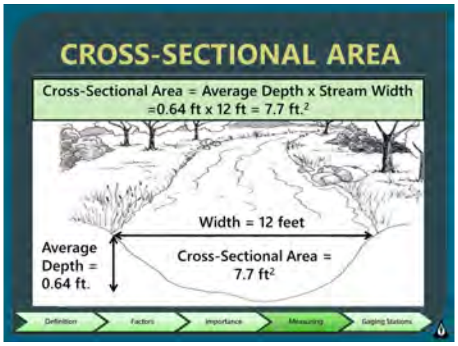


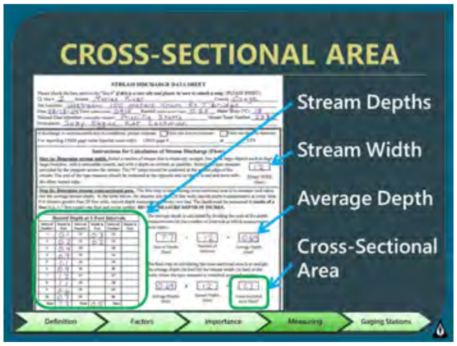
Stream depth is measured in feet to the 10th of a foot, not inches. Make a depth stick out of a dowel rod using the correct side (tenths) of the measuring tape provided.

When taking your depth readings, always stand downstream so your legs do not impede stream flow. With the tape measure still anchored to the stakes at the stream banks, measure the stream depth at the appropriate intervals across the transect. Do not measure on top of large rocks or other objects. You want to be sure you are measuring the stream bottom. Record each depth reading on the front of your Stream Discharge Data Sheet.

Once all measurements have been taken across your stream, add all the depths and record the ***Sum of Depths***. Divide the sum of depths by the number of depth intervals to determine your ***Average Depth.***

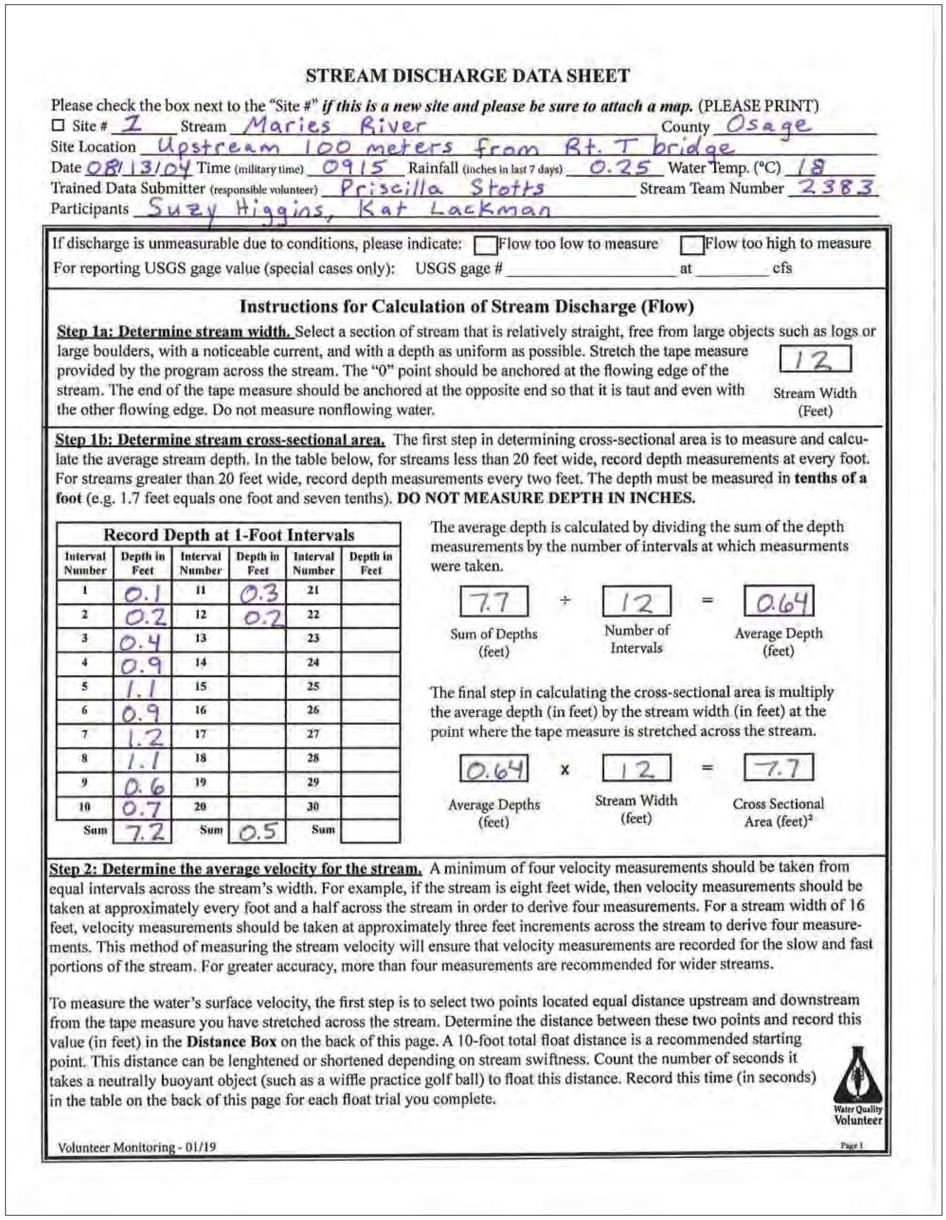






Cross-Sectional Area

Once you have determined the average depth, determining the cross-sectional area is easy. Simply multiply the average depth by the stream width to calculate the cross-sectional area. The following example shows how the cross sectional area is determined on the Stream Discharge Data Sheet.



STREAM DISCHARGE DATA SHEET

Please check the box next to the "Site #" *if this is a new site and please be sure to attach a map.* (PLEASE PRINT)

☐ Site # 2 Stream Maries River County Osage

Site Location Upstream 100 meters from Rt. T bridge

Date 08/13/04 Time (military time) 0915 Rainfall (inches in last 7 days) 0.25 Water Temp. (°C) 18

Trained Data Submitter (responsible volunteer) Priscilla Stotts Stream Team Number 2383

Participants Suzy Higgins, Kat Lackman

If discharge is unmeasurable due to conditions, please indicate: ☐ Flow too low to measure ☐ Flow too high to measure

For reporting USGS gage value (special cases only): USGS gage # ______ at ______ cfs

Instructions for Calculation of Stream Discharge (Flow)

Step 1a: Determine stream width. Select a section of stream that is relatively straight, free from large objects such as logs or large boulders, with a noticeable current, and with a depth as uniform as possible. Stretch the tape measure provided by the program across the stream. The "0" point should be anchored at the flowing edge of the stream. The end of the tape measure should be anchored at the opposite end so that it is taut and even with the other flowing edge. Do not measure nonflowing water.

12 Stream Width (Feet)

Step 1b: Determine stream cross-sectional area. The first step in determining cross-sectional area is to measure and calculate the average stream depth. In the table below, for streams less than 20 feet wide, record depth measurements at every foot. For streams greater than 20 feet wide, record depth measurements every two feet. The depth must be measured in **tenths of a foot** (e.g. 1.7 feet equals one foot and seven tenths). **DO NOT MEASURE DEPTH IN INCHES.**

Record Depth at 1-Foot Intervals

Interval Number	Depth in Feet	Interval Number	Depth in Feet	Interval Number	Depth in Feet
1	0.1	11	0.3	21	
2	0.2	12	0.2	22	
3	0.4	13		23	
4	0.9	14		24	
5	1.1	15		25	
6	0.9	16		26	
7	1.2	17		27	
8	1.1	18		28	
9	0.6	19		29	
10	0.7	20		30	
Sum	7.2	Sum	0.5	Sum	

The average depth is calculated by dividing the sum of the depth measurements by the number of intervals at which measurments were taken.

7.7 (Sum of Depths (feet)) ÷ 12 (Number of Intervals) = 0.64 (Average Depth (feet))

The final step in calculating the cross-sectional area is multiply the average depth (in feet) by the stream width (in feet) at the point where the tape measure is stretched across the stream.

0.64 (Average Depths (feet)) x 12 (Stream Width (feet)) = 7.7 (Cross Sectional Area (feet)²)

Step 2: Determine the average velocity for the stream. A minimum of four velocity measurements should be taken from equal intervals across the stream's width. For example, if the stream is eight feet wide, then velocity measurements should be taken at approximately every foot and a half across the stream in order to derive four measurements. For a stream width of 16 feet, velocity measurements should be taken at approximately three feet increments across the stream to derive four measurements. This method of measuring the stream velocity will ensure that velocity measurements are recorded for the slow and fast portions of the stream. For greater accuracy, more than four measurements are recommended for wider streams.

To measure the water's surface velocity, the first step is to select two points located equal distance upstream and downstream from the tape measure you have stretched across the stream. Determine the distance between these two points and record this value (in feet) in the **Distance Box** on the back of this page. A 10-foot total float distance is a recommended starting point. This distance can be lenghtened or shortened depending on stream swiftness. Count the number of seconds it takes a neutrally buoyant object (such as a wiffle practice golf ball) to float this distance. Record this time (in seconds) in the table on the back of this page for each float trial you complete.

