WI DNR PUB-WT-992

Exploring Streams:

Stream Monitoring *Curriculum Guide*

for Middle & High School Teachers & Students

HANDS-ON LEARNING ABOUT STREAMS WITHIN & OUTSIDE THE CLASSROOM

Acknowledgements

DEVELOPED BY:

Kris Stepenuck, University of Wisconsin-Extension and Wisconsin Department of Natural Resources
Katie Murphy, Middle School Science Teacher

CONTRIBUTORS AND/OR EDITORS: (Some activities previously developed for WAV)

Kevin Amundson, Poynette High School

Scott Arnold, Department of Soil Science at University of Wisconsin-Madison

Judy Aspling, Friends of the St. Croix Headwaters

Amalia Baldwin, Wisconsin Department of Natural Resources

Rebecca Betsul, Eau Claire Area School District

Laura Bruhn, Michigan State University Extension

Chris Clayton, River Alliance of Wisconsin

Kevin Fermanich, Department of Soil Science at University of Wisconsin-Madison

Ann Gaffney, Londonderry (NH) Middle School

Elizabeth Goers, University of Wisconsin-Madison

Ed Grunden

Paul Hlina

Allison Hughes, Georgia Adopt-A-Stream

Pete Jopke, Dane County Land Conservation Department

Susan Klaubert, Londonderry (NH) Middle School

Peter Kling, Department of Soil Science at University of Wisconsin-Madison

Ann Kroncke, Platteville Public School District

Carolyn Lipke, Wisconsin Department of Natural Resources

Tara Muenz, Georgia Adopt-A-Stream

Dave Niemi, Mt. Calvary-Grace Lutheran School

Mike Pelech, Department of Soil Science at University of Wisconsin-Madison

Dr. Bret Shaw, University of Wisconsin-Madison

Heather Smith, University of Wisconsin-Extension

Ed Sommers, Poynette High School

Theresa Stabo, Wisconsin Department of Natural Resources

Christophe Stoelinga

Jeff Strobel, University of Wisconsin-Extension

Ron Struss

Allison Werner, River Alliance of Wisconsin

Lois Wolfson, Michigan State University Extension

Catherine Woodward, University of Wisconsin-Madison Center for Biology Education

Andy Yencha, University of Wisconsin-Extension

Rob Zemenchik, Department of Soil Science at University of Wisconsin-Madison

Thanks to the many teachers and volunteer monitors who provided valuable input for this curriculum. We also wish to acknowledge the many volunteers who have given countless hours monitoring, training others, and working effortlessly to protect and improve their local streams. It was through their encouragement that the Water Action Volunteers (WAV) stream monitoring methods were configured for use in schools.

Many of the activities in *Exploring Streams: Stream Monitoring Curriculum Guide for Middle and High School Teachers and Students: Hands-on Learning about Streams Within and Outside the Classroom* are based on the Water Action Volunteers' Stream Monitoring Fact Sheet Series (2006).

For more information about volunteer stream monitoring opportunities in Wisconsin, and for printable pdfs of this curriculum and addendum, visit: **http://watermonitoring.uwex.edu/wav**

WI DNR PUB-WT-992 2013

Exploring Streams: Stream Monitoring Curriculum Guide for Middle and High School Teachers and Students: Hands-on Learning about Streams Within and Outside the Classroom

Wisconsin Department of Natural Resources, Box 7921, Madison, WI 53707-7921

Printing funded in part by The Department of Natural Resources' Citizen-based Monitoring Partnership Program.

Graphic Design by Jeffrey J. Strobel and Katie Gaab, UW-Extension Environmental Resources Center

Exploring Streams: Stream Monitoring Curriculum Guide

HANDS-ON LEARNING ABOUT STREAMS WITHIN & OUTSIDE THE CLASSROOM – *FOR MIDDLE & HIGH SCHOOL TEACHERS & STUDENTS*

Table of Contents

Preface .... **VI**

Section 1: Pre-Field Trip Activities *(Learning the Monitoring Procedures)* **1-1**

Activity 1: Optional Pre-test 1-2
Activity 2: The Human Watershed 1-9
Activity 3: Watershed In a Box 1-12
Activity 4: Stream Savers 1-15
Activity 5: Transparency 1-27
Activity 6: Temperature 1-32
Activity 7: Dissolved Oxygen 1-36
Activity 8: Stream Flow 1-41
Activity 9: Habitat Assessment 1-44
Activity 10: Biotic Index 1-51
Pre-Field Trip Optional Activity Descriptions 1-55
E. coli Bacteria Monitoring 1-55
Erosion in a Bottle 1-63
Urban Runoff Model 1-68
Transparency Tube Case Construction 1-72
Stream Ecosystem – What Makes a Stream Healthy? 1-73
Parts Per Million Lab 1-78
Making and Using Dichotomous Keys 1-82
Researching Macroinvertebrates 1-84
Stream Walk Survey 1-88
What is a Watershed Video 1-94
Optional Activities From Other Sources 1-96

Section 2: Field Trip **2-1**

Station 1: Finding Your Watershed and Transparency 2-5
Station 2: Temperature / Water Samples / Magic Spots 2-10
Station 3: Dissolved Oxygen 2-15
Station 4: Stream Flow 2-17
Station 5: Habitat Assessment 2-19
Station 6: Macroinvertebrate Collection 2-21
Station 7: Macroinvertebrate Identification 2-24
Optional Activities From Other Sources 2-25

Section 3: Post Field Trip *(Calculation of Results and Data Interpretation)* **3-1**

Activity 1: Calculating Transparency Statistics 3-3

Activity 2: Calculating Water Temperature Statistics 3-3

Activity 3: Calculating Dissolved Oxygen in Percent Saturation and Statistics 3-4

Activity 4: Calculating Stream Flow and Statistics 3-4

Activity 5: Calculating Habitat Assessment Statistics 3-5

Activity 6: Calculating a Biotic Index Score and Statistics 3-6

Post Field-Trip Optional Activities 3-7

E. coli Sample Incubation, Colony Counting and Calculating *E. coli* 3-7

Statistics 3-7

Assessment 3-8

Computer Graphing and Presentations 3-15

Community Outreach: Letter to the Editor 3-17

Community Outreach: Video/PowerPoint Presentation of Project 3-19

Community Issue-based Research and Role Play 3-20

Scientific Reports 3-23

Data Entry to the Water Action Volunteers Online Database 3-25

Thank You Notes 3-26

Storm Drain Stenciling 3-27

River Cleanup 3-30

Optional Activities From Other Sources 3-33

Section 4: Student Workbook **4-1**

Section 5: Resources **5-1**

Water Action Volunteers' Education Materials 5-2

Related Wisconsin Curricula 5-2

Other Educational Resources 5-3

Wisconsin Model Academic Standards 5-4

I. Agricultural Education 5-4

II. English 5-4

III. Environmental Education 5-5

IV. Information and Technology Literacy 5-6

V. Mathematics: Measurement 5-10

VI. Mathematics: Statistics and Probability 5-11

VII. Science A, Science Connections 5-11

VIII. Science B, Nature of Science 5-12

IX. Science C, Science Inquiry 5-12
X. Science F, Life and Environmental Science 5-13
XI. Science H, Science in Personal and Social Perspectives 5-14
XII. Social Studies 5-14
Wisconsin's Major Watersheds and Watershed Education Resource Center Contacts 5-15
Connecting with Volunteers in Your Community to Assist with your Field Trip 5-16

Section 6: Field Trip Materials 6-1
A. Equipment Bin Materials Lists 6-2
B: Field Trip Procedures 6-4
Station 1: Topographical Maps *(Finding Your Watershed)* and Transparency 6-5
Station 2: Temperature / Water Sample / Magic Spots 6-7
Station 3: Dissolved Oxygen 6-9
Station 4: Stream Flow 6-10
Station 5: Habitat Assessment 6-12
Station 6: Macroinvertebrate Collection 6-13
Station 7: Macroinvertebrate Identification 6-16
C: Student Field Data Sheets 6-17
D: Station Leader Data Sheets 6-23

PREFACE

Streams are dynamic places to study! Middle and high school students will learn about at least six aspects of stream health in this Water Action Volunteers (WAV) stream monitoring curriculum. The following activity guide is divided into six sections:

Section 1:	Pre-Field Trip Activities
Section 2:	Field Trip Activities
Section 3:	Post Field Trip Activities
Section 4:	Student Workbook
Section 5:	Resources
Section 6:	Field Trip Materials

The first three sections contain teacher guidelines and activity descriptions designed to allow students to learn why water monitoring is important and methods to assess water quality. Optional extension activities are listed within each section, offering teachers the opportunity to address a topic in more depth if time and interest allow. Answer keys are provided for teacher reference where relevant. The fourth section, a student workbook, is designed to be photocopied (or printed from the WAV website) and distributed to students. Each student will work through the activities to learn how to monitor stream health as guided by their teacher and field trip facilitators. The fifth section contains resources that are referenced in or that augment the curriculum. The final section contains information and materials for use during the field trip.

We expect that carrying out the basic activities in these sections will take approximately three to four weeks of class time (depending on scheduling and depth of coverage), including one half-day to a full-day field trip. Resources are provided to extend the unit beyond this time period for teachers who are interested in doing so. Each activity is aligned with Wisconsin Model Academic Standards for grades 8 and 12. As this curriculum was developed during the shift to Common Core State Standards, an addendum has been developed to aid teachers in understanding how these new standards align with each activity. The addendum will be updated as new core curriculum standards are approved. (Visit: **http://watermonitoring.uwex.edu/wav** for printable pdfs of this curriculum and addendum.) The basic program is set up as follows:

Sample schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
WEEK 1	Water monitoring pre-test and The Human Watershed	Why We Care: What is a Watershed video	Why We Care: Watershed in a Box and Are You a Stream Saver?	How does transparency show the health of a stream? Video, discussion, method and data recording practice	How do temperature and dissolved oxygen show the health of a stream? Videos, discussion, method and data recording practice
WEEK 2	How does stream flow show the health of a stream? Video and discussion	How does habitat show the health of a stream? Video, discussion, method and data recording practice	How does biotic index show the health of a stream? Video, discussion, method and data recording practice	Field trip	(Field trip rain date)
WEEK 3	Calculate mean, median, mode and range for data	Discuss real world applications of water monitoring results. Assign reports.			Water monitoring post-test
WEEK 4	Report presentations	Report presentations			

Week 1 (3-5 days in classroom): To help students understand why we care about studying water, they will first be introduced to the concept of a watershed and will learn about how our uses of the land can affect water quality. Then to prepare to monitor a local stream, they will watch short (2-15 minute) videos about each monitoring method, read information about each to supplement the video training, and then practice the tests (when possible) in the classroom. The students will answer discussion questions for each parameter and will hypothesize what results they will find for each parameter when they monitor during the field trip. Students may have to answer some questions as homework.

Week 2 (3 days in classroom, 1 day in field): Students will complete watching videos and practicing how to monitor the parameters. Then students will take a one-half to a full day field trip to a local stream site. Field trip length depends on distance to the stream site from the school and teacher preference. Students will monitor at least six parameters and will complete a watershed activity.

Weeks 3 and 4 (2-4 days each in classroom): Students will make calculations to determine results of their monitoring efforts during the field trip. They will analyze their results and make conclusions about their findings. Optional extension activities include having students outreach to their local community with results of their monitoring (e.g., by writing a letter to the editor or visiting a town board), researching the meaning of their findings and making conclusions and recommendations for community action, preparing a report, and learning more about the science of streams by conducting various experiments.

▶ SECTION 1: PRE-FIELD TRIP ACTIVITIES

(LEARNING THE MONITORING PROCEDURES)

Contents

Activity 1:
Optional Pre-Test................ p. 1-2 to 1-8

Activity 2:
The Human Watershed....... p. 1-9 to 1-11

Activity 3:
Watershed In a Box ....p. 1-12 to 1-14

Activity 4:
Stream Savers .... p. 1-15 to 1-26

Activity 5:
Transparency.................. p. 1-27 to 1-31

Activity 6:
Temperature................... p. 1-32 to 1-35

Activity 7:
Dissolved Oxygen............ p. 1-36 to 1-40

Activity 8:
Stream Flow.................... p. 1-41 to 1-43

Activity 9:
Habitat .... p. 1-44 to 1-50

Activity 10:
Biotic Index .... p. 1-51 to 1-54

Pre-Field-Trip Optional
Activity Descriptions........ p. 1-55 to 1-95

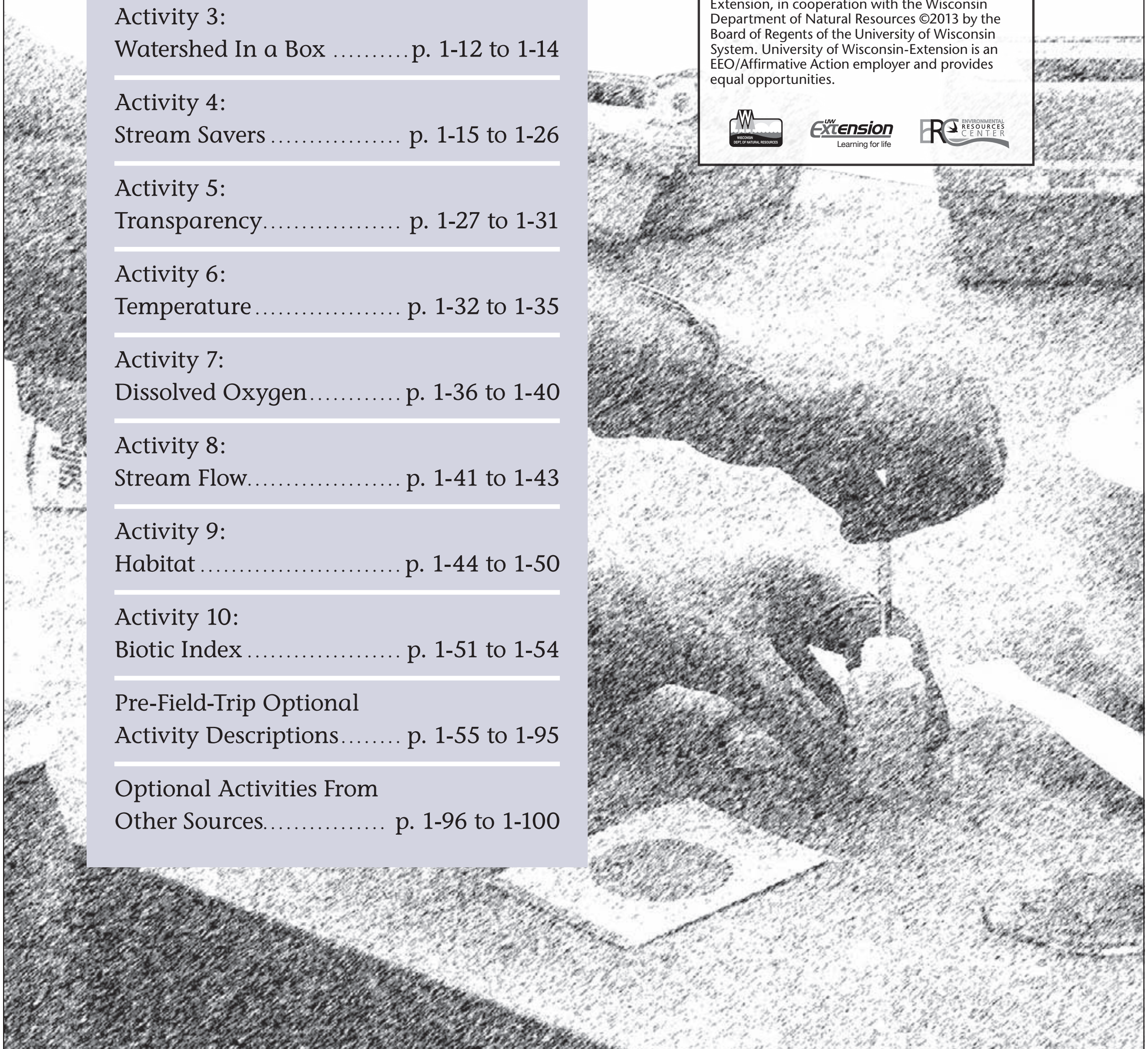
Optional Activities From
Other Sources................ p. 1-96 to 1-100

Section 1 of six curriculum sections

Developed by Kris Stepenuck, University of Wisconsin-Extension and Wisconsin Dept. of Natural Resources; and Katie Murphy, Middle School Science Teacher

For more information about volunteer stream monitoring opportunities in Wisconsin, and for printable pdfs of this curriculum visit:

watermonitoring.uwex.edu/wav



HANDS-ON LEARNING ABOUT STREAMS WITHIN & OUTSIDE THE CLASSROOM – *FOR MIDDLE & HIGH SCHOOL TEACHERS & STUDENTS*

ACTIVITY 1: OPTIONAL PRE-TEST

Learning Objectives:

- Students will show what background knowledge on stream health they already possess.

Materials:

- Pre-test
- Writing instrument
- Pre-test answer key

Time: 30 minutes

PROCEDURE:

1. Students answer the questions on the test to the best of their ability.
2. Teachers will score these, but not share the results with the students until after the students have taken the test again at the end of this mini-unit on stream health.

Name: ____

Date: ____

Period: ____

Stream Water Monitoring Pre-Test

Matching: Write the letter for the correct vocabulary word on the line next to the definition.

A. Turbidity	F. Riparian zone
B. Respiration	G. Photosynthesis
C. Macroinvertebrates	H. Riffle
D. Substrate	I. Impervious surface
E. Watershed	J. Transparency

_____1. An area of land that drains to a main body of water.

_____2. The land between the water's edge and the upper edge of the flood plain.

_____3. The stream bottom surface on which plants and animals attach or live.

_____4. Small animals without backbones that are visible to the human eye.

_____5. Cloudiness in the water caused by suspended particles.

_____6. The process in which green plants convert carbon dioxide and water, using the sun's energy, into simple sugars and oxygen.

_____7. The cellular process in which plants and animals use oxygen and release carbon dioxide.

_____8. A measure of water clarity.

_____9. Shallow area in stream where water flows swiftly over rocks.

_____10. A surface that does not allow water to pass through it.

Multiple Choice: Choose the best answer for each question and write the corresponding letter on the line.

_____11. Warm water holds ______________ dissolved oxygen than/as cold water.

A. More
B. Less
C. The same amount of

_____12. Streams with greater turbidity will likely

A. Be colder
B. Have more dissolved oxygen
C. Have less light penetration

_____13. Water clarity can be a useful indicator of

A. Industrial discharges
B. Runoff from construction sites or fields
C. Both A and B

_____14. The biotic index is

A. A reference book often used when studying Biology
B. A scale used to evaluate stream health based on its macroinvertebrate population
C. A list of macroinvertebrates found in the back of a book

_____15. Food sources, spawning areas and migration paths of fish and other wildlife are all affected and defined by

A. Stream flow and velocity
B. Substrate
C. Riffle zones
D. Both B and C

_____16. Signs of fish stress include

A. Increased respiration
B. Faster scale growth
C. Reduced feeding rates
D. Both A and C

_____17. Streams that are healthy will have

A. A large population of pollution tolerant macroinvertebrates
B. A large population of pollution sensitive macroinvertebrates
C. A wide variety of both pollution tolerant and pollution sensitive macroinvertebrates

_____18. What type(s) of habitat(s) would support a more diverse fish and insect population?

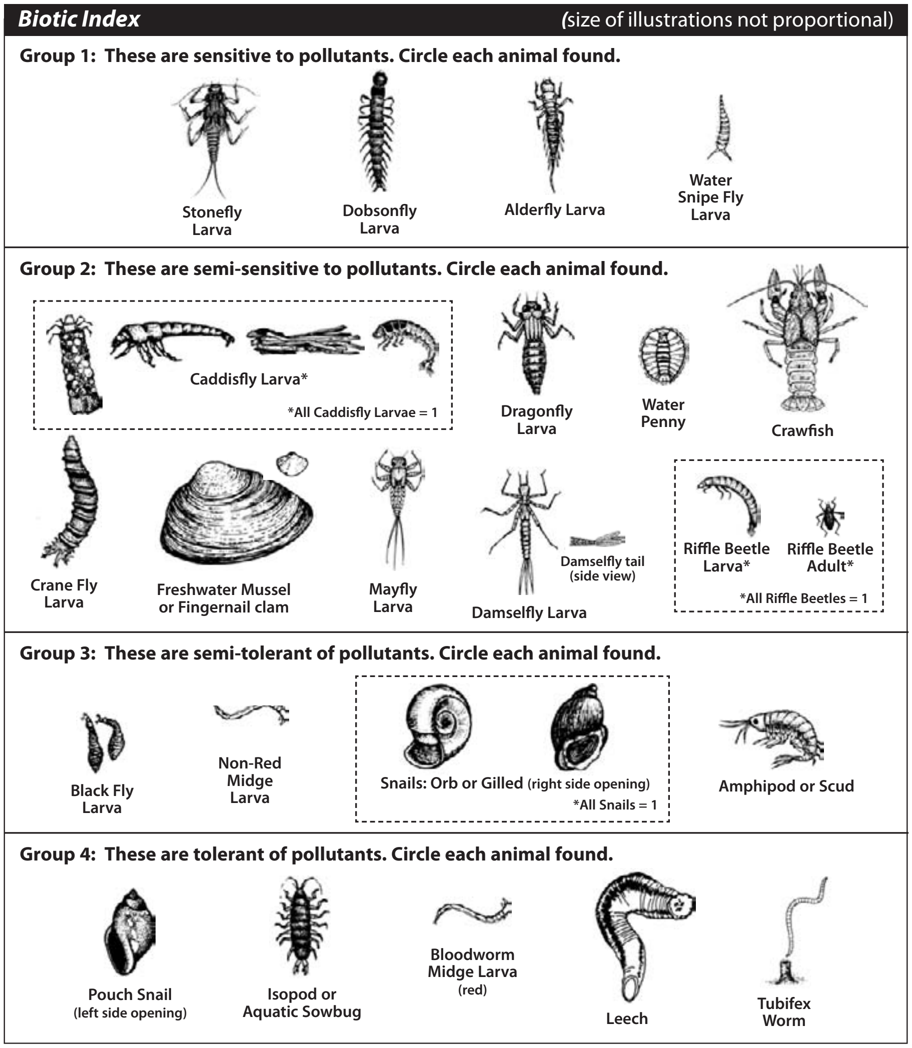
A. Riffles
B. Pools
C. Runs
D. A combination of A, B and C

_____19. What can the shape and condition of the streambank provide clues to?

A. Land uses in the adjacent watershed
B. The number of animals living nearby
C. How much water to expect during snowmelt season

Short Answer: Answer the following to the best of your ability. Use complete sentences.

20. If you collected caddisflies, mayflies, riffle beetles, amphipods, and both non-red midges and bloodworms, what would your biotic index score be?



Group Number	Number of Animals			Scoring (add the 4 groups for total)
Group 1	________	x4	=	________
Group 2	________	x3	=	________
Group 3	________	x2	=	________
Group 4	________	x1	=	________

Total Number = [ ] Total Score = [ ]

Total Score [ ] / Total Number [ ] = [ ]

(3.6+=Excellent, 2.6-3.5=Good, 2.1-2.5=Fair, 1.0-2.0=Poor) Index Score

21. Name at least three factors that can influence stream flow and velocity.

22. Explain why dissolved oxygen levels may be higher in the day than they are at night.

23. What are some advantages to using macroinvertebrates to identify water quality as compared to studying other physical or chemical aspects of water quality?

24. What impact(s), if any, might a cheese factory have on a nearby stream?

25. What would you expect to find in a healthy riparian zone? What purpose does the riparian zone serve for the health of the stream?

Stream Water Monitoring Pre-Test (TEACHER KEY)

Matching: Write the letter for the correct vocabulary word on the line next to the definition.

A. Turbidity	F. Riparian zone
B. Respiration	G. Photosynthesis
C. Macroinvertebrates	H. Riffle
D. Substrate	I. Impervious surface
E. Watershed	J. Transparency

__ __ 1. An area of land that drains to a main body of water.

__ __ 2. The land between the water's edge and the upper edge of the flood plain.

__ __ 3. The stream bottom surface on which plants and animals attach or live.

__ __ 4. Small animals without backbones that are visible to the human eye.

__ __ 5. Cloudiness in the water caused by suspended particles.

__ __ 6. The process in which green plants convert carbon dioxide and water, using the sun's energy, into simple sugars and oxygen.

__ __ 7. The cellular process in which plants and animals use oxygen and release carbon dioxide.

__ __ 8. A measure of water clarity.

__ __ 9. Shallow area in stream where water flows swiftly over rocks.

__ __ 10. A surface that does not allow water to pass through.

Multiple Choice: Choose the best answer for each question and write the corresponding letter on the line.

__ __ 11. Warm water holds ______________ dissolved oxygen than/as cold water.

A. More
B. Less
C. The same amount of

__ __ 12. Streams with greater turbidity will likely

A. Be colder
B. Have more dissolved oxygen
C. Have less light penetration

__ __ 13. Water clarity can be a useful indicator of

A. Industrial discharges
B. Runoff from construction sites or fields
C. Both A and B

__ __ 14. The biotic index is

A. A reference book often used when studying Biology
B. A scale used to evaluate stream health based on its macroinvertebrate population
C. A list of macroinvertebrates found in the back of a book

__ __ 15. Food sources, spawning areas and migration paths of fish and other wildlife are all affected and defined by

A. Atream flow and velocity
B. Substrate
C. Riffle zones
D. Both B and C

__ __ 16. Signs of fish stress include

A. Increased respiration
B. Faster scale growth
C. Reduced feeding rates
D. Both A and C

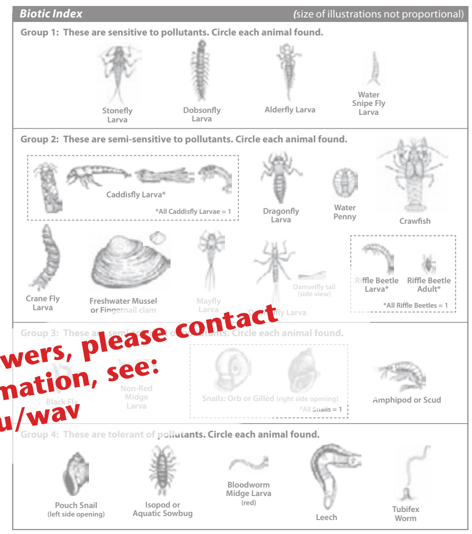
__ __ 17. Streams that are healthy will have
- A. A large population of pollution tolerant macroinvertebrates
- B. A large population of pollution sensitive macroinvertebrates
- C. A wide variety of both pollution tolerant and pollution sensitive macroinvertebrates

__ __ 18. What type(s) of habitat(s) would support a more diverse fish and insect population?
- A. Riffles
- B. Pools
- C. Runs
- D. A combination of A, B and C

__ __ 19. What can the shape and condition of the streambank provide clues to
- A. Land uses in the adjacent watershed
- B. The number of animals living nearby
- C. How much water to expect during snowmelt season

Short Answer: Answer the following to the best of your ability. Use complete sentences.

