Water Investigation Websites

Biological Resources Division - USGS

The US Geological Survey has a great amount of info at this site about many areas of biology. Click on the water tab and you will find background info, water quality standards and much more. http://biology.usgs.gov

WRD of New Hampshire and Vermont - Home Page

This site offers a wealth of information about watersheds in Vermont and New Hampshire as well as water quality data about factors such as mercury and arsenic. http://nh.water.usgs.gov

Hach Information Central: Frequently Asked Questions about Water Analysis

This site is sponsored by the Hach Company, which makes water chemistry testing kits. There is very clear info about each test, problems you may experience in the field, and much more. Check this site out **before** you go to get your water samples. http://www.hach.com/cs/cstech.htm

NCDC: Get/View Online Climate Data

This site gives information about weather in many different ways. This is a must see site for a site analysis team. http://www.ncdc.noaa.gov/ol/climate/climatedata.html

All Along A River

This is a "Think Quest" site created by high school students in China who are also studying rivers. You will find this site fun, and helpful, it is a must see for velocity and total discharge teams as well as site analysis teams. This is also an excellent site if you are doing the "Alternate River Assignment." This site is amazing and highly recommend! http://library/thinkquest.org/28022

Where is Earth's water located?

This is another US Geological Survey site that every one should check out. It has excellent information about the amount of fresh water available on planet Earth and where it is located. There is a wonderful picture gallery of how to take your water samples in the field, a database of water use in our country, and a special topics section that is a lab report, poster, or presentation maker's dream. http://ga.water.usgs.gov/edu/earthwherewater.html

Drinking Water Quality Water Testing Water Contamination and Groundwater Protection

This is the Wilkes University site for information about all the chemical factors in water, the bacteria like E. coli and hazardous pollutants you might find in water. One of the good characteristics of this site is that they explain how to interpret results for many of the tests performed on water. This site does have a slow load time for its pictures so be prepared to wait a bit. http://wilkes.edu/~eqc/helpguide.htm

Lab Report Scoring Guide

Scientific Method 7.1 Students use scientific methods to describe, investigate, and explain phenomena: raise questions.
Writing - Conventions 1.6 Students independent writing demonstrates command of appropriate English conventions, including grammar, usage, and mechanics.
Writing - Reports 1.8 In written reports students organize and convey information and ideas accurately and effectively.

VT Standard / Criteria	Standard Not Met Yet	Standard Met	Standard Exceeded
Title	Title is not connected to topic.	Title clearly identifies concept in biology.	Title clearly identifies the biological concept and context.
Question	Question is unclear and/or not testable. Does not use scientific methods or knowledge.	Question is clear, concise and testable. Uses scientific methods, knowledge, and vocabulary.	
Background Research	Background research is missing, incomplete or not related to the question.	Background research clearly relates to the problem and the concept in biology.	Background research is based on a variety of sources, i.e. journals, textbook, and web sources.
Hypothesis	Hypothesis is not related to question. Cause or effect is incorrectly identified or missing.	Hypothesis is related to the question and a testable statement. Cause and effect are accurately identified and their relationship explained. Independent and dependent variables are identified.	
Materials list	List is incomplete. Items are identified incorrectly.	Materials are all listed using correct scientific terms and units.	
Experimental Design Procedure	Design is not a true test of the question and/or hypothesis Procedure steps are not sequenced or not numbered. Safety procedures and/ or equipment are not explained. No diagram of set up.	Design is not a true test of the question and hypothesis Procedure steps are sequenced and numbered. Safety procedures and equipment are completely explained. Diagram of set up is clear and labeled. Scientific vocabulary is used correctly.	Procedure description allows a peer to reproduce the procedure and results.

Criteria	Standard Not Met Yet	Standard Met	Standard Exceeded
Data / Observations	Title is not relevant to data. Data is not relevant to the variable(s) being tested. Data is incomplete or inconsistent. Units are incorrect.	Title identifies the variables. Data is relevant to variable(s) being tested. Units are appropriate. Descriptions are qualitative and quantitative.	Data includes retesting of questionable results when feasible.
Charts and Graphs	Title is not related to data. Data lacks organization, sequencing, and / or labels. Variables are not identified. Axes are labeled incorrectly.	Title is relevant to data. Axes are scaled and labeled correctly. Scale is proportioned to data Data is complete and consistent. Data is organized, sequential and labeled. Variables tested are clear.	Charts and graphs are computer generated.
Calculations	Calculations are inaccurate. Units are incorrect or missing. Some data is missing.	Calculations are accurate. Units are correct. All available data is used.	
Discussion	Hypothesis is not addressed. Cause and effect are not identified. Relationships are unclear or missing. Conclusions are not supported by data analysis. Relevance of conclusion to concept in biology is unclear or missing.	Hypothesis is supported or refuted. Cause, effect, and their relationship are clearly defined. Conclusions are supported by data analysis. Relevance of conclusion to concept in biology is clearly expressed.	Conclusions are connected to current research identified in the Background Research. Data analysis includes evaluation of reliability.
Evaluation of your scientific method	Evidence is unclear or missing.	Evidence of good scientific method or flaws in your experiment are identified. Example from procedure is evident.	Evaluation includes an explanation of why the evidence exemplifies good scientific method.
Next Step	New question and hypothesis are not testable or related to the concept in biology investigated.	New question and hypothesis are testable and clearly related to the concept in biology investigated.	New question furthers the knowledge gained in the original investigation.
Writing Conventions	Many grammar, usage and spelling errors.	Three or less grammar, usage and spelling errors.	Active voice is used where appropriate.
Writing Reports	Report lacks the required format, the peer evaluation, the revision conference or a needed revision.	Report is word-processed, has required format, peer review, revision conference, and all recommended revisions.	Report includes a title page with graphics and an annotated bibliography of three or more sources.

River Investigation Poster Scoring Guide

Writing – Reports 1.8 In written reports, students organize and convey information and ideas accurately and effectively.
Information Technology – Communication of Data 1.20 Students use graphs, charts, and other visual presentations to communicate data accurately and appropriately.