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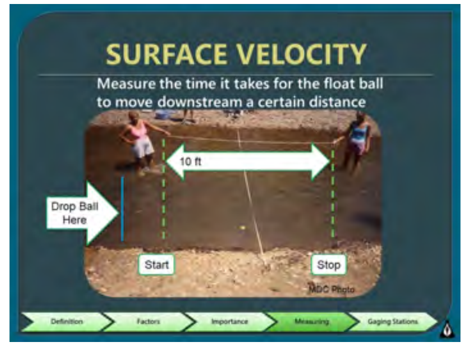
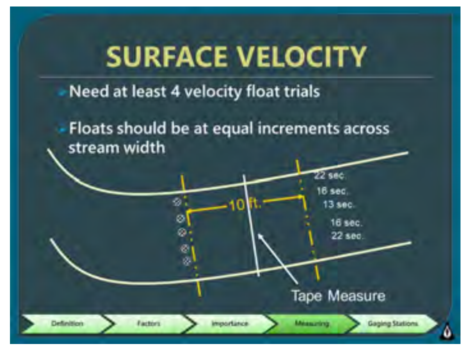
Surface Velocity



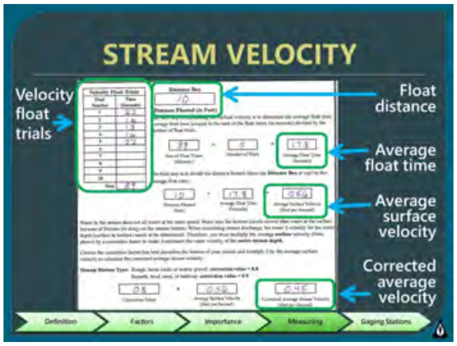


The third step of measuring stream discharge is to determine surface velocity. ***Velocity is expressed as a rate: distance per unit of time.*** To measure this, you will conduct a series of velocity float trials; measuring the time it takes for the wiffle ball to float downstream a certain distance.

A minimum of four velocity float trials are required. Since we will also be taking an average of the velocity float trials, the greater number of measurements, the more accurate the average float time velocity will be.

Use the following process to measure surface velocity:

1. Select two points located equal distance upstream and downstream from the tape measure you have stretched across the stream. The distance will depend on the swiftness of the stream, usually 10 feet. In faster water, you may want this distance to be greater, while shorter in slow water.
2. Record this distance in feet in the ***Distance Floated*** box on page 2 of the Stream Discharge Data Sheet.
3. Place stakes, large rocks, or distinct sticks on each side of the stream to mark the start and finish lines of the float distance.
4. Drop the wiffle golf ball upstream from the start point and record the time it takes to float from the start point to the finish point using a stop watch.
5. Record each float time in seconds in the "Velocity Float Trials" column on your data sheet. Float trials should be spaced at equal increments across the stream width if possible, so that your floats represent the different velocities across the entire stream.
6. Add all the float trials together and record the ***Sum of Float Trials***.
7. Divide this sum by the number of float trials to get an ***Average Float Time***.
8. Divide the ***Distance Floated*** (in feet), by the ***Average Float Time*** (in seconds, to get your ***Average Surface Velocity*** (in feet/seconds).
9. Multiply the ***Average Surface Velocity*** by a correction value to make it represent the water velocity of the entire stream depth. If the stream bottom has rough loose rocks or coarse gravel, the correction value you use is 0.8. If the stream bottom is smooth, muddy, or is bedrock, the correction value you use is 0.9. This will give you the ***Corrected Average Stream Velocity*** (in feet/second).



Surface Velocity

The following example shows how the surface velocity is determined on the Stream Discharge Data Sheet (page 2).

Velocity Float Trials

Trial Number	Time (seconds)
1	22
2	16
3	13
4	16
5	22
6	
7	
8	
9	
10	
Sum	89

Distance Box

10

Distance Floated (in feet)

The next step in calculating the surface velocity is to determine the average float time. Average float time is equal to the sum of the float times (in seconds) divided by the number of float trials.

Sum of Float Times (seconds)	÷	Number of Trials	=	Average Float Time (seconds)
89	÷	5	=	17.8

The final step is to divide the distance floated (from the **Distance Box** at top) by the average float time.

Distance Floated (feet)	÷	Average Float Time (seconds)	=	Average Surface Velocity (feet per second)
10	÷	17.8	=	0.56

Water in the stream does not all travel at the same speed. Water near the bottom travels slower than water at the surface because of friction (or drag) on the stream bottom. When calculating stream discharge, the water's velocity for the entire depth (surface to bottom) needs to be determined. Therefore, you must multiply the average **surface** velocity (from above) by a correction factor to make it represent the water velocity of the **entire stream depth.**

Choose the correction factor that best describes the bottom of your stream and multiply it by the average surface velocity to calculate the corrected average stream velocity.

Stream Bottom Type: Rough, loose rocks or coarse gravel: **correction value = 0.8**
Smooth, mud, sand, or bedrock: **correction value = 0.9**

Correction Value	x	Average Surface Velocity (feet per second)	=	Corrected Average Stream Velocity (feet per second)
0.8	x	0.56	=	0.45

Step 3: Calculate the stream discharge. Multiply the cross-sectional area (Feet)^2 from **Step 1** by the corrected average stream velocity (Feet/Second) from **Step 2.**

Cross-Sectional Area (feet)^2	x	Corrected Average Stream Velocity (feet per second)	=	Stream Discharge (feet)^3 per second or cubic feet per second (cfs)
7.7	x	0.45	=	3.47

Fish Present (Please Mark) **Yes** ✓ or **No** ☐

PLEASE KEEP A COPY AND SEND ORIGINAL DATA TO: VWQM Coordinator
Water Protection Program
Department of Natural Resources
PO Box 176
Jefferson City, MO 65102-0176

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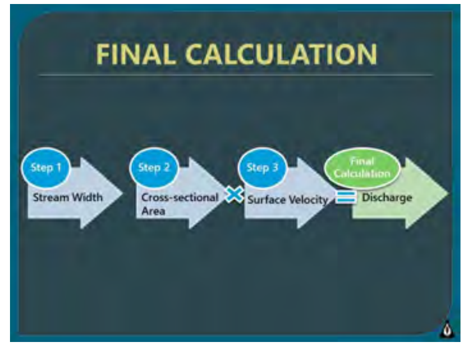
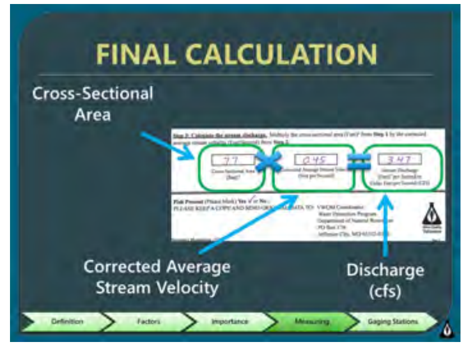
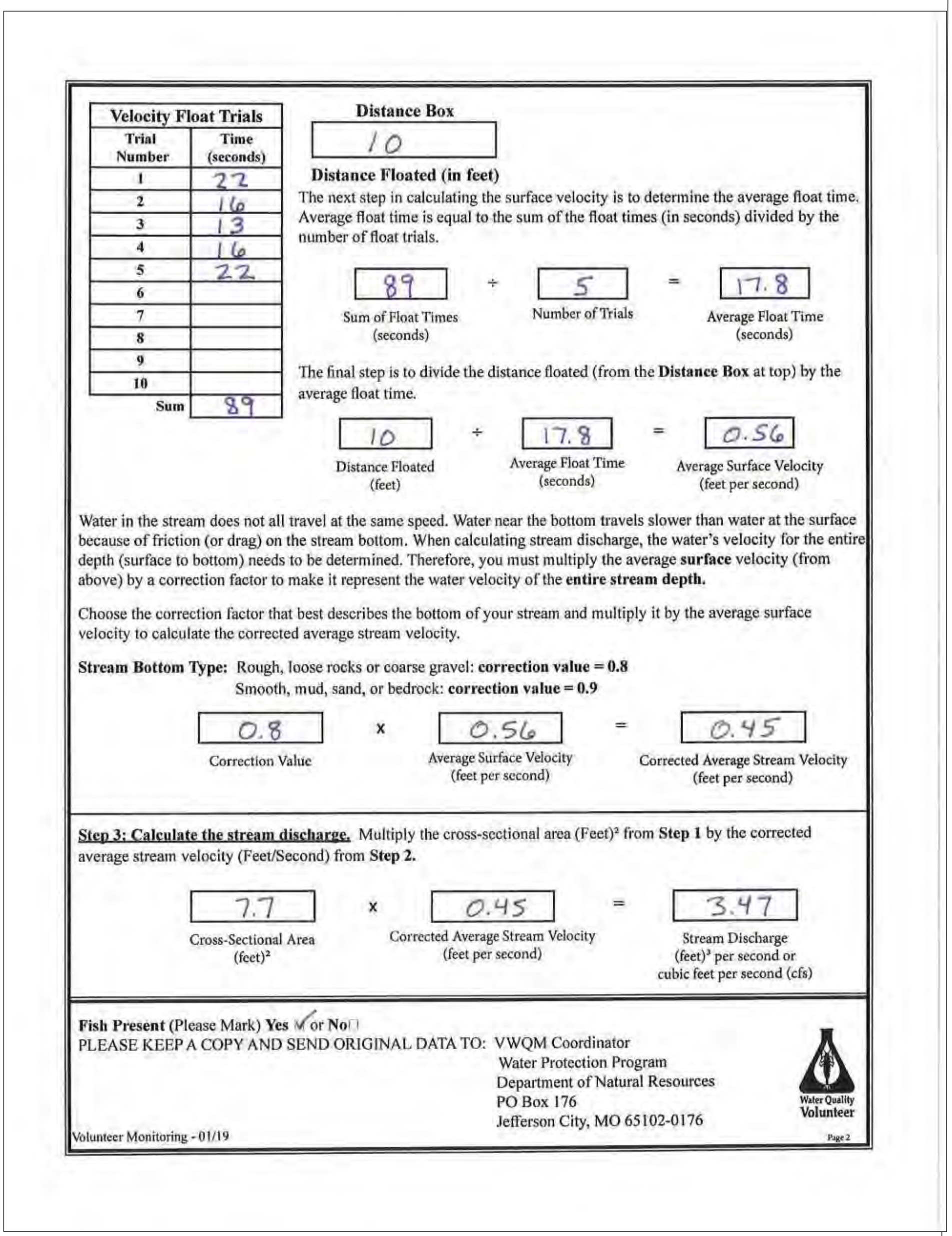
Calculate Stream Discharge





The final step is the easiest! Simply multiply the ***Cross-Sectional Area*** from the front of your Stream Discharge Data Sheet, by the ***Corrected Average Stream Velocity*** from the back of your data sheet, to arrive at the ***Stream Discharge*** in cubic feet per second (cfs). Below is an example of the final calculation on a data sheet:



Velocity Float Trials	
Trial Number	Time (seconds)
1	22
2	16
3	13
4	16
5	22
6	
7	
8	
9	
10	
Sum	89

Distance Box

10

Distance Floated (in feet)

The next step in calculating the surface velocity is to determine the average float time. Average float time is equal to the sum of the float times (in seconds) divided by the number of float trials.