20. If you collected caddisflies, mayflies, riffle beetles, amphipods, and both non-red midges and bloodworms, what would your biotic index score be?



Group Number	Number of Animals			Scoring (add the 4 groups for total)
Group 1	______	______	x4	=
Group 2				
Group 3				
Group 4				

Total Number = ______ Total Score = ______

Total Score ______ / Total Number ______ = ______

(3.6+=Excellent, 2.6-3.5=Good, 2.1-2.5=Fair, 1.0-2.0=Poor) Index Score

21. List at least three factors that can influence stream flow and velocity. (Complete sentences are not necessary on this question).

Teachers use your judgment. Student answers may include but are not limited to the following:

22. Explain why dissolved oxygen levels may be higher in the day than they are at night.

23. What are some advantages to using macroinvertebrates to identify water quality as compared to studying other physical or chemical aspects of water quality?

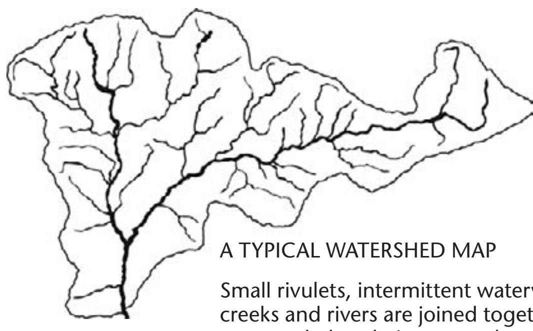
24. What impact(s), if any, might a cheese factory have on a nearby stream?

25. What would you expect to find in a healthy riparian zone? What purpose does the riparian zone serve for the health of the stream?

ACTIVITY 2: THE HUMAN WATERSHED

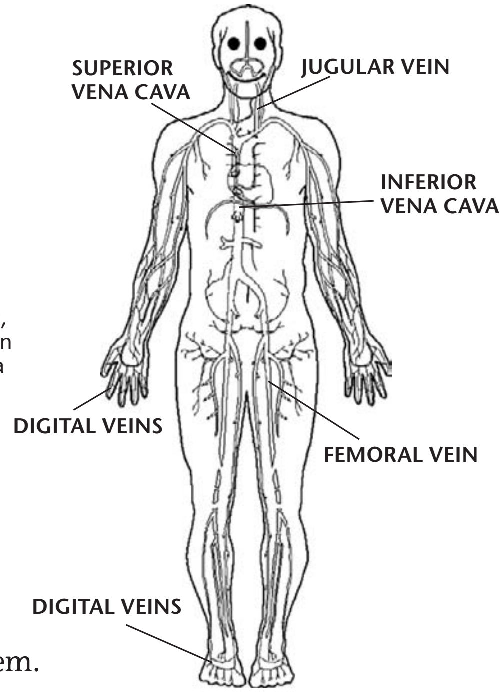
Activity developed by Andy Yencha, UW-Extension.

Students will compare the human circulation system to the streams and rivers that crisscross Wisconsin.



A TYPICAL WATERSHED MAP

Small rivulets, intermittent waterways, creeks and rivers are joined together in a network that drains water through a large area.



Learning Objectives:

By participating in this activity, students will:

- Compare the similarities between a human circulatory system and a typical waterway system.
- Identify and locate various blood vessels in the human body.
- Identify and locate major streams and rivers in Wisconsin.

Standards:

Environmental Education A.8.4, A.8.5; Science Connections A.8.6; Science Inquiry C.8.4, C.8.6

Materials:

- Two poster-sized sheets of paper for the instructor
- Two letter-sized sheets of paper for each participant, or rolled paper to draw actual body outlines
- Red, blue, and black colored markers, pencils, pens, crayons
- A Wisconsin road map or topographic map (or localize this activity by using a map of your local watershed instead)

You can obtain U.S. Geological Survey topographical maps online (at: http://topomaps.usgs.gov). Your UW-Extension office or county Land Conservation Department may also be able to help you find a map of your watershed.

Time:

15 minutes preparation time, plus 45 minutes to do the activity (Note: This activity can be abbreviated by having students work in teams to do the sketches, or limit the activity to a comparison and discussion of the wall posters.)

Background:

The blood vessels that return blood to the heart are much like the streams, creeks and rivers that carry surface water through a watershed. Very tiny capillaries in the tips of our toes return blood through increasingly larger vessels on the way to the heart. In similar fashion, rain water and snowmelt flow off the land, first via small rivulets, then intermittent streams and then via larger creeks and rivers. The blood vessels which carry blood to our hearts are classified by increasing size: capillaries (smallest), venules (mid-sized) and veins (largest).

Streams have a classification system as well. The smallest streams on the edge of a watershed are called first-order streams. When two first-order streams join, they form a second-order stream. When two second-order streams meet, they form a third-order stream. The largest rivers in the world like the Amazon and the Mississippi are considered 9th- and 10th-order streams. The largest veins in the body – the inferior and superior vena cava – average ¾ to 1¼ inches in diameter.

PROCEDURE:

1. Before your group arrives, outline the boundaries of Wisconsin on poster-sized paper. Accuracy is not that important. Include a few local towns and roads so your group knows where they live on the map. Don't sketch-in the streams yet!
2. Sketch a human outline on poster-sized paper the best you can. Don't sketch-in any blood vessels yet!
3. Tape human outline on wall.
4. Keep the Wisconsin map out-of-sight for now.
5. When students arrive, pass out paper/markers. Give everyone in the group paper, and a blue, red and black marker.
6. Have the group sketch a human outline. Let them use the outline taped to the wall for inspiration, but encourage creativity.
7. Ask the group how the blood in the tips of their toes and fingers gets to their heart. Ask them to name the different blood vessel types (i.e., veins, venules, capillaries) and explain why they are different. Continue this discussion as far as your knowledge of the cardiovascular system will carry you.

8. Have each student draw blood vessels. Starting at the tips of the toes, use a red marker to sketch (use the example on page 1-9 for guidance) a pathway of capillaries, venules, and veins leading to the heart. When completed, have them set these drawings aside.

9. Next, discuss watersheds with the group. Ask the group where the water in a well known creek or river comes from and goes to. Discuss how rain and melted snow start the journey to small rivulets and intermittent waterways, before forming creeks and rivers. If they mention groundwater springs, ask them where groundwater comes from. (Answer: surface water that soaks into the ground.)

10. Tape Wisconsin map on wall. Ask the group to identify their current location on the map.

11. Have the group copy the outline of Wisconsin on their paper.

12. Ask for volunteers to name major streams and rivers in Wisconsin. Find these waterways on the wall map. Ask the group to copy them to their personal maps.

13. Ask the group to compare their drawings. Keep these things in mind: Blood vessels and streams share many similarities. They both:

    i. Carry life-giving water and nutrients

        1. Streams enrich the landscape

        2. Blood nourishes the body

    ii. Remove waste

        1. Streams remove sediment and nutrients

        2. Blood removes metabolic waste

    iii. Work in cycles

        1. The hydraulic cycle for streams

        2. The circulation system for blood

    iv. Are affected by human decisions

        1. Wise land management promotes clean streams

        2. A healthy lifestyle promotes a healthy body

Optional Activity:

- Stream Walk Survey (see page 1-88)

ACTIVITY 3: WATERSHED IN A BOX

Learning Objectives:

- Students will understand why we care about monitoring water quality in streams.
- Students will begin to make a connection between our actions on the land and the effects on water quality.
- Students will learn what a watershed is.
- Students will distinguish between point source and nonpoint source pollution.
- Students will create a model to represent nonpoint source pollution and demonstrate how this pollution affects surface water.
- Students will design a community that will try to minimize the effects of pollution on surface water.

Standards:

Agricultural Education B.8.3, E.8.2; Environmental Education B.8.5, B.8.15, B.8.19, B.12.3, B.12.17, D.8.1; Science Connections A.8.6 ; Science Inquiry C.8.1, C.8.3, C.8.5, C.8.6, C.8.11; Life and Environmental Science F.8.8, F.8.10

Materials for each model:

- A box cover or other shallow box that is 12” x 12” or larger
- Foam pieces, Styrofoam® or paper
- Heavy-duty aluminum foil or white plastic bag
- Permanent markers
- Spray bottle
- Cup of water
- Powdered, unsweetened drink mix – two or three different colors
- Bucket

Time:

25 minutes

Background:

No matter where you live, the water quality in rivers and streams is determined by what happens on the land around them. The area of land that drains to a stream or river is called a watershed.

One watershed is separated from another watershed by a low rise, the crest of a hill or a mountain chain. Rain or snow that falls on opposite sides of the higher land results in water flowing into different watersheds. Not all watersheds are the same. Some watersheds are hilly, while other watersheds are flat plains. Regardless, precipitation that falls within the watershed that does not infiltrate into the ground, flows over land to reach a lower point – a lake, river or stream.

As water flows over land, it picks up soil, chemicals and other pollutants and carries them to lakes, rivers or streams. This water transportation system is called runoff.

In rural or agricultural areas, runoff water carries a wide variety of materials, including pesticides, soil and animal wastes, directly into waterways.

In urban areas, hard surfaces such as driveways, sidewalks, rooftops and roadways prevent water from soaking into the ground. As a result, the runoff water, which can be contaminated with road salt, heavy metals or automobile fluids, flushes quickly into storm drains that dump directly into streams and rivers.

Pollutants that do not have a single source are called nonpoint source pollution. This pollution originates from many different places.

Everyone lives in a watershed. We may not realize that what happens somewhere in the watershed will eventually have an impact on a lower point in the watershed – a lake, a river, or a stream.

PROCEDURE:

1. Use a box cover or a shallow box to contain the runoff model.
2. Arrange pieces of foam or crumpled paper to represent hills and land forms in the bottom of the box. Encourage your group to be creative. Remember, the highest points should be near the box walls. Leave a gully or valley in the middle of the box to represent a stream or river.
3. Cover the land forms with a large piece of aluminum foil, shiny side up. Start in the middle of the box and gently press the foil into all of the hills and valleys, working your way towards the box walls. Push the edges of the foil up along the walls of the box and fold the foil over the edge of the box. Be careful not to tear the foil.

4. With a permanent marker, draw on the foil to outline the streams or rivers in your model. Next, draw houses, roads, farm fields, feed lots, stores or anything else that you want in your community.

5. Sprinkle different colors of powdered drink mix onto the model. The colors represent different kinds of pollution. For example:

   - Use red powder to represent yard care chemicals and sprinkle it around the houses.
   - Use green powder to represent salt on the roads or automobile waste and sprinkle it along roadways or in a parking lot.
   - Use brown powder to represent exposed soil at a farm field or a construction site.
   - Use blue powder to represent human or animal waste and leave little piles of powder near homes and farms.

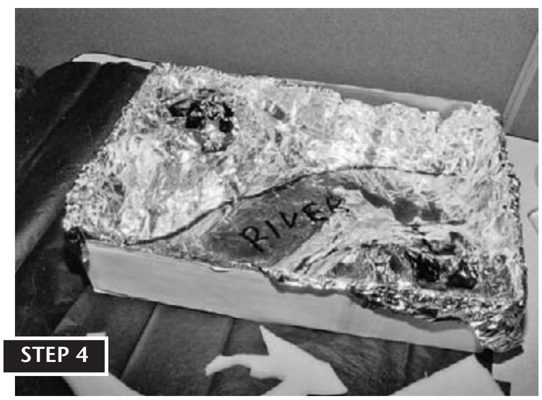
6. Ask the group what they think would happen if it rained.

7. Using the spray bottle to represent a rain storm, spray water on the hillsides. Watch the water flow toward the rivers and streams.

8. Ask the group to tell you what happened. Then ask the group how they would redesign the community to prevent water pollution.

9. Dump the water from the model into a bucket. Remove the foil from the model and set it aside. Place a new piece of foil on the watershed. Ask the group to redesign the community to prevent water pollution. Sprinkle powdered drink mix in the appropriate areas. Let it rain. Was there an improvement?

10. Ask the group what parameters they might monitor in a stream to help assess effects of our uses of the land on water quality. Discuss with students the types of water pollution issues that local communities are facing as a result of land use.



STEP 4

STEP 5

STEP 7

ACTIVITY 4: STREAM SAVERS

This activity was developed by and is used here with permission from Georgia Adopt-A-Stream (http://www.georgiaadoptastream.org). It has been slightly modified from its original version.

Learning Objectives:

Students will be able to identify practices that contribute to nonpoint source pollution.

Standards:

Agricultural Education B.8.3, E.8.2; Environmental Education B.8.5, B.8.8, B.8.10, B.8.15, B.8.17, B.8.18, B.8.19, B.8.21, B.12.11; Science Connections A.8.1, A.12.2; Nature of Science B.8.6; Life and Environmental Science F.8.9, F.12.8

Materials:

Each group will need:

- One die from another game board
- Playing board (included in the back of this curriculum)
- Cards (included on pages 1-23 to 1-26 – copy a set for each group)
- Squares from different color construction paper or various coins to use as game pieces (Optional: Vials with aquatic insects or cut-outs of invertebrates from the Key to Life in the River, included in the back of this curriculum)

Time:

30-45 minutes

Background:

Pollution is divided into two groups, depending on how the pollution enters a body of water. Point source pollution is waste that comes from a specific point. Factories and wastewater treatment plants may have discharge pipes that lead directly to a waterway. These are considered point sources because they are easily identified as coming from one site.

Nonpoint source pollution comes from more than one specific location. It results from the runoff of water (e.g., rainfall, snowmelt, etc.) over land. As water passes over the ground, it picks up pollutants and carries them into local streams and rivers. Nonpoint source pollution can also result from airborne pollutants that are deposited in waterways.

Nonpoint sources can be either rural or urban. Nonpoint source pollution in rural areas usually results from such things as poor agricultural or forestry practices but can also include runoff such as trash, oil, gas and fertilizers from lawns, the common culprit in urban and suburban areas.

CAUSES AND POSSIBLE SOLUTIONS FOR NONPOINT SOURCE POLLUTION

Cause (POLLUTANT OR STRESSOR)

Sediment & Siltation

Possible Sources

- Construction
- Cropland/Pasture
- Forestry activities
- Gullies
- Livestock operations
- Mining operations
- Roads
- Storm drains
- Streambanks
- Other land-disturbing activities

Potential Adverse Impacts

Suspended sediment decreases recreational values, reduces fishery habitat, reduces sunlight penetration, increases water temperature, adds to mechanical wear on water supply pumps and distribution systems, and adds treatment costs for water supplies. Nutrients and toxic substances attached to sediment particles may enter aquatic food chains, cause fish toxicity problems, impair recreational uses or degrade the water as a drinking water source.

Possible Solutions

Construction site managers should implement both short-term and long-term water pollution management practices. Construction removes vegetation from the ground, inviting erosion and thereby sediment pollution to streams. Practices to reduce erosion include diverting water flow to sediment ponds that allow silt and other materials to settle before water runs off into streams. Silt screens, hay bales, mulch, and planting temporary grasses can all be used to control erosion before more permanent landscaping can be done.

Cause (POLLUTANT OR STRESSOR)

Nutrients (Phosphorus, Nitrogen)

Possible Sources

- Erosion and runoff from fertilized fields
- Urban runoff
- Wastewater plants
- Industrial discharges
- Septic systems
- Animal production operations
- Cropland or pasture where manure is spread

Potential Adverse Impacts

Nutrients are essential for the growth and survival of aquatic plants and animals. Excess nutrients may cause excessive algae and aquatic plant growth, which may choke open waters and consume oxygen (primarily from decomposition of dead plants and algae). These conditions will adversely affect fish and aquatic organisms, fishing and boating, and the taste and odor of drinking water. High levels of nitrogen contaminants in drinking water may cause methoglobinemia (blood disease) in infants, and have forced the closure of many water supplies.

Possible Solutions

Conservation tillage can be used to reduce erosion and sediment pollution (and therefore nutrient pollution). Instead of plowing under the residue from a previous crop and exposing bare soil, conservation tillage uses a disc to cut through the residue to plant seeds. This allows a protective layer of vegetation to remain on top of the soil to retard erosion and to retain more water in the soil. Agricultural Extension provides soil testing to determine the need for fertilizers. The tests will indicate which nutrients are needed so over-fertilization does not occur. Buffers of vegetation next to a stream also help prevent overland runoff.

Cause (POLLUTANT OR STRESSOR)

Pathogens (Bacteria & viruses)

Possible Sources

- Human and animal excreta
- Animal operations
- Cropland or pasture
- Wastewater treatment
- Septic systems
- Urban runoff
- Wildlife

Potential Adverse Impacts

Waterborne diseases may be transmitted to humans through drinking or contact with pathogen-laden water. Eating shellfish taken from or uncooked crops irrigated with pathogen-laden waters may also transmit waterborne diseases. The principal concern in both surface and ground waters is the potential degradation of public water supply sources. Pathogens reaching a lake or other surface water may limit primary contact recreation, such as swimming.

Possible Solutions

A farm waste management system must have three basic components: collection, transportation, and storage or disposal of animal wastes. Many facilities have storage ponds that treat wastes before discharging into waters. Sometimes animal manure or composted manure is sold to be used as fertilizer on fields.

Cause (POLLUTANT OR STRESSOR)

Pesticides

Possible Sources

- All land where pesticides are used
- Urban runoff
- All sites of historical usage (e.g., chlorinated pesticides)
- Irrigation return flows

Potential Adverse Impacts

Pesticides may enter surface waters either dissolved in runoff or attached to sediment or organic materials and may enter groundwater through soil infiltration. Principal concerns in surface water include entry into the food chain, bioaccumulation, toxic effects on fish, wildlife and microorganisms, habitat degradation and potential degradation of public water supply sources. Groundwater impacts are primarily related to water supply sources.

Possible Solutions

Integrated pest management (IPM) can be used to identify the pest control methods that will be the most environmentally-friendly and least hazardous to human health. In IPM, pests are monitored and threshold levels at which action will be necessary to prevent troublesome populations are identified. Steps are taken to prevent pest populations from reaching threshold levels, but if they do, the least risky control methods are implemented before pesticides are sprayed. These include trapping pests or using pheromones to disrupt their reproduction.

Cause (POLLUTANT OR STRESSOR)

Toxic Substances
(Heavy Metals, Oil & Petroleum Products)

Possible Sources

- Urban runoff
- Wastewater treatment
- Industrial discharges

Potential Adverse Impacts

Toxic substances may enter surface waters either dissolved in runoff or attached to sediment or organic materials and may enter groundwater through soil infiltration. Principal concerns in surface water include entry into the food chain, bioaccumulation, toxic effects on fish, wildlife and microorganisms, habitat degradation and potential degradation of public water supplies. Groundwater impacts are primarily related to degradation of water supply sources.

Possible Solutions

Urban runoff is still controlled primarily by voluntary means, but cities have adopted new practices like leaf collection and street cleaning at critical times, that can reduce the flow of sediment and other contaminants into waterways. Detention-retention ponds have been incorporated into some water control systems to allow contaminants to settle, and to feed rainwater into runoff channels at a controlled rate.

Cause (POLLUTANT OR STRESSOR)

Organic Enrichment (Depletion of Dissolved Oxygen)

Possible Sources

- Human and animal excreta
- Decaying plant and animal matter
- Discarded litter and food waste

Potential Adverse Impacts

Organic materials may enter surface waters dissolved or suspended in runoff. Natural decomposition of these materials may deplete oxygen supplies in surface waters below the threshold necessary to maintain aquatic life.

Possible Solutions

On farms, careful manure management can help minimize organic inputs to streams. Farmers can work with trusted sources such as Extension to identify high risk areas (e.g., highly erodible soils, steep slopes, karst topography), and high risk times (e.g., when soil moisture is already high, frozen ground) where manure spreading should be minimized. Homeowners can remove leaves from storm drains and refrain from dumping grass clippings into waterways. Backyard composting of these materials can produce a nutrient-rich compost to enrich gardens later on.

Cause (POLLUTANT OR STRESSOR)

Thermal Stress & Sunlight

Possible Sources

- Riparian corridor destruction
- Bank destruction
- Urban runoff
- Hydromodifications
- Industrial discharges

Potential Adverse Impacts

Direct exposure of sunlight to streams (e.g., by cutting trees along banks) may elevate stream temperatures, which can exceed fish tolerance limits, reduce dissolved oxygen and promote the growth of nuisance algae. Thermal stress may also be the result of stormwater runoff, which is heated as it flows over urban streets. Hydomodifications that create wider, shallower channels create more surface area and allow for quicker temperature changes. Modifications that create pools and increase the storage time of water may also contribute to thermal stress by increasing surface area and not allowing the warmed water to wash out of the watershed. Coldwater fish may be eliminated or only marginally supported in streams affected by thermal stress.

Possible Solutions

Many logging companies use selective cutting practices that allow for better timber choices and minimal impact on the land. Logging roads may wind around hills to reduce erosion and allow natural growth to quickly "retake" the land after cutting is finished. A "buffer zone," an area of timber lining the streambanks, can be left. The remaining trees reduce the amount of erosion reaching the stream and the trees shade the stream leaving the water temperature normal.

Cause (POLLUTANT OR STRESSOR) pH Level

Possible Sources

- Mine drainage
- Mine tailings runoff
- Atmospheric deposition
- Industrial point source discharges

Potential Adverse Impacts

Acidic or alkaline waters will adversely affect many biological processes. Low pH or acidic conditions adversely affect the reproduction and development of fish and amphibians, and can decrease microbial activity important to nutrient cycling. An extremely low pH will kill all aquatic life. Acidic conditions can also cause the release of toxic metals that were attached to sediments into the water column. High pH, or alkaline conditions, can cause ammonia toxicity in aquatic organisms.

Possible Solutions

Factories with smokestacks can install scrubbers which operate like filters to remove sulfur particles and gases that result during coal and petroleum processing that would soon become airborne.

Cause (POLLUTANT OR STRESSOR) Flow Alterations

Possible Sources

- Channeling
- Dams
- Dredging
- Streambank modifications

Potential Adverse Impacts

Hydrologic modifications alter the flow of streamwater. Structures or activities in the water body that alter stream flow may in turn be the source of stressors, such as habitat modifications, or exacerbate others, such as thermal stress. Dams may also act as a barrier to the upstream migration of aquatic organisms. Stream flow alterations may result from a stressor such as sedimentation, which may change a streambed from narrow with deep pools to broad and shallow.

Possible Solutions

Streams can be restored and allowed to meander along their path as well as be provided an adequate floodplain area alongside the stream (i.e., riparian area). This will allow increased infiltration of water into the ground following a storm, and thus decreased storm runoff peak flows. This will in turn allow water velocities following storms to be less dramatically different from baseflow periods, and thus streambank erosion will be minimized. Dams can be removed to allow natural flow conditions to resume.

Cause (POLLUTANT OR STRESSOR) Habitat Modifications

Possible Sources

- Channeling
- Construction
- Changing land uses in the watershed
- Stream burial
- Dredging
- Removal of riparian vegetation
- Streambank modifications

Potential Adverse Impacts

Habitat modifications include activities on the landscape or in the water body that alter the physical structure of the aquatic and riparian ecosystem. Some examples include: removal of streamside vegetation that stabilizes the streambank and provides shade; excavation in the stream and removal of cobbles from the stream bed that provide nesting habitat for fish; stream burial; and development that alters the natural drainage pattern by increasing the intensity, magnitude and energy of runoff waters.

Possible Solutions

Increased education of citizens about the value of streamside and in-stream habitat for health of aquatic organisms might result in fewer people implementing activities that damage habitat. Shoreland zoning regulations and required minimum set-backs (e.g., minimum distance to a stream in which a structure can be built) can be implemented by local community officials or state agencies to provide overarching protection to streams and lakes to ensure healthy waters are maintained.

Cause (POLLUTANT OR STRESSOR) Refuse, Litter & Debris

Possible Sources

- Litter
- Illegal dumping of solid wastes

Potential Adverse Impacts

Refuse and litter in a stream can clog fish spawning areas; stress aquatic organisms, injure wildlife; reduce water clarity; impede water treatment plant operations; and impair recreational uses of the water body, such as swimming, fishing and boating.

Possible Solutions

Citizens can carry out local stream and river clean ups to remove trash and other debris from waterways. Educational programs can be implemented to help citizens understand the impacts of such wastes on water quality and overall stream health. Local communities can host tire and/or appliance collection events to help minimize illegal dumping of large items into streams. Companies can offer financial incentives for people to recycle items such as TVs and computers.

Preparation:

Copy the "card page" and "card page answers" back to back on cardstock or thick paper. Have each group cut out a set for their game. Also make copies of the playing board – one per group.

PROCEDURE:

1. Review the definitions of nonpoint source and point source pollution with students and discuss the various causes, sources and solutions covered in the background information for this activity. Divide the class into groups of five. Have each student cut a small shape out of construction paper to represent them as a player. Make sure each team member has a different colored square. Alternatively, students can use different coins, small vials of different types of aquatic insects, or cut-outs of drawings of aquatic insects from the Key to Life in the River to represent each player.

2. Have the students look over the playing board and, as a team, identify some of the spaces with proper and improper water quality practices. Point out that improper practices are in red and proper are in green.

3. Let's play the game – GAME RULES:

    i. Each player is to line up on the "starting line."

    ii. Roll the die to see who will move first. (The highest number rolls first.)

    iii. Moving clockwise around the group, each student should take a turn rolling the die and moving their playing piece the number of spaces rolled on the die.

    iv. When a student lands on the space marked "read card," they are to take the card from the top of the pile, read it and answer the question. If they get the answer right, they follow instructions and return the card to the bottom of the pile. If they answer incorrectly, they stay on the square and their turn is over.

    v. The game continues until a student reaches the "finish."

Discussion:

1. What is nonpoint source pollution? What is point source pollution?
2. Give two examples of point and nonpoint source pollution.
3. List two things that indicate a healthy stream.
4. List two things that can harm a stream.

Optional Activities:

1. Have the students make up additional cards for the game.
2. Have the students participate in a Stream Walk Survey (page 1-88).

Give two examples of nonpoint source pollution.

Move 2 spaces.

Name two rivers in Wisconsin.

Move 2 spaces.

Name two animals that live in a stream.

Move 1 space.

Cutting trees along the streambank can be harmful to aquatic organisms.

(True/False)

Move 1 space.

What does nonpoint source pollution mean?

Move 2 spaces.

List two things that could harm a stream.

Move 1 space.

How can cows damage a stream if they walk through it?

Move 1 space.

List two things you can do to help a stream.

Move 1 space.

Answer	**Answer**
Answer	**Answer**
Answer	**Answer**
Answer	**Answer**

When oils and chemicals get in a stream, they end up downstream

(True/False)

Move 1 space.

Name two activities for which a stream can be used.

Move 1 space.

Nonpoint source pollution can easily be seen in a stream

(True/False)

Move 1 space.