Criteria	Standard Not Met Yet	Standard Met	Standard Exceeded
Title	Title is not connected to the investigation.	Title clearly describes the investigation.	Title relates to the concept in the investigation.
Introduction	Key information about how to evaluate the health of a river is missing, incorrect, or unclear.	Key information about water quality and its importance, riparian law, river ecosystem components, and your feelings about the health of the river are concisely explained.	Key information is supported by graphics and artwork.
Materials	Materials are missing or unclear.	All materials used for your inquiry are included	The connection of the materials to data is clear.
Procedures	Procedures are vague or incomplete. .	Procedures are described clearly, accurately, and completely.	The description includes criteria for evaluation of data.
Description of Field Site Observations	Description is incomplete or inaccurate based on data.	Description includes; aspect, percent cover over the stream, substrate type, discharge rate, and site map with sample locations, soil types, invertebrate populations, and human impacts.	Description is concise; much information in a few well constructed sentences. Scientific terms are used consistently and accurately. Photograph of the site is included.
Data	Data is missing or incomplete. Graphs or charts are missing or inaccurate.	Data is accurate and conveyed using graphs, charts and illustrations, labeled and titled appropriately.	Graphs, charts and illustrations are precise and aesthetically pleasing to the viewer.
Discussion Condition of the River	Connection to data is missing.	The data is analyzed and meaning of the data is explained in the conclusion. Connections are made to pertinent chemical data, site conditions and human impacts.	Meaning is connected to possible consequences for the community.
Bibliography	Little or no outside research is evident.	Bibliography is included and follows conventions.	A variety of appropriate sources are included.
Creativity	Poster has no original or eye-catching dimensions. Visual impact is cluttered and/or disorganized.	Poster is neat and uses creative and eye-catching dimensions to improve the viewer's understanding.	Poster is a creative unified whole. The creative dimensions further the viewer's understanding.
Writing Conventions	More than three grammar, usage, and mechanics errors.	Text and labels have less than three grammar, usage, and mechanics errors.	Text and labels are error free.

Presentation Scoring Guide

Expression – Speaking 1.15 Students use verbal and nonverbal skills to express themselves effectively.

Criteria	Standard Not Met Yet	Standard Met	Standard Exceeded
Preparation	No role is assumed in the group.	Presentation demonstrates planning and practice. Clear roles are assumed in the group.	Presentation demonstrates thoughtful planning and practice prior to presentation.
Organization	Introduction does not include overview; organization is unclear; or speech ends without a conclusion.	Introduction includes and overview; speech supports introduction; and ends with an appropriate conclusion.	Strong and engaging introduction provides an overview; speech supports introduction; conclusion reinforces main points.
Evidence	Main ideas are unclear; facts, examples, and details are lacking or fail to support ideas.	Main ideas are supported with appropriate facts, examples, and details.	Main ideas are presented in depth and effectively supported with many facts, vivid details, and engaging examples.
Integration	Presenter does not make relevant connections to visual aid and reading/research.	Presenter makes relevant connections to visual aid and reading/research.	Presenter makes insightful connections to visual aid and reading/research.
Physical Expression	Presenter rarely makes eye contact. Distracting mannerisms interfere with communication.	Presenter engages eye contact with audience; distracting mannerisms are controlled.	Presenter maintains eye contact with audience, communicates passion for topic with energy and poise and uses gestures effectively.
Voice	Speaker is difficult to understand because of volume or clarity; speaks too slowly or too quickly.	Speaker has adequate volume and clarity, speaks at appropriate rate and communicates interest.	Speaker has excellent control of volume, articulation, and speaking rate; uses emphasis effectively.
Visual Aids	Visual aids not visible to audience, not used effectively or of poor quality.	Visual aids adequately support presentation.	Visual aids significantly enhance the presentation.

Argumentation Essay Scoring Guide

Scientific Method 7.1 Students use scientific methods to describe, investigate, and explain phenomena: raise questions.
Persuasive Writing 1.11 In persuasive writing, students judge, propose, and persuade.
Writing - Conventions 1.6 Students independent writing demonstrates command of appropriate English conventions, including grammar, usage, and mechanics.

Criteria	Standard Not Met Yet	Standard Met	Standard Exceeded
Significant Problem	Problem is unclear to the reader.	The problem, issue, topic, or concern is clearly defined.	Problem is universal.
Authoritative Stand	No clear stand or position is taken.	An authoritative stand on the topic is taken.	
Shared concerns, doubts, and criticisms	The reader's concerns, doubts and criticisms are ignored or incorrectly interpreted.	The potential doubts and criticisms of the reader are recognized, analyzed, and evaluated.	
Reasoning	Statements and arguments are not supported or faulty reasoning is used.	Statements and arguments are supported with logical reasoning and evidence.	
Evidence	No definitions, descriptions, illustrations, examples, experiences, and anecdotes support proposals.	Definitions, descriptions, illustrations, examples, experiences, and anecdotes support proposals, as appropriate.	Descriptions and/or illustrations, examples, experiences, and anecdotes are vivid and memorable.
Conclusions	Opinions are not supported by your data. Conclusions are unclear or missing.	Scientific conclusions are based on your data, and clearly communicated.	Conclusions are based on recognized science concepts
Solutions	Solutions are not reasonable.	Solutions are reasonable, based on data, and clearly stated.	Solutions are realistic and based on recognized science concepts.
Strategies	No strategies are used to elaborate or persuade the audience.	A range of strategies is used to elaborate and persuade.	Strategies used to elaborate and persuade include analogy, metaphor and/or simile.
Writing Conventions	Grammar usage, and mechanics do not follow the conventions of the English language.	Few grammar, usage, and mechanics errors are found.	A variety of sentence structures are used.
	Few scientific terms are used or they are used incorrectly.	Scientific vocabulary is used.	Scientific vocabulary is used correctly and consistently.

WATER CANARIES

Objectives

Students will be able to: 1) identify several aquatic organisms; and 2) assess the relative environmental quality of a stream or pond based on indicators of pH, water temperature, and the presence of a diversity of organisms.

Method

Students investigate a stream or pond using sampling techniques.

Background

In the early days of coal mining, canaries were taken into mines. Since canaries were more sensitive than humans to the presence of dangerous gases in the air, their discomfort or death indicated whether or not the air was safe to breathe. Although this practice no longer exists, it stands as an example of how animals have differing sensitivities to environmental factors.

In streams and ponds the presence or absence of certain organisms called indicator species reveals much about the quality of the water. These creatures comprise a **biotic index**. That is, their absence or presence tells us something about water quality.

Water with a rich and varied range of aquatic creatures is usually a "healthy" environment, whereas water with just a few different species usually indicates conditions that are less "healthy." Healthy is used here to indicate an environment supportive of life. Pollution generally reduces the quality of the environment and in turn the diversity of life forms. In some cases the actual biomass or amount of living material will increase due to pollution, but the diversity inevitably goes down.

The major purpose of this activity is for students to be able to recognize indicators of environmental quality in streams, ponds, or other aquatic habitats.