89 ÷ 5 = 17.8

Sum of Float Times (seconds) ÷ Number of Trials = Average Float Time (seconds)

The final step is to divide the distance floated (from the **Distance Box** at top) by the average float time.

10 ÷ 17.8 = 0.56

Distance Floated (feet) ÷ Average Float Time (seconds) = Average Surface Velocity (feet per second)

Water in the stream does not all travel at the same speed. Water near the bottom travels slower than water at the surface because of friction (or drag) on the stream bottom. When calculating stream discharge, the water's velocity for the entire depth (surface to bottom) needs to be determined. Therefore, you must multiply the average **surface** velocity (from above) by a correction factor to make it represent the water velocity of the **entire stream depth.**

Choose the correction factor that best describes the bottom of your stream and multiply it by the average surface velocity to calculate the corrected average stream velocity.

Stream Bottom Type: Rough, loose rocks or coarse gravel: **correction value = 0.8**
Smooth, mud, sand, or bedrock: **correction value = 0.9**

0.8 x 0.56 = 0.45

Correction Value x Average Surface Velocity (feet per second) = Corrected Average Stream Velocity (feet per second)

Step 3: Calculate the stream discharge. Multiply the cross-sectional area (Feet)² from **Step 1** by the corrected average stream velocity (Feet/Second) from **Step 2.**

7.7 x 0.45 = 3.47

Cross-Sectional Area (feet)² x Corrected Average Stream Velocity (feet per second) = Stream Discharge (feet)³ per second or cubic feet per second (cfs)

Fish Present (Please Mark) **Yes** ✓ or **No** ☐

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Jefferson City, MO 65102-0176

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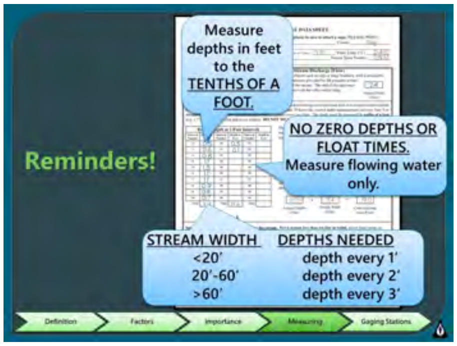
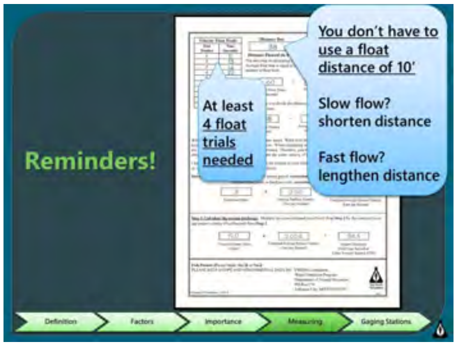
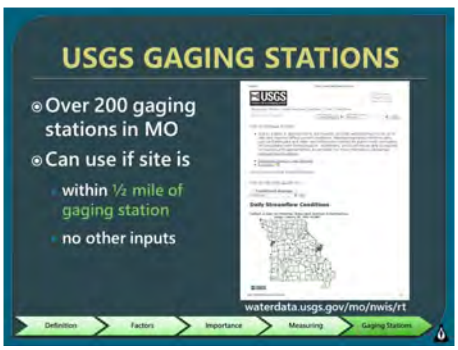
Page 2







A Few Reminders

- Measure depths of your stream in feet to the tenths of a foot.
- No zero depths or float times are permitted. Only measure flowing water.
- Double check to make sure you have recorded enough depths for your stream's width:

Stream Width	Depths Measurements
< 20 feet	Depth every 1 foot
20 feet to 60 feet	Depth every 2 feet
60 feet to 90 feet	Depth every 3 feet
> 90 feet	Depth every 4 feet

- Double check to make sure you have recorded enough float trials for your stream:

Minimum Number of Float Trials
4 Trials

- Your distance floated does not have to be 10 feet. However, remember to record whatever distance you decide to use.
- Submit data sheet, including header information, even if flow is too low or too high to measure.
- Read the directions on the data sheet to prevent errors in your calculations. You may want others to review your data sheet for accuracy.

USGS Gaging Stations

The United States Geological Survey maintains over 200 gaging stations on streams throughout Missouri. Many of these stations record stream discharge every day. Data is in real-time format and updated hourly. The site also includes an interactive map. You can use a gaging station for your stream discharge data if there is a station within a half mile of your site location AND there are no inputs or outputs between your site and the gaging station. Fill in the data sheet header and record the gage number and stream discharge at the time of sampling.

USGS website:

waterdata.usgs.gov/mo/nwis/rt

Practice Exercise

Stream Width	**Depth Measurement Intervals**
< 20 ft.	every 1 ft.
20 - 60 ft.	every 2 ft.
> 60 ft.	every 3 ft.

1. For a stream width of **29.60 ft.**, *stream depth* should be measured every ______ ft.
2. How many *depth measurements* should be recorded? _______
3. How many *velocity float trials* should be recorded? _______
4. Use the values given below to calculate stream discharge.

Record Depth at 1-Foot Intervals

Interval Number	Depth in Feet	Interval Number	Depth in Feet	Interval Number	Depth in Feet
1	0.3	11	1.0	21	
2	0.6	12	1.0	22	
3	0.7	13	0.8	23	
4	0.9	14	0.5	24	
5	1.1	15	0.1	25	
6	1.2	16		26	
7	1.2	17		27	
8	1.2	18		28	
9	1.2	19		29	
10	1.1	20		30	
Sum		Sum		Sum	

Velocity Float Trials

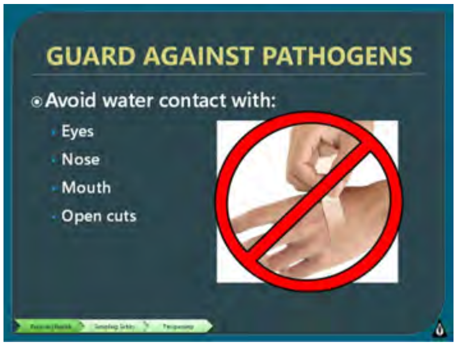
Trial Number	Time (Seconds)
1	15.09
2	13.40
3	14.37
4	11.56
5	
6	
7	
8	
9	
10	
Sum	

Sum of Depths (feet)	÷	15 Number of Intervals	=	Average Depth (feet)
Average Depth (feet)	×	29.60 Stream Width (feet)	=	Cross Sectional Area (feet)^2
Sum of Float Times (seconds)	÷	4 Number of Trials	=	Average Float Time (seconds)
10 Distance Floated (feet)	÷	Average Float Time (seconds)	=	Average Surface Velocity (ft/sec)
0.8 Correction Value	×	Average Surface Velocity (ft/sec)	=	Corrected Avg Stream Velocity (ft/sec)
Cross Sectional Area (feet)^2	×	Corrected Avg Stream Velocity (ft/sec)	=	Stream Discharge (cubic feet/second, cfs)

Chapter 5
Safety and Trespass

Your safety is important. In this chapter, you will learn how to keep yourself healthy and safe when monitoring a stream site. Specifically, you will explore safety responsibilities in three main areas:

- Precautions for your personal health
- Sampling safety protocol
- Trespassing



Personal Health

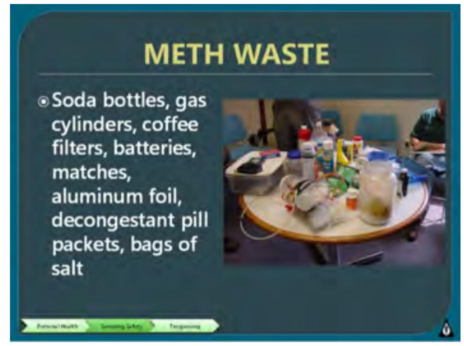
Keeping you healthy and safe as you monitor a stream begins by taking the right precautions:

- ***Immunizations:*** Before monitoring your stream, check with your doctor or county health department to ensure you are up to date with the appropriate immunizations.
- ***Foot Protection:*** Always wear some type of foot protection. Never go bare foot or wear sandals in a stream. Water boots or old tennis shoes provide good protection from sharp objects in a stream bed.
- ***Life Jacket:*** Always wear a life jacket when the depth of the stream is unknown.
- ***Bug Repellent:*** Use a bug repellent to avoid bites that may lead to serious illness.
- ***Guard Against Pathogens:*** Avoid water contact with your eyes, nose, mouth, or open wounds. Be sure to wash your hands thoroughly with soap and warm water before rubbing your eyes or bringing your hands to your mouth.

Sampling Safety

Pay close attention to your surroundings as you monitor your streams.

- ***Methamphetamine Waste:*** Volunteers may encounter common household objects in the woods that are actually methamphetamine waste. If you find soda bottles, gas cylinders, coffee filters, batteries, matches, aluminum foil, decongestant pill packets, or bags of salt, ***do not touch or remove.*** Instead, document the location and report the waste to your local sheriff, police, or conservation agent.



Sampling Safety

Pay close attention to your surroundings as you monitor your streams.