Name two things you can find in a healthy (clean) stream.

Move 1 space.

If you find water that smells bad and looks very dirty, who should you tell?

Move 1 space.

How do you know when water is polluted?

Move 1 space.

Answer

Answer

Answer

Answer

Answer

Answer

ACTIVITY 5: TRANSPARENCY

Learning Objectives:

- Students will know why it is important to know the baseline transparency of a stream.
- Students will know what changes in aquatic life and physical attributes of the water (i.e., temperature, dissolved oxygen) to expect with changes in transparency.
- Students will understand and practice how to use a transparency tube to assess water clarity.

Standards:

English A.8.1, A.8.4; Environmental Education B.8.5; Mathematics: Statistics and Probability E.12.1; Science Inquiry C.8.1, C.8.3, C.8.4, C.12.1, C.12.2, C.12.5

Materials:

- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #1
- Student Workbook (see Section 4)
- Writing instrument
- Computer with Internet access (optional)
- Transparency tubes (approximately one per three or four students)
- Water sample from local stream or lake (optional)

Time:

35 minutes

Background:

- Water clarity is one of the most obvious measures of water quality.
- Water clarity can be a useful indicator of runoff from construction sites, fields, logging activity, industrial discharges and other sources.
- Monitoring transparency before, during and immediately after rain can provide a useful picture of potential runoff problems.

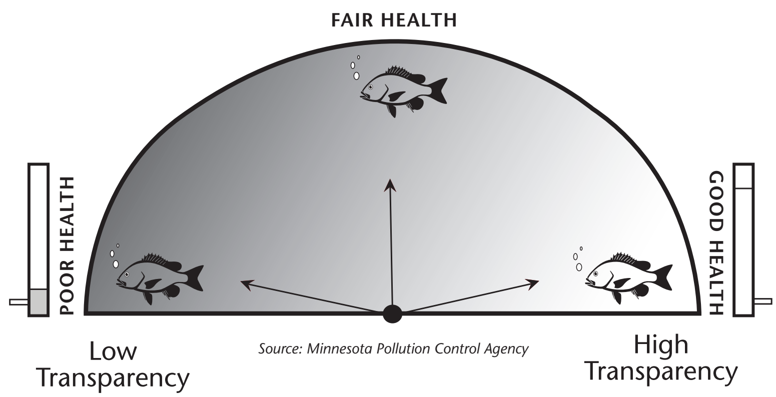
Murky water is easily seen as unhealthy. However, natural substances which are not harmful to the water can sometimes make water appear brown and murky. How do we know if the murky water is a cause for concern? Scientists have found a way to quantify the cloudiness of water by measuring its turbidity, which relates to the amount of suspended particles in the water. These small particles of soil, algae or other materials generally range in size from the microscopic level to about one millimeter (about as thick as a pencil lead). More free-floating particles cause greater turbidity, resulting in less light penetration through the water. This hinders photosynthesis, necessary for healthy aquatic plant growth and production of dissolved oxygen. The water also becomes warmer because the suspended particles absorb heat.

Sources of turbidity include: erosion from fields, construction sites, urban runoff from rainstorms and melting snow, eroding streambanks, large number of bottom feeders (such as carp) which stir up bottom sediments, and excessive algal growth. The faster a stream flows, the more energy it has and the more sediment it can carry.

Since we assess water clarity visually, we don't directly measure how many suspended particles are in the water. Instead we measure the transparency of the water, which takes into account both color and suspended particles. You will measure water clarity in centimeters (cm) using a transparency tube that is approximately 120 cm long. There is a black and white disc in the bottom of the tube that you will look down to - through the water sample - to attempt to see. If you cannot see the disc in the bottom of the tube, your monitoring partner will open a release valve to allow water to flow out of the tube. Your job is to alert your partner to close the valve when you can just see the contrast between black and white on the disc. However, if you can see the disc in the bottom of the tube when the tube is full, you will report a transparency value of 120 cm. It's important to note that you cannot determine the exact transparency if you can see the disc with the tube full, you only know that transparency is greater than 120 cm. This high transparency indicates good water quality.

All streams have background turbidity/transparency, or a baseline standard for a natural amount of turbidity/transparency. Fish and aquatic life that are native to streams have evolved over time to adapt to varying levels of background water clarity. For example, some native fish and aquatic life in the Mississippi River are very happy with their murky environment.

LOW WATER TRANSPARENCY INFLUENCES FISH HEALTH



What causes problems in any stream or river are unusual concentrations of suspended particles and how long the water clarity stays at a deviated level.

TRANSPARENCY VALUE CONVERSION CHART

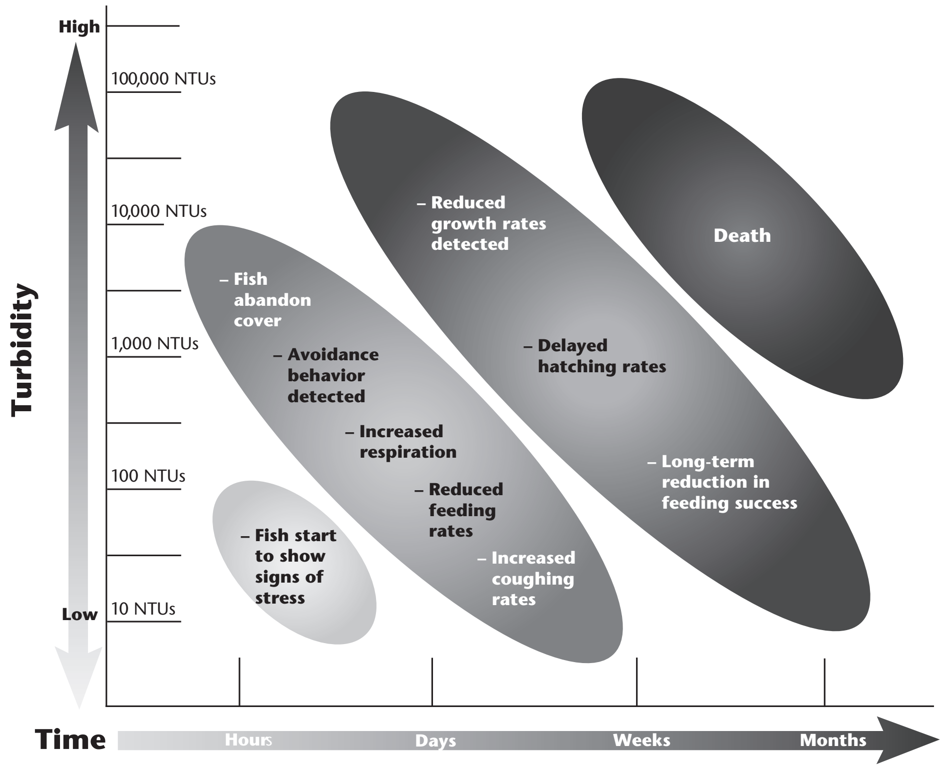
Centimeters	Turbidity (NTUs)
6.4 to 7.0	240
7.1 to 8.2	185
8.3 to 9.5	150
9.6 to 10.8	120
10.9 to 12.0	100
12.1 to 14.0	90
14.1 to 16.5	65
16.6 to 19.1	50
19.2 to 21.6	40
21.7 to 24.1	35
24.2 to 26.7	30
26.8 to 29.2	27
29.3 to 31.8	24
31.9 to 34.3	21
34.4 to 36.8	19
36.9 to 39.4	17
39.5 to 41.9	15
42.0 to 44.5	14
44.6 to 47.0	13
47.1 to 49.5	12
49.6 to 52.1	11
52.2 to 54.6	10
>54.7	<10

When you collect transparency samples, it is important to note any fluctuations in values, which can help detect trends in water quality. Time is probably the most influential factor in determining how turbidity affects the aquatic environment. The longer the water remains at unusually high values, the greater effect it has on fish and other aquatic life. Fish in particular become very stressed in waters that remain highly turbid for a long time. Signs of stress include increased respiration rate, reduced growth and feeding rates, delayed hatching and in severe cases, death. Fish eggs are ten times more sensitive to turbidity than adult fish.

Turbidity is measured in Nephelometric Turbidity Units (NTU) when scientists use a special meter, called a nephelometer, to assess this parameter. This type of meter shines light through a water sample and measures how much light is scattered by suspended material in the sample. We have a conversion chart for transparency measurements (which assess both particles in the water and water color) to NTU which can allow scientists to roughly compare transparency results obtained with a tube to those obtained with a nephelometer *(See conversion chart at left)*. This conversion also allows you to assess potential impacts of water clarity on organisms in the stream you sampled.

To further understand how time and turbidity impact fish, look at the graph to the right. The graph shows that the longer time turbidity levels are elevated, the greater the impact on aquatic life. High turbidity levels affect humans too. An acceptable turbidity level for recreation is 5 NTU and an acceptable level for human consumption ranges from 1-5 NTU.

RELATIONAL TRENDS OF FRESHWATER FISH ACTIVITY TO TURBIDITY VALUES AND TIME



For additional information about monitoring transparency visit this website:

http://watermonitoring.uwex.edu/wav/monitoring/transparency.html

PROCEDURE:

1. Show students the video about turbidity/transparency monitoring that is on the Water Action Volunteers DVD Set (from the main menu on Disc 1, choose "Monitoring Protocols" and then "Turbidity"; Run time 5:20). The video is also available online at: http://watermonitoring.uwex.edu/wav/monitoring/video.html
2. Have students read the section in the student workbook entitled "Transparency" (See Section 4).
3. (Optional) Have students conduct additional reading about transparency monitoring on the website listed in the background section for this parameter.
4. Have students answer discussion questions in their workbook.
5. Have students make a hypothesis about the turbidity/transparency levels they will measure at their stream site. Students should record their hypothesis in their workbook.
6. Have students practice using transparency tubes in the classroom using tap water or a water sample you have collected from a nearby stream, following the procedure outlined in the video and available in sections 2 and 6.

Student Discussion Questions and Sample Answers:

1. High turbidity hinders plant _ _ and the production of which gas? _ _
2. List four factors that can make water more turbid:

   ________________________________.

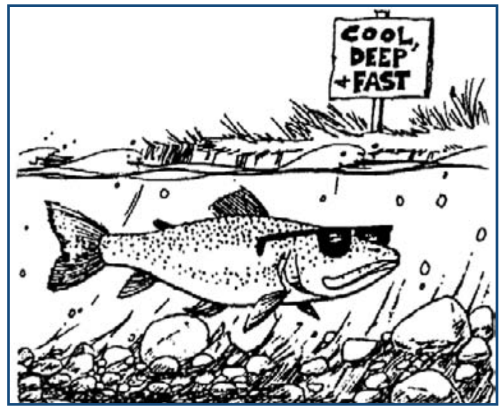
3. Turbid waters often have higher temperature because the suspended particles absorb ______ .
4. Turbidity is measured in what units? _ _
5. Would you more likely find more smallmouth bass or trout in waters that are very turbid? Give at least two reasons to support your hunch.
6. How might a large change in the turbidity of stream water over a long period of time affect aquatic organisms?

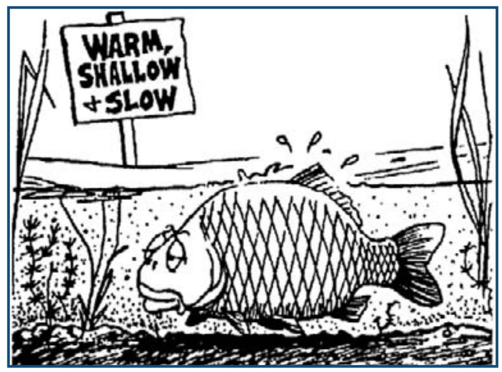
7. What might increased turbidity or lower transparency tell us about human activities within the watershed?
8. When assessing transparency you will take two measurements with the transparency tube and then calculate the average transparency (cm). Then you will convert the average transparency (cm) to turbidity (NTU). If your transparency tube readings were 106 cm and 98 cm, what is the average transparency? What turbidity does that convert to?
9. You will soon be assessing the transparency of a stream near your school. Do you think that your stream will be very transparent or not? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

Optional Activities:

- Erosion in a Bottle (See page 1-63)
- Urban Runoff Model (See page 1-68)
- Transparency Tube Case Construction (See page 1-72)
- Stream Ecosystem – What Makes a Stream Healthy? (See page 1-73)
- Branching Out (See page 1-97)
- A-maze-ing Water (See page 1-97)
- Sum of the Parts (See page 1-97)
- Just Passing Through (See page 1-97)
- Rainy Day Hike (See page 1-97)
- Color Me A Watershed (See page 1-97)
- To the Point (See page 1-99)
- Filtration Activity, Illinois NCRS (See page 1-100)
- Soil Glue, Illinois NRCS (See page 1-100)
- Erosion in the Zone (See page 1-100)
- Filter Plants (See page 1-100)
- Percolation Test (See page 1-100)

ACTIVITY 6: TEMPERATURE





Learning Objectives:

- Students will understand the impact that changes in temperature can have on stream life.
- Students will understand the relationships between temperature and dissolved oxygen and between temperature and turbidity.
- Students will understand and practice how to monitor water temperature.

Standards:

English A.8.1, A.8.4; Environmental Education B.8.5; Mathematics: Statistics and Probability E.12.1; Science Inquiry C.8.1, C.8.3, C.8.4, C.12.1, C.12.2, C.12.5

Materials:

- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #1
- Student Workbook (see Section 4)
- Writing instrument
- Computer with Internet access (optional)
- Thermometers (approximately one per three or four students)

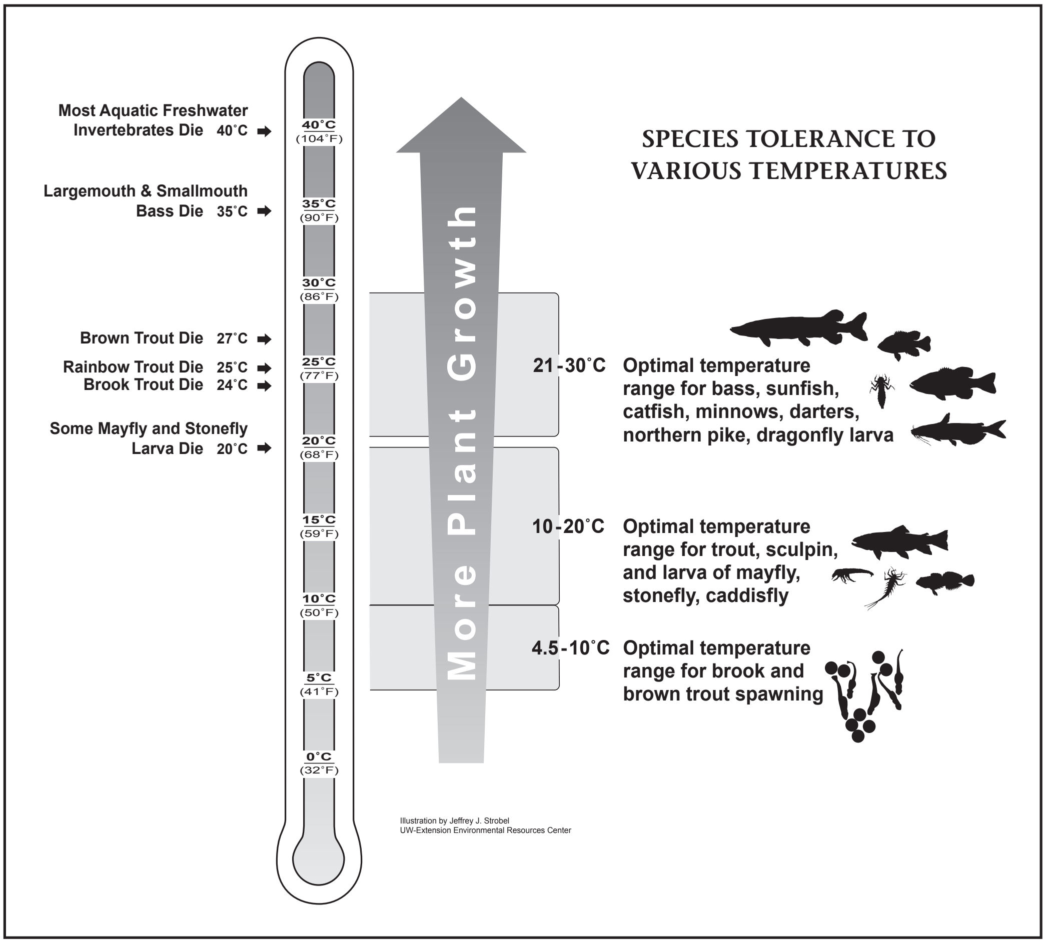
Time:

25 minutes

Background:

- Although most aquatic life has adapted to survive within a range of water temperatures, some fish species (e.g., trout) require cooler waters. The metabolic rate of organisms, or the rate at which they convert food into energy, also increases with higher water temperatures, resulting in even greater demands on oxygen.
- Research also shows that extreme temperature fluctuations can make fish and insects more susceptible to disease, parasites and the harmful effects of toxic waste.

Stable water temperature is a critical factor in maintaining the health of a stream and its inhabitants. Temperatures over 75° F (24° C) for example, are usually fatal to brook trout, which need waters in the range of 55°-65° F (12.8°-18.3° C) in order to thrive. Other fish such as the smallmouth bass can survive to 90° F (35° C) and carp can live in even warmer waters. So as temperature increases, cold water species will gradually be replaced by warm water ones.



One of the most drastic ways that stream temperature is increased is by thermal pollution. Thermal pollution occurs when warm water is added to the stream. Industries such as power plants, paper mills and cheese factories may discharge heated water used in the manufacturing process into streams. Runoff, in a more indirect way, can also add warm water to streams. Rainwater running off warmed surfaces, especially parking lots, roof tops and roads, increases stream temperatures.

The table to the left shows temperature ranges for cold, cool and warm streams.

THERMAL CRITERIA FOR COLD, COOL AND WARM WATER STREAMS IN WISCONSIN

Thermal regime	Maximum instantaneous temperature	Maximum daily mean temperature
Cold water stream	<25°C (77°F)	<22°C (72°F)
Cool water stream	25-28°C	22-24°C
Warm water stream	>28°C (82°F)	>24°C (75°F)

Mill ponds and impoundments also increase water temperature because they contain a large surface area of slow-moving water which is warmed by the sun, affecting water temperature downstream.

Removing all overhanging trees that shade and cool the stream can also negatively impact stream temperatures. Another factor contributing to higher stream temperatures is eroding soil. Turbid water that results from eroded soil heats up quickly because the suspended sediments absorb the sun's radiant heat. Sediment also makes stream channels shallow. A shallow stream warms up faster than deep waters.

Temperature changes can affect all aquatic life. For example, warm water holds less dissolved oxygen than cold water and triggers higher plant growth and respiration rates. The lowered oxygen levels of warmer waters are further reduced when plants and animals die and decay.

For additional information about water temperature, visit this website:
http://watermonitoring.uwex.edu/wav/monitoring/temp.html

PROCEDURE:

1. Show students the video about water temperature monitoring that is on the Water Action Volunteers DVD Set (from the main menu on Disc 1, choose "Monitoring Protocols" and then "Temperature"; Run time 2:27). The video is also available online at: http://watermonitoring.uwex.edu/wav/monitoring/video.html
2. Have students read the section in the student workbook entitled "Temperature" (See Section 4).
3. (Optional) Have students conduct additional reading about temperature on the website listed at the end of the background section for this parameter.
4. Have students answer discussion questions in their workbook.
5. Have students make a hypothesis about the water temperature they will measure at their stream site. Students should record this hypothesis in their workbook.
6. Have students practice taking water temperature with the thermometers following the procedure outlined on the video and available in sections 2 and 6.

Student Discussion Questions and Sample Answers:

1. Warm water holds less ______ than cold water.
2. Increased temperatures trigger ______ plant growth and ______ rates.
3. ______ decisions and stream ______ are often closely tied to water temperatures.
4. The water temperature of Stream X measured 27° C. What type of fish might you expect to find living here? What factors may be impacting the temperature of this stream? Explain.

5. If you were a developer in a local community, what are some things you might do to minimize changes in stream water temperature?
6. What impacts would drastic fluctuations in water temperature have on life in the stream?
7. You will soon be measuring water temperature at a stream near your school. What water temperature do you expect to find? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

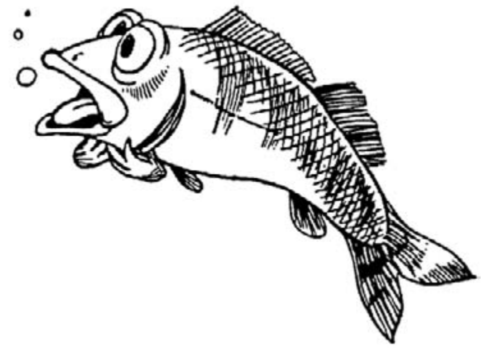
Optional Activities:

- Stream Ecosystem – What Makes a Stream Healthy? (See page 1-73)
- Branching Out (See page 1-97)
- A-maze-ing Water (See page 1-97)
- Sum of the Parts (See page 1-97)
- Just Passing Through (See page 1-97)
- Rainy Day Hike (See page 1-97)
- Color Me A Watershed (See page 1-97)
- Water of Life (See page 1-99)

ACTIVITY 7: DISSOLVED OXYGEN

Learning Objectives:

- Students will understand what variables may influence changes in the dissolved oxygen level of a stream.
- Students will understand what levels of dissolved oxygen are needed for aquatic life and why drastic changes may be harmful.
- Students will understand and practice how to assess dissolved oxygen.



Standards:

English A.8.1, A.8.4; Environmental Education B.8.5; Mathematics: Statistics and Probability E.12.1; Science Inquiry C.8.1, C.8.3, C.8.4, C.12.1, C.12.2, C.12.5

Materials:

- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #1
- Student Workbook (see Section 4)
- Writing instrument
- Computer with Internet access (optional)
- Hach Model OX-2P dissolved oxygen kits (approximately one kit per three or four students)
- Safety glasses (one pair per student)

Time:

50 minutes

Background:

- All plants and animals require oxygen for survival.
- Dissolved oxygen levels in streams fluctuate over the course of 24 hours.
- Cold water can hold more dissolved oxygen than warmer water.

Oxygen is a clear, colorless, odorless and tasteless gas that dissolves in water. Small but important amounts of it are dissolved in water. It is supplied by diffusion of atmospheric oxygen (air) into the water and by production of oxygen from photosynthesis by aquatic plants. Wind, waves and tumbling water in fast-moving streams increase the rate of diffusion.

Both plants and animals depend on dissolved oxygen for survival. Lack of dissolved oxygen can cause aquatic animals (e.g., fish, macroinvertebrates) to quickly leave the area or face death. Under low oxygen conditions, the aquatic animal community changes quickly. Under extreme conditions, lack of oxygen can kill aquatic plants and animals. Measuring dissolved oxygen is probably the most significant water quality test to determine the suitability of a stream for fish and many other aquatic organisms. However, these measures only provide a snapshot of the oxygen levels at that particular time. Levels can fluctuate widely throughout the day and year. Fish and other organisms have to live and breathe in that water all year long. A short time without oxygen can be fatal.

Dissolved oxygen (D.O.) is reported as milligrams of oxygen per liter of water (mg/L) which can be called parts per million (ppm) by weight. Different aquatic organisms have different oxygen needs. Trout and stoneflies, for example, require high dissolved oxygen levels. Trout need water with at least 6 mg/L D.O. Warm water fish such as bass and bluegills survive nicely at 5 mg/L D.O. and some organisms such as carp and bloodworms can survive with less than 1 mg/L of D.O. Based on this, there are stream classifications in Wisconsin that define the minimum amount of oxygen that must be maintained in a stream with a given classification (See charts at right).

DISSOLVED OXYGEN REQUIREMENTS OF AQUATIC PLANTS AND ANIMALS

Very High D.O.	Moderately High D.O.	Low D.O.
ANIMALS		
Brook or rainbow trout	Brown trout	Carp
Mottled sculpin	Redbelly dace	Green sunfish
	Bass	Fathead minnow
PLANTS		
Much plant variety	Moderate plant variety	Little plant variety

Source: Dane County Water Watchers

MINIMUM DISSOLVED OXYGEN LEVELS ALLOWED FOR WATERS WITH VARIED CLASSIFICATIONS IN WISCONSIN

Stream Classification	Minimum Dissolved Oxygen Allowed
Trout waters	6 mg/L (out of spawning season) and 7 mg/L (during spring/fall spawning season)
Fish or aquatic life-designated waters	5 mg/L
Limited forage fish waters	3 mg/L
Limited aquatic life waters	1 mg/L

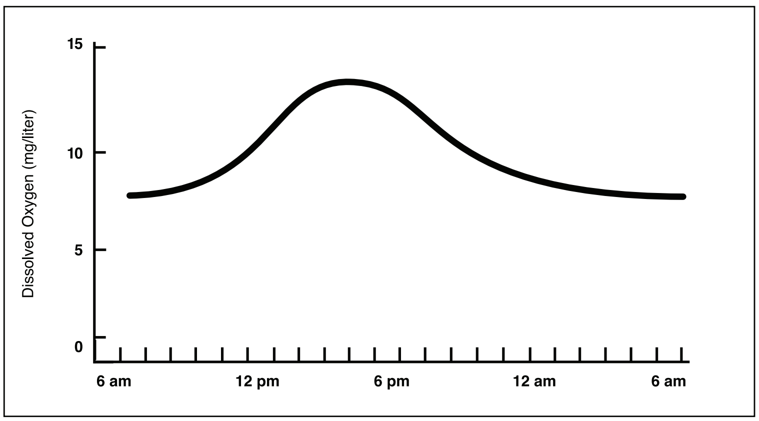
The oxygen demand of aquatic plants and cold-blooded animals also varies with water temperature. A trout uses five times more oxygen while resting at 80° F (26.7° C) than at 40° F (4.4° C).

There are many factors that affect the amount of dissolved oxygen in the water (see chart on the following page). A major one is photosynthesis.

Factors That Could **Increase** The Amount of Dissolved Oxygen in Water	Factors That Could **Decrease** The Amount of Dissolved Oxygen in Water
• High atmospheric pressure • Clear water • Photosynthesis • Much turbulence/wave action • Cold water • Presence of excessive amounts of plants (during daytime)	• Respiration of animals and plants living in the water • Chemical reactions of the decaying process • Low atmospheric pressure • High levels of turbidity (such as from erosion) • Warm water • Presence of excessive amounts of plants (during nighttime) • Excessive organic materials (such as sewage, manure or fertilizers)

Aquatic plants produce oxygen by photosynthesis during daylight hours, but they also use oxygen for respiration. High day-time levels of D.O. are often countered with low night-time levels (see a sample diel cycle for dissolved oxygen below). This is due to respiration of living organisms, including fish, bacteria, fungi and protozoans, as well as the cessation of photosynthesis. Wide daily fluctuations of D.O. stress fish and other aquatic animals. Oxygen depletion can occur because of heavy plant growth. Complete depletion of D.O. can sometimes be detected with your nose. Anaerobic decay results in a rotten egg smell (hydrogen sulfide gas). However, oxygen levels can be improved with good management practices such as planting or maintaining vegetation that filters rainwater runoff and shades the water, and protecting the stream channel in other ways to maintain or increase turbulence.