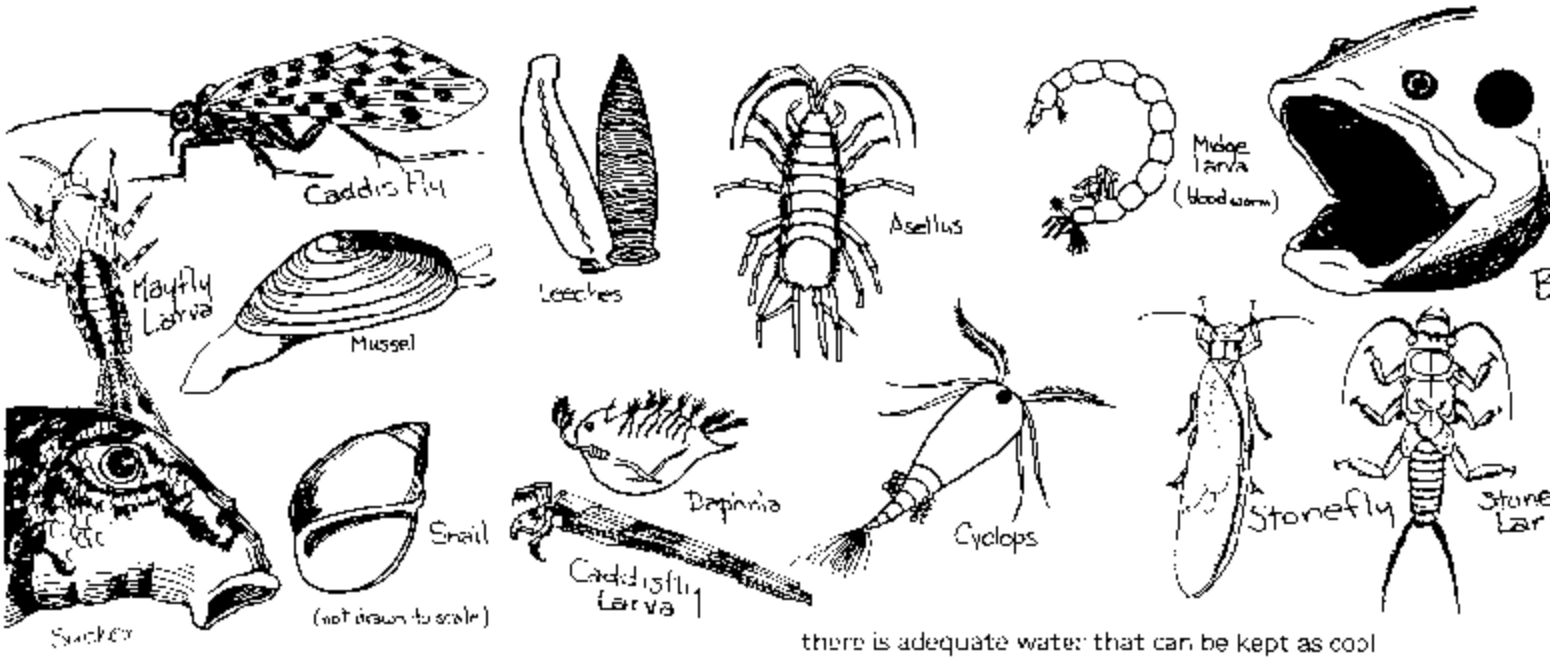
Materials

identification books (taxonomic keys, e.g., *The Golden Guide to Pond Life*); student Worksheets I and II (provided); sampling equipment, such as seine nets, sieves, trays, assorted containers; white trays (styrofoam, plastic, porcelain are all satisfactory); magnifying lenses (stereomicroscope optional); eye droppers; forceps, water quality test kit (such as a hydron kit to test both pH and dissolved O_2); thermometer; meter sticks or tape measure

Procedure

1. Select a sampling site. Try to find a small, fairly shallow, slow-moving stream or pond. Be alert to the safety of the students. If the stream is not a public site, be sure to gain permission to visit. Advise the student in advance to dress for the setting. Old shoes, shorts or jeans would likely be best. NOTE: If a site visit is not possible, modify the activity to be conducted in the classroom.

Age: Grades 4—12
Subject: Science
Skills: analysis, application, classification, comparing similarities and differences, computation, description, discussion, drawing, evaluation, experimenting, generalization, identification, inference, interpretation, kinesthetic concept development, listing, matching, measuring, observation, prediction, psychomotor development, reading, research, recognition, synthesis, writing (limited)
Duration: one or two 45 minute periods; may take longer if done as a field study activity
Group Size: any
Setting: outdoors
Conceptual Framework Reference: II.B., II.B.1., II.B.2., II.B.3., II.E., III.A., III.B., III.B.4.
Key Vocabulary: indicator species, quality, healthy, diversity, temperature, pH



2. Brief the students on habitat courtesies. Alert them to ways to minimize the potential for damaging the habitat and encourage care in their collecting techniques. Emphasize that all the wildlife is to be returned to its habitat unharmed. You may choose whether or not to take some of the organisms back to school for further study. See the appendices for additional recommendations on doing field studies.

3. Start by observing the water. Look for organisms on the surface and in the depths. Using the sampling equipment (nets, trays, assorted containers, etc.), have the students collect as many different forms of animal life as possible. Ask them to be alert to differing micro-habitats near rocks, in riffles, and in eddies. Place the animals to be observed in the white trays for viewing and drawing. The whiteness of the trays allows detail to be seen in the animals collected. Keep an adequate amount of water in the trays and place them in a cool shady spot. Change the water as often as needed to keep the animals cool. This is a good time for microscopes if they were brought along.

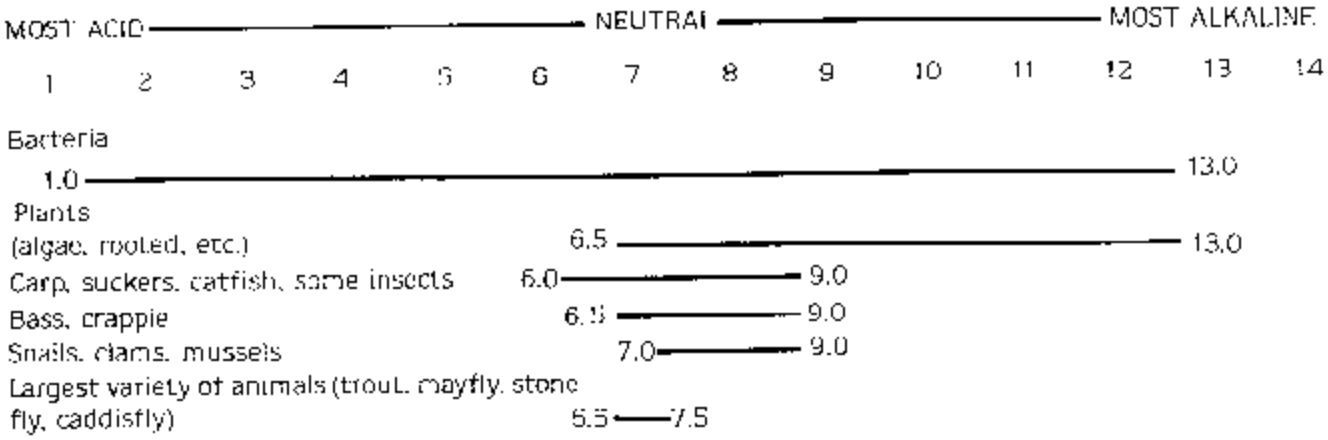
4. Have the students identify and draw the animals on Worksheet I - those observed in their natural setting and those temporarily removed for observation in the collection containers. Ask them to fill in the number of each kind found and describe the actual location where the animal was found. Once these observations are completed, carefully return the animals to their natural habitat. (NOTE: If you choose to take some of the animals to the classroom, be sure there is adequate water that can be kept as cool as the natural setting. Petri dishes or any shallow transparent dish and an overhead projector make for exciting viewing.)