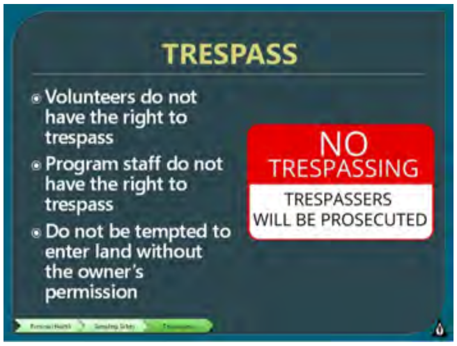
- ***Hazardous Waste Drums:*** Volunteers may encounter chemical storage drums while in the field. ***Do not open, move, or relocate a drum until it is verified by authorities not to contain hazardous waste.*** If a volunteer removes a drum from a site, they now assume all responsibility for the drum and its contents, including fees for disposal and environmental risks. This may also interfere with any investigation to hold the appropriate parties accountable. Instead follow the procedures outlined below:

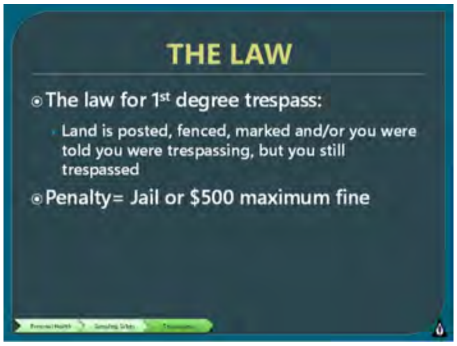
    1. Visually check to see if the drum is leaking, seeping gaseous fumes, or bulging.
    2. Look for a label. Labels should list the manufacturer, contents, hazards and other important information about the drum's contents. If a label is not present, assume it is hazardous.
    3. Take photographs of the drum and label.
    4. Mark the area with a bright flag and a "Do Not Disturb" sign.
    5. ***Contact the 24 hour Environmental Emergency Response hotline at 573-634-2436.***

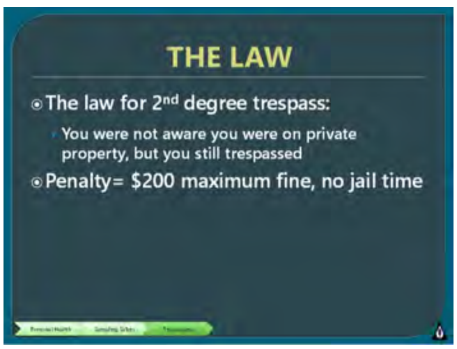
Sampling Safety

Think safety when monitoring your stream site:

- Use common sense and maintain awareness of your surroundings and potential dangers.
- Never put yourself or anyone else in jeopardy with a potential safety threat.
- Never enter a stream when the current is swift and the depth of water is above your knees. The force from a strong current can easily cause you to lose your balance.
- Use the buddy system. Tell someone where you are sampling and when you are expected to return.







Trespassing

Trespassing is against the law and can be dangerous. Stream Team volunteers and program staff do not have the right to trespass on private land. Although it can be tempting, never enter onto land without the owner's permission.

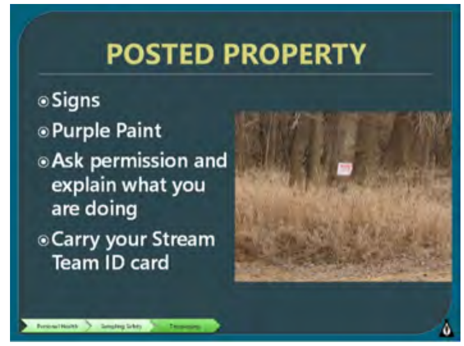
- ***First–degree trespass (RSMo569.140)*** states that a person commits the crime of trespass in the first degree if he or she knowingly enters and remains unlawfully in a building or upon real property. The property must be fenced or enclosed in a manner designed to exclude intruders and notice of trespass is given either by actual communication or by post. The penalty for first-degree trespass is jail or $500.00 maximum.
- ***Second-degree trespass (RSMo 569.150)*** occurs when a person unknowingly enters unlawfully upon real property of another. In this instance, land does not need to be fenced, nor does the property owner need to post a *No Trespassing* sign. The penalty for second-degree trespass is a $200.00 maximum fine, but no jail.

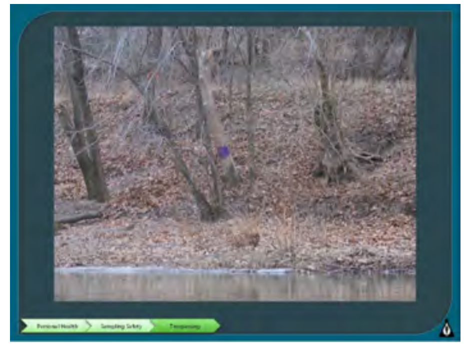
Posted Property

Property owners can protect their land from trespassers in a number of different ways. The most common method is with posted signs. Volunteers should heed any signs such as *No Trespassing, No Hunting, Posted, or Keep Out.*

Additionally, the Purple Paint Statue (RSMo 569.145) specifies how purple paint can be used by landowners to protect their property from trespassers. Even though the law specifies the use of purple paint on a post cap or a vertical line on a tree, volunteers should look for any purple postings such as bandanas, flags, etc. Assume when you see purple, it means keep out!

Acquire landowner permission before you monitor. Explain your objectives and ask them for permission to be on their property. You should do the same when monitoring a stream in a public park or any state land by seeking permission from the appropriate authorities. When seeking permission, you may find it helpful to show your Stream Team Identification Card to landowners.





How to Find Property Owners

If you are unsure who owns the land, you can easily contact your local County Assessor. They will have a collection of plat maps showing ownership of parcels of land. Some counties even have interactive GIS mapping software online. A list of county assessors can be found at:

www.moassessorsassn.org/assessors.htm

Landowner Permission

Stream Team volunteers can use the ***Streamside Landowner Permission brochure*** when visiting with property owners. The brochure explains the purpose of the Stream Team and includes a permission slip for landowners to complete.

Citizens caring for Missouri streams

Landowner: please keep this portion for your records.

Dear Streamside Property Owner,

As a volunteer member of the Missouri Stream Team Program, I am seeking permission to enter the stream on your property to perform stewardship activities in hopes of improving the health of the stream. The Missouri Stream Team Program is a grass-roots citizen effort to protect Missouri streams by conducting activities such as litter pickups, tree planting, water quality monitoring, storm drain stenciling, and many others.

With your permission, I plan to perform (check all that apply):

- ❐ Litter Pickup
- ❐ Water Quality Monitoring
- ❐ Tree Planting
- ❐ Storm Drain Stenciling
- ❐ Invasive Species Monitoring/Removal
- ❐ Photo Point Monitoring
- ❐ Other ______________

I respectfully ask for your permission to access the creek through your property. My access will be during daylight hours only. If necessary, access may be limited to times of your choosing. I fully understand that trash disposal is my responsibility, and I promise to be respectful of your property rights. I also understand that as the property owner, you may revoke permission at any time for any reason.

I will share with you the results of our activities (water quality data, trash collected, etc.) after our work is completed. This information is also shared with the Missouri Departments of Conservation and Natural Resources as part of the reporting requirements of the Program.

If this is acceptable, please provide your contact information on the Landowner Permission Slip at right. Thank you for your support of the Missouri Stream Team Program.

Sincerely,

Volunteer Name ______________ Stream Team Number ______________

Address ______________ Phone (______) ______-______

City, State, Zip ______________ Email ______________

Stream Team 3117 "The Litter Gitter Ridders"

Stream Team 4502 "Newburg Children's Museum"

Landowner Permission Slip

Stream Team member: please keep this portion.

I, as property owner, permit Missouri Stream Team (Number/Name) ______________

to access the stream adjoining my property for the purpose of:

- ❐ Litter Pickup
- ❐ Water Quality Monitoring
- ❐ Tree Planting
- ❐ Storm Drain Stenciling
- ❐ Invasive Species Monitoring/Removal
- ❐ Photo Point Monitoring
- ❐ Other ______________

and with the following conditions as applicable.

____

I also reserve the right to revoke permission at any time for any reason.

Landowner Name ______________

Date ______________

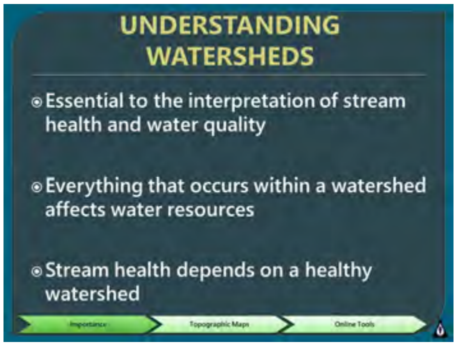
Phone ______________

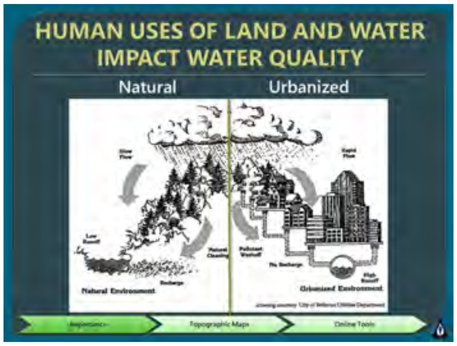
Email ______________

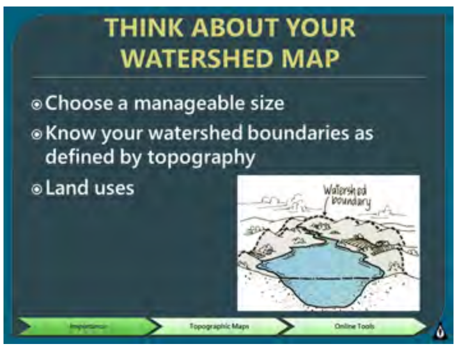
Chapter 6
Mapping and Online Tools

The stream site you monitor is just part of a much larger system. When analyzing stream health, it is important to take a holistic view by considering the entire watershed. This chapter will introduce you to:

- The importance of watershed mapping
- How to interpret topographic maps
- Utilizing online tools