SAMPLE DIEL FLUCTUATION OF DISSOLVED OXYGEN IN A STREAM



Dissolved Oxygen Levels (% Saturation)
Excellent: 91-110
Good: 71-90
Fair: 51-70

SOURCE: Field Manual for Water Quality Monitoring (13th Edition)

Recording dissolved oxygen differs from other tests in that it requires two distinct calculations. We are interested in both the absolute amount of D.O. and how close the value is to the equilibrium value for that temperature and air pressure (known as the percentage of saturation.) Values between 91% and 110% of saturation are excellent. Supersaturated (over 100%)

values may sound good but they can also indicate problems, such as excessive plant growth.

You can assess the range of dissolved oxygen levels that aquatic plants and animals at your stream site must withstand by monitoring twice in one day – early in the morning, just before sunrise, and later in the afternoon when plants have been exposed to the most direct sunlight for an extended period.

For additional information about monitoring dissolved oxygen visit this website:

http://watermonitoring.uwex.edu/wav/monitoring/oxygen.html

PROCEDURE:

1. Show students the video about dissolved oxygen monitoring that is on the Water Action Volunteers DVD Set (from the main menu on Disc 1, choose "Monitoring Protocols" and then "Dissolved Oxygen"; Run time 13:10). The video is also available online at: http://watermonitoring.uwex.edu/wav/monitoring/video.html
2. Have students read the section in the student workbook entitled "Dissolved Oxygen" (See Section 4).
3. (Optional) Have students conduct additional reading about dissolved oxygen on the website listed in the background section for this parameter.
4. Have students answer discussion questions in their workbook.
5. Have students make a hypothesis about the dissolved oxygen levels they will measure at their stream site. Students should record this hypothesis in their workbook.
6. Using tap water or a stream sample you have collected, have students practice assessing dissolved oxygen following the methods outlined in the video and available in sections 2 and 6.

Student Discussion Questions and Sample Answers:

1. How does oxygen get into the water?

2. What factors affect the levels of dissolved oxygen in the water?

3. When is oxygen consumed in streams?

4. What is the problem with wide fluctuations in dissolved oxygen?

5. The dissolved oxygen level of the water in Stream Z was recently tested. It was found to have a dissolved oxygen level of 4 ppm. Is this considered low or high? _ _

6. Which organisms might you expect to find thriving in Stream Z?

7. Based on this dissolved oxygen level (of 4 ppm), what might you expect to be true about the transparency and temperature of the stream?

8. Explain why dissolved oxygen levels may be higher in the day and lower at night. What other variables can cause changes in the dissolved oxygen levels?

9. You will soon be testing the dissolved oxygen content of a stream near your school. Make a hypothesis. Do you think that your stream will have high or low levels of dissolved oxygen? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

Optional Activities:

- Stream Ecosystem – What Makes a Stream Healthy? (See page 1-73)
- Parts Per Million Lab (See page 1-78)
- Reaching Your Limits (See page 1-97)
- Fish Food (See page 1-99)
- Water of Life (See page 1-99)

ACTIVITY 8: STREAM FLOW

Learning Objectives:

- Students will understand what conditions can lead to high and low flow rates.
- Students will understand how different flow rates can affect life in the stream.

Standards:

English A.8.1, A.8.4; Environmental Education B.8.5; Mathematics: Statistics and Probability E.12.1

Materials:

- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #1
- Student Workbook (see Section 4)
- Writing instrument
- Computer with Internet access (optional)

Time:

25 minutes

Background:

- Stream flow is a measure of the volume of water moving past a point during a span of time.
- Stream flow is affected by runoff of rain or snowmelt to the stream from the surrounding watershed, and also by groundwater inputs.

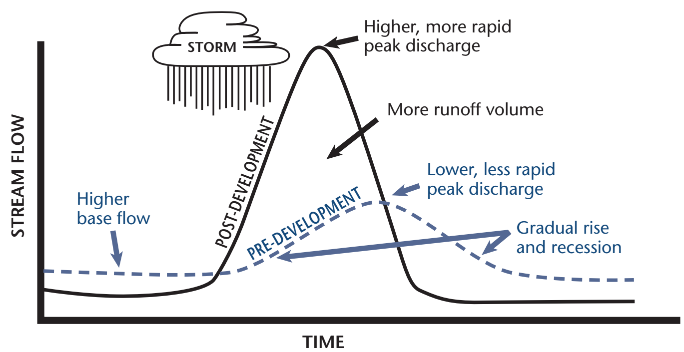
Note to teachers:

Although it is often preferred to teach students Systéme International (SI) Notation, we measure stream flow in cubic feet per second (cfs) following methodology of the lead stream flow monitoring agency in the United States, the US Geological Survey (Turnipseed and Sauer, 2010).

Stream flow, or discharge, is the volume of water moving past a cross-section of a stream over a set period of time. It is usually measured in cubic feet per second (cfs).

Stream flow is affected by the amount of water within a watershed – increasing with rainstorms or snowmelt, and decreasing during dry periods. Flow is also important because it defines the shape, size and course of the stream. It is integral not only to water quality, but also to habitat. Food sources, spawning areas and migration paths of fish and other wildlife are all affected and defined by stream flow and velocity. Velocity and flow together determine the kinds of organisms that can live in a stream (some need fast-flowing areas; others need quiet, low-velocity pools). Different kinds of vegetation require different flows and velocities as well.

Stream flow is affected by both forces of nature and by humans. In undeveloped watersheds, soil type, vegetation and slope all play a role in how fast and how much water reaches a stream. In watersheds with high human impacts, water flow might be depleted by withdrawals for irrigation, domestic or industrial purposes. Dams used for electric power generation may affect flow, particularly during periods of peak need when stream flow is held back and later released in a surge. Drastically altering landscapes in a watershed, such as with development, can also change flow regimes. For instance, increasing areas of impervious surface causes faster runoff during storm events and higher peak flows. These altered flows can negatively affect an entire ecosystem by upsetting habitats and organisms dependent on natural flow rates.



A hydrograph is a graph that shows stream flow over time. This hydrograph shows how stream flow changes as a watershed goes from a natural land cover (pre-development) to an urbanized land cover (post-development).

Tracking stream flow measurements over a period of time can give us baseline information about the stream's natural flow rate.

For more information about stream flow, visit this website:
http://watermonitoring.uwex.edu/wav/monitoring/flow.html

Reference: Turnipseed, D.P. and V.B. Sauer. 2010. Discharge Measurements at Gaging Stations. Chapter 8 of Book 3, Section A. U.S. Department of the Interior. U.S. Geological Survey. 87 pp.

PROCEDURE:

1. Show students the video about stream flow monitoring that is on the Water Action Volunteers DVD Set (from the main menu on Disc 1, choose "Monitoring Protocols" and then "Stream Flow"; Run time 7:21). The video is also available online at: http://watermonitoring.uwex.edu/wav/monitoring/video.html
2. Have students read the section in the student workbook entitled "Stream Flow" (see Section 4).
3. (Optional) Have students conduct additional reading about stream flow on the website listed at the end of the background section for this parameter.
4. Have students answer discussion questions in their workbook.
5. Have students make a hypothesis about the stream flow they will measure at their stream site. Students should record this hypothesis in their workbook.

Student Discussion Questions and Sample Answers:

1. What is stream flow?

2. What units are used to measure stream flow?

3. Name at least three ways that humans can alter stream flow.

4. Name at least four ways that changes in stream flow can affect fish.

5. Why would a stream in the forest have lower peak flows following a rain storm than a stream of the same size in a city?

6. You will soon be measuring stream flow at a stream near your school. What flow do you expect to find? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

Optional Activities:

- Stream Ecosystem – What Makes a Stream Healthy? (See page 1-73)
- Branching Out (See page 1-98)
- Rainy Day Hike (See page 1-98)
- Back to the Future (See page 1-98)
- Just Passing Through (See page 1-98)
- Color Me a Watershed (See page 1-98)
- Putting on the Brakes (See page 1-100)

ACTIVITY 9: HABITAT ASSESSMENT

Learning Objectives:

- Students will understand how stream life and water quality are affected by uses of the land nearby the stream.
- Students will understand how different substrates are important for stream life.
- Students will understand and practice how to assess habitat.

Standards:

English A.8.1, A.8.4; Environmental Education B.8.5; Mathematics: Statistics and Probability E.12.1

Materials:

- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #1
- Student Workbook (see Section 4)
- Writing instrument
- Computer with Internet access (optional)

Time:

30 minutes

Background:

- The habitat functions holistically, so any changes to a part may affect the entire habitat.
- Certain land uses affect habitat quality and stream health.
- The Habitat Checklist uses visual measurements of land and water conditions to help pinpoint land uses affecting water quality.

A healthy stream is a busy place. Wildlife find shelter and food near and in its waters. Vegetation grows along its banks, shading the stream and filtering pollutants before they enter the stream. Within the stream are fish, insects and other tiny creatures with specific needs: dissolved oxygen to breathe; rocks, overhanging tree limbs, logs and roots for shelter; vegetation and other tiny animals to eat; and special places to breed and hatch their young. For any of these activities, organisms might also need water of specific velocity, depth and temperature. Many land-use activities can alter these characteristics, causing problems within the entire habitat. The Habitat Assessment is an easy-to-use approach for identifying and assessing the elements of a stream's habitat. This assessment is useful as: 1) a screening tool to identify habitat stressors and 2) a method for learning about stream ecosystems and environmental stewardship.

Taking stock of the habitat's characteristics may begin at the riparian zone where land is making a transition into water. Within healthy stream corridors, this area generally has certain kinds of vegetation that act as a buffer between land and water, soaking up many pollutants carried in runoff. Moving on, the stream assessment will then focus on the condition of the upper and lower banks and finally the stream channel and stream itself. In order to help prepare you to fill out the Habitat Checklist, certain stream and river characteristics and concepts are defined in the following text.

RIPARIAN ZONE

The healthy riparian zone is characterized by trees, bushes, shrubs and tall grasses that help to buffer the stream from polluted runoff and create habitat for fish and wildlife. These plants also provide stream shading (or overhead canopy) and serve several important functions in the stream habitat. The canopy helps keep water temperatures cool by shading the water from the sun, while offering protection and refuge for animals. Certain conditions in the riparian zone can negatively affect the stream's habitat. Lawns maintained to the water's edge are abrupt transitions from land to water, offering very little or no buffering protection for the stream. In these cases, lawn care products and grass clippings could be entering the stream. Short-grassed streambanks also provide poor habitat for animals. Bare soil and pavement provide no buffering action from runoff. Features to note in riparian zones:

- Evergreen trees (conifers) – cone-bearing trees that do not lose their leaves in winter.
- Hardwood trees (deciduous) – in general, trees that shed their leaves at the end of the growing season.
- Bushes – short conifers or deciduous shrubs less than 15 feet high.
- Tall grass, ferns, etc. – includes tall, natural grasses, ferns, vines and mosses.
- Lawn – cultivated and maintained short grass.
- Boulders – rocks larger than 10 inches.
- Gravel/cobbles/sand – rocks smaller than 10 inches in diameter; sand.
- Bare soil
- Pavement or structures – any structures or paved areas, including paths, roads, bridges, houses, etc.
- Garbage or junk adjacent to the stream – note the presence of litter, tires, appliances, car bodies or other large objects.

STREAMBANK CHARACTERISTICS

Note to teachers:

See the Habitat Section of the student workbook on pages 4-31 - 4-40 for illustrations of these characteristics.

The **streambank** consists of the upper bank and lower bank. The shape and condition of the streambank can give many clues to the types of land uses in the adjacent watershed. For example, sometimes the channel may be altered by too much water flooding the stream in a short time. This may indicate a nearby urban area with many impervious surfaces, so the rain or melting snow cannot naturally soak into the ground. Large volumes of runoff then flood the nearest stream with too much water, which erodes and distorts the stream channel. Sometimes it is obvious that the banks have been eroded by excessive water because the normal flow does not reach the new shoreline which has been pushed back.

A **vertical or undercut bank** rises vertically (at an approximate 90-degree angle) or overhangs the stream. This type of bank generally provides good cover for aquatic invertebrates (small animals without backbones) and fish, and is resistant to erosion. This bank usually has a good vegetative cover that helps to stabilize the bank. If seriously undercut, however, the bank could collapse.

A **steeply sloping bank** slopes at more than a 45-degree angle. This type of bank is very vulnerable to erosion.

A **gradually sloping bank** has a slope of about 30 degrees or less. Although this type of streambank is highly resistant to erosion, it does not provide much streamside cover.

Artificial bank modifications include ditching and other changes such as concrete embankments and gabions to stem further erosion due to the action of the water. Also included are LUNKER structures which are wooden underwater habitats set into the bank and designed for trout and other game fish. Rock rip rap placed at bends and other areas subject to erosion serve to improve fish habitat and stabilize stream meanders. Poor streambank conditions can include the loss of natural plant cover. Erosion can occur when streamside vegetation is trampled or missing or has been replaced by poorly designed landscaping or pavement. More severe cases of streambank erosion include washed away banks or banks that have collapsed. Excessive mud or silt entering the stream from erosion can distort the stream channel, and interfere with beneficial plant growth, dissolved oxygen levels and the ability of fish to sight prey. It can also irritate fish gills and smother fish eggs in spawning areas. Often it is the result of eroding streambanks, poor construction site practices, urban area runoff, silviculture (forestry practices) or ditches that drain the surrounding landscape.

IN-STREAM CHARACTERISTICS

Stream bottoms (substrate) are classified according to the materials that they are made of. Rocky-bottom streams are defined as those made up of gravel, cobbles and boulders in any combination. They usually have definite riffle areas. Soft-bottom streams have naturally muddy, silty or sandy bottoms that lack riffles. Usually, these are slow-moving, low-gradient streams (i.e., streams that flow along flat terrain). A different questionaire for each type of stream bottom has been designed for you to use. Substrate types include:

Silt/clay/mud – This substrate has a sticky feeling. The particles are fine. The spaces between the particles hold a lot of water, making the sediments feel like ooze.

Sand (up to 0.1 inch) – A sandy bottom is made up of tiny, gritty particles of rock that are smaller than gravel but coarser than silt (gritty, particles are smaller than a grain of rice).

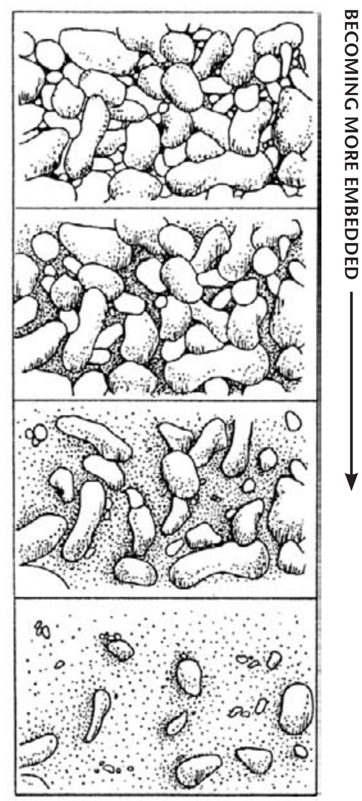
Gravel (0.1-2 inches) – A gravel bottom is made up of stones ranging from tiny quarter-inch pebbles to rocks of about 2 inches (fine gravel is rice size to marble size; coarse gravel is marble to ping pong ball size).

Cobbles (2-10 inches) – Most rocks on this type of stream bottom are between 2 and 10 inches (between a ping pong ball and a basketball in size).

Boulders (greater than 10 inches) – Most of the rocks on the bottom are greater than 10 inches (between a basketball and a car in size).

Bedrock – This kind of stream bottom is solid rock (or rocks bigger than a car).

Embeddedness is the extent to which rocks (i.e., gravel, cobbles and boulders) are buried by silt, sand or mud on the stream bottom. Generally, the more embedded the rocks, the less rock surface or space between rocks there is available for aquatic macroinvertebrate habitat and for fish spawning. Excessive silty runoff from erosion can increase a stream's embeddedness. To calculate embeddedness, estimate the amount of silt or finer sediments overlying, inbetween, and surrounding the rocks (see diagram at right).



A rocky-bottom stream becomes embedded with sand. As sand settles on the streambed, spaces between the rocks fill up.

Presence of logs or woody debris in streams can provide important fish habitat. Be sure to differentiate between logs or woody debris and naturally occurring or moderate amounts of organic material in streams, which includes leaves and twigs.

WATER CHARACTERISTICS

Streams are made up of pools, riffles and runs. A mixture of flows and depths creates a variety of habitats to support fish and invertebrate life.

- Riffles are shallow with fast turbulent water running over rocks.
- Runs are deeper with fast-moving water with little or no turbulence.
- Pools are deep with slow water.

Stream velocity influences the health, variety and abundance of aquatic animals. If water flows too quickly, some organisms might be unable to maintain their hold on rocks and vegetation, and they may be flushed downstream. If water flows too slowly, oxygen diffusion might be insufficient for species needing high levels of dissolved oxygen. Dams, channelization or straightening out a stream's natural bends (sinuosity), certain kinds of terrain, runoff and other factors can also affect stream velocity.

Rooted aquatic plants provide food and cover for aquatic organisms. They can also indicate water quality problems. Sometimes, excess nutrients may flush into the stream and stimulate unnatural aquatic plant growth. To decide if there are too many plants, compare the amount of plants in your stream to other streams in the area with varied land uses in their watersheds.

Algae are simple plants that do not grow true roots, stems or leaves and that mainly live in water, providing food for animals low on the food chain. Algae may be green or brown, grow on rocks, twigs or other submerged materials, or float in the water. Excessive algal growth may indicate excessive nutrients (e.g., organic matter or a pollutant such as fertilizer) in the stream.

What do Habitat Assessments Mean?

Each stream will have a unique habitat assessment value ranging between 13 (worst) and 52 (best). This value is an important baseline measure for future comparisons. By comparing specific habitat parameter scores (between years at one site or between sites in small watersheds) the connection between land use and aquatic habitat may be better understood.

For more information about habitat, visit this website:
http://watermonitoring.uwex.edu/wav/monitoring/habitat.html

PROCEDURE:

1. Show students the video about habitat assessment monitoring on the Water Action Volunteers DVD Set (from the main menu on Disc 1, choose "Monitoring Protocols" and then "Habitat"; Run time 14:49). The video is also available online at: http://watermonitoring.uwex.edu/wav/monitoring/video.html
2. Have students read the section in the student workbook entitled "Habitat Assessment" (see Section 4).
3. (Optional) Have students conduct additional reading about habitat assessment on the website listed in the background section above and in their workbook.
4. Have students answer discussion questions in their workbook.
5. Have students make a hypothesis about the habitat score they will measure at their stream site. Students should record this hypothesis in their workbook.
6. (Optional) Download a presentation from the Water Action Volunteers' website:

   http://watermonitoring.uwex.edu/pdf/level1/Habitat_Assessment_PPT.pdf

   Show this to your students so they can practice ranking habitat based on the sites shown and using the data sheets available in section 6.

Student Discussion Questions and Sample Answers:

1. Why do you think it is important to include a quantitative habitat assessment when evaluating the health of a stream?
2. Why is it important for a stream to have a healthy riparian zone?

For a version (for teachers only) that includes answers, please contact the WAV Coordinator. For contact information, see: http://watermonitoring.uwex.edu/wav

3. What types of habitat would support a more diverse fish and aquatic insect population?
4. You will soon be assessing habitat at a stream near your school. What habitat score do you expect to find? Why? (A total score of between 13 and 52 is possible; the higher the score, the healthier the stream.) Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

Optional Activities:

- Stream Ecosystem – What Makes a Stream Healthy? (See page 1-73)
- Wetland Metaphors (See page 1-96)
- Edge of Home (See page 1-96)
- Blue Ribbon Niche (See page 1-96)
- Where Does Water Runoff (formerly, Where Does Water Runoff After School) (See page 1-96)
- Dragonfly Pond (See page 1-96)
- Branching Out (See page 1-98)
- A-maze-ing Water (See page 1-98)
- Sum of the Parts (See page 1-98)
- Just Passing Through (See page 1-98)
- Rainy Day Hike (See page 1-98)
- Color Me A Watershed (See page 1-98)
- Water Address (See page 1-98)
- Home Sweet Home (See page 1-99)
- To the Point (See page 1-99)
- Shared Interests (See page 1-99)
- Restoration Nation (See page 1-99)
- Reading the Water (See page 1-99)
- Community Site Checklist (See page 1-100)
- Home Site Checklist (See page 1-100)
- School Site Checklist (See page 1-100)
- Farm Site Checklist (See page 1-100)
- On the Edge (See page 1-100)
- Zone Search (See page 1-100)
- Putting on the Brakes (See page 1-100)
- Plant Power (See page 1-100)

ACTIVITY 10: BIOTIC INDEX

Learning Objectives:

- Students will be able to define aquatic macroinvertebrate.
- Students will understand how macroinvertebrates are used to learn about the long-term health of a stream.
- Students will understand and practice how to assess water quality, using a biotic index.
- Students will understand how to use the macroinvertebrate data sheet to assess stream water quality.

Standards:

English A.8.1, A.8.4; Environmental Education B.8.5, B.8.8; Mathematics: Statistics and Probability E.12.1; Life and Environmental Science F.8.8

Materials:

- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #1
- Student Workbook (see Section 4)
- Writing instrument
- Computer with Internet access (optional)
- Macroinvertebrate "dice": For each group of students, have four one-inch blocks with a drawing of a macroinvertebrate (from data sheets) copied, cut out, and taped or glued to each block face
- Keys to Macroinvertebrate Life in the River
- Macroinvertebrate data sheets

Time:

45 minutes

Background:

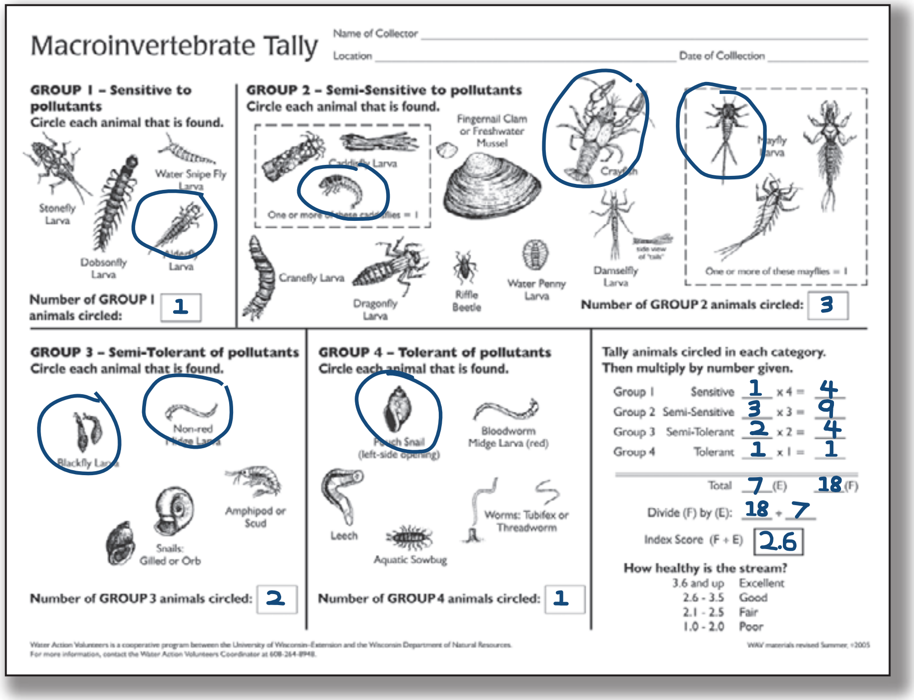
- Aquatic macroinvertebrates are small animals without backbones. Their presence or absence can reflect a stream's general condition.
- Certain macroinvertebrates respond differently to the physical, chemical and biological conditions within a stream.
- Aquatic macroinvertebrates are relatively immobile so they can't escape either short-term or long-term pollution exposure. This is important when assessing long-term pollution events within the stream.

From the crayfish burrowing in the streambed to the tiny aquatic insects skirting the water's surface, streams and rivers swarm with life. The inhabitants of this living place are affected by poor water quality just like humans are affected by an unhealthy environment. However, scientists have found that not all aquatic organisms react the same to poor water quality. Some species are pollutant-tolerant while some are very pollutant-sensitive.

From this knowledge, a scale was developed to determine water quality based on the types of life found in the water. For example, streams with primarily pollutant-tolerant organisms generally have poorer water quality than those streams with many pollutant-sensitive animals. This is because streams that become more polluted gradually lose pollutant-sensitive animals until only the pollutant-tolerant species are left. A healthy stream will have many different organisms, both pollutant-tolerant and those sensitive to pollution.

Although relatively accurate in assessing stream conditions, the Citizen Monitoring Biotic Index does have its limitations. The biotic index can indicate a problem, but it cannot specify what that problem might be. For example, manure, sewage, fertilizers, sediment and organic materials all negatively impact water quality. In order to pinpoint these possible pollutant sources, other monitoring such as habitat assessment, dissolved oxygen and temperature needs to be conducted. The biotic index is useful for identifying long-term pollution problems, since these organisms carry out a portion or all of their life cycle in streams. Most of the other parameters you will monitor (except habitat) only indicate the water quality conditions at the time of testing.

To determine a biotic index score, you will collect organisms, identify them, and rate them based on their tolerance to pollution using a chart like the Macroinvertebrate Tally on the next page. The most tolerant organisms will get a score of 1; the least tolerant will get a score of 4. Review the example on the following page to see how a biotic index score is determined.



For additional information about macroinvertebrates, visit these websites:

http://watermonitoring.uwex.edu/wav/monitoring/biotic.html

http://watermonitoring.uwex.edu/wav/monitoring/coordinator/ecology/macro.html

PROCEDURE:

1. Show students the video about biotic index monitoring from the Water Action Volunteers DVD Set (from the main menu on Disc 1, choose "Monitoring Protocols" and then "Biotic Index"; Run time 11:40). The video is also available online at: http://watermonitoring.uwex.edu/wav/monitoring/video.html

2. Have students read the section in the student workbook entitled "Biotic Index" (see Section 4).

3. (Optional) Have students conduct additional reading about biotic index on the website listed in the background section for this parameter.

4. Have students answer discussion questions in their workbook.

5. Have students make a hypothesis about the biotic index they will measure at their stream site. Students should record this hypothesis in their workbook.

6. Have students roll the macroinvertebrate "dice" three times (to represent collecting three biotic index samples) and determine which macroinvertebrates are present in their stream using the Key to Macroinvertebrate Life in the River.