5. Still in the outdoors, encourage the students to discuss their observations. Were a lot of different aquatic organisms found? Introduce the concept of **diversity** of life - that is, a variety of different kinds of plants and animals is usually an indication of a healthy ecosystem.

6. Now it is time to test the water at the field site for other indicators of quality. Using the water quality kit, have the students determine the pH and the temperature of the water, as well as the air temperature. If you choose to measure the amount of dissolved oxygen as indicated in Extension #1, include those values with water temperature and pH. NOTE: Many teachers are not able to measure the dissolved oxygen (O_2), due to the difficulty for younger students. If it is convenient for you to do so, this measure contributes greatly to rounding out the picture of water quality. These data should be recorded on student worksheet II. You may also choose to measure stream velocity. This can be done by timing a floating object (e.g., a ping pong ball) as it travels a known distance (e.g., 10 feet).

7. Help the students understand that the values for pH, water and air temperature affect the diversity of life forms found in aquatic environments. Ask whether they would expect the same variety of life in other locations. Help them realize that predictions of animal diversity can be made from measurements of pH and water temperature. Likewise, certain indicator species can tell you about pH and water temperature.

pH Ranges That Support Aquatic Life



Temperature Ranges (Approximate) Required for Certain Organisms

Temperature	
Greater than 68° F. (20° C) warm water	Much plant life, many fish diseases Most bass, crappie, bluegill carp, catfish, caddisfly
Middle range: 55° - 68° F (12.8 - 20° C)	Some plant life, some fish diseases Salmon, trout, stonefly, mayfly, caddisfly, water beetles
Low range: Less than 55° F (12.8° C) cold	Trout, caddisfly, stonefly, mayfly

Dissolved Oxygen Requirements for Native Fish and Other Aquatic Life

D.O. in parts per million

(below 68° F.)	(above 68° F)
Cold-water organisms, including salmon and trout	Warm-water organisms (including fish such as bass, crappie, catfish and carp)
6 ppm	5 ppm

From "A Lesson Plan for Some Water Investigations," *Investigating Your Environment Series*. U.S. Forest Service, Revised 1977. Printed with permission.

8. Ideally, this activity should be repeated at other sites with different characteristics. The students should understand that biologists examine hundreds of sites in order to try to understand and predict what their evidence suggests is going on in natural systems. If another site is visited, it might be useful to divide the class into two groups with one half doing Worksheet I and the others doing Worksheet II. When each group is finished, they could come together and mutually predict what the other group had found.
9. Summarize the study with a re-emphasis that the diversity of specific animals is a useful indicator of habitat quality as well as an overall indicator of environmental quality.
NOTE: A simple water quality kit can be obtained from scientific supply houses dealing with high school biology supplies. Often a kit can be borrowed from a high school biology teacher. They are called hycrion kits or Hach kits.

Extensions

1. Measure and record the dissolved oxygen for the sites visited. Look at the relationships to the values for water temperature and pH.
2. Sample the streams both above and below the local water supply.
3. Find the most diverse and least diverse streams in the area.
4. Contact local wildlife, environmental and conservation groups to find out what their concerns are regarding water quality. Determine what can be done as an individual and as a community to improve or maintain local water quality.
5. Sample streams above and below your local waste water treatment plant.
6. What do the conditions you discovered in your stream mean for wildlife in and out of the water?
7. Research other examples of biological indicators. Determine how some substances such as DDT result in bio-magnification (increased accumulation) in such creatures as birds of prey, fish, shellfish, etc. (See the Project WILD Activity, "Deadly Links.")

Evaluation

Draw a simple illustration of one or more of the following organisms: asellus (water sowbug), bass, caddisfly larva, carp, cyclops, daphnia, leech, mayfly nymph, midge larva, stonefly nymph. Write the correct name beside the picture.
You found a trout in a stream along with a large variety of other organisms. Predict ranges you would expect to find for pH, water temperature,

WORKSHEET I

WHERE ORGANISM WAS FOUND	SKETCH OF ORGANISM	LOCATION	NUMBER FOUND

WORKSHEET II

	OBSERVATIONS	PREDICTIONS
WATER TEMPERATURE		
AIR TEMPERATURE		
pH ACIDITY vs. ALKALINITY		
O_2 DISSOLVED		

RIPARIAN RETREAT

Objectives

Students will be able to: 1) describe habitat characteristics of riparian areas; 2) identify animals that inhabit them; and 3) state the importance of riparian areas to wildlife and humans.

Method

Awareness of a riparian zone is created through the use of guided imagery and art work.

Background

Riparian areas are important and valuable in many ways, including as ecologies for whole communities of life. Riparian areas are the green ribbons of life found on the edges of water courses (streams, lakes, ponds, etc.). Conditions there support plant communities that grow best when their root systems are near the level of high ground water. These zones range in width from narrow ribbons in desert and mountain settings to wide bands on the plains and lowlands.

Riparian areas provide space, shelter, and food for the plant and animal communities with which they are associated. For example, leaf litter and terrestrial insects falling from vegetation into a stream are a source of detritus, providing nourishment for some aquatic life. Vegetation may also provide shade from the sun for aquatic plants and animals and land-dwelling creatures at the water's edge. Riparian areas are also transportation corridors or highways for animals that depend on water bodies for food and shelter. The riparian plant community, especially shrubs and trees, provides shelter and food for animals as large as deer. Trees and marshy areas provide shelter for nesting birds and the banks provide homes for burrowing animals.

The riparian zone may serve as a buffer between the uplands and the water. For example, rainfall dropping on uplands and flowing downhill can be cleansed as it flows through a riparian zone. The banks of riparian areas store water during periods of high flow such as rainstorms or snow melt and release this water to the stream during low flow times. Riparian vegetation strengthens the stream banks. This tends to prevent erosion and maintains the stream channel, keeping the water clear.