Importance of Watersheds

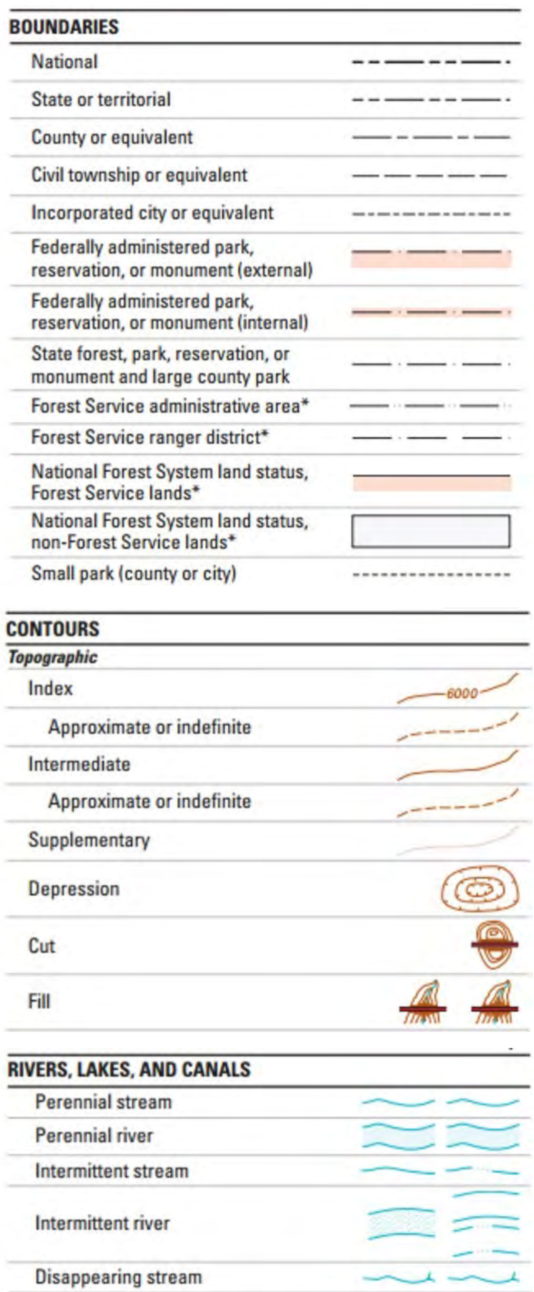
Knowing the boundaries of the watershed in which your stream site is located allows you to see the big picture when analyzing the health or impairment of a stream. Everything that occurs within a watershed affects the water resources in it. A healthy stream is a good indicator of a healthy watershed.

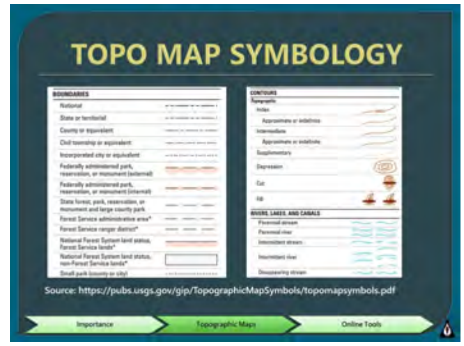
For example, consider the differences between natural and urbanized environments. Natural environments have a slower rate of overland flow due to plants, trees, and vegetation. This allows for the filtering of water before it enters a stream and a greater recharge of groundwater. Urbanized environments with concrete and other infrastructure has rapid overland flow. This results in higher runoff, no filtering and little or no groundwater recharge.

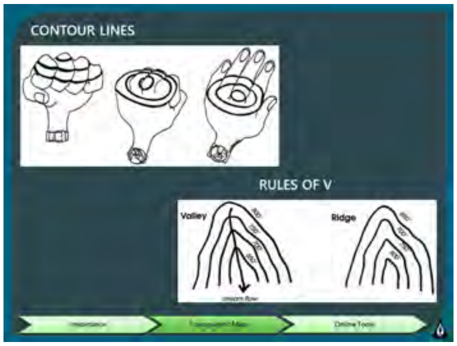
Mapping the watershed of your stream site has many benefits. It can help identify sources of pollution, aid in locating optimal monitoring sites, provide information to educate your local community leaders, and provide a sense of value. If your site is located in a large watershed, you may want to consider mapping a limited portion of it so it is more manageable. Once mapped, you can identify how the land within its boundaries is used and how this will affect your sampling results.

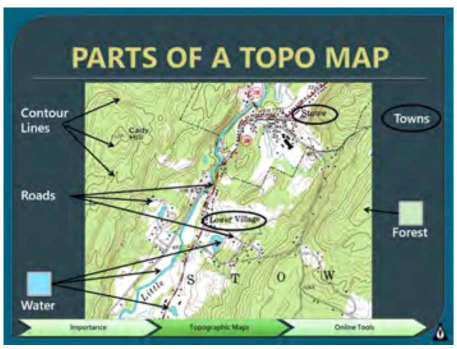
Topographic Maps

Because a watershed is defined by the topography of the land, a topographic map will be your best resource in defining the watershed for your stream site. Topographic maps represent a specific area of land or quadrangle; a four-sided region bounded by a particular latitude and longitude. These maps use contour lines to show the shape of the earth's surface. The contour lines make it possible to show the elevation and shape of mountains, hills, and the steepness of slopes. Maps are drawn to a scale that represent distance. This is a ratio comparing a measurement on the map to the distance you would find in real life between two points. Topographical maps will also use symbols to show boundaries, surface features, building, roads, railroads, and communication features. The following symbols are often used on a topographical map:



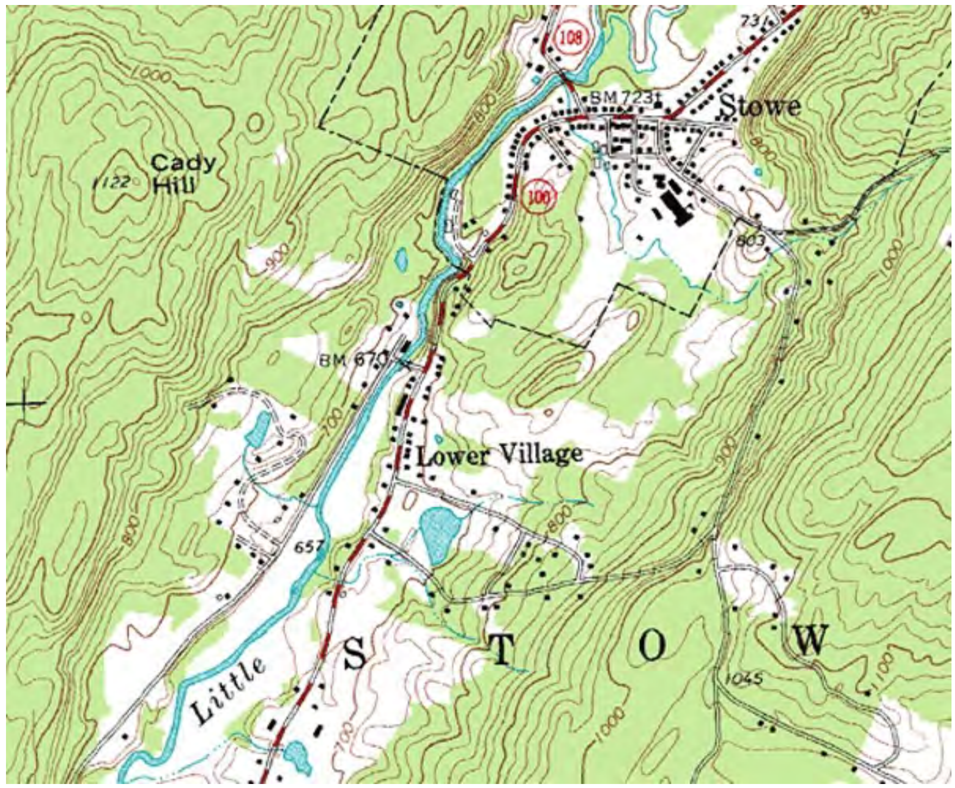




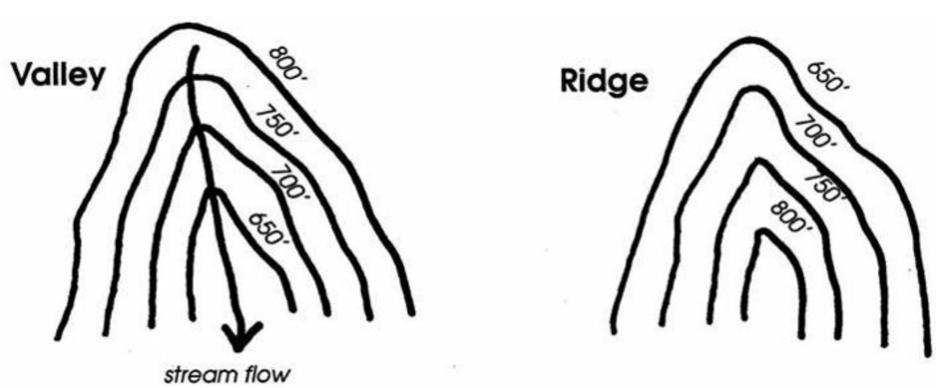


Parts of Topographic Maps

The most striking feature of a topographic map is the contour lines. These lines show the elevation of the earth's surface. Notice that these lines will never cross on a map. Some contour lines are marked with a specific elevation. You can determine the elevation of the unmarked intermediate contour lines by using the contour interval printed in the margin of a map. When contour lines are close together, it indicates steep terrain. When these lines are drawn further apart, there is a more gentle slope to the terrain.