7. Have students fill out the macroinvertebrate data sheet (available in section 6) to show which macroinvertebrates were present in their three biotic index samples. Then have them complete the calculations on the data sheet to determine the health of the stream.

Student Discussion Questions and Sample Answers:

1. What are aquatic macroinvertebrates?

2. Give some examples of aquatic macroinvertebrates.

3. What are some advantages to using macroinvertebrates to identify water quality as compared to studying other physical or chemical aspects of water quality?

4. After sampling the macroinvertebrate population at Stream X in Central Wisconsin that had low gradient and a muddy bottom, you noticed that there were not very many different types of organisms present. Before filling out the biotic index sheet, what would you speculate about the water quality of Stream X? Why?

5. If you were standing on the edge of a stream planning where to go within it to collect aquatic macroinvertebrates, where would you try looking for them?

6. If you collected caddisflies, mayflies, riffle beetles, amphipods and both non-red midges and bloodworms, what would your biotic index score be?

7. You will soon be determining a biotic index score at a stream near your school. What water quality do you expect to find? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

Optional Activities:

- Making and Using Dichotomous Keys (See page 1-82)
- Researching Macroinvertebrates (See page 1-84)
- Fashion a Fish (See page 1-97)
- Macroinvertebrate Mayhem (See page 1-98)
- Build a Bug (See page 1-100)

E. coli BACTERIA MONITORING

The background material for this parameter is used with permission from Chapter 2 of the Citizens Monitoring Bacteria manual, by Laura Bruhn and Lois Wolfson. Citizens Monitoring Bacteria was a three-year multi-state, multi-partner project funded by USDA to develop a training program and scientifically select a reliable bacteria monitoring method appropriate for use by volunteers monitoring surface waters. The full manual is available at: http://www.usawaterquality.org/volunteer/EColi/Manual.htm

Learning Objectives:

- Students will understand what *E. coli* bacteria are and some sources of these bacteria.
- Students will understand how *E. coli* bacteria are used to learn about the health of a stream.
- Students will understand and practice how to assess water quality using *E. coli* bacteria.

Standards:

English A.8.1, A.8.4; Environmental Education B.8.5; Mathematics: Statistics and Probability E.12.1; Science Inquiry C.8.1, C.8.2, C.12.1, C.12.2, C.12.3

Materials:

- Wisconsin State Laboratory of Hygiene “Beach Water Collection for *E. coli* Testing” Video (accessible using Internet Explorer at: http://www.slh.wisc.edu/ehd/watermicro/)
- Student Workbook (See Section 4)
- Writing instrument
- Sterile 30 mL sample bottles (available from Microbiology Labs)
- 3M™ Petrifilm™ plates (this is a good opportunity to use expired plates)
- 3M™ Petrifilm™ spreaders
- Sterile 1 mL pipettes
- Bleach (dilute solution)
- Antibacterial hand wipes
- Permanent markers
- Paper towels
- Latex or nitrile gloves
- Photos of bacteria colonies on 3M Petrifilm plates
- *E. coli* bacteria data sheets
- Computer with Internet access (optional)

Time:

50 minutes

Background:

- Most bacteria do not cause human health problems; some, including *E. coli,* can be used as indicators of possible pollution in surface waters.
- Runoff from land is the leading cause of surface water pollution in the United States.
- Sources of fecal coliform bacteria in surface waters include manure spread on land that has run off into surface waters, failed septic systems, pet wastes, and wildlife and bird feces.

Bacteria are microscopic, single-celled organisms that are the most numerous organisms on earth. They are so small that over five million could be placed on the head of a pin. Bacteria can live in numerous environments and perform many complex actions, some of which are beneficial and some harmful. Most bacteria, however, are not harmful and do not cause human health problems. Those that are disease producing are referred to as pathogenic. Viruses and some protozoans can also be pathogenic.

Coliform bacteria are part of the Enterobacteriaceae family and individual cells cannot be seen with the naked eye due to their small size (but colonies can be seen.) While some coliform bacteria can be naturally found in soil, the type of coliform bacteria that live in the intestinal tract of warm-blooded animals and originate from animal and human waste are called fecal coliform bacteria.

Escherichia coli (*E. coli*) is one subgroup of fecal coliform bacteria. Even within this species, there are numerous different strains, some of which can be harmful. However, the release of these naturally-occurring organisms into the environment is generally not a cause for alarm. However, other disease causing bacteria, which can include some pathogenic strains of *E. coli* or viruses, may also be present in these wastes and pose a health threat.

E. coli as indicator bacteria

Trying to detect disease-causing bacteria and other pathogens in water is expensive and may pose potential health hazards. Further, testing for pathogens requires large volumes of water, and the pathogens can often be difficult to grow in the laboratory and isolate. *E. coli* bacteria are good indicator organisms of fecal contamination because they generally live longer than pathogens, are found in greater numbers, and are less risky to collect or culture in a laboratory than pathogens. However, their presence does not necessarily mean that pathogens are present, but rather indicates a potential health hazard may exist.

The Environmental Protection Agency (EPA) has determined that *E. coli* are one of the best indicators for the presence of potentially pathogenic bacteria (US EPA, 2002). Because *E. coli* monitoring does not measure the actual pathogens, the assessment is not foolproof; however, it is a good approach for assessing the likelihood of risks to human health. Monitoring for these indicator organisms is an easy and economical method for citizens or professionals to assess health risks due to bacterial contamination of surface waters.

Common sources of *E. coli*

Bacteria in water can originate from the intestinal tracts of both humans and other warm-blooded animals. Human sources include failing septic tanks, leaking sewer lines, wastewater treatment plants, sewer overflows, boat discharges, swimming "accidents" and urban storm water runoff. In urban watersheds, fecal indicator bacteria are significantly correlated with human density (Frenzel and Couvillion, 2002). Animal sources of fecal coliform bacteria in surface waters include manure that has been spread on the land, livestock defecating in streams, pet wastes (e.g., dogs, cats), wildlife (e.g., deer, elk, raccoons), and birds (e.g., geese, pigeons, ducks, gulls). If you are sampling in a watershed area without significant human impact and are finding *E. coli,* the source may be birds or wildlife. In a study comparing *E. coli* concentrations in waters from agricultural and "pristine" sites, contamination was found in both settings. The researchers deduced that the levels of *E. coli* at the pristine site likely came from wildlife, such as deer and elk, living the area (Niemi and Niemi, 1991).

Another source of bacteria pollution to stream waters comes from Combined Sewer Overflows (CSOs). Some sewer and storm water pipes are not separated. When a large storm event occurs, the wastewater treatment plants cannot handle the excess volume of water being pumped to them. As a result, untreated sewage along with storm water is dumped directly into rivers and streams.

Remember, the presence and levels of *E. coli* in a stream do not give an indication of the source of the contamination. Though monitoring them can be a good first step in investigating a watershed for potential sources.

Common routes of bacteria to streams

Polluted water runoff from the land is the leading cause of water quality problems nationwide (US EPA, 2002). Fecal material as well as other pollutants can be transported to waterways through runoff. How quickly they are transported partially depends on the type of land use. Non-developed lands including grasses and other vegetation tend to soak up rainfall, thereby increasing infiltration into the ground and reducing runoff to waterways. Developed lands such as streets, rooftops, sidewalks, parking lots, driveways and other hard surfaces that are impervious to infiltration cause runoff to increase. Lands that support domesticated animals, such as cattle, hogs or horses, can also be a source of bacteria, particularly if animals enter the water for drinking or if heavy rains wash manure from the land into receiving waters.

Risks to human health

Most people are concerned about the risk that bacteria may pose to human health. When bacterial counts are above health standards, people exposed to water that contain bacteria may exhibit fever, diarrhea, abdominal cramps, chest pain or hepatitis. While *E. coli* by itself is not generally a cause for alarm, other pathogens of fecal origin that are health threats include *Salmonella*, *Shigella*, and *Psuedomonas aeruginosa*. Non-bacterial pathogens that may be present with fecal material include protozoans, such as *Cryptosporidium* and *Giardia*, and viruses.

There are some strains of *E. coli* that are pathogenic themselves. One that has received much attention is the *E. coli* strain named 0157:H7 that lives in the intestinal tract of cattle. This strain is primarily spread to people who eat contaminated, undercooked beef or drink unpasteurized milk and is not generally found in surface waters.

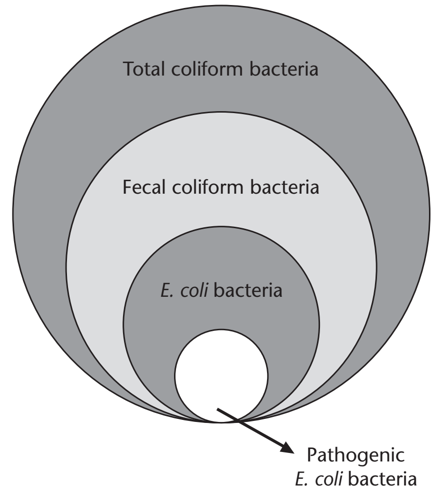
Examples of at-risk concentration levels

Criteria for acceptable concentrations of indicator bacteria in recreational waters have been developed by the US EPA (1986). Initially, total coliform bacteria were used as the benchmark. However, because it was shown that *E. coli* were more closely correlated with swimming-related illnesses, the US EPA later recommended that *E. coli* be used as the indicator in freshwater recreational areas (US EPA, 2002).

Many states have since adopted this recommendation; however, some such as Wisconsin, still use total fecal coliform bacteria when determining acceptable concentrations for recreating in surface waters. For *E. coli* the EPA mandates that the acceptable risk level for total body contact recreation, which involves activities such as swimming or water skiing, is 126 colonies of organisms (referred to as colony forming units or cfu) per 100 milliliters (ml) of water or less, based on a geometric mean (calculated over 30 days with at least 5 samples) or a one-time concentration of 235 cfu/100 ml. The risk of getting sick increases as total numbers of colonies are exceeded.

The number of colony forming units of *E. coli* organisms per 100 ml of water and the method of determination may vary slightly by state, based on state public health codes and water quality standards. The EPA recommends a set of standards for *E. coli* in freshwater bodies as a single maximum allowable count. These rates correspond to an acceptable risk level of 8 people out of

1,000 getting sick. In Wisconsin, these guidelines are used for swimming beaches, but a fecal coliform standard (of which *E. coli* is a subset) is used for other recreational waters. The fecal coliform standard is 400 cfu/100 mL for a single event.



Fecal coliform bacteria which include *E. coli* are part of a larger group of colifom bacteria. (Figure not to scale.)

Even with good watershed management measures, there will always be fecal material in the environment. If you find unusually high levels of *E. coli* on a long-term, regular basis in your stream samples, you should alert and work with your local health agency.

Weather and seasonal influences

The number of bacteria colonies can be influenced by weather and seasonal effects. This variability makes the bacterial concentrations in natural water difficult to predict at any one time. Bacteria counts often increase following a heavy storm, snow melt or other excessive runoff. *E. coli* bacteria are often more prevalent in turbid waters because they live in soil and can attach to sediment particles. Bacteria can also remain in streambed sediments for long periods of time. If the streambed has been stirred up by increased flow or rainfall, your sample could have elevated bacteria levels. This is why you should avoid disturbing the streambed as you wade out into the stream to collect your sample. You should also collect the water sample upstream from you. If you are collecting at several sites within the stream, collect the furthest downstream sample first and proceed upstream.

A number of other weather influences may affect bacteria levels in the stream. Higher *E. coli* counts may be found in warmer waters because *E. coli* survive more easily in these waters. (*E. coli* typically live in the warm environment of the intestines of warm-blooded animals). Ultraviolet rays of sunlight, however, can also kill bacteria, so a warm sunny day may produce counts lower than expected.

For more information about *E. coli* bacteria monitoring, visit this website:
http://www.usawaterquality.org/volunteer/EColi/Manual.htm

References:

Frenzel, S.A. and C.S. Couvillion (2002) Fecal-indicator bacteria in streams along a gradient of residential development. Journal of the American Water Resources Association. 38:265-273.

Niemi, R.M. and J.S. Niemi (1991) Bacterial pollution of waters in pristine and agricultural lands. Journal of Environmental Quality. 20:620-627.

US EPA (1986) Ambient Water Quality Criteria for Bacteria, EPA 440/5-84-002. Office of Water.

US EPA (2002). Implementation Guidance for Ambient Water Quality Criteria for Bacteria (Draft). May 2002 (www.epa.gov/waterscience/standards/bacteria/bacteria.pdf).

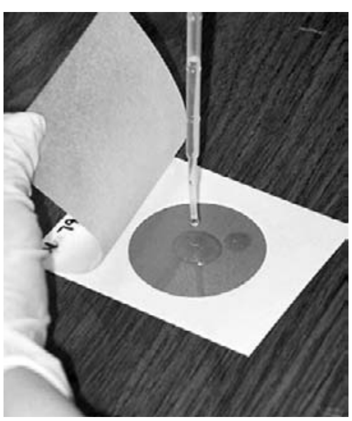
Classroom Procedure for *E. coli* Bacteria Monitoring:

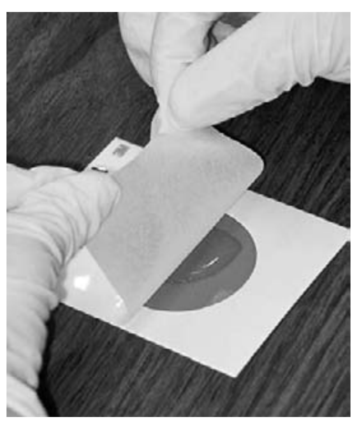
During your class field trip, you will collect your sample from a stream near your school using methods outlined in the Wisconsin State Lab of Hygiene video, and transport your sample on ice to your classroom. You will then use 3M™ Petrifilm™ to monitor *E. coli*. It is essential that you maintain sterile conditions while plating your sample, since this is the time with the greatest potential for external contamination of the samples. Follow these steps to process the sample:

1. Remove 3M™ Petrifilm™ from refrigerator and allow the package to come to room temperature before opening. This will take at least 10-15 minutes.
2. Sanitize your working surface by spraying or wiping it with a dilute bleach solution.
3. Wash your hands thoroughly with soap and water.
4. Label the back side of three 3M™ Petrifilm™ plates with the date, time, sampling site and replicate number (1 to 3).
5. Always shake your sample bottle before extracting a sample with a pipette.
6. Place a 3M™ Petrifilm™ plate on a level surface.
7. Lift the top film and dispense 1 mL of sample in the upper portion of the pink portion of the plate.
8. Slowly roll the top film down onto the sample to prevent trapping air bubbles.

Note to teachers:

- **Do not use plates that show orange or brown discoloration.**
- **Ensure plates to be used for field monitoring have not expired. The expiration date and lot number are noted on each package. (Example expiration date: 2012-10, would expire in the 10th month (October) of the year 2012.)**





9. If needed with the smooth side down, place the plastic spreader over the closed plate and distribute sample evenly across the pink area of the plate by *gently* tapping with one finger on the center of the plastic spreader.

10. If used, remove the spreader and leave plate undisturbed for at least one minute to permit the gel to solidify.

11. Repeat this process for your other two replicate samples.

12. Incubate the plates in a horizontal position, with the clear side up in stacks of up to 20 plates.

13. Incubate for 24 hours at 35˚C.

Note to teachers:

The incubator should be humidified with distilled water. Set up the incubator several hours in advance to allow it to get to temperature prior to plates being placed within it. For first-time use, allow a few days to manipulate the temperature to adjust it to 35˚C. After use, use a mild bleach solution to clean the incubator before storing.

PROCEDURE:

1. Show students the video about *E. coli* bacteria monitoring that is on the Wisconsin State Lab of Hygiene website (In Internet Explorer, go to: http://www.slh.wisc.edu/ehd/watermicro and scroll three quarters down the page to links for "Video - Beach Water Collection for *E. Coli* Testing"; Run time is 12:26, however the pertinent section for student use is approximately 6:30 – 8:20 as the State Lab of Hygiene will not be used for student sampling). Note: Smaller sample bottles are recommended for use by students than are shown in this video.

2. Have students read the section in the student workbook entitled "*E. coli* Bacteria Monitoring" (see Section 4).

3. (Optional) Have students conduct additional reading about *E. coli* bacteria on the website listed in the background section for this parameter.

4. Have students answer discussion questions in their workbook.

5. Have students make a hypothesis about the *E. coli* bacteria they will measure at their stream site. Students should record this hypothesis in their workbook.

6. Using tap water in a bucket, have students practice collecting a water sample to be analyzed for bacteria, following methods outlined in the video.

7. Have students follow methods described above to plate their practice sample.

Student Discussion Questions and Sample Answers:

1. What are three sources of *E. coli* in surface waters?

2. Disease-causing bacteria are called ____________ bacteria.

3. Are the majority of bacteria disease-causing? ______

4. What are some advantages to using *E. coli* bacteria to monitor water quality?

5. What symptoms might humans infected with water-borne pathogens display?

6. In what units is *E. coli* measured?

7. What is the EPA-recommended one-time concentration limit for *E. coli* for total body contact activities such as swimming?

8. What factors can influence the concentration of bacteria in surface waters?

9. You will soon be monitoring the *E. coli* bacteria level in a stream near your school. What water quality do you expect to find? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

EROSION IN A BOTTLE

Activity developed for WAV by: Kevin Fermanich, Mike Pelech, Scott Arnold, Rob Zemenchik and Peter Kling, with the Department of Soil Science at University of Wisconsin-Madison (608-262-2633).

Groups will build a model that demonstrates runoff and erosion, which can occur in both urban and agricultural settings.

Learning Objectives:

By participating in this activity, students will:

1. Understand what factors contribute to erosion and runoff in urban and agricultural settings.
2. Build a bottle runoff model.
3. Use the bottle runoff model to demonstrate runoff and erosion.

Standards:

Environmental Education B.8.5, B.8.17

Materials:

- 4 two-liter plastic soda bottles
- One bottle cap
- A permanent marker
- Photocopies of tower hole pattern (page 1-67)
- Dark topsoil
- Sand
- Mulch or sod (or newspaper or woodchips)
- Water
- 2 two-cup measuring cups
- 2 containers such as glasses or small bowls
- Razor knife
- Scissors
- Push pin or ice pick/drill
- Powdered drink mix

Time:

30 minutes

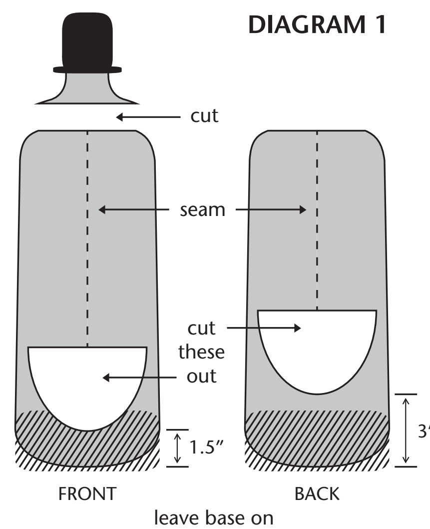
Background:

Runoff and erosion are problems in both rural and urban areas. Runoff is a term for the water that flows over the land and eventually reaches a water body. Runoff causes erosion, which is the wearing away of soil and rock by water or wind. Open fields, bare hillsides and construction sites are prime candidates for erosion because the runoff water easily carries unprotected soil to surface water.

Soil and rocks that are washed into streams and rivers cause sedimentation. The buildup of sediment at the bottom of a stream or river creates a muddy bottom. This extra mud changes the living environment for many fish and wildlife, and can restrict water flow. Runoff nutrients, and toxics such as fertilizers and pesticides carried with the soil can cause rapid algae and weed growth that may harm fish and other aquatic organisms.

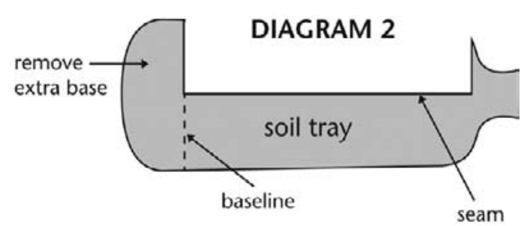
PROCEDURE:

Bottle 1: "The Support Tower"



1. Photocopy and cut out the tower hole template on page 1-67.
2. Cut the top off the bottle with a knife or scissors (see Diagram 1).
3. Choose a front and back on the tower and mark these locations with a marker or pen at the base of the bottle. You may want to use the side seams of the bottle as a guide for the front and back.
4. Measure 1½ inches (4 cm) up from the "front" mark on the bottle. Make another mark.
5. Take the tower hole template and trace it on the front side of the bottle. The rounded edge or bottom of the pattern should be on the 1½-inch mark (see Diagram 1).
6. Turn the bottle around to the back mark.
7. Measure 3 inches (7.5 cm) up from the mark on the back of the bottle.
8. Using the tower hole template, trace it onto the back side of the bottle. The rounded edge of the pattern should be on the 3-inch mark (see Diagram 1).
9. Cut out both the front and back holes (recycle the plastic). Leave the base on the bottle for stability.

Bottles 2 & 3: "Soil Tray" (need at least two of these)



1. Use hot water to loosen the glue and remove the extra plastic base from the bottom of both bottles that will be used as soil trays (see Diagram 2).

2. Use a permanent marker to draw a line (baseline) around the base of the bottle about 2 inches from the bottom of the bottle.
3. Lay the bottle on its side.
4. Find the seams that run the length of the bottle. You can use these seams as a guide.
5. Use the marker to draw a line along each seam from the baseline to the neck of the bottle (see Diagram 2).
6. At the neck of the bottle, draw a line from one seam line to the other seam line.
7. Cut along lines and remove the side of the soil tray (recycle the plastic). The soil tray is ready to be filled with soil.
8. Repeat steps 1-7 for the second soil tray.

Filling the soil tray

1. With the bottle lying on its side, fill one bottle with about ½-inch of sand. This is the subsoil. Level the subsoil and gently press it down to make it firm.
2. Put ¼ inch of moist topsoil over the sand. Remove or break up any soil clumps. The layers of soil should be easy to see through the side of the bottle (see Diagram 4).
3. The bare soil tray is done.
4. Repeat steps 1 and 2 for a second soil tray.
5. In the second soil tray, press mulch (grass clippings in the summer; finely shredded newspaper or wood chips in the winter) into the moist topsoil so most of the surface is covered. You may want to use a piece of sod instead of mulch. If you have the extra time, you can grow your own plants such as alfalfa sprouts or grass in the second soil tray.
6. Sprinkle about one-half-bottle-cap-full of powdered drink mix evenly over the surface of both trays. The mix represents some kind of fertilizer or pollution.

DIAGRAM 3

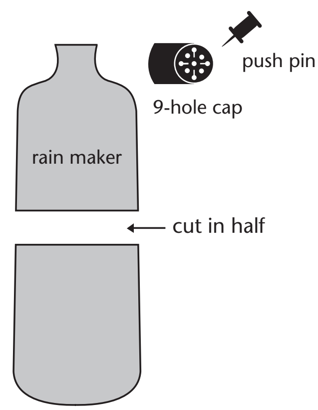
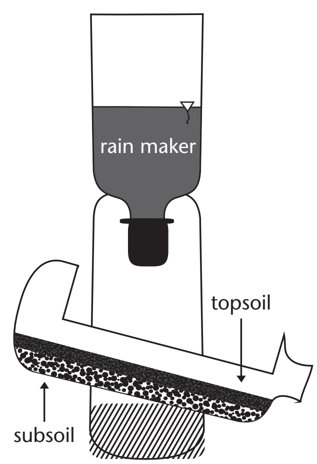


DIAGRAM 4



Bottle 4: "Rain Maker"

1. Cut the next bottle in half to form a funnel and a water container (see Diagram 3).
2. The funnel or top portion is the rain maker.
3. Poke holes in the bottle cap by using a push pin, ice pick or drill. Make nine holes. It's best to leave the rubber seal in the cap so water doesn't leak around the rim.
4. Screw the cap tightly on the rain maker and fill the rain maker about halfway with water to test whether

all holes are free-flowing. If the water is only dribbling out, enlarge the holes by wiggling the push pin back and forth a bit more.

5. The bottom half of the bottle can be used to hold the water added to the rain maker.

Putting the model together

1. Pour sand into the tower (Bottle 1) to make it stable.
2. Push the bare soil tray through the holes in the tower. The neck of the soil tray should be lower than the base of the soil tray (see Diagram 4).
3. Place the model on a block of wood or a platform so the mouth (bottle cap end) of the soil tray is high enough to place measuring cup beneath it.
4. Insert the empty rain maker into the top of the tower.

Collecting runoff

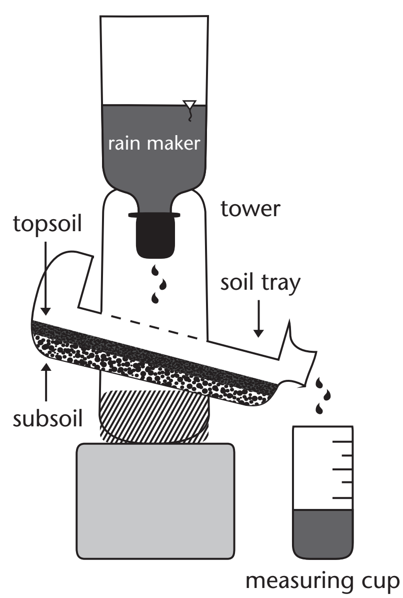
1. Use the two-cup measuring cup to collect runoff. It's important to use the same size collection container when comparing runoff between different demonstrations.

How to do the demonstration

1. Pour water into two separate containers so both containers have two cups of water. This water will be added to the rain maker. Place the measuring cup below the soil tray to collect runoff (see Diagram 5).
2. Dump the water from one container into the rain maker.
3. Observe the amount of drink mix and soil being "eroded" into the measuring cup.
4. When all of the runoff water has flowed into the measuring cup, set it aside. You will need to use it to compare runoff with the next soil tray.
5. Remove the first soil tray from the tower and replace it with the second soil tray (mulch tray).
6. Repeat demonstration steps 2 through 4, but this time use the mulch tray and the second container of water.
7. Compare the results.
   - Which measuring cup has the most water? Colored water from drink mix?
   - Was the mulch helpful in reducing the amount of runoff? Erosion?
   - Was the topsoil washed away directly beneath the rain maker?

   Look at the collection containers. Think of these containers as a stream or river. How would the "drink mix" affect water quality and aquatic life?

DIAGRAM 5



Extra ideas

Try these ideas to make your "Erosion in a Bottle" experiment even more interesting!