Among the many values of riparian areas, they have aesthetic and recreational values for humans. They are used for fishing, hiking, camping, picnicking, and resting.

The major purpose of this activity is for students to increase their appreciation of the importance of riparian areas.

Age: Grades 6 – 12
Subjects: Language Arts, Science
Skills: analysis, comparing similarities and differences, description, discussion, drawing (optional), inference, interpretation, listening, listing, observation, visualization
Duration: 30-45 minutes
Group Size: any
Setting: outdoors or indoors
Conceptual Framework Reference: II.A., II.A.3., II.B., II.C., II.D., II.E., II.F., III.A., III.B., I.A.1., I.A.2., I.B., I.B.4., I.C., I.C.1., I.C.2., I.D.
Key Vocabulary: riparian, ecology, habitat, value

Materials

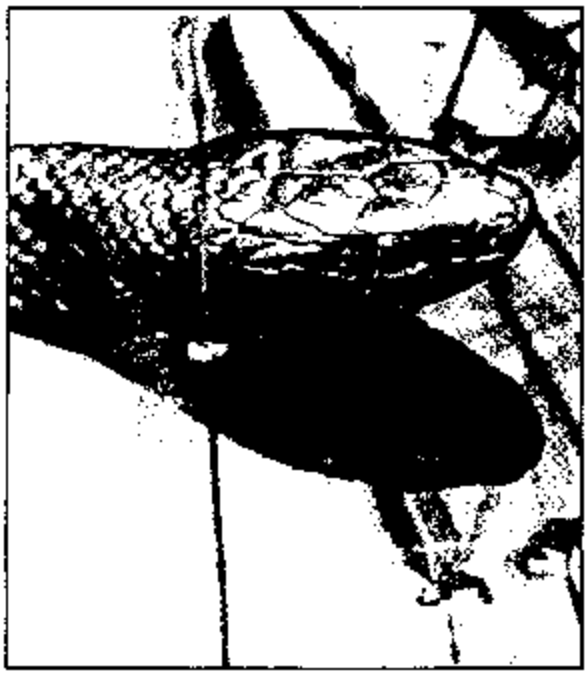
art materials: water colors, acrylics, poster paints, crayons

Procedure

1. Find out if anyone has ever been to a stream or river bank. What was it like? Were there plants growing there? What did the area look like? Was it hot or cool? Simply encourage the students to talk and share descriptions of any area by a stream or riverbank they may have been to or at least have seen pictures of.

2. Next tell the students that the kind of area they have been describing has a special name. In some parts of the country, it is called a "riparian area." Riparian areas are important natural areas for people and wildlife. In order to learn more about these kinds of areas, the students will need to close their eyes and imagine the things you will be describing. They will be imagining these things from their own point of view, as themselves, in the setting and circumstances you will describe. Invite the students to get in a comfortable position, close their eyes, and do their best to imagine what they hear.

NOTE: You may want to read the section about guided imagery that appears in the appendices to this activity guide for additional suggestions concerning use of this instructional strategy with students.



"It is a hot summer day. You are walking in a meadow filled with knee high grasses. Here and there are masses of tiny blue wildflowers. The ground beneath your feet is uneven, but you are in no hurry as you walk slowly toward a grove of trees. As you near the trees, you notice the changing colors of green. A breeze whispers through, showing first a shiny green, then a dull green underside of the leaves. As you step into the grove of trees, you are surrounded with a welcome coolness. You immediately feel the protection of the canopy of green above your head. A tap-tap-tapping sound breaks into your thoughts. Searching about among the rough-barked trunks, your eyes finally spot a bird, black and white with a touch of red on its head, clinging to a vertical tree trunk and bobbing its head in time to the rhythmic tapping. Your eyes fill with the beauty of the setting. Your skin welcomes the cool. As you breathe deeply, the very scent of 'green' comes to you. The aroma of earth and growing things is strong and you detect here and there almost a memory of the sweet perfume of the flowers. Once in a while the pungent but not unpleasant odor of wet soil and last seasons' decaying leaves and grasses catches your attention.

"As you explore further, you notice that the tree trunks are not as crowded and close as before. Grass, which earlier reached to your knees, is being overshadowed by chest-high bushes. Although these bushes have no thorns, they nevertheless snag your clothing. Your arms are lightly scratched by the twig ends. Several of the bushes are covered with small berries, pink and pale green, ripening into red in the warm sun.

"The bushes become taller. You find yourself pulling aside thick, tangled willows taller than your head. You carefully choose a safe path along the precarious trail beneath your feet. Suddenly your left foot drops six inches and, looking down to examine the terrain more closely, you notice that, where you stepped, the tunnel of a burrowing animal collapsed from your weight. Moving on again you feel the whisper of an abandoned spider web touch the side of your face. Brushing it aside, you notice the slope of the land is steeper. You pause, listening . . . listening.

"You can hear the high drone of insects . . . It has come upon you so gradually, you are surprised that you didn't hear it before . . . Now it seems almost frighteningly loud. And beneath the buzzing drone, and lower in pitch and volume, is the sound of water gently spilling over rocks.

"Above the place where the water must be, you see thousands of tiny spots milling before your eyes, the creators of that high buzzing sound. The spots are hundreds of swarming insects in a cloud too thick to imagine. A dragonfly flashes by with its irridescent pinks and greens, darting here, pausing, darting there, pausing, snatching dozens of the dots, relishing a meal in an unending insect buffet.

"You step aside, ducking beneath the swarming insects. You smile as your eyes come to rest on the splashing waters of the stream a few feet below. As you proceed, you use your arms to open a space to walk between the graceful tan green willows that bounce back undisturbed in your wake.

"As your eyes comb the scene for a place to rest, you notice a hip-high rock ahead of you—gray, warm, and not yet water-smoothed. You pause before reaching the rock and bend toward the water, gathering a handful of pebbles from the stream bed. One leg anchors itself on the ground between two willows while the other reaches over to the water. With the pebbles in your hand, you swing up onto the dry perch of the rock. You settle down and look at the still wet pebbles. . . gray, pink, tan and cool in your warm hand. After you examine them carefully, you toss the stones one at a time into the stream, listening to the pleasing plop of stone on water.

"Then your eyes drift downward to the waters of the stream near the base of your rock. In an eddy you see a fish, hidden like an illusion in the stone and silt, waiting, waiting, unblinking and still, only the faint wave of a gill, a tail fin, showing any evidence of life at all.

"As you continue to look downstream you notice all kinds of small insects are now dancing across and above the water. A small ripple occurs in the water, then another and another. You realize that fish are rising up from below and feeding on the surface insects. Birds dart in and out of the tangle of vegetation. Some fly through.