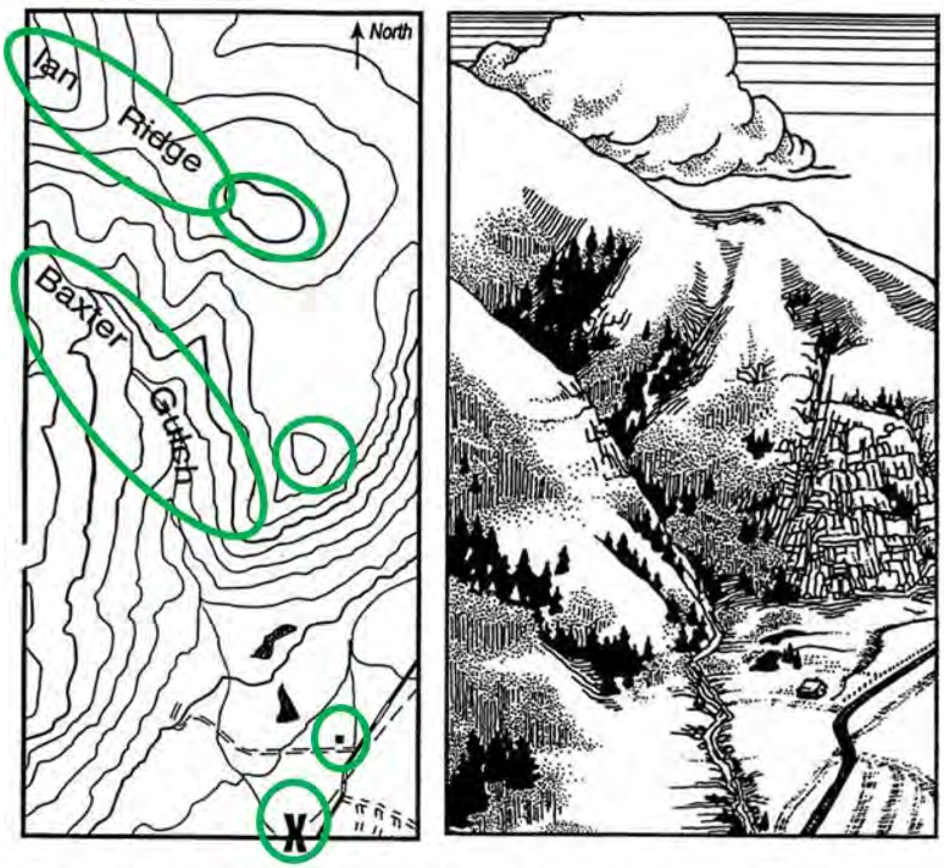


The Rule of the V: When contour lines cross a river or stream, they form a "V" shape that always points upstream. This helps you determine the direction of flow in a stream. The Rule of the V's also applies to ridges. The top of a ridge is shown as an enclosed shape, like an irregular oval. As contour lines extend out from the ridge, they often form rows of parallel "V's" that point downhill towards lower elevations. Other features like forests, water features, town, and roads are depicted on topographic maps.

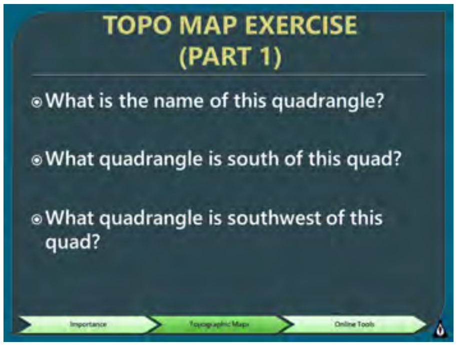


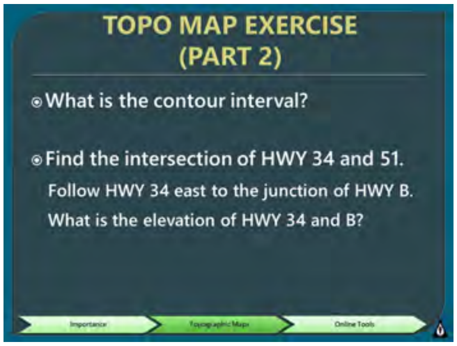
Translating Topographic Maps

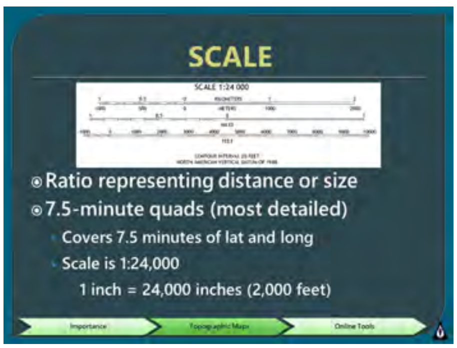
It is sometimes difficult to translate the contour lines on a two dimensional map to what a specific landscape might look like in three dimensions. The illustration below might help. Imagine you are standing where the X is marked on the topographical map on the left and looking north. The picture on the right demonstrates the landscape you would see.

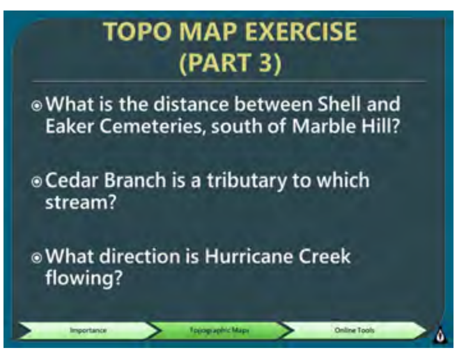


Standing at the "X" on the topo map (above left), someone looking north would see the scene depicted above, right, including the secondary highway, streams, house, unfinished roads, ponds, and mountain ridges.









Topographic Map Exercise

Using the map and materials provided to you, answer the following questions and complete the activity:

Part 1:

1. What is the name of this quadrangle?
2. What quadrangle is south of this quad?
3. What quadrangle is southwest of this quad?

Part 2:

1. What is the contour interval?
2. Find the intersection of HWY 34 and 51. Follow HWY 34 east to the junction of HWY B. What is the elevation of HWY 34 and B?

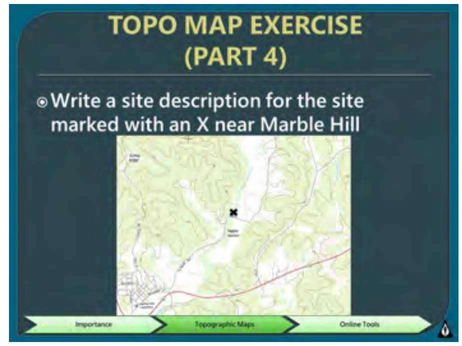
Part 3:

1. What is the distance between Shell and Eaker Cemeteries, south of Marble Hill?
2. Cedar Branch is a tributary to which stream?
3. What direction is Hurricane Creek flowing?

Topographic Map Exercise

Part 4:

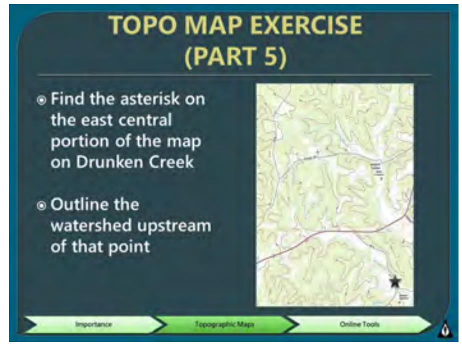
Write a site description for the site marked with an X near Marble Hill.



Part 5:

Delineate the watershed for the given monitoring point.

1. Find the asterisk on the east central portion of the map on Drunken Creek to identify the most downstream point of the watershed to map. This is the monitoring point.
2. Trace the stream and tributaries in blue upstream from the monitoring.
3. Mark ridge tops with an X.
4. Connect the Xs following the contour lines.



Watershed Mapping Tools

Tools to help delineate watersheds are constantly being updated and improved online. A couple resources that monitors may find helpful are:

- Model My Watershed

  modelmywatershed.org/

- EPA WATERS GeoViewer

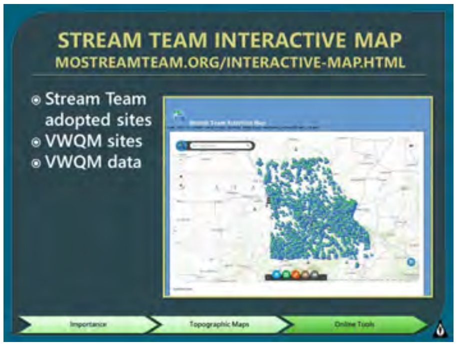
  epa.gov/waterdata/waters-geoviewer

Online Tools

There are many resources and tools online to aid you in your monitoring efforts:

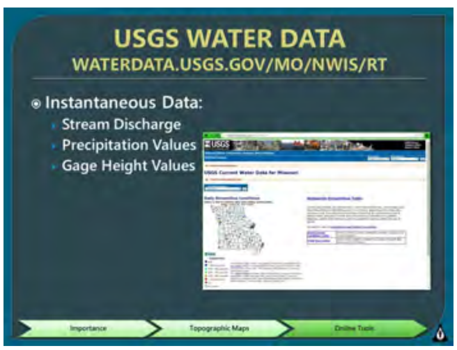
Stream Team Website
mostreamteam.org

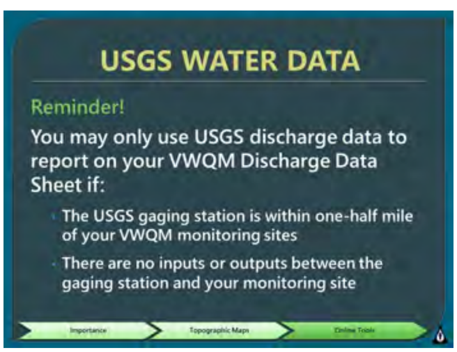
The Missouri Stream Team website has many resources available for you. Under the ***Forms*** tab, you can submit activity reports, request equipment, and add new members to your Stream Team. The ***Water Quality*** tab has many of the documents and resources you have covered in this workshop, helpful tips for monitoring, and information on future workshops. The ***Calendar*** keeps you informed of the many events taking place around the state. You can even post your own events to this calendar.



Stream Team Interactive Map
mostreamteam.org/interactive-map.html

This map can be used to find Stream Team adopted sites and corresponding VWQM data. If you use this map to find a site, note that not all locations are currently adopted or monitored. If you see a VWQM icon at the site you want to monitor, contact Stream Team staff to see if it is currently being monitored.





United States Geological Survey Water Data
waterdata.usgs.gov/mo/nwis/rt

This site offers water data online, including stream discharge and precipitation. This is an excellent tool to evaluate general stream conditions before you monitor your site. For instance, you may want to know if recent flood waters have receded or if stream discharge has increased with a recent snow melt. ***Remember, you may only use USGS stream discharge data if the USGS gage station is within one-half mile of your monitoring site and there are no inputs or outputs between the gaging station and your monitoring site.***

STREAM DISCHARGE DATA SHEET

Please check the box next to the "Site #" ***if this is a new site and please be sure to attach a map.*** (PLEASE PRINT)

☐ Site # ________ Stream ____ County ________________

Site Location ____

Date ____/____/____ Time (military time) ____________ Rainfall (inches in last 7 days) ____________ Water Temp. (°C) __________

Trained Data Submitter (responsible volunteer) ________________________________ Stream Team Number __________

Participants ____

If discharge is unmeasurable due to conditions, please indicate: ☐ Flow too low to measure ☐ Flow too high to measure

For reporting USGS gage value (special cases only): USGS gage # ____________________ at _________ cfs

Instructions for Calculation of Stream Discharge (Flow)

Step 1a: Determine stream width. Select a section of stream that is relatively straight, free from large objects such as logs or large boulders, with a noticeable current, and with a depth as uniform as possible. Stretch the tape measure provided by the program across the stream. The "0" point should be anchored at the flowing edge of the stream. The end of the tape measure should be anchored at the opposite end so that it is taut and even with the other flowing edge. Do not measure nonflowing water.