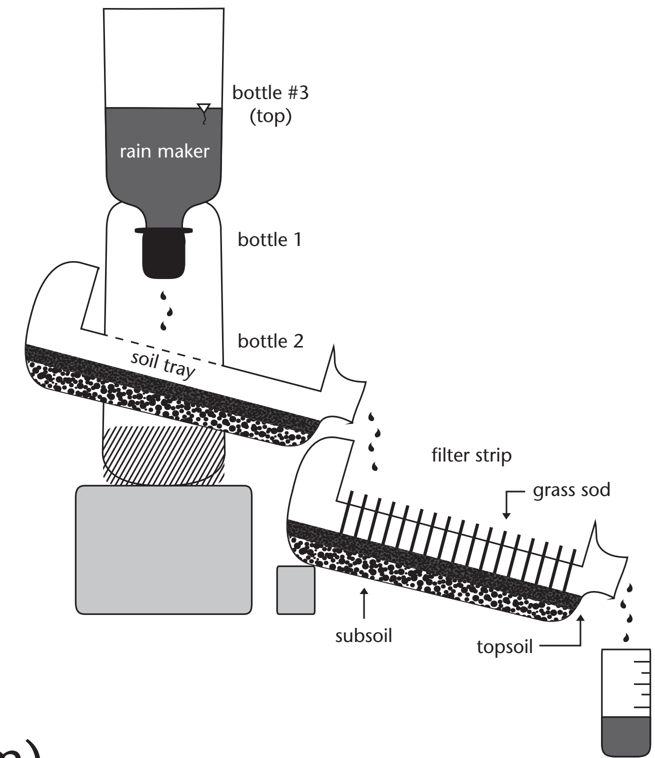
Create a filter strip

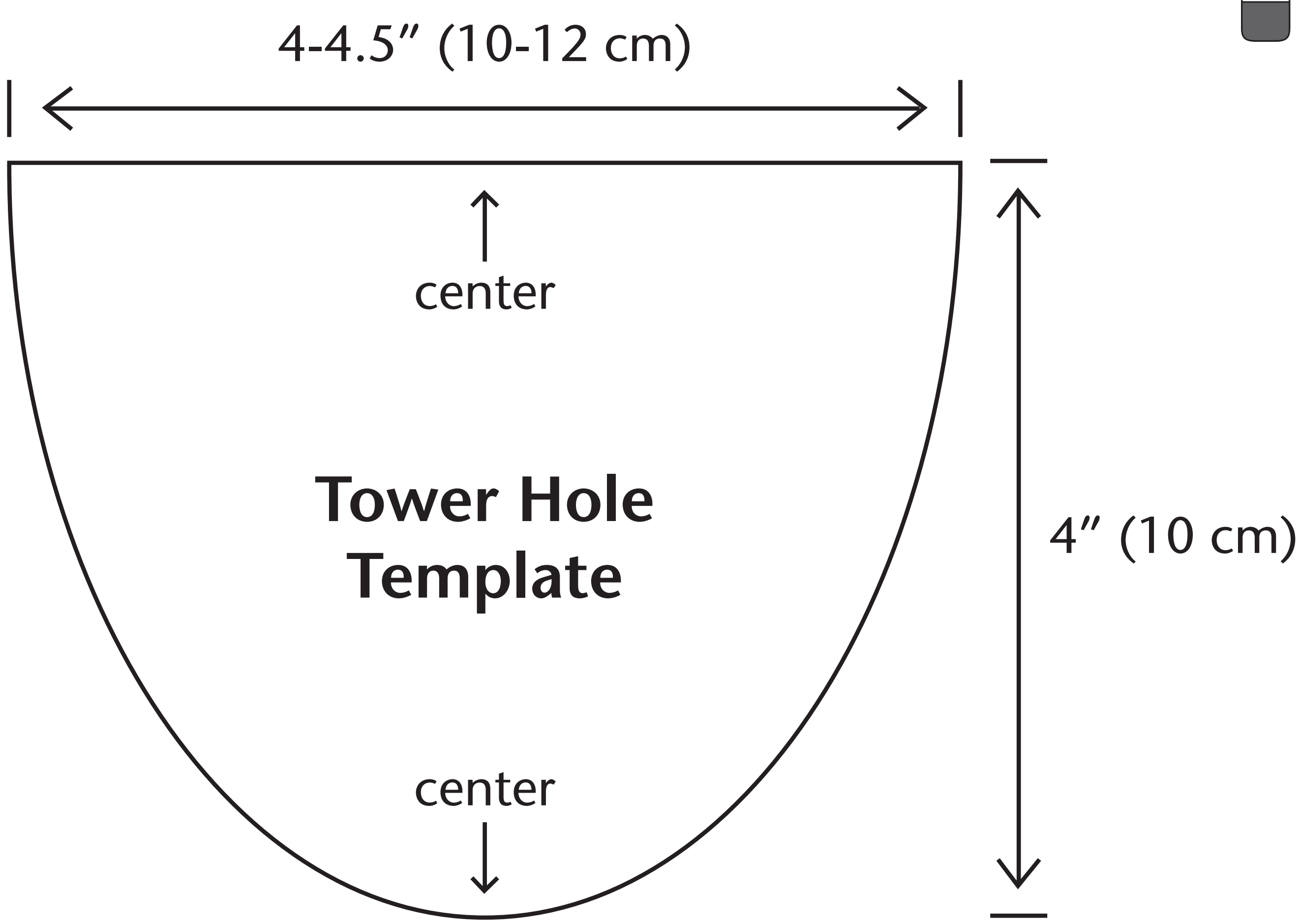
A filter strip is an area of grass that slows runoff and captures soil and pollutants. To create an erosion model with a filter strip, make an extra soil tray with sod.

Then, let runoff from the bare soil tray pour onto the soil tray with sod and then into the measuring cup (see diagram below). This activity will demonstrate how filter strips help to prevent runoff pollution.

Different amounts of rainfall

Experiment with the amount of "rainfall" and how this affects the amount of erosion.





URBAN RUNOFF MODEL

Developed for WAV by Ron Struss and Paul Hlina.

Students will build a simple watershed model that demonstrates how the volume of stormwater runoff increases as urban watersheds are roofed and paved over.

Learning Objectives:

By participating in this activity, students will:

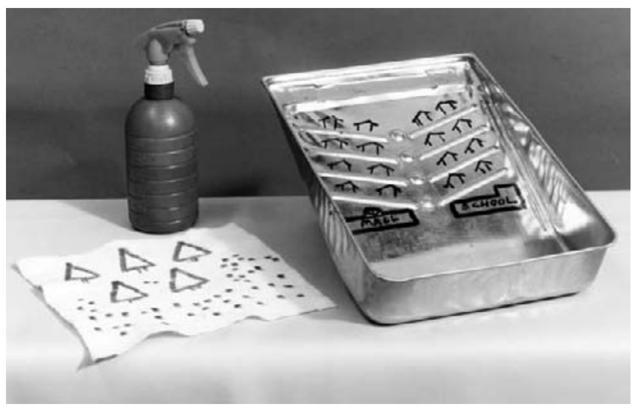
1. Demonstrate that as watersheds urbanize and increase in area under hard surfaces (e.g., roofs and pavement), the speed and volume of stormwater runoff leaving watersheds will also increase.
2. Demonstrate the need for stormwater sewers and ponds to prevent urban flooding.

Standards:

Environmental Education B.8.5, B.8.10, B.12.2, B.12.3, D.8.5

Time:

25 minutes



Materials:

- A paint roller tray
- A spray bottle
- A 10” X 10” square of white felt
- Green, blue and black permanent markers
- Cloth or paper towels
- Measuring cup
- Extra felt (optional)
- Modeling clay (optional)
- Tape

Background:

Why do cities have storm sewers? Why are streams in urban areas usually in poor condition? Why are cities starting to install more stormwater runoff ponds?

The one answer to all the above questions is: Impervious surfaces. Impervious surfaces are hard surfaces like roofs, roads and parking lots into which that water cannot soak.

Urban areas are covered with impervious surfaces. They are what make a city a city and not the countryside. In fact, urban areas are often defined by the amount of ground that is covered by "streets, shingles and sidewalks." (See table on page 1-71.)

Stormwater runoff is the water that runs off the surface of the ground during rainfall or snow melt. As a watershed (the area of land that drains to a lake or stream) becomes urbanized and covered with impervious surfaces, the amount of stormwater runoff also increases. This is because:

1. Impervious surfaces prevent stormwater from reaching the soil. Soil acts like a big sponge, soaking up runoff water. When soil is covered by hard surfaces, water can no longer soak in, increasing the amount of surface runoff.
2. Land is reshaped when buildings, roads and parking lots are built in order to speed stormwater drainage. Areas where stormwater once puddled are eliminated, which leads to increased amounts of runoff flooding streets and parking lots. Stormwater sewer systems are installed in cities to drain stormwater from paved areas to nearby lakes and streams. Unless redesigned to have a larger floodplain, streams can only handle a set amount of water.

When urbanization increases the amount of runoff, streambanks are often eroded away as the increased volume of water and speed of runoff push against them.

PROCEDURE:

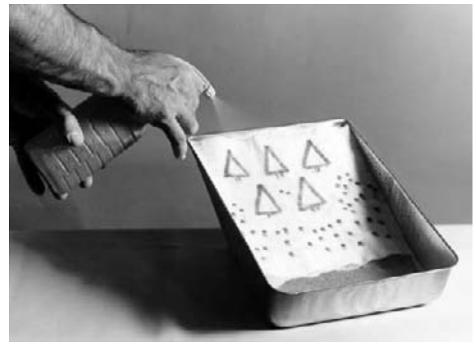
How to make the model:

1. Using a black permanent marker, illustrate the sloped area of the paint roller tray with an urban scene complete with houses, schools, stores, streets and parking lots. Write the word "stream" at the flat bottom area of the tray with a blue marker.
2. Cut a piece of felt to fit over the sloped area of the paint roller tray. Using a green permanent marker, draw a scene of natural vegetation on the felt. It is best to use white felt or paper towels as dyes may "run" when wet.
3. Adjust the spray bottle so that it sprays an area smaller that the width of the tray. Getting water on the sides of the tray should be avoided.

How to use the model:

1. The paint roller tray is a watershed; the bare tray is an urban watershed with 100% impervious surfaces, the tray with felt cover is a natural vegetated watershed with 0% impervious surfaces. Just like soil, the felt acts like a sponge soaking up stormwater. The flat bottom area of the paint roller tray is a stream that receives stormwater runoff. The spray bottle is rain.

2. Create "rain" on the natural vegetation watershed. Place the felt over the sloped area of the paint roller tray. Spray the felt with even sprays while counting the number of sprays. Record the number of sprays it took to get one drop of runoff from the "natural vegetated watershed" into the "stream" (it should take 75-100 sprays).



Making rain on the "natural vegetation watershed" (number of sprays are counted).

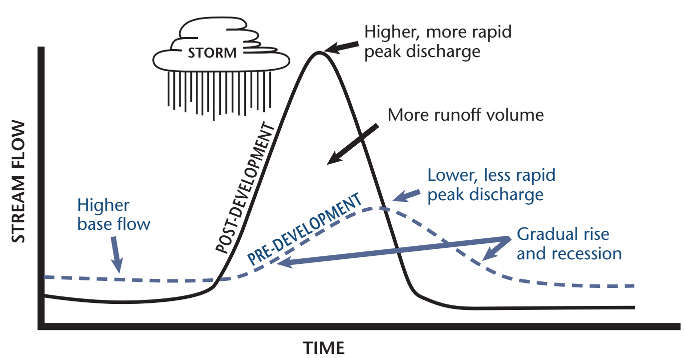
3. Remove the felt and dry out paint roller pan. Pretend the natural vegetated watershed has been dramatically converted into an urban watershed with 100% impervious surface. Make bulldozer noises if you like as the felt is removed and the urban scene is revealed. Point out that this is a dramatic illustration; going directly from a fully naturally vegetated watershed to a fully urbanized one will take some time in real life.

4. Create "rain" on the urban watershed. Spray the sloping area of the bare metal paint roller pan with even sprays. Count the sprays it takes to get one drop of runoff from the "urban watershed" into the "stream" (it should only take 3 to 5). Continue spraying until the spray count is the same as what produced a single drop of runoff in the "naturally vegetated" watershed. How much water is in the stream?

Making rain on the "urban" watershed (number of sprays are again counted).

5. Compare the two – discuss. It should be obvious that urbanization results in faster runoff and more runoff. Discuss what the impact on the receiving stream would be as the speed and volume of stormwater runoff from a watershed increases. Discuss ways that stormwater runoff speed and volume can be reduced from urban watersheds.

A hydrograph is a graph that shows stream flow over time. This hydrograph shows how stream flow changes as a watershed goes from a natural land cover (pre-development) to an urbanized land cover (post-development).



Urban Land Use	Percent Area in Impervious Surfaces
Downtown areas or shopping malls	95% - 100%
Apartments or closely-spaced houses	45% - 60%
Suburban houses on typical lots (¼ acre)	35% - 45%
Suburban houses on large lots	20% - 40%
Open park areas	0% - 10%

Source: Modified from the Wisconsin Stormwater Manual, Department of Natural Resources

Discussion Question:

1. What actions could individual people take to improve the health of the watershed?

Other ideas:

Add Green Spaces

Cut small pieces of felt (e.g., 2" X 3") and stick this onto the "urban watershed" with rolled tape. These represent parks, playgrounds, golf courses and yards in urban areas. Spray the watershed a set number of times before and after the felt squares are in place and see how the addition of "green" spaces in cities affects the volume of stormwater runoff.

Add Stormwater Ponds

Using modeling clay, construct a number of "U"-shaped dikes on the "urban watershed" where the "V"-shaped ridges come together in the center of the tray. These dikes represent stormwater ponds built at the end of storm sewer lines. Do a set number of sprays, drying out the ponds with towels afterwards to represent pond water that infiltrates into the soil or evaporates. Measure the remaining runoff in the "stream" and see how the addition of stormwater ponds affects the volume of stormwater runoff.

Resources

Chapter One, The Wisconsin Stormwater Manual, UW-Extension Publication G3691

Storm Sewers – The rivers beneath our feet, UW-Extension Publication GWQ-004

TRANSPARENCY TUBE CASE CONSTRUCTION

Pattern developed by Judy Aspling and Carolyn Lipke.

Learning Objectives:

- Students will practice measurement skills.
- Students will understand the meaning of a seam allowance.
- Students will understand how to use a sewing machine to create a product.

Standards:

Mathematics: Measurement D.8.3, D.12.2

Time:

50 minutes

Materials:

- 13-inch x 57½-inch piece of medium weight fabric
- Thread
- 30-inch cord or shoelace
- 32-inch 1½-inch-wide webbing or fabric strap

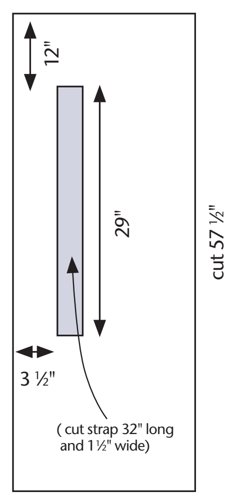
Background:

Volunteer stream monitors across Wisconsin use transparency tubes to quantify stream clarity. These cases will help protect the tubes during travel to and from field sites and while in storage.

Note to teachers:

Please use fabric that is machine washable and dryable. Fabrics that will dry quickly and are somewhat durable are preferred (polar fleece is an excellent option). Feel free to use scrap/repurposed fabric.

PROCEDURE:



1. Attach strap to rectangle of fabric. Place webbing lengthwise on right side of fabric rectangle, 3½ inches from the side, 12 inches from top. Use zigzag stitch to attach top edge of webbing. Measure down 29 inches and attach bottom edge of webbing. Strap will not lay flat.
2. Fold fabric, right sides together, seam bottom side and long side, stopping 6 inches from top edge.
3. Using an overcast zigzag finish all raw edges.
4. Turn under ½-inch seam allowance at side opening, topstitch in place.
5. Turn down 1¼-inch casing at top edge, topstitch ⅛ inch from lower casing edge. Thread shoelace through casing and tack in place at the halfway point. This will keep the lace from getting pulled out.
6. Use completed cases for school-owned transparency tubes or send completed cases to: Kris Stepenuck, Environmental Resources Center 445 Henry Mall, Rm 202, Madison, WI 53706.

STREAM ECOSYSTEM – WHAT MAKES A STREAM HEALTHY?

Developed by Ann Kroncke, Platteville Public School District

Learning Objective:

- Students will learn basic principles of stream ecology related to the monitoring they will participate in on their upcoming field trip.

Standard:

Environmental Education B.8.5

Materials:

- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #2
- Copies of student worksheet (this can be found on the following two pages)
- Writing instrument

Time:

50 minutes

Background:

Dr. Kristopher Wright, Assistant Professor of Biology at UW-Platteville, developed this PowerPoint presentation that introduces basics of stream ecology. The presentation links the six aspects of stream health that students will monitor with the water cycle, food webs and basic concepts of stream development.

PROCEDURE:

1. Show students the video about stream ecology from the Water Action Volunteers DVD Set (from the main menu on Disc 2, choose "Stream Ecology Basics").
2. Have students answer questions on the worksheet that correspond with the Stream Ecology presentation.

Name: ____

Date: ____

Period: ____

Stream Ecosystem – *What Makes a Healthy Stream?*
Student Worksheet

1. List four ways in which water gets into a stream.

2. Complete the following definitions:

   _________________ is the ability to do work (e.g., transport sediments)

   _________________ is the speed of the water (distance/time)

   _________________ is the amount of water that passes a given point over time (volume/time)

3. Habitats can be defined by changes in flow along the length of a stream. Record where riffles, pools, waterfalls, rapids and runs fall along this continuum.

Slow moving ◄——————————————————————► Fast moving

4. Draw a picture of a meander in the space below. Add arrows and label where the current or flow is the strongest. Explain what this does to the streambank (For instance, where would there be erosion? Deposition?)

5. Why are meanders important?

6. Autochthonous production is photosynthesis that happens ________________________

7. How does the energy from allocthonous production get into the stream?

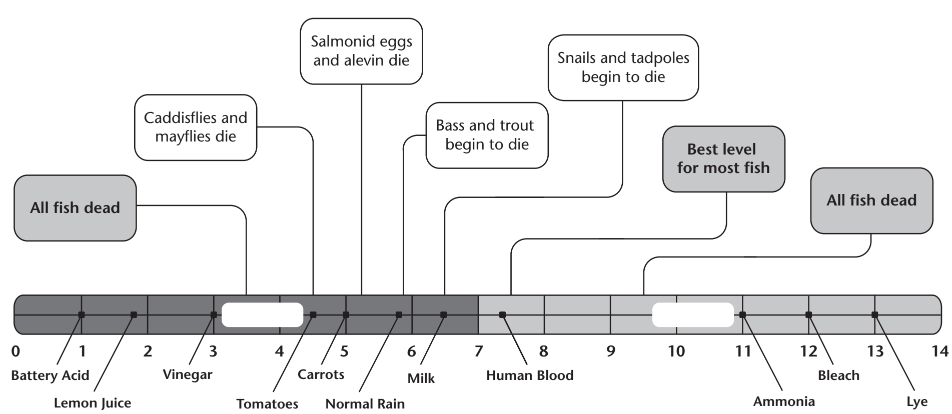
8. List and explain one factor that can affect photosynthesis in a stream (autochthonous production).

9. List and explain one factor that can reduce water clarity.

10. Water temperature in a headwater system *does/does not* change much during the day. (circle one)

11. Dissolved oxygen levels are increased by these three factors:

12. pH is a measure of acidity. Complete the pH scale below by circling the number that is considered neutral and then labeling the acid and basic/alkaline ends of the scale.



Stream Ecosystem – *What Makes a Healthy Stream?*
(Student Worksheet KEY)

1. List four ways in which water gets into a stream.

2. Complete the following definitions:

   _____ _____ is the ability to do work (e.g., transport sediments)

   _____ _____ is the speed of the water (distance/time)

   _____ _____ is the amount of water that passes a given point over time (volume/time)

3. Habitats can be defined by changes in flow along the length of a stream. Record where riffles, pools, waterfalls, rapids and runs fall along this continuum.

   ◄──────────────────────────────►

   Slow moving … Fast moving

4. Draw a picture of a meander in the space below. Add arrows and label where the current or flow is the strongest. Explain what this does to the streambank (For instance, where would there be erosion? Deposition?)

5. Why are meanders important?

6. Autochthonous production is photosynthesis that happens ______________________ ______________________

7. How does the energy from allocthonous production get into the stream?

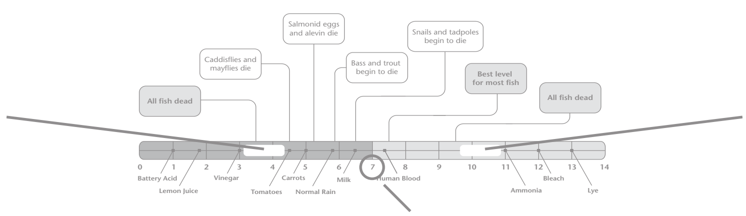
8. List and explain one factor that can affect photosynthesis in a stream (autochthonous production).

9. List and explain one factor that can reduce water clarity.

10. Water temperature in a headwater system *does / does not* change a lot during the day. (circle one)

11. Dissolved oxygen levels are increased by these three factors:

12. pH is a measure of acidity. Complete the pH scale below by circling the number that is considered neutral and then labeling the acid and basic/alkaline ends of the scale.



PARTS PER MILLION LAB

Activity developed by Susan Klaubert and Ann Gaffney, science teachers at Londonderry Middle School, NH

Learning Objectives:

- Students will understand what one part per million means (and looks like).

Standards:

Environmental Education A.8.4, A.8.5; Mathematics: Measurement D.8.3; Science Inquiry C.8.4

Materials:

- 100 mL of dark colored unsweetened drink mix or concentrated dye
- 7 beakers or plastic cups
- Graduated cylinders or air pistons
- Stirring rod
- Student worksheet (page 1-79 to 1-80)

Time:

15-25 minutes

Background:

Sometimes, when discussing water or air, a scientist will have to talk about extremely small amounts of a chemical. Just because the amounts are small does not mean they are unimportant. For example, fish such as trout need a dissolved oxygen level of 6 parts per million (ppm) to survive. This means that out of every million molecules in a sample of water, at least six of them must be oxygen. Living things can be affected by very small amounts of materials in water. It is important to know the human tolerance level of a substance when determining if water is safe for humans to drink. As technology continues to improve, scientists are able to detect smaller and smaller amounts of materials. The smallest amount that can be detected is called the detection limit. The smaller the detection limit, the more we know about what is in our water, and the more that can be done to keep our water safe. Some materials can now be found in concentrations as small as parts per billion or parts per trillion!

PROCEDURE:

1. Set up materials for the Parts per Million Lab. This can be done as a demo in the front of the classroom or as a lab done by students. (It will take less time as a demo.)
2. Have students follow step-by-step procedure on the lab sheet and answer the questions.
3. The teacher can go over the answers with the class after all groups have finished their labs.

Name: ____

Date: ____

Period: ____

Parts per Million Lab: Concentration of Color and Parts Per Million

Student Worksheet

1. Label your beakers or plastic cups 1 through 7.
2. Measure 100 mL of the original solution from the front of the room and put it into beaker 1. This solution has a concentration of one part per one or 1/1. Every bit of it is a concentrated solution. Describe the color of this solution in your data table. Be as descriptive as possible.
3. Measure out 90 mL of water into beakers 2 through 7.
4. Carefully measure out 10 mL of solution from beaker 1. What is the concentration of this solution? __________ Explain your reasoning.
5. Add this to beaker 2 and stir it up.

   How many milliliters of concentrated solution are there? _________ How many milliliters of liquid are there? __________ What fraction of the solution in beaker 2 is the concentrated solution? __________ Reduce this ratio. ___________ This is the concentration of beaker 2. Enter the concentration and a description of the color of the solution into your data table.
6. Carefully measure out 10 mL of solution from beaker 2. Stir this into beaker 3. What fraction of the solution is now colored? ___________
   How is this related to the concentration?

   Enter the concentration and a description of the color of the solution into your data table on the back of this worksheet.
7. Carefully measure out 10 mL of solution from beaker 3. Stir this into beaker 4. Enter the concentration and color of this solution into your data table.

8. Carefully measure out 10 mL of solution from beaker 4. Stir this into beaker 5. Enter the concentration and color of this solution into your data table.

9. Carefully measure out 10 mL of solution from beaker 5. Stir this into beaker 6. Enter the concentration and color of this solution into your data table.

10. Carefully measure out 10 mL of solution from beaker 6. Stir this into beaker 7. Enter the concentration and color of this solution into your data table.

Beaker	Concentration (as a ratio)	Concentration (written out)	Description of Color
1	1/1	1 part per 1	
2			
3			
4			
5			
6			
7			

Discussion Questions:

1. Describe what happens to the concentration of the color as you dilute each solution.

2. Is there color in all of the beakers? ___________ How do you know?

3. What happens to the concentration of the beakers as you move 10mL of the solution from one to the next? Be very specific.

4. If there was only one molecule of color in beaker 7, how many color molecules did you start with in beaker 1? ____________ How do you know?

Parts per Million Lab (TEACHER KEY)

1. Label your beakers or plastic cups 1 through 7.
2. Measure 100 mL of the original solution from the front of the room and put it into beaker 1. This solution has a concentration of one part per one or 1/1. Every bit of it is a concentrated solution. Describe the color of this solution in your data table. Be as descriptive as possible.
3. Measure out 90 mL of water into beakers 2 through 7.
4. Carefully measure out 10 mL of solution from beaker 1. What is the concentration of this solution? _____ Explain your reasoning. ______________________________
5. Add this to beaker 2 and stir it up. How many milliliters of concentrated solution are there? _____How many milliliters of liquid are there? _____ What fraction of the solution in beaker 2 is the concentrated solution? ________ Reduce this ratio. _______This is the concentration of beaker 2. Enter the concentration and a description of the color of the solution into your data table.
6. Carefully measure out 10 mL of solution from beaker 2. Stir this into beaker 3. What fraction of the solution is now colored? ________ How is this related to the concentration? ______________

Enter the concentration and a description of the color of the solution into your data table.

7. Carefully measure out 10 mL of solution from beaker 3. Stir this into beaker 4. Enter the concentration and color of this solution into your data table.
8. Carefully measure out 10 mL of solution from beaker 4. Stir this into beaker 5. Enter the concentration and color of this solution into your data table.
9. Carefully measure out 10 mL of solution from beaker 5. Stir this into beaker 6. Enter the concentration and color of this solution into your data table.
10. Carefully measure out 10 mL of solution from beaker 6. Stir this into beaker 7. Enter the concentration and color of this solution into your data table.

Discussion Questions:

1. Describe what happens to the concentration of the color as you dilute each solution. ______________________________
2. Is there color in all of the beakers? *Yes.* How do you know? ______________________________
3. What happens to the concentration of the beakers as you move 10mL of the solution from one to the next? Be very specific. ______________________
4. If there was only one molecule of color in beaker 7, how many color molecules did you start with in beaker 1? _________ How do you know? ______________________________

Beaker	Concentration (as a ratio)	Concentration (written out)	Description of Color
1	1/1	1 part per 1	
2	1/10	1 part per 10	
3	1/100	1 part per 100	
4	1/1,000	1 part per 1,000	
5	1/10,000	1 part per 10,000	
6	1/100,000	1 part per 100,000	
7	1/1,000,000	1 part per 1,000,000	

MAKING AND USING DICHOTOMOUS KEYS

Learning Objective:

- Students will understand how to use a dichotomous key to identify an unknown critter or object.