"Downstream a frog begins to croak. Much nearer, another frog offers a reply. You look around quickly to see if you can find the nearer frog. For a moment you think you spot it, but then realize that, unless it sings again, you may never find it. Your eyes search for a moment as more frogs telegraph their messages back and forth. But then it seems time to leave. You take one last sweeping look all around this beautiful setting. You slowly get up from your rock along the streamside and head back home."

3. Ask the students to continue to sit quietly with their eyes closed and review the whole experience. Ask them to pay particular attention to their favorite images. Tell them they are going to be asked to describe this setting as they saw it. Invite them to open their eyes.
4. Ask them to describe their favorite images. Once each student has done this, invite all of the students to select art materials. Each should draw or paint his or her favorite images on the paper provided. Once they are finished, have the students tape up their art work on a display area.
5. Ask the students to identify some of the characteristics of riparian areas. What kinds of plants did they see? What kinds of animals? Was the environment different near the water than it was farther away from the water? If yes, what were some of the similarities and some of the differences? Ask the students to list, describe, and discuss some of the many reasons that riparian areas are important and have value intrinsic value as well as value to wildlife and humans.

Extensions

1. Visit a riparian habitat. Look for things that you encountered in your imagery. List things that were not in your imagery.
2. Generate a list of things that could be done to make it possible for people to visit a riparian area without damaging or destroying it.
3. Put your discriptions in writing—if you have not already! Combine words and visual images to convey some of the diversity in riparian areas.
4. Is a different word used in your region to describe these kinds of areas? If not riparian areas, what are they called?

Evaluation

What is a riparian area?
Name four animals that you would expect to find in a riparian area?
Why are riparian areas important to wildlife?
Why are riparian areas important to humans?
Why are riparian areas intrinsically valuable?
Describe your position on a plan to develop a riparian habitat for recreational use by hikers, birdwatchers, and other "low impact" users. A parking area, restrooms, walkways, garbage removal and other needs must be considered.

ALICE IN WATERLAND

Objectives

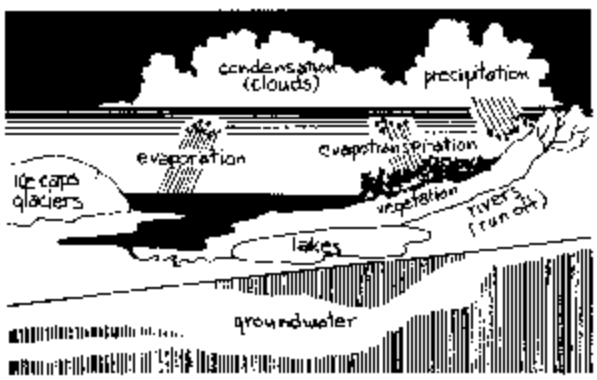
Students will be able to: 1) trace their domestic water to its source prior to human use and to its destination after use; 2) identify potential effects from human water use on terrestrial and aquatic wildlife; and 3) develop and practice responsible water conservation behaviors.

Method

Using guided imagery, lecture-discussion and student-gathered data, water use and its effects on wildlife habitat will be explored.

Background

Water use is such an automatic and habitual daily activity that students often do not understand the consequences of its use. Seldom do they connect the water that comes out of the faucet to its sources in the natural world.



A model that traces the dynamics of water is called the water cycle or the hydrologic cycle. The water cycle involves the path of water from when it falls in the form of rain or other precipitation on a watershed; to its travel as runoff that flows into streams, groundwater systems, lakes, reservoirs, estuaries, and oceans; to its eventual return to the atmosphere through evaporation and evapotranspiration; to its formation into clouds; to its condensation in the form of precipitation as it again falls on a watershed in this continuing process. The great storehouses of water—glaciers and icecaps—are also part of this cycle. All forms of life on earth are dependent upon and affected by this cyclical journey of water.

Age: Grades 5—12
Subjects: Science, Math
Skills: analysis, application, computation, description, discussion, drawing, estimating, evaluation, generalization, identification, inference, interpretation, investigation, listening, listing, mapping, media construction, observation, problem solving, synthesis, using time and space, visualization
Duration: two or three 45-minute periods
Group Size: any
Setting: indoors or outdoors
Conceptual Framework Reference: VII.A., VII.A.1., VII.A.2., VII.A.3., VII.A.4., VII.B., VII.B.1., VII.B.2., VII.B.3., VII.B.4., VII.B.5., VII.B.6., VII.B.7., VI.A., VI.A.2., VI.A.3., VI.A.4., VI.A.5., VI.B., VI.C., VI.D., IV.A., IV.B., IV.C., IV.D., IV.E., IV.F., I.D.
Key Vocabulary: water cycle, hydrologic cycle, conservation

In between the watershed and the sea, we humans divert the water from its natural course for our own uses. Water for domestic purposes is the most obvious use in our lives. About eight percent of total water use in the United States is domestic. Much more is consumed for agricultural purposes (33%) and industrial/commercial uses (59%). (U.S. Geologic Circular 1001.) Human uses of water have dramatic effects on wildlife. Each time we draw water from its natural setting or modify the natural journey of water, we are likely to have an impact on wildlife and wildlife habitat. For example, building dams floods river and stream valleys. Draining wetlands removes water from natural nurseries for wildlife. Once water is diverted from its natural path and used by humans, it is often contaminated or polluted. If contaminated water is returned to human habitats or to wildlife habitats, the effects may be devastating. Salinity from irrigation that damages soil's productivity; nutrient loading in lakes receiving runoff from agricultural fertilizers and pesticides; toxic chemicals seeping into human and wildlife water supplies are all examples of forms of contamination that can enter the water cycle with damaging consequences for people, wildlife, and the environment.

Humans have a variety of choices in terms of how we use water, and how we treat water. In our own lives, we can make decisions to use water respectfully and carefully. We can conserve water as a part of our daily lifestyle. Conservation of water not only reduces or prevents destruction of natural habitats by lessening the need for dams and other interventions; it also reduces the depletion of underground water stores which supply moisture for many riparian and other habitats. Conservation of groundwater supplies also benefits human populations that depend upon underground aquifers for municipal water supplies. For example, such conservation can slow the depletion of the groundwater supplies and, at times, help to regenerate such supplies. Groundwater is the water we do not see—it is the water that is under the ground. Conservation of both groundwater and surface waters protects the continued availability of water for humans, wildlife, and the environment. Conserving water is one action we can take. We can also pay attention to what we put into water and the water cycle—being careful with potential toxins like pesticides, detergents, fertilizers, motor oils, aerosols, cleaning fluids and powders, and caustic acids; as well as fuels and their byproducts. Humans can affect both the quantity and quality of available water through our personal and public conservation practices.