☐ Stream Width (Feet)

Step 1b: Determine stream cross-sectional area. The first step in determining cross-sectional area is to measure and calculate the average stream depth. In the table below, for streams less than 20 feet wide, record depth measurements at every foot. For streams greater than 20 feet wide, record depth measurements every two feet. The depth must be measured in **tenths of a foot** (e.g. 1.7 feet equals one foot and seven tenths). **DO NOT MEASURE DEPTH IN INCHES.**

Record Depth at 1-Foot Intervals

Interval Number	Depth in Feet	Interval Number	Depth in Feet	Interval Number	Depth in Feet
1		11		21	
2		12		22	
3		13		23	
4		14		24	
5		15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	
Sum		Sum		Sum	

The average depth is calculated by dividing the sum of the depth measurements by the number of intervals at which measurments were taken.

☐ ÷ ☐ = ☐

Sum of Depths (feet) | Number of Intervals | Average Depth (feet)

The final step in calculating the cross-sectional area is multiply the average depth (in feet) by the stream width (in feet) at the point where the tape measure is stretched across the stream.

☐ x ☐ = ☐

Average Depths (feet) | Stream Width (feet) | Cross Sectional Area $(feet)^2$

Step 2: Determine the average velocity for the stream. A minimum of four velocity measurements should be taken from equal intervals across the stream's width. For example, if the stream is eight feet wide, then velocity measurements should be taken at approximately every foot and a half across the stream in order to derive four measurements. For a stream width of 16 feet, velocity measurements should be taken at approximately three feet increments across the stream to derive four measurements. This method of measuring the stream velocity will ensure that velocity measurements are recorded for the slow and fast portions of the stream. For greater accuracy, more than four measurements are recommended for wider streams.

To measure the water's surface velocity, the first step is to select two points located equal distance upstream and downstream from the tape measure you have stretched across the stream. Determine the distance between these two points and record this value (in feet) in the **Distance Box** on the back of this page. A 10-foot total float distance is a recommended starting point. This distance can be lenghtened or shortened depending on stream swiftness. Count the number of seconds it takes a neutrally buoyant object (such as a wiffle practice golf ball) to float this distance. Record this time (in seconds) in the table on the back of this page for each float trial you complete.

Water Quality Volunteer

Velocity Float Trials	
Trial Number	**Time (seconds)**
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Sum	

Distance Box

[ ]

Distance Floated (in feet)

The next step in calculating the surface velocity is to determine the average float time. Average float time is equal to the sum of the float times (in seconds) divided by the number of float trials.

[ ]	÷	[ ]	=	[ ]
Sum of Float Times (seconds)		Number of Trials		Average Float Time (seconds)

The final step is to divide the distance floated (from the **Distance Box** at top) by the average float time.

[ ]	÷	[ ]	=	[ ]
Distance Floated (feet)		Average Float Time (seconds)		Average Surface Velocity (feet per second)

Water in the stream does not all travel at the same speed. Water near the bottom travels slower than water at the surface because of friction (or drag) on the stream bottom. When calculating stream discharge, the water's velocity for the entire depth (surface to bottom) needs to be determined. Therefore, you must multiply the average **surface** velocity (from above) by a correction factor to make it represent the water velocity of the **entire stream depth.**

Choose the correction factor that best describes the bottom of your stream and multiply it by the average surface velocity to calculate the corrected average stream velocity.

Stream Bottom Type: Rough, loose rocks or coarse gravel: **correction value = 0.8**
Smooth, mud, sand, or bedrock: **correction value = 0.9**

[ ]	x	[ ]	=	[ ]
Correction Value		Average Surface Velocity (feet per second)		Corrected Average Stream Velocity (feet per second)

<u>Step 3: Calculate the stream discharge.</u> Multiply the cross-sectional area (Feet)^2 from **Step 1** by the corrected average stream velocity (Feet/Second) from **Step 2.**

[ ]	x	[ ]	=	[ ]
Cross-Sectional Area (feet)^2		Corrected Average Stream Velocity (feet per second)		Stream Discharge (feet)^3 per second or cubic feet per second (cfs)

Fish Present (Please Mark) **Yes** ☐ or **No**☐

PLEASE KEEP A COPY AND SEND ORIGINAL DATA TO: VWQM Coordinator
Water Protection Program
Department of Natural Resources
PO Box 176
Jefferson City, MO 65102-0176

MACROINVERTEBRATE DATA SHEET

Please check the box next to the "Site #" ***if this is a new site and please be sure to attach a map.*** (PLEASE PRINT)

☐ Site # ________ Stream ________________________________ County ______________

Site Location ____

Date ____/____/____ Time (military time) __________ Rainfall (inches in last 7 days) __________ Water Temp. (°C) ________

Trained Data Submitter (responsible volunteer) ______________________________ Stream Team Number __________

Participants ____

Invertebrate Type	***Net Set #1***	***Net Set #2***	***Net Set #3***	***Score***
Habitat type →				*After entering the **number(#) of organisms collected**, circle the number below for every type of organism collected. Add the numbers circled and record the totals as your Water Quality Rating.*
Net Type *(circle type)* →	*Kick Net* **or** *D-Net*	*Kick Net* **or** *D-Net*	*Kick Net* **or** *D-Net*	
Time Spent Picking (Minutes picking x number of people picking)	min. picking _____ × # people _____ = total min. _____	min. picking _____ × # people _____ = total min. _____	min. picking _____ × # people _____ = total min. _____	
Sensitive	**# of Organisms**	**# of Organisms**	**# of Organisms**	**Circle Types Present**
Caddisfly Larvae				3
Hellgrammites				3
Mayfly Nymphs				3
Gilled Snails (right)				3
Riffle Beetles				3
Stonefly Nymphs				3
Water Penny Larvae				3
Somewhat Tolerant	**# of Organisms**	**# of Organisms**	**# of Organisms**	**Circle Types Present**
Other Beetle Larvae				2
Clams/Mussels				2
Crane Fly Larvae				2
Crayfish				2
Dragonfly Nymphs				2
Damselfly Nymphs				2
Scuds				2
Sowbugs				2
Fishfly Larvae				2
Alderfly Larvae				2
Watersnipe Fly				2
Tolerant	**# of Organisms**	**# of Organisms**	**# of Organisms**	**Circle Types Present**
Aquatic Worms				1
Black Fly Larvae				1
Leeches				1
Midge Larvae				1
Pouch Snails (left)				1
Other Snails (flat)				1
< 12 = Poor	12-17 = Fair	18-23 = Good	>23 = Excellent	**Water Quality Rating** ____

Comments (mention any changes from your usual readings) ________________________________

____

____

Fish Present (Please Mark) **Yes**❑ or **No**❑

Instructions for Biological Monitoring

- Collect three net sets of invertebrates from three different microhabitats. This ensures a more complete picture of what lives in your stream and more accurately reflects health. Adequate sampling requires two people and the use of a kick net. If sampling by yourself, a D-frame net may be needed.
- If possible, take all three net sets from different areas within a stable riffle. Microhabitats to sample include differences in: rock size, flow, leaf packs and emergent vegetation.
- Be sure to note which type of net you use to sample: kick net or D-frame net.
- Always work in an upstream direction so sampling activities do not disturb portions of the riffle to be sampled later.
- *If, and only if, you do not have enough riffle habitat with in your 300 ft. sampling site* to collect three net sets, you may also want to sample alternative microhabitats.
  - Prioritize sampling of habitat types as follows:
    - Riffle
    - Root mat
    - Snags
    - Non-flow
  - Whatever habitats you decide to sample at your site (e.g., two riffle net sets and one root mat), always sample those same three habitats at the site every time you sample there and list the habitat type for each sample. This will ensure that the data you collect remains consistent over time.

Sampling Streams With Riffles

Adequate sampling requires two people, one to hold the net and the other to dislodge invertebrates from the substrate.

1. Place the net in the riffle facing upstream, and tilt it enough to provide a "pocket."
2. Ensure the bottom of the net is on the stream bottom leaving no room between the net and the substrate. This prevents organisms from washing under the net.
3. Rub all large stones in the 3-foot by 3-foot (3'x3') area immediately upstream of the net to dislodge invertebrates and wash them into the net.
4. "Dance and Kick" with your feet in the 3'x3' area until you have disturbed all the substrate <u>3 inches to 6 inches deep</u> to dislodge the invertebrates into the net.

Streams Without Riffles (or without riffles large enough for 3 net sets)

Sample Collection from Root Mats - Adequate sampling requires two people

1. Have one person place the side of the kick net against the bank on the downstream side of the root mat.
2. Make sure that the net is anchored to the stream bed.
3. The other person will then kick the root mat in a swirling motion with one foot to create a circular current in order to dislodge the invertebrates from the root mat. The circular motion of the sampler's foot will drive the invertebrates into the net, even if there is no current.

Sample Collection from Snags - Adequate sampling requires two people.

1. Have one person hold the net horizontal position about 6-12 inches under the water.
2. The 2nd volunteer will remove the snag from the water. When removing the snag from the water pull the snag out of the water quickly. If the snag is removed too slowly, the invertebrates may swim off.
3. Brush the snag down with a brush above the net to dislodge invertebrates.
4. Sample approximately 3-5 snags for one net set.

Sample non-flow areas in the same manner as a riffle, collecting three separate samples. However, the sampler will need to use a swirling motion with the foot to create a current to move debris into the net. Although this habitat can be sampled using a kick net, it is easier with a D-frame net. If using a D-frame net, you will need to disturb the substrate and sweep the net in a circular motion over the disturbed substrate to collect the organisms. Be sure to run two passes with the D-frame net to equal one net set.