Standard:

Life and Environmental Science F.12.5

Materials:

- Chalk board (or white board)
- Students' shoes
- "Key to Macroinvertebrate Life in the River"
- Paper
- Writing instruments

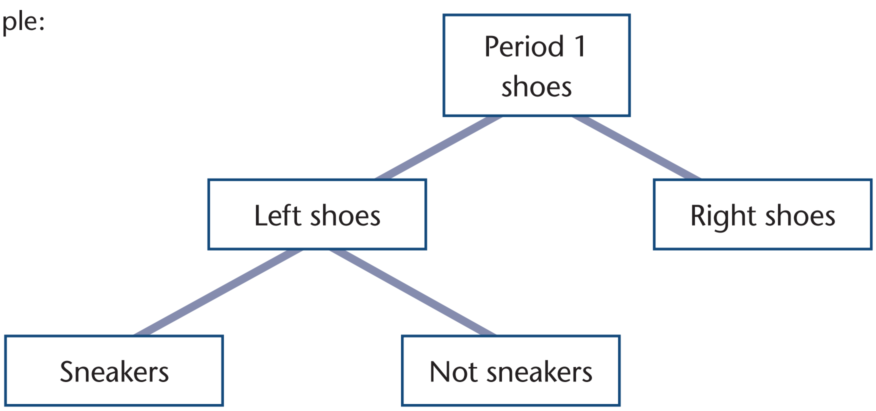
Time:

45 minutes

PROCEDURE:

1. Ask each student to take off one shoe and pass it to the front of the classroom. Have one volunteer at a time come to the front and decide how to divide one pile of shoes into two piles (e.g., left shoe and right shoes, sneakers and not sneakers). The teacher can follow the splits on the board, forming a branching chart.

Example:



2. After the chart is fairly complete, introduce a new shoe (perhaps one of the teacher's shoes).
3. Have students use the chart to identify in which group the new shoe belongs.
4. Introduce classification of living things (Kingdom-Phylum-Class-Order-Family-Genus-Species).
5. Compare the shoe sorting activity to the classification of living things where the Kingdom level is the same as the "Period 1 Shoes", Phylum would be "Left" and "Right" etc.
6. Then show the students the "Key to Macroinvertebrate Life in the River" that they will be using to identify macroinvertebrates in the field.
7. Have students use the Key to Macroinvertebrate Life in the River to answer the following discussion questions:
    a. This macroinvertebrate is orange. It does not have a shell or an obvious tail, nor does it have wings. It has six legs. *(Answer: Caddisfly larva)*
    b. This worm-like macroinvertebrate has no shell and no legs. It is green and has a distinct head. *(Answer: Midge larva)*
    c. This macroinvertebrate has two shells. It is dark colored and can be as large as five inches across. *(Answer: Freshwater mussel)*
8. Extension (possible homework assignment):

    Have the students design their own branching charts. Have them choose 10 things that they would consider to be in the "same Kingdom" (e.g., 10 cds, 10 shirts, 10 books, etc.). Have them develop a branching chart to organize those things. When they are done, the teacher can suggest an eleventh object and see if it will fit into the existing organization. This is a good way to illustrate the importance of categorizing carefully. For example instead of dividing objects into black and white; divide objects into black and not black. Then if a yellow object is added it has a place in the existing organization.

RESEARCHING MACROINVERTEBRATES

Learning Objectives:

- Students will become familiar with specific stream macroinvertebrates.
- Students will practice identifying macroinvertebrates and assessing stream water quality.
- Students will work collaboratively as part of a group.

Standards:

Life and Environmental Science F.8.2; Information and Technology Literacy D.8.1, D.12.1

Materials:

- Research cards made from booklet “Wonderful, Wacky Water Critters”
- Macroinvertebrate wildcards
- “A Guide to Common Freshwater Invertebrates of North America” by J.R. Voshell (2002, McDonald & Woodward Publishing Co., Blacksburg, VA), or “Guide to Aquatic Invertebrates of the Upper Midwest” by R.W. Bouchard, Jr. (2003, Regents of the University of Minnesota), or other macroinvertebrate identification guide
- Construction paper
- Scissors
- Markers
- Glue
- Macroinvertebrate worksheet for each student
- Macroinvertebrate checklist for each group

① **HYDRA:** The amazing hydra is related to the jellyfish. Living only in clean, unpolluted waters, it likes to just “hang around,” but can either move slowly on its “foot” or somersault end over end like a gymnast. Long tentacles surround an opening that is used for both eating and going to the bathroom! The hydra dines on meals of one-celled animals, water fleas, and seed or clam shrimp. It paralyzes its food by injecting poison into the prey before eating. It gets oxygen right through its skin. Its “ears” are used as both fingers to feel surroundings, and as a nose, to smell!

Example of a research card made from the booklet *Wonderful, Wacky Water Critters*.

Time:

Two 45-minute class periods if only the research is done, three class periods if oral presentations are done and four class periods if the stream quality (#6 Procedure Extension on the following page) is done.

PROCEDURE:

1. Photocopy the macroinvertebrate worksheet (page 1-86) double sided for each student and one checklist (page 1-87) for each group.
2. Students will work in groups. Each member of the group will complete a worksheet on each of four different macroinvertebrates. Using the macroinvertebrate checklist, group members will be sure that they all research different organisms. (Note the blank area in the lower right corner of each card is for students to draw and color a picture of their organism.)
3. Using construction paper, students can then create two of their organisms. Since many of these organisms are very tiny, the teacher might suggest a scale. For example all organisms will be made 5 or 10 times their actual size.
4. Each student will teach the class about the two macroinvertebrates they created.
5. The students can then “release” their organisms into the “stream.” Teachers can use a long length of blue paper to represent a stream. Attach this to the classroom or hallway wall.
6. Extension: After all students have presented and attached their organisms to the stream on the wall, the teacher may choose to divide the stream into segments. Assign each group to a segment and allow them to practice with the data sheet they will be using in the field on the sampling day. Students should assess the quality of the water based on the organism variety found in their section of the stream.

MACROINVERTEBRATE WORKSHEET

Common Name: ________________________________ **Scientific Name:**____

Order: ____ **Sub-Order (if applicable):** _____________________________

Tolerance to pollution? ____

____

What does it eat? ____

____

How does it get its food? ____

____

How does it get oxygen? ____

____

How does it get away from enemies? ______________________________________

____

Other unique adaptations? ____

____

Drawing of Macroinvertebrate

MACROINVERTEBRATE WORKSHEET

Common Name: ________________________________ **Scientific Name:**____

Order: ____ **Sub-Order (if applicable):** _____________________________

Tolerance to pollution? ____

____

What does it eat? ____

____

How does it get its food? ____

____

How does it get oxygen? ____

____

How does it get away from enemies? ______________________________________

____

Other unique adaptations? ____

____

Drawing of Macroinvertebrate

Macroinvertebrate Group Checklist

(Be sure that each person researches four different macroinvertebrates and that there are no repeats within your group.)

- ☐ Aquatic sowbug or isopod
- ☐ Alderfly
- ☐ Backswimmer
- ☐ Black fly
- ☐ Bristle worm
- ☐ Caddisfly
- ☐ Caterpillar or pyralid moth
- ☐ Crane fly
- ☐ Crawling water beetle
- ☐ Crayfish
- ☐ Cyclops or copepod
- ☐ Damselfly
- ☐ Dobsonfly
- ☐ Dragonfly
- ☐ Fairy shrimp
- ☐ Fishfly
- ☐ Fishing spider
- ☐ Freshwater mussel
- ☐ Giant water bug
- ☐ Horse fly and deer fly
- ☐ Hydra
- ☐ Leech
- ☐ Limpet
- ☐ Marsh treader
- ☐ Mayfly
- ☐ Midge or bloodworm
- ☐ Mosquito
- ☐ Nematode or horsehair worm
- ☐ Phantom midge
- ☐ Pill or fingernail clam
- ☐ Planaria or flatworm
- ☐ Predaceous diving beetle
- ☐ Rat-tailed maggot
- ☐ Riffle beetle
- ☐ Scud or amphipod
- ☐ Seed shrimp or clam shrimp
- ☐ Snail
- ☐ Soldier fly
- ☐ Spring tail
- ☐ Stonefly
- ☐ Threadworm or nematode
- ☐ Tubifex worm
- ☐ Water boatman
- ☐ Water flea or daphnia
- ☐ Water mite
- ☐ Water penny
- ☐ Water scavenger beetle
- ☐ Water scorpion
- ☐ Water snipe fly or *Atherix*
- ☐ Water strider
- ☐ Whirligig beetle

STREAM WALK SURVEY

Learning Objectives:

- Students will become aware of the plants and animals that live near the stream or river.
- Students will understand how the stream or river is being used by people.
- Students will understand how land uses affect river/stream water quality and streambank habitat.

Standards:

Agricultural Education: B.8.3, E.8.2; Environmental Education: A.8.4, A.8.5, A.8.6, A.12.5, B.8.5, B.8.10, B.8.17, B.8.18, C.8.2

Time:

A stream walk survey will take one afternoon (depending on the length of stream being surveyed).

Materials:

Stream Walk Worksheet (Pages 1-92 and 1-93)

Background:

Conducting a survey is the first way to collect information about your stream or river. From this survey, you will gain information to help you to decide what actions may be needed to improve the quality of the stream or river.

Use the Stream Walk Worksheet to evaluate the health of your waterway.

PROCEDURE:

1. Ask for permission to conduct a survey if the survey site is on private property.
2. Before going on your stream walk, make copies of the Stream Walk Worksheet for all members of the group. This worksheet will be your guide to completing the survey.
3. If you have a topographic map of the waterway, draw a circle around the area to be surveyed.
4. If storm drains or drainage pipes enter the stream, do your best to follow the pipes to find their sources.
5. Take pictures or a video of the stream or river to document your trip and the stream's quality.
6. Complete a new Stream Walk Worksheet for every survey done. Include photos and other information that you collect. Use this information to build a portfolio about your stream, or share the information with your community through media releases, newsletters, or displays at local malls, schools, banks, etc.

How to Complete the Form:

Complete the box that asks for information about the name of the stream, where it is located, and the date and time that you collected the data. In the weather section, check the box that best describes the weather conditions.

1. Water Appearance is a physical indicator of water pollution. Select the term(s) that best describe the physical appearance of the water in the stream:

   Clear: Colorless, transparent.

   Turbid: Cloudy brown. May be due to silt or plant material suspended in the water.

   Milky: Cloudy-white or gray. May be natural or due to pollution.

   Foamy: May be natural or caused by excessive nutrients or detergents from pollution. (Foam that is several inches high and does not brush apart easily is generally due to some sort of pollution.)

   Dark Brown: Tea-colored. May indicate that acids are being released into the stream due to decaying plants.

   Oily Sheen: A multi-colored reflection. Can occur naturally or it may indicate oil or other petrochemicals in the stream.

   Orange/Reddish: May indicate acids draining into the water or iron bacteria.

   Green: Caused by algae. May indicate excess nutrients are being released into the stream.

2. Water Odor is also a physical indicator of water pollution.

   None: Indicates good water quality.

   Sewage: May indicate the release of human waste material, livestock manure flow from an upstream feed lot. If you smell sewage/manure or rotten eggs coming from stream, please do not enter the water. Notify the nearest DNR Service Center.

   Chlorine: May indicate that a sewage treatment plant is over-chlorinating its effluent or may be from swimming pool discharge. Also a component of milk house cleaning.

Fishy: May indicate the presence of excessive algal growth or dead fish.

Rotten Eggs: A sulfurous smell may indicate muck soils or sewage/manure pollution, as hydrogen sulfide gas is a product of organic decomposition.

Petroleum: May indicate an oil spill from boats, land or storm drains.

3. Temperature controls the growth/activity of bacteria which can strongly influence the amount of oxygen in the water. Cold water holds more dissolved oxygen than warm water, thus temperature directly affects the amount of oxygen available to these organisms.

    a. Measure air temperature by holding the thermometer in the shade for at least two minutes. If there is no tall vegetation, use your body to shade the thermometer. Repeat and record both measurements.

    b. Measure water temperature by submerging a thermometer for at least two minutes in a stream run. Do not measure temperature in a slow-moving part of the stream or right next to the banks. Repeat in another section of the stream and record both measurements.

4. Submerged Aquatic Plants. Record if there are submerged plants in the stream and describe what they look like and where they are located.

5. Riparian (streamside) vegetation and other riparian surfaces. Identify the riparian vegetation or other land covers by type. Use the left column for the left-hand side of the waterway (looking upstream); use the right column for the right-hand side.

6. Canopy Cover. Estimate how shaded your site is. Do not include overhanging grasses. Check the box that is closest to your estimate.

7. Bottom Substrate is the material in and on the stream bottom that macroinvertebrates attach to, feed from or crawl on. Check the boxes that best describe the stream bottom in the study site.

8. Stream Discharge Estimate. To estimate the volume of water flowing through the stream at a particular point, measure the width, depth and average water velocity. You will need someone to help you with this measurement.

    a. Stream Width: Measure the width of the stream with a tape measure. If the stream is too deep, wide or polluted to measure directly, you might be able to measure the depth indirectly by using a bridge. Indicate on the data sheet that the measurement was an estimate.

    b. Stream Depth: Record the stream depth at five evenly distributed points across the channel. Total the five depth values and divide by five to determine the average depth in feet.

    c. Stream Velocity:

        i. Mark off a distance of 20 feet of stream at your site. Place a person in the water or on the bank at the "top" spot and the other person 20 feet downstream at the end of the measured length of stream.

        ii. Have the downstream person be the time keeper with a stopwatch.

Note to teachers:

If you are conducting the field trip, students will complete the Stream Discharge Estimate at that time, so you may opt to skip this step during your stream walk survey.

iii. The person at the "top" spot should gently toss an orange, apple or other float at least five feet upstream from the "top" spot. Once the object passes the "top" person, that person should yell "start" to begin timing how long it takes the object to float 20 feet.

iv. When the object passes the "downstream" person, that person should yell "time" and stop the watch. Don't forget to retrieve the object for a few more trials.

v. Record the time in seconds in the appropriate space on the Stream Walk Worksheet.

vi. Repeat this procedure two more times. Try to place the float in different places across the channel. Do not count any trials where the float gets stuck in debris, along the bank or in an eddy.

vii. Keep track of the type of float used. Notes on floats: Oranges and apples seem to work very well. Many groups use tennis balls. Vials half full of water, corks and even sticks have been used as well. The type of float used should be consistent. Do not use something that can be affected by the wind. Many people like to use something that is biodegradable.

viii. Total the three trial times and divide by three to determine the average time.

ix. Divide this number into 20 to get the velocity (feet/second). For example if the three times it took your orange to travel 20 feet were 16, 9, and 11 seconds. The average time equals 36 divided by 3 = 12 sec. To get the final velocity divide 20 feet by 12 seconds = 1.67 feet/sec.

d. Stream Discharge: Multiply the width by the average depth by the velocity to get the discharge.

9) Watershed Features. Record all land uses observed upstream of your site for about ¼ mile. Indicate which land uses are present with a check in the first column. If the land use is clearly having an impact on the stream, check the second column.

10) Channel Alteration. Indicate whether or not the stream segment has been channelized or straightened.

11) Personal Observations. Enter here any observations that you feel are important to the quality of the habitat of the stream and its environs. Include any characteristics not mentioned on the data sheet.

Stream Walk Worksheet

Stream Name ______________________________

County ______________ **State** ______________

Your Name ______________________________

Monitoring Location
(general description and longitude/latitude)

____

Date ______________ **Time** ______________

Attach a photo or sketch your site:

Note features that affect stream habitat, such as riffles, runs, pools, ditches, wetlands, dams, rip rap, outfalls, tributaries, landscape features, logging, paths and roads. Include an arrow showing which way the stream is flowing, and another arrow showing 'north.'

Weather in the past 24 hours:

- ❒ **Storm** (heavy rain)
- ❒ **Rain** (steady rain)
- ❒ **Showers** (intermittent rain)
- ❒ **Overcast**
- ❒ **Clear/Sunny**

Weather Now:

- ❒ **Storm** (heavy rain)
- ❒ **Rain** (steady rain)
- ❒ **Showers** (intermittent rain)
- ❒ **Overcast**
- ❒ **Clear/Sunny**

1. Water Appearance

❒ Clear ❒ Dark Brown
❒ Turbid ❒ Oily Sheen
❒ Milky ❒ Orange/red
❒ Foamy ❒ Green
❒ Other ______________

Notes ______________
____
____

2. Water Odor

❒ None ❒ Fishy
❒ Sewage ❒ Rotten Eggs
❒ Chlorine ❒ Petroleum
❒ Other ______________

Notes ______________
____
____

3. Temperature

Air ______ ______ ˚F ˚C
Water ______ ______ ˚F ˚C
(circle temp. scale used)

(continued on next page)

4. Submersed Aquatic Plants

Are there submersed aquatic plants?

Yes ______ No ______

Where? ___________________________

Identify or describe them: __________

____

____

5. Riparian Vegetation

Looking upstream, describe the streamside cover.

a) Note vegetation on streambank only and check boxes if present (left column is for left-hand side of stream; right column is for right-hand side).

left		right
❒	Evergreen trees	❒
❒	Hardwood trees	❒
❒	Bushes, shrubs	❒
❒	Tall grasses, ferns, etc.	❒
❒	Lawn	❒
❒	Boulders/rocks	❒
❒	Gravel/sand	❒
❒	Bare soil	❒
❒	Pavement/structures	❒

b) Note vegetation from the top of streambank back 66 feet.

left		right
❒	Evergreen trees	❒
❒	Hardwood trees	❒
❒	Bushes, shrubs	❒
❒	Tall grasses, ferns, etc.	❒
❒	Lawn	❒
❒	Boulders/rocks	❒
❒	Gravel/sand	❒
❒	Bare soil	❒
❒	Pavement/structures	❒
❒	Agricultural fields	❒
❒	Pasture	❒

6. Canopy Cover

Pick the category that best describes how much vegetation shades the stream at your site.

❒ 0% ❒ 25% ❒ 75% ❒ 100%

Notes on vegetation: _______________

____

____

7. Bottom Substrate

Record the materials that make up the stream bottom.

Bottom types:

❒ Bedrock
❒ Boulder (>10 inches)
❒ Cobble (2.5 inches - 10 inches)
❒ Gravel (0.1 inches - 2.5 inches)
❒ Sand (<0.1 inches)
❒ Silt
❒ Other (include organics)

Notes on substrate: ____________

____

____

8. Stream Discharge Estimate

Stream width: ______ feet
(a)

Depth measurements:

______ ft.
______ ft.
______ ft.
______ ft.
______ ft.

______ total /5 =______ avg. depth
(b)

Velocity: Time (per 20 ft)

______ sec.
______ sec.
______ sec.

______ total

divide total by number of trials

______ /3 = ______ secs. (avg.)

Velocity = foot/second

20 ft. / ______ sec. (avg. time)

= [ ] ft./sec.
(c)

Discharge: (width x depth x velocity)

____ feet x ____feet x ____ ft/sec. =
(a) (b) (c)

= [ ] ft^3/sec.

9. Watershed Features

(within about ¼ mile of the site – upstream)

Adjacent land used can impact the stream. Check "1" if present, "2" if clearly having an impact on the stream:

1 2 **Residential**

❒ ❒ single-family housing (dense)
❒ ❒ single-family housing (>1 acre lots)
❒ ❒ multifamily housing
❒ ❒ lawns
❒ ❒ commercial/institutional

1 2 **Roads, etc.**

❒ ❒ paved roads, parking lots, bridges
❒ ❒ unpaved roads

1 2 **Construction underway on:**

❒ ❒ housing development
❒ ❒ commercial development
❒ ❒ road or bridge building/repair

1 2 **Agricultural**

❒ ❒ grazing land (pastures)
❒ ❒ feed lots, animal holding areas
❒ ❒ cropland (type ____________)
❒ ❒ inactive agricultural land

1 2 **Recreation**

❒ ❒ golfing
❒ ❒ camping
❒ ❒ swimming/fishing/canoeing
❒ ❒ hunting land/natural

1 2 **Other**

❒ ❒ mining
❒ ❒ logging
❒ ❒ industry
❒ ❒ sanitary landfill
❒ ❒ sewage treatment plant
❒ ❒ dams

10. Channel Alteration

Has the stream been channelized?

Yes ______ No ______

WHAT IS A WATERSHED VIDEO

Learning Objectives:

- Students will understand what a watershed is.
- Students will be able to explain how human resource use can impact the environment.
- Students will be able to identify major air, water or land pollutants and their sources.
- Students will be able to identify types of human land uses and how those may affect water quality.
- Students will be able to identify at least three aspects of streams that may be affected by human impacts in a watershed.
- Students will be able to explain the concept of pollution as it relates to watersheds.

Standards:

Environmental Education B.8.17, B.8.18, B.12.17

Materials:

- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #2
- Student Workbook (see Section 4)
- Writing instrument

Time:

25 minutes

Background:

Helping students understand why we care about water and monitoring water is a key aspect to making this curriculum successful when used in Wisconsin's middle and high schools. This video introduces the concept of a watershed and that human uses of the land within a watershed affect those downstream. In this video, the concepts of stream order, natural and man-made changes and time scales for expected change are discussed by Dr. Kristopher Wright from UW-Platteville. The importance of monitoring streams and how to design monitoring to identify sources of pollution are also discussed.

PROCEDURE:

1. Show students the "What is a Watershed" video that is on the Water Action Volunteers DVD Set (from the main menu on Disc 2, choose "What is a Watershed"; Run time 16:47).
2. Have students answer the following discussion questions.

Student Discussion Questions and Sample Answers:

1. Name two activities humans might do in Wisconsin that could affect water quality in the Mississippi River in New Orleans.

2. For a watershed to change naturally, would you expect this to happen over a short time period (e.g., a day) or a long time period (e.g., hundreds or thousands of years)?

3. What are two of the major concerns about human impacts on watersheds?

4. Name three things related to streams that may be affected by human impacts in a watershed.

OPTIONAL ACTIVITIES FROM OTHER SOURCES

Please see Section 5 for contact information for any of the curricula listed below.

Suggested Optional Activities from Project Wild Aquatic

Overall Experience

- To Dam or Not to Dam – "Students will role play individuals representing differing perspectives and concerns related to a complex issue."
- What's in the Water (formerly, Deadly Waters) – "Students will analyze the pollutants found in a hypothetical river. They graph the quantities of pollutants and make recommendations about actions that could be taken to improve the habitat."
- Alice in Waterland – "Students will use a simulated field trip, lecture-discussion and student-gathered data to explore water use and its effects on wildlife habitat."

Other

- Where Have All The Salmon Gone? – "Students will graph and interpret actual fish population data in relation to historical events."
- Students will use topographical maps to do suggestions for Shrinking Habitat ("Aquatic Extensions to Project WILD Activities" found in the indices in the back of the Project WILD Aquatic guide) – Students will use maps to compare historic and present land use.

Habitat

- Wetland Metaphors – "Students are presented with a selection of hands-on objects for investigation as metaphors for natural functions of wetlands."
- Edge of Home – "Students will explore the concept of ecotones by visiting places where habitats overlap."
- Blue Ribbon Niche – "Students will create a variety of representations of animals that live in riparian habitats."
- Where Does Water Runoff (formerly, Where Does Water Runoff After School) – "Students will measure and calculate the area of the school ground, calculate the volume and weight of water falling on the school ground; determine specific and annual rainfall and runoff; and trace the course of that water to aquatic habitats."
- Dragonfly Pond – "Students will create a collage of human land-use activities around an image of a pond."

Art

- Fashion a Fish – "Students will design a variety of fish adapted for various aquatic habitats."
- Fashion a Fish – (Specifically the suggestion called Adaptation Artistry listed in "Aquatic Extensions to Project WILD Activities" found in the indices in the back of the Project WILD Aquatic guide.) "Students will invent an insect specially adapted to be able to land on water to feed, swim underwater as well as fly in the air and travel long distances."
- Fashion a Fish – (Specifically, the suggestion listed in "Aquatic Extensions to Project WILD Activities" found in the indices in the back of the Project WILD Aquatic guide) "Students will explore stream invertebrates."

Suggested Optional Activities from Project WET

Transparency and Temperature

- Branching Out – Students will construct a watershed model.
- A-maze-ing Water – Students will negotiate a maze to investigate nonpoint source pollution.
- Sum of the Parts – Students will demonstrate nonpoint source pollution.
- Just Passing Through – Students will mimic the movement of water down a slope.
- Rainy Day Hike – Students will explore schoolyard topography and its effect on the watershed.
- Color Me A Watershed – Students will interpret maps to analyze changes in a watershed.

Dissolved Oxygen

- Reaching Your Limits – Students will "limbo" to learn basic water quality concepts and standards development.

Stream Flow

- Branching Out – Students will construct a watershed model.
- Rainy Day Hike – Students will explore schoolyard topography and its effect on the watershed.
- Back to the Future – Students will analyze stream flow data to predict floods and water shortages.
- Just Passing Through – Students will mimic the movement of water down a slope.
- Color Me a Watershed – Students will interpret maps to analyze changes in a watershed.

Habitat

- Branching Out – Students will construct a watershed model.
- A-maze-ing Water – Students will negotiate a maze to investigate nonpoint source pollution.
- Sum of the Parts – Students will demonstrate nonpoint source pollution.
- Just Passing Through – Students will mimic the movement of water down a slope.
- Rainy Day Hike – Student will explore schoolyard topography and its effect on the watershed.
- Color Me A Watershed – Students will interpret maps to analyze changes in a watershed.
- Water Address – Students will analyze clues to match organisms with water-related adaptations.

Macroinvertebrates

- Macroinvertebrate Mayhem – Students will illustrate, through a game of tag, how macroinvertebrate populations indicate water quality.

Overall Experience

- Water Works – Students will create a web of water users.
- Choices and Preferences – Students will develop a “water index” to rank water uses.
- Hot Water – Students will debate water issues.

Other

- Where Are The Frogs? – Students will run a simulation and experiment to understand the effects of acid rain.

Suggested Optional Activities from Hook, Line & Thinker

Transparency

- To the Point – Students will plan an information program to alert the public to specific nonpoint source pollution problems and solutions for their watershed.

Temperature

- Water of Life – Students will watch a demonstration of summer lake stratification. Students will discuss oxygen and temperature changes in lakes during other seasons and work in partners to design an experiment.

Dissolved Oxygen

- Fish Food – Students will complete a set of math problems to show how energy is lost in a food chain and play a population dynamics game.
- Water of Life – Students will watch a demonstration of summer lake stratification. Students will discuss oxygen and temperature changes in lakes during other seasons and work in partners to design an experiment.