The major purpose of this activity is for students to develop a greater awareness of how humans use water, and the effects of our water use on wildlife and wildlife habitat. In addition, students are encouraged to develop a personal ethic of responsible water use, demonstrating it through their actions.

Materials

one water use information sheet per student (see sample); several long sheets of butcher paper for murals; art materials for the murals (poster paints, vivid pastels or chalks, etc.)

Procedure

1. Using guided imagery, ask the students to sit quietly, close their eyes, and imagine that they could shrink down to a size that would let them travel up through their faucet and into their water pipes. NOTE: You may want to adapt the text of this imagery so it will apply to local settings. Or, if many of the students have well water as their domestic source, you can convert the imagery to a school setting. Even if this imagery does not apply exactly to the students' situation, it can be used to explore a typical source of water and its routes in this country. You may want to refer to the appendices for additional suggestions concerning use of guided imagery for instructional purposes. Ask the students to visualize in their minds what you will describe for them in the following words.

"Imagine that you are small enough to climb into the faucet in your kitchen. . . .Pretend you have magic powers that allow you to travel through the water that comes from the faucet to its origins. . .You will be able to pass through all the pipes, valves, and other barriers on the way. . . The first part of the journey takes you through the pipes in your house to where it connects to your water source. . .If you live on a farm or ranch the source would probably be a well or perhaps a spring. In the city, the water source for your home probably would be far away. . . First you get into a water main. . .Then you come to a pumping plant where water pressure is maintained. . .Past the pumping plant is a place where the water is purified. . .This may be very complex—a place with filters, chemical tanks, and treatment equipment. . .Beyond the purification plant, the water may be in an aqueduct or open channels coming from a reservoir. The reservoir is a huge lake where water is stored. . .There are often trees and bushes on its edges. . .Wildlife is common, fish are usually abundant, and people often use the site for recreation . . Natural streams usually flow into the reservoir. . .They drain large areas of the land's surface which are called watersheds. . .A watershed is the land area that catches and transports water through streams, underground flow, and rivers. . .The water in a watershed contains all the water that is naturally available for use by all living things in that area. . .If you want, stay in the watershed. Try to see the plants and animals that live in the area. Or, follow your route all the way back through the reservoir and channels and treatment plant and pumping plant to the water main and the pipes in from your house and out your faucet. Then, open your eyes."

2. After this imagery, discuss the journey of the water from its source to the faucet. Identify the components of the journey. Emphasize the places where wildlife habitats are affected positively, negatively, or with unknown effects—by the intervention of people as they use the water or influence how the water is to be used.
3. Have the students create a mural on a single long sheet of butcher paper, depicting the origins and journey of water from their home to its source. Have them emphasize wildlife and habitat all along the way.
4. Repeat the imagery process for a journey down the drain into the wastewater system:

"Imagine you are small again. This time the journey will be down the drain in your sink. You move along through the used water system to a treatment site. . .If you live on a farm, the site probably will be a septic tank. . .A septic tank is usually a large concrete box. . .Here bacteria break down the substances carried in the water. . .Once the water is cleansed to the degree possible, it flows out through drainage fields and back into groundwater sources or streams. . .If you live in a city, there is much more water being used and large water treatment plants must attempt to cleanse the water before it is returned to rivers and streams. . .In these treatment plants there are great filters and holding tanks. . .The water must be held in place for solid substances to settle out by gravity. . .Air is often pumped through the waste water to increase the oxygen content so bacteria can break down the impurities more quickly. . . Eventually the treated water is released into rivers and streams. . .It again re enters the natural habitat for wildlife. . .There it provides an essential component for continued life. . .If all was done well, animals, plants, and humans will safely re-use the water. . .It will nourish the crayfish caught by the raccoon. . . .It will provide the pond for the box turtle. . .It will provide the refreshing drink for someone like yourself in some downstream city. . .After you have followed the water out into the environment, open your eyes."

5. Repeat the discussion and create a downstream mural. Include places where humans and wildlife are affected—positively, negatively, or with unknown effects—by the reentry of this water into the hydrologic cycle.

6. Look at the entire mural—upstream and downstream. Identify, list, and discuss places in which the **quality** of the water in the water cycle may be affected by human activities, not just the quantity of available water.

7. Now shift the emphasis to the amount of water that people typically use. Pass out water use information sheets. See the master provided.

8. Ask the students to keep track of how much water is used in their homes for five days. Suggest that the sheet be posted on the refrigerator and that each family member help by putting a mark in the section designated on the sheet after each water use. The miscellaneous section is for special uses not listed above.

9. After the water-use data have been gathered, make a master chart that summarizes the total use in the classmembers' homes for the entire week. Discuss places where water use might be conserved. Challenge each student to intentionally reduce his or her water use and invite their families to join in. Have them monitor use for another five day period and tabulate the results.

10. Once the results are tabulated, discuss how wildlife, habitat, and humans can benefit from human water use conservation. Discuss the potential appropriateness and effectiveness of a variety of water conservation behaviors. Examine the concept of trade offs by considering potential negative as well as positive effects. Discuss more than ways to reduce and conserve water use—also discuss ways to protect the **quality** of the water we use. List and discuss actions that each of us can take to reduce or prevent a variety of toxins or pollutants from entering the hydrologic cycle.

WATER INFORMATION SHEET
all values are approximate

3.5 gallons	flushing a toilet
3 gallons	shaving and letting the water run
5 gallons per min.	shower
8 gallons	cooking three meals
8 gallons	cleaning house
10 gallons	washing dishes (3 meals)
20-30 gallons	washing clothes
30-40 gallons	watering a lawn
30-40 gallons	taking a bath
30-40 gallons	washing a car

m scellaneous use

Extensions

1. Water use conservation also saves money unless you have your own water supply (a well). Calculate how much money your family would save in water and energy bills if you carried out conservation practices for a year.
2. Monitor water use in the school. Identify ways to conserve water use in the school.
3. Take field trips to water purification systems and waste water treatment plants.
4. Modify the murals to show the effects of water conservation and improved water quality on wildlife habitat.
5. Create a poster campaign for raising the awareness in the community about water conservation and water quality.
6. Create a Water-Waste-Enders team and charge them with identifying water wasters in the community. Have them devise a way to encourage the wasters to change their practices. Give credit to the successful Water-Waste-Enders who change their practices!
7. Design a closed-loop water system for a space station.

Evaluation

Draw and label a flow chart tracing water in your community from where it comes--to your home—to where it goes after it leaves your home.

Estimate the number of gallons of water you use each day for personal use. What do you do that uses the greatest amount of water in a year? Name three ways you might conserve water. How much water could you conserve using each method for a year? How appropriate will other people think your water conserving actions are? How might wild animals be affected by your water-conservation actions? How might plants be affected?