PLEASE KEEP A COPY AND SEND ORIGINAL DATA TO:

Stream Team Coordinator/Water Protection Program
Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102-0176

Water Quality Volunteer

Missouri Stream Team Activity Report

Stream Team Number________________________

Team Name________________________________

Your Name________________________________

Shipping Address (no PO Box please)
Is this a business address? Yes No

____

____

____

Home Phone (_______)_________-_____________

Work Phone (_______)_________-_____________

Email____________________________________

Contact Person for Team______________________

Is there a change in Contact Person? Yes No
Is there a change in Contact Person address? Yes No

If yes, new address__________________________

____

Mail this Activity Report to:

MISSOURI STREAM TEAM
PO BOX 180
JEFFERSON CITY MO 65102-0180

We welcome your activity **photos**. They may be published in our newsletter or annual report. Thank you!

Activity Order

Please help save shipping costs. Ship to your office or school.

Please allow 3 weeks shipping.

Supply Items

These free supplies are for your Stream Team activities	Number requested
First Aid Kits (limit one per 5-10 participants)	
Litter Pickup Bags (green mesh 24” x 36”)	
Litter Pickup Bags (red mesh 14” x 26”)	
Work Gloves (adult size)	
Work Gloves (youth size)	

Thank You Items

These free incentives are for your Stream Team volunteers	Number requested
Bookmarks (dragonfly)	
Bookmarks (spring peeper)	
Bumper Stickers (Quality Water, 3 1/2” x 9 1/4”)	
Colorbook: Stream Team Most Wanted (Grade 4-6)	
Colorbook: Stream Team Superstars (Grade K-3)	
Mini-Buttons (Stream Team, 1” pins)	
Patches (Stream Team, Scouts only 3”)	
Pencils (Get Into Missouri Streams)	
Post-it Notes (Stream Team, 3” x 4”)	
Scratch Pads (Stream Team, 5 1/2” x 8”)	
Stickers “Get Into Missouri Streams” (3” round)	
Stickers “I Love Missouri Streams” (3” round)	
T-shirts (Stream Team) Size Small	
T-shirts (Stream Team) Size Medium	
T-shirts (Stream Team) Size Large	
T-shirts (Stream Team) Size X-Large	
T-shirts (Stream Team) Size XX-Large	

For a full list of Thank You items visit mostreamteam.org

Activity Prize Drawing

The more activities you submit, the better your chances!

New prizes every three months!	Check one
If you would like to be included in our Activity Prize Drawing, please check the box at right and attach a list of participant names. Please print clearly.	☐
	or
Attention teachers and youth group leaders: For a youth group prize, please check the box at right. You do not need to include a participant list for group prizes.	☐ Youth Group Prize

Activity Report

Stream Team Activity 1

Activity Type (see codes at right)____________________

Activity Date______________________________

Stream Name______________________________

Activity County_____________________________

Activity Basin (optional)__________________________

Miles of River Covered (optional)____________________

Count of Volunteers__________________________

Hours Spent on Project_______________________

Measurement: Please list **number** of trash bags collected, trees planted, letters written, storm drains stenciled, WQM trips, etc. See list at right.

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Location Description: Please provide a detailed location for your activity. Example: 100 yds. downstream from Hwy. 63 bridge over Cedar Creek a mile south of River City. A good source for maps is at www.usgs.gov.

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Project Description: Please describe your activity and include some fun facts. Example: “Held 4th annual litter pickup and picnic at Brush Creek, found an awesome antique bottle, removed 3 tires, saw an eagle!”

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Stream Team Activity List

Activity	Code	Measurement
Adopt-An-Access	AAA	New access adopted
Advocacy on stream issue	ADV	Number of events
Article written for newspaper	ART	Number of articles
Assisted MDC fish stocking	FIS	Number of events
Award received	AWA	Number of awards
Education project	EDU	Number of events
Forestkeepers monitoring	FOR	Number of trips
GPS reading	GPS	Number of trips
Grant applied/received	GRT	Number of projects
Greenway development	GRE	Number of projects
Habitat improvement	HAI	Number of projects
Letter written on stream issue	LET	Number of letters
Litter pickup	LPU	Number of litter bags
Media contact/interview	MED	Number of interviews
Monofilament recycling	MRP	Weight of line recycled
Other: please describe	OTH	Number of projects
Photo-point monitoring	PPM	Number of photos
Pre-activity planning	PLN	Number of events
Presentation to groups	PRE	Number of presentations
Rain garden/barrel, green roof	NPS	Number of projects
Recruited new Team/members	REC	Number of new members
ST Association activity	ASC	Number of events
ST display at school, fair, etc.	DIS	Number of events
ST Inventory Guide submitted	INV	Number of inventories
Storm drain stenciling	SDS	Number of drains marked
Stream access maintenance	SAM	Number of litter bags/events
Stream Team meeting	MTG	Number of attendees
Stream Team mentoring	MEN	Team mentored & events
Stream workshop attended	WKS	Number of attendees
Streambank stabilization	SSP	Number of projects
Tree planting	PLT	Number of trees
Water quality monitoring	WQM	Number of trips
Watershed mapping	WAT	Number of trips
Zebra mussel monitoring	ZEB	Number of trips

Report more activities on back!

If you ordered supplies in advance, please don’t forget to report your accomplishments AFTER your event.

12/5/2018

Your activities power the Stream Team Program! Thank you!

Missouri Stream Team Activity Report continued

Stream Team Activity 2

Activity Type (see codes at right) ____________________

Activity Date ____________________

Stream Name ____________________

Activity County ____________________

Activity Basin (optional) ____________________

Miles of River Covered (optional) ____________________

Count of Volunteers ____________________

Hours Spent on Project ____________________

Measurement: Please list number of monitoring trips, bags of trash collected, letters written, trees planted, storm drains stenciled, events held, etc. See list at right.

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Location Description: Please provide a detailed location for your activity. Example: 100 yds. downstream from Hwy. 63 bridge over Brush Creek a mile south of River City. A good source for maps is at www.usgs.gov.

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Project Description: Please describe your activity and include some fun facts. Example: "Held 4th annual litter pickup and picnic at Brush Creek, found an awesome antique bottle, removed 3 tires, saw an eagle!"

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Stream Team Activity 3

Activity Type (see codes at right) ____________________

Activity Date ____________________

Stream Name ____________________

Activity County ____________________

Activity Basin (optional) ____________________

Miles of River Covered (optional) ____________________

Count of Volunteers ____________________

Hours Spent on Project ____________________

Measurement: Please list number of monitoring trips, bags of trash collected, letters written, trees planted, storm drains stenciled, events held, etc. See list at right.

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Location Description: Please provide a detailed location for your activity. Example: 100 yds. downstream from Hwy. 63 bridge over Brush Creek a mile south of River City. A good source for maps is at www.usgs.gov.

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Project Description: Please describe your activity and include some fun facts. Example: "Held 4th annual litter pickup and picnic at Brush Creek, found an awesome antique bottle, removed 3 tires, saw an eagle!"

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Stream Team Activity List

Activity	Code	Measurement
Adopt-An-Access	AAA	New access adopted
Advocacy on stream issue	ADV	Number of events
Article written for publication	ART	Number of articles
Assisted MDC fish stocking	FIS	Number of events
Award received	AWA	Number of awards
Education project	EDU	Number of events
Forestkeepers monitoring	FOR	Number of trips
GPS reading	GPS	Number of trips
Grant applied/received	GRT	Number of projects
Greenway development	GRE	Number of projects
Habitat improvement	HAI	Number of projects
Letter written on stream issue	LET	Number of letters
Litter pickup	LPU	Number of litter bags
Media contact/interview	MED	Number of interviews
Monofilament recycling	MRP	Weight of line recycled
Other: please describe	OTH	Number of projects
Photo-point monitoring	PPM	Number of photos
Pre-activity planning	PLN	Number of events
Presentation to groups	PRE	Number of presentations
Rain garden/barrel, green roof	NPS	Number of projects
Recruited new Team/members	REC	Number of new members
ST Association activity	ASC	Number of events
ST display at school, fair, etc.	DIS	Number of events
ST Inventory Guide submitted	INV	Number of inventories
Storm drain stenciling	SDS	Number of drains marked
Stream access maintenance	SAM	Number of litter bags/events
Stream Team meeting	MTG	Number of attendees
Stream Team mentoring	MEN	Team mentored & events
Stream workshop attended	WKS	Number of attendees
Streambank stabilization	SSP	Number of projects
Tree planting	PLT	Number of trees
Water quality monitoring	WQM	Number of trips
Watershed mapping	WAT	Number of trips
Zebra mussel monitoring	ZEB	Number of trips

Additional notes and information

Notes ____________________

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If you ordered supplies in advance, please don't forget to report your accomplishments AFTER your event.

The Stream Team Program needs your final results!

Questions?
Need help getting started?
Please contact us at:

Phone: 1-800-781-1989 (voicemail)
Email: streamteam@mdc.mo.gov
Website: www.mostreamteam.org
Facebook: www.facebook.com/mostreamteams
Fax: 573/526-0990

Thank you for volunteering to help Missouri's waterways.

Water Quality Monitoring Procedures

Data to Collect	How Often to Collect
Stream discharge	Each monitoring trip
Biological	Twice per year (max of 4x/year) Late winter/early spring Late summer/early autumn

Volunteer Water Quality Monitoring Field Checklist

________ *Introduction to Volunteer Water Quality Monitoring* training notebook*
________ Clipboard*
________ Litter bag*
________ Thermometer*
________ Appropriate footwear (e.g., boots, waders, athletic shoes)
________ Pencil

Site Identification

________ Initial Site Selection Form*

Biological Monitoring

________ Macroinvertebrate Data Sheet*
________ Hand lens or magnifier*
________ Forceps*
________ Kick net*
________ Two 1 1/8-inch diameter rods to slide into the sides of your kick net
________ White ice cube trays and/or large white tray
________ Squirt bottle

Stream Discharge

________ Stream Discharge Data Sheet*
________ Floats (whiffle golf balls)*
________ 100-foot tape measure marked in tenths of a foot*
________ Stopwatch
________ Two sticks or stakes
________ 10-foot rope
________ Depth rod marked in tenths of a foot

**Program provided items*