Habitat

- Home Sweet Home – Students will create a “travel brochure” for a particular fish species’ spawning habitat and present it to the class. The travel brochure will include a detailed description of the environment, a description of the amenities that the fish requires for spawning, and graphics from the internet or another source.
- To the Point – Students will plan an information program to alert the public to specific nonpoint source pollution problems and solutions for their watershed.
- Shared Interests – Students will read a scenario and take on the roles of characters in the story as they develop a land use proposal, argue the merits of their proposal and attempt to compromise on a decision.
- Restoration Nation – Students will work in small teams to develop a creek restoration plan and present their results to the class.
- Reading the Water – Students will profile a fish and share their research with others. Students will use a lake map to discuss possible fish locations.

Suggested Optional Activities from Give Water a Hand Action Guide

- Research Needs for Action – Students will use a site map and a checklist to help identify specific water problems, and determine which ones need action in one of four locations (community, school, home, or farm). In addition, they will find out what is already being done and what still needs to be done to protect the watershed and conserve water. Available checklists:
    - Community Site Checklist
    - Home Site Checklist
    - School Site Checklist
    - Farm Site Checklist

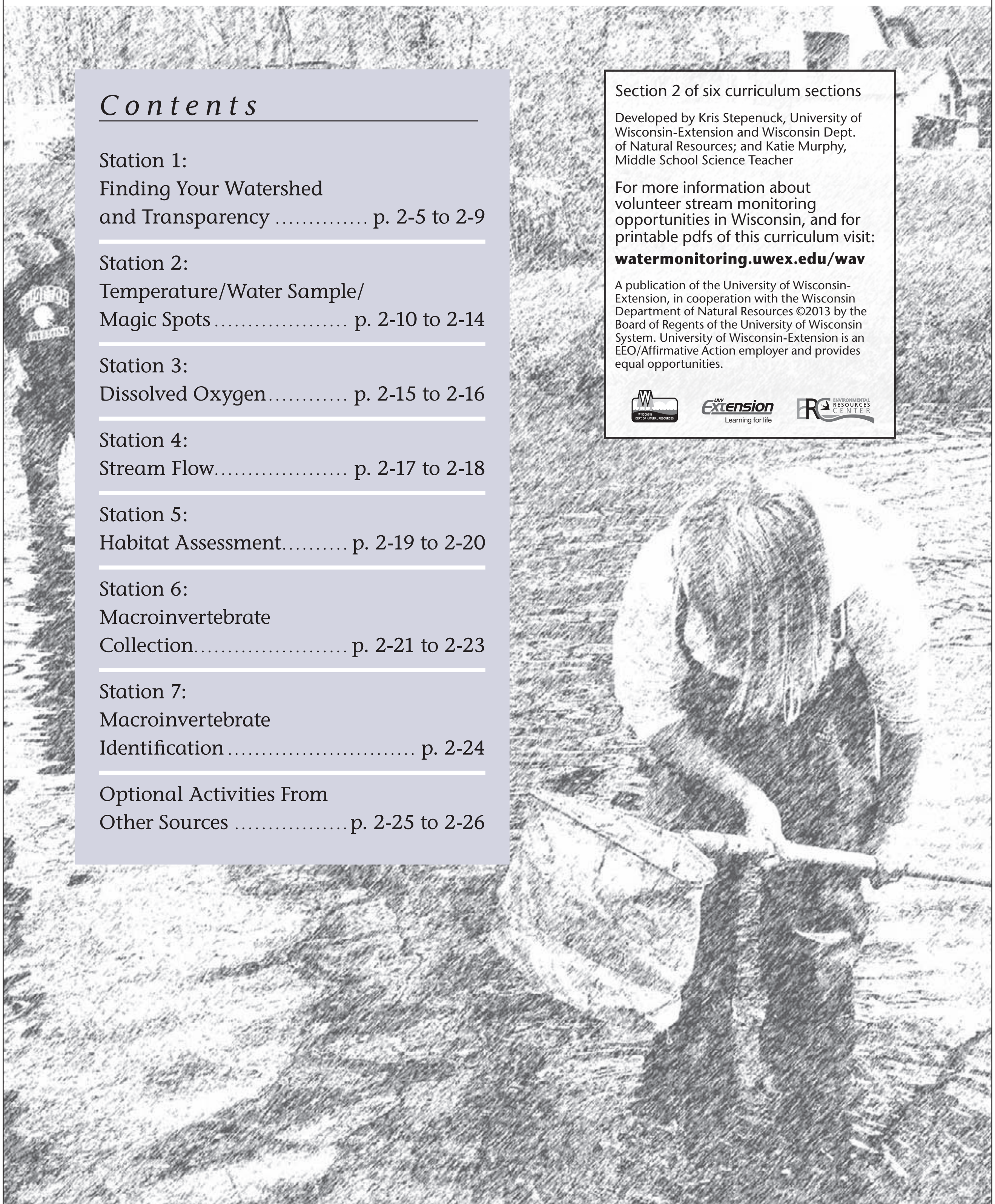
Suggested Optional Activities from Holding onto the GREEN Zone

- Erosion in the Zone – Students will compare and contrast the effects of rainfall on bare soil and land protected by vegetation.
- Filter Plants – Students will demonstrate that plants can filter some pollutants from a riparian area.
- On the Edge – Students will describe characteristics of water bodies and shorelines that they have visited or that they can view in photographs.
- Zone Search – Students will explore more about riparian areas by locating the GREEN Zone in two photos.
- Putting on the Brakes – Students will make a shoe-box model of a stream and will devise ways to slow down water (a marble) in their shoe-box stream to demonstrate the relationship between water speed and stream shape in the riparian zone.
- Plant Power – Students will observe detailed drawings of plants and examine characteristics that can help maintain a healthy riparian zone.
- Percolation Test – Students will time the flow of water through different soils; measure the amount of water held in these soils; and observe the ability of soils to filter water.

Suggested Optional Activities from Other Sources

- Filtration, Illinois NRCS – Students will learn that "soils can filter and clean water. The ability of a soil to filter water is largely dependent upon particle size and how fast water flows through soil."
- Soil Glue, Illinois NRCS – Students will learn that "surface soil particles are held together by organic proteins to form larger pieces called aggregates. The binding of soil particles together helps maintain pore spaces for aeration and water infiltration. The soil aggregates are harder to wash away than individual soil particles during rain storms."
- Build a Bug, Utah 4H – Students will learn about macroinvertebrates and their adaptations.

▶ SECTION 2: FIELD TRIP



Contents

Station 1: Finding Your Watershed and Transparency .... p. 2-5 to 2-9

Station 2: Temperature/Water Sample/ Magic Spots .... p. 2-10 to 2-14

Station 3: Dissolved Oxygen............ p. 2-15 to 2-16

Station 4: Stream Flow.................... p. 2-17 to 2-18

Station 5: Habitat Assessment.......... p. 2-19 to 2-20

Station 6: Macroinvertebrate Collection....................... p. 2-21 to 2-23

Station 7: Macroinvertebrate Identification .... p. 2-24

Optional Activities From Other Sources ....p. 2-25 to 2-26

Section 2 of six curriculum sections

Developed by Kris Stepenuck, University of Wisconsin-Extension and Wisconsin Dept. of Natural Resources; and Katie Murphy, Middle School Science Teacher

For more information about volunteer stream monitoring opportunities in Wisconsin, and for printable pdfs of this curriculum visit:

watermonitoring.uwex.edu/wav

HANDS-ON LEARNING ABOUT STREAMS WITHIN & OUTSIDE THE CLASSROOM – *FOR MIDDLE & HIGH SCHOOL TEACHERS & STUDENTS*

FIELD TRIP

Note:

You should know the general condition of the stream you will visit prior to your field trip. Contamination from agricultural, industrial, commercial and/or residential sources (such as pesticides, sewage or industrial wastes) can be hazardous. If you suspect contamination, use precautions to protect students and facilitators. Boots, gloves and safety glasses should be worn when needed or if conditions warrant their use. Contact the Wisconsin Department of Natural Resources hotline 1-800-TIP-WDNR (847-9367), or #367 by cellular phone, or text TIPWDNR [space] followed by the tip to 847411 (tip411) if you find serious problems at the monitoring site.

Learning Objectives:

- Students will use equipment to monitor six (or more) aspects of stream water quality.
- Students will gather data and record their information on data sheets.

Standards:

Environmental Education B.8.8, B.8.15, C.8.2, E.12.3; Mathematics: Measurement D.8.3, D.8.4, D.12.2, D.12.3; Mathematics: Statistics and Probability E.8.1, E.12.1; Science Inquiry C.8.1, C.8.2, C.8.3, C.12.4; Social Studies A.8.1, A.12.2

Time:

If the stream is close to the school, half a school day should be enough time. If bus travel is necessary, a full school day may be required for the field trip.

Materials:

- Materials needed for each station are included for each activity in this section, and also collectively (for easy photocopying) in Section 6 (page 6-2). Quantities of equipment listed are for a group size of 8-12 students working in pairs or groups of three. Laminated copies of these materials lists should be placed in or attached to each station bin.
- Teachers should encourage any student with access to hip boots, chest waders or tall rubber boots to bring them on the field trip day. Alternatively, the teacher should contact a local Watershed Education Resource Center to arrange to borrow hip boots or chest waders for the field trip (see page 5-15).
- Laminated copies of procedures should be placed in each station bin. Procedures that can be photocopied are included in Section 6 (see pages 6-4 to 6-16).
- Two types of data sheets will be used during the field trip: Student data sheets and Station Leader data sheets. These are included in Section 6 (see pages 6-17 and 6-23).
- Students and Station Leaders will need pencils to record the data.
- A first aid kit, cell phone and emergency contact information are also important to bring along.
- Have the students dress appropriately for the weather, and bring sunscreen, water, baseball hats, bug dope, etc.
- It's also a good idea to bring a whistle or horn for indicating station changes.

PROCEDURE:

As Soon as Possible Prior to the Field Trip

1. Pick a date and location for the field trip, along with a rain date. You will need to select a site that is both accessible and safe to enter. You should think about the following when choosing your site: Is there access to a wadable stream, a sheltered location in case of inclement weather, and bathroom facilities at the site? Can a school bus access the site? Will students be safe from traffic or other hazards while they are participating in the field trip? Is there a cost associated with using the site? Is there a minimum or maximum number of people who can attend the training based on site constraints? Do you need landowner permission to use the site (you should get written permission to have a field trip on private lands)? If needed, your local UW-Extension Natural Resource Educators, County Land Conservation Staff or DNR Biologists may be able to assist with locating a suitable site.

2. You should also determine who will be leading stations during the field trip and make contact with those people as soon as possible to ask for their help. Remember, like you, these people have busy schedules, so the earlier you can request their assistance and fill them in on details about the field trip location, times and date, the more successful the trip will be. Volunteer field trip leaders could include other teachers or staff from your school, local college students, Water Action Volunteers' citizen monitors, parents or others (e.g., advanced placement biology or chemistry high school students). See Section 5 (page 5-16) for information about connecting with and organizing volunteer station leaders for your field trip.

3. If needed, arrange to borrow equipment from one of the Watershed Education Resource Centers (see page 5-15). The earlier you can arrange to borrow the equipment, the better off you will be to hold the field trip on the day you hope to carry it out.

4. As needed, arrange for student transportation to the field location and for substitute teachers. Distribute permission slips for parental permission for students to attend the field trip, and address other logistical details that will enable you to bring your students to the stream for the field trip.

5. Review this section and Section 6 of this curriculum to better understand how the field trip will run, and to educate your station leaders about their roles.

During the Field Trip

6. Students should be divided into six groups.* At each station, students will work in pairs or groups of three.

Note:

If students and teachers/station leaders will arrive at the site simultaneously, to facilitate station set-up, teachers may choose to carry out the Magic Spot language arts exercise with all students immediately upon arrival (see Station 2 description). However, if this is done, another optional activity should be used in place of the Magic Spots activity at Station 2.

---

* If only a few volunteers are available to lead station activities, the stations could be condensed as follows:

1. Water sample/Dissolved Oxygen/Temperature
2. Macroinvertebrate Collection and Identification/Transparency
3. Habitat/Stream Flow

If this option is chosen, each station will take approximately one hour to complete.

In this situation, neither the Magic Spots Language Arts Activity nor the Topographical Maps activity would be part of a set station. These could be offered as an additional station or used by a Station Leader if they had extra time after completing regular station activities.

7. Student groups will rotate through the following stations:

    Station 1: Transparency/Topographical Maps (most upstream station)

    Station 2: Water Sample Collection/Temperature/Language Arts

    Station 3: Dissolved Oxygen

    Station 4: Stream flow

    Station 5: Habitat

    Station 6: Macroinvertebrate Collection

    Station 7: Macroinvertebrate Identification

General notes to teachers regarding field trip stations:

- Teachers may also opt to offer additional stations from the suggested list of optional activities (see page 2-25) to reduce group size if there is a large number of students to accommodate.
- No students should initiate the field trip at Station 7, as macroinvertebrates need to be collected prior to a group working at that station.
- It is recommended that the transparency station be located most upstream at your field location if possible, to avoid students upstream from contaminating the transparency samples.
- The temperature and dissolved oxygen stations should be located near the transparency station to facilitate sharing of hip boots and delivering the water sample, respectively.
- If *E. coli* bacteria are to be monitored, a classroom component of that monitoring is required the same day.
- Methods for each station should be used as a guideline for station leaders, but since students have prepared in advance, in general, methods are not designed to be handed out to the students (except for dissolved oxygen).

8. Each station will take approximately 30 minutes to complete. An additional 10 minutes should be allowed for students to move between stations and to act as a time buffer for stations that may need a few extra minutes to have students complete their tasks. It's a good idea to assign one teacher, parent or volunteer to blow a whistle or horn when there are five minutes left in the session, so station facilitators are aware of the time.

9. The lead teacher should collect student data sheets at the end of the field trip. However, for Middle School students or students who require more guidance; after students have completed the data collection at a station, station leaders can record student data on a station leader data sheet for the appropriate parameter (page 6-23). Station leaders should provide this completed data sheet to the lead teacher at the end of the field trip. There is no data sheet to complete at the macroinvertebrate collection station.

Station 1: FINDING YOUR WATERSHED AND TRANSPARENCY

Finding Your Watershed activity based in part on Georgia Adopt-a-Stream's Educator's Guide "How Big is the River – Really?" activity.

Learning Objectives for Finding Your Watershed activity:

- Students will use topographical maps to locate the stream they are studying.
- Students will learn to read topographical maps (including symbols, scale and the legend).

Find Your Watershed Materials:

- Copy of Major Watersheds of Wisconsin map (See page 5-15)
- Copies of a topographical map(s) showing the stream being studied and the school (See Other Resources in Section 5)
- Copies of a topographical map of a different location (See Other Resources in Section 5)
- Copies of USGS brochure "Topographic Map Symbols" (See Other Resources in Section 5)
- 1 box pencils
- Clipboards
- Rulers (1 per group of three students)

Time:

20 minutes

Background:

By studying a map of the watershed within which they are monitoring while streamside, students can look out onto the landscape to see what is depicted on the map by contours, shading, etc. Taking time to think about the entire watershed while at the stream monitoring site will also help students develop theories to explain results of their monitoring – they will have a better understanding of land use and the landscape within the watershed.

PROCEDURE:

1. Ask students to gather around a topographical map (not the one they'll use for their activity) for a general explanation of what the map shows and how to read it.
2. Explain what a topographical map shows (i.e., topography or a graphical representation of the earth's surface including elevation) and what that means in terms of watersheds and water flowing downhill to form streams, rivers and lakes.
3. Explain to students how to find the scale, legend and contour lines on the map. Talk through how to determine contour interval and steepness of slope based on the contour lines (the closer together the contour lines are, the steeper the slope).
4. Observe a watershed on the map with them, outlining (with your finger) watershed edges, and viewing streams and their direction of flow down gradients.
5. Explain that students will now be given topographical map(s) of the location of the field trip. They will be asked to answer several questions about the stream and the surrounding landscape.
6. Have students break into groups of three to complete the activity.
7. Students should study the map/images and locate their stream.
8. Students should complete the Finding Your Watershed worksheet.

Optional Activity:

- Map Your Watershed (See page 2-26)
- River Profiles (See page 2-26)
- Where is My Watershed? (See page 2-26)

Name: ____

Date: ____

Period: ____

Finding Your Watershed

Student Worksheet

Refer to you map to answer the following questions. Leave this paper with the station teacher before rotating to the next station.

1. What is the scale on this map?
2. Locate the stream you are studying. Now locate your school. How far is the straight-line distance from the stream to your school? (Estimate the distance if your school and the stream site are not located on the same map.)
3. What body (or bodies) of water flows into the stream you are studying?
4. Are the contour lines close together or far apart near the stream at your monitoring site? (circle one)
5. What does this tell you about the slope of the land alongside the stream?
6. Describe the watershed surrounding this stream (e.g., Is the land open, forested, urban? What is the topography like?)
7. What body of water does this stream empty into?
8. What else can you say about this stream and the land nearby it by studying this map?

Learning Objectives for transparency monitoring:

- Students will assess transparency of the stream and record information on their data sheets.

Transparency bin contents:

- 4 pairs hip boots (share with temperature monitoring station)
- 4 transparency tubes
- 1 box pencils
- Student data sheets
- Station Leader data sheet
- Nylon stocking (optional)
- Bucket (optional)
- Stirring stick (optional)

TRANSPARENCY PROCEDURES

Collecting the sample:

1. Collect the sample away from the river bank in the main flow area upstream from where you are standing. Enter the water downstream from the sampling location. Be careful not to stir up the bottom sediment upstream of your sampling location.
2. Face upstream (into the current).
3. Collect your water sample by holding your transparency tube horizontally and plunging it 8-12 inches beneath the surface or halfway down from the surface. Scoop away from your body and into the current.
4. Scoop water into the tube so it is filled to the top, or use a bucket to collect additional water from the stream at the site to fill the tube to the top.
5. Be careful not to collect water that has sediment from bottom disturbances (toss out the sample and try again if you get bottom sediment in your sample).
6. Return to shore with the sample.

Assessing transparency:

7. Remove large objects from the water sample. (Filter through nylon stocking if necessary.)
8. If the sample has settled, use a stirring stick to stir the sample, or pour the sample into a clean bucket and back into the transparency tube to suspend all materials.
9. Stand out of direct sunlight. If you cannot get to a shady place, use your body to cast a shadow on the tube.
10. If you are wearing sunglasses, remove them. Then look for the target (black and white) disc on the bottom of the tube. If the disc is visible, record the length of the tube (e.g., 120 cm) on the data sheet.
11. If the target disc is not visible, have your partner let water out a little at a time using the valve at the bottom until the disc is just visible. Have them stop letting water out immediately when you can just see the contrast between black and white on the disc.
12. Read the height of water in the tube using the measuring tape on its side.
13. Record the measurement on your data sheet in cm.
14. Dump contents of the tube on the ground.
15. Repeat steps 1 through 14. Record the second measurement in cm on your data sheet.
16. Add both of the readings, divide by 2, and record the average transparency on your data sheet.
17. Tell your results to your station leader.

Station 2: TEMPERATURE/WATER SAMPLES/MAGIC SPOTS

Learning Objectives for water sampling and temperature monitoring:

- Students will collect water sample(s).
- Students will monitor water and air temperature and record information on their data sheets.

Temperature/Water Sampling bin contents:

- 4 pairs hip boots (share with transparency monitoring station)
- 4 thermometers
- 4 stopwatches or digital watches
- 4 Hach dissolved oxygen sampling bottles
- 1 box pencils
- 4 clear plastic cups
- Student data sheets
- Station Leader data sheet
- Optional – only if doing *E. coli* monitoring
    - Antibacterial hand wipes
    - Sharpie permanent marker
    - Sterile 30 mL collection bottle
    - Nitrile or latex gloves
    - Cooler with ice

WATER SAMPLING PROCEDURE FOR DISSOLVED OXYGEN (for each pair or group of students):

1. One person per group should put on a pair of hip boots (or tall rubber boots).
2. Use a Hach dissolved oxygen sampling bottle (glass bottle with the stopper) to collect a sample in normally moving water.
3. Facing upstream, slowly lower the bottle so the opening of the bottle faces away from you, and water current is entering the bottle.
4. Allow the bottle to fill with water gradually, turning it to allow air bubbles to float out.
5. Cap the bottle while still submerged, and leave extra water in the neck of the bottle.
6. When lifting out of water, look for bubbles. If you see any, pour out the sample and collect another using the same procedure.
7. Immediately pass this sample on to the dissolved oxygen station for analysis.

TEMPERATURE MONITORING PROCEDURE (for each pair or group of students):

1. Use the thermometer to measure the air temperature. Record the temperature on your data sheet. Be careful to hold the thermometer away from its base, as that is where the sensor is located.
2. To measure water temperature, test in the middle of the stream where the water is moving, not in pools or backwater areas. Test near where the water samples were gathered.
3. Lower the thermometer about four inches below the surface, as close as possible to the middle of the stream.
4. Leave the thermometer immersed until the reading has stabilized. This usually takes about two minutes. Try to take the reading with the base of the thermometer still immersed. You can fill a clear plastic cup with water and raise it to eye level to read the temperature.
5. Record your measurement on your data sheet. If you measured in ° F, use the chart on the front to convert and record your measurement in ° C.
6. Tell your air and water temperature results to your station leader.

(Optional) *E. COLI* BACTERIA WATER SAMPLE COLLECTION PROCEDURE (for each pair or group of students):

1. One person should put on a pair hip boots (or tall rubber boots).
2. Wash hands with antibacterial hand wipes.
3. Put on nitrile or latex gloves.
4. Obtain a 30 mL collection bottle.
5. Label the sample bottle with student group number or names, location and date with a permanent marker.
6. With the bottle in hand, gently wade into the stream to the main area of flow. Walk slowly to avoid suspending sediments at the sampling site which could lead to false high *E. coli* counts.
7. Remove the bottle cap carefully so as to avoid touching the inside of the cap or bottle.
8. Sampling upstream from your location, face the open mouth of the bottle downward and immerse it 6-12 inches below the surface (or about midway down through the water column if the water depth does not allow sampling at this depth). While keeping it the same distance under the surface, turn and sweep the bottle in the direction of its opening, then turn it upright and remove it from the water.
9. After bringing the bottle above the surface, pour out a few centimeters of water so that there is a little bit of air space that will allow the sample to be mixed, then replace the lid on the bottle.
10. Place the sample in a cooler with ice packs to be transported back to your school.

CLASSROOM PROCEDURE FOR *E. COLI* BACTERIA MONITORING:

You will use 3M™ Petrifilm™ to monitor *E. coli*. It is essential that you maintain sterile conditions while plating your sample, since this is the time with the greatest potential for external contamination of the samples. Follow these steps to process the sample:

1. Remove 3M™ Petrifilm™ from refrigerator and allow the package to come to room temperature before opening. This will take at least 10-15 minutes.
2. Sanitize your working surface by spraying or wiping it with a dilute bleach solution.
3. Wash your hands thoroughly with soap and water.
4. Label the back side of three 3M™ Petrifilm™ plates with the date, time, sampling site and replicate number (1 to 3).
5. Always shake your sample bottle before extracting a sample with a pipette.
6. Place a 3M™ Petrifilm™ plate on a level surface.
7. Lift the top film and dispense 1 ml of sample in the upper portion of the pink portion of the plate.
8. Slowly roll the top film down onto the sample to prevent trapping air bubbles.
9. If needed, with the smooth side down, place the plastic spreader over the closed plate and distribute the sample evenly across the pink area of the plate by gently tapping with one finger on the center of the plastic spreader.
10. If used, remove the spreader and leave plate undisturbed for at least one minute to permit the gel to solidify.
11. Repeat this process for your other two replicate samples.
12. Incubate the plates in a horizontal position, with the clear side up, in stacks of up to 20 plates.
13. Incubate for 24 hours at 35˚C.

Note to teachers:

- **Do not use plates that show orange or brown discoloration.**
- **Ensure plates to be used for field monitoring have not expired. The expiration date and lot number are noted on each package. (Example expiration date: 2012-10, would expire in the 10th month (October) of the year 2012.)**

Note to teachers:

The incubator should be humidified with distilled water. Set up the incubator several hours in advance to allow it to get to temperature prior to plates being placed within it. For first-time use, allow a few days to manipulate the temperature to adjust it to 35˚C.

Learning Objectives for Magic Spots: A Language Arts Activity:

- Students will use their senses to make observations about their surroundings.
- Students will record their observations in their student workbook.
- Students will share one observation with other students orally.

Materials:

- Magic Spot data sheet
- Clipboard
- Pencil

Time:

20 minutes

PROCEDURE:

1. Explain to students that they will be making observations of their surroundings and recording those on their data sheet.
2. Explain that they will have about five minutes to sit quietly in a location on their own and assess what they see, hear, smell and feel in that area.
3. Also explain that they will have the opportunity to write a paragraph or a poem (Haiku) about the spot where they will sit.
4. Have students move to locations at least 10 feet from any other student. (If the teacher feels comfortable, and the group is mature enough, students can be asked to find a location out of sight of all other students. This can also be done in pairs.)
5. Begin timing this quiet activity and assisting students having difficulties with the assignment.
6. After the allotted time has passed, have the students come back to a central area and form a circle.
7. Ask each student to share something they observed during the activity. They can read a Haiku or a paragraph they wrote about their location, or they can share something they remember that was special or unique about the place where they sat.

Optional Activity:

- Stream Sense (see page 2-25)

Name: ____

Date: ____

Period: ____

Magic Spot

Student Worksheet

First take a few moments to observe your surroundings. Use all of your senses and list descriptive words for each below:

Sight	Hearing	Smell	Touch
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________

Now use some of the words you have listed to write about this location/experience/habitat, etc. You might choose to write a few Haikus (three lines consisting of 5, 7 then 5 syllables respectively) or a descriptive paragraph.

Station 3: DISSOLVED OXYGEN

Learning Objectives:

- Students will monitor dissolved oxygen content of a water sample and record information on their data sheets.

Dissolved Oxygen bin contents:

- 4 Hach test kits
- 8 pairs safety goggles
- 1 box gloves
- 1 box pencils
- Student data sheets
- Station Leader data sheet

PROCEDURE:

Fixing the Dissolved Oxygen Sample

These directions, with some minor modifications, are written for the Hach water testing kit for dissolved oxygen. Remember that photosynthesis and respiration will continue after a sample is collected, so water can gain or lose oxygen while sitting in the sample bottle. Therefore, you should ***BEGIN D.O. TESTING IMMEDIATELY UPON RECEIVING THE WATER SAMPLE.***

1. Put on protective gloves and safety goggles. If your skin comes in contact with any powder or titrant, rinse the area liberally with water.
2. Remove the stopper and add the contents of D.O. powder pillow #1 (manganous sulfate powder) and D.O. powder pillow #2 (alkaline iodide azide powder) to the sample.
3. Insert