Order the following water uses according to those which use the most water to those which use the least in the United States: domestic, industrial, agricultural/irrigation, recreational. 1 = most.

What effect, if any, does human water use have on animals that live on the land? What effect, if any, does human water use have on animals that live in or around water?

Give examples of ways that water quality can be affected **negatively** by human use. Give examples of actions people can take to protect the quality of water.

Postenbeam Booming Town
Or
Big Trouble in River City

I would like to build a dam on the Onion River that runs through the tow of Posten beam (See attached map.) The water behind the dam would back up and flood some minor rapids and the insect infested Big Swamp in the north part of town. Down stream of the dam there is a swamp that I would like to drain and sub-divide to build a lovely housing development. Take the position of Town manager and respond to my request. Please consider the following:

- The dam will provide low cost electricity for an economically depressed area.
- There is an aquiculture enterprise (fish farm) planned near the reservoir.
- The local farmers will use the reservoir to supply water for irrigation thus enhancing the growing season for produce.
- More houses will increase the taxes paid to the town.
- There are trout in the southern end of the river.
- There is a rare bog plant that grows in Big Swamp.
- Big Swamp collects and purifies water from farms in the northwest corner of town.

Use the following titles in your response. Hint: there is no one correct answer. You need to decide what is important to you and defend your position.

Titles:
Statement of Position (Will you allow the dam and development to be built?)

Rationale for Position (Why are you taking this position?)

River Investigation Data

Class _____ Date _____

Test	Result	Standard	Test	Result	Standard
Dissolved Oxygen		S>4mg./L	Nitrate		S>10mg./L
Biological Oxygen Demand River DO_1 Lab DO_2 DO_1-DO_2 = Demand			Phosphate-Ortho		S = 0.05 mg./L
Carbon Dioxide		S=0.0 to 0.8 mg./L	Turbidity or Color		Color < 15
Velocity Average			Total Solids Calcium & Magnesium		
Total Discharge Average			Macros % Mayflies % Stoneflies % Caddisflies % Others		
pH		S= 6.8 to 8.0	Chloride		
Alkalinity		S=>25 mg./L $CaCO_3$	Site Analysis Field Sheets		1 sheet / team Site sketches
Fecal Coliforms			Pictorial Evidence		SLR Digital Video
Temperature		Seasonal	Data Management		Results from all teams

River Investigation Teams

Class _____ Date _____

Test	Team Members	Test/Task	Team Members
Dissolved Oxygen Biological Oxygen Demand		Turbidity/Color	
Carbon Dioxide Velocity & Discharge		Chloride Calcium/Magnesium	
pH Alkalinity		Macroinvertebrates Mayflies Stoneflies Caddisflies Others	
Fecal Coliforms Temperature		Site Analysis	
Nitrate		Camera – SLR Camera – Digital Camera – Video	
Phosphate Total		Data Management Presentation	

Benthic Macroinvertebrate Sample Site Field Sheet

Sample site should be in riffle area with stream velocity between 0.4 - 2 ft./sec.

SECTION I.

River:_____ Town: _____ Estimated Elevation:_____

Site #: _____ Site Location (be specific):_____

_____

Name(s): _____ Date:_____ Time:_____ # Replicates:_____

Weather: today:_____ prev. 2 days:_____

Sample Type: (choose one) Kick Net_____ Artificial Substrate_____ Dredge_____

SECTION II. STREAM CHARACTERISTICS (taken at the sample site)

1. Water Temp: (sample 2x and take average) a._____ b._____

2. Air Temp: (sample 1x)

3. Avg. Width: (sample 1x)

4. Avg. Depth: (sample 3x and take average) a._____ b._____ c._____

5. Avg. Velocity in ft./sec. (Sample 2x and take average) *time it takes a float to travel 10 ft.*

		sec.		ft./sec.	average [(v1 + v2) ÷ 2]
a.	10 ft ÷	_____	=	v1_____	
b.	10 ft ÷	_____	=	v2_____	=

6. Relative Flow: (circle) *relative to your estimate of year round average*

present flow: High Average Low

prev. 2 days: High Average Low

7. Sediment deposits: sludge_____ sawdust_____ sand_____ paper fiber_____ other_____

8. Does the water smell of: sewage_____ oil_____ chlorine_____ rtn eggs_____ other_____

9. Water color: green_____ tea_____ milky_____ cloudy_____ muddy_____ clear_____ other:_____

10. Algal Growth: >75%_____ 50% - 75%_____ 25% - 50%_____ 0% - 25%_____ None_____
% of bottom covered

11. Does the river appear to be straightened or channelized?: Y or N Describe:_____

12. Upstream Dam?: Y or N How far upstream is the dam?:_____

13. Are there wastewater treatment plant discharges upstream? Y or N Distance:_____

14. Do you see pipes emptying directly into or near the water Y or N How many: _____

Notes:_____

Benthic Macroinvertebrate Sample Site Field Sheet - Page 2

SECTION III. HOW WOULD YOU CHARACTERIZE THE SETTING:

Place a "D" for Dominant and "X" if Present (otherwise leave blank)

Roadless Wooded Area		Cropland		Dairy Farm		Scattered Residential	
Wooded Area w/ Roads		Grazed Pasture		Park Area		Village or Urban	
Woodlot Logging Area		Ungrazed Meadow		Golf Course		Commercial/Industrial	

SECTION IV. STREAMBANK CHARACTERISTICS

15. Left Bank (facing upstream)

Shrubs____% Grass____% Softwood____% Hardwood____% Unvegetated____%

Is upstream bank unstable or eroding into stream? _____

16. Right Bank (facing upstream)

Shrubs____% Grass____% Softwood____% Hardwood____% Unvegetated____%

Is upstream bank unstable or eroding into stream? _____

17. Please sketch a segment of the river streambank & corridor and indicate where your sample site is. (Please note any unusual observations)

(circle direction of flow) ← →

SECTION V. HABITAT CHARACTERISTICS

18. SUBSTRATE COMPOSITION - The composition of the streambed in the area of your sample.

% Bedrock____ % Boulder____ (>10") % Rubble____ (2 - 10") % Gravel____ (.1 - 2") % Sand____ (<.1") % Silt____ (easily suspended) % Organic Debris____

19. EMBEDDEDNESS - Percent surface area of larger particles (boulder, rubble or gravel) surrounded or covered by fine sediment (sand or silt).

<5% ____ 5 - 25% ____ 25 - 50% ____ 50 - 75% ____ 75+% ____

20. OVERHEAD CANOPY - Percentage of stream width covered or shadowed by overhanging grasses, shrubs and trees.

<5% ____ 5 - 25% ____ 25 - 50% ____ 50 - 75% ____ 75+% ____

Notes: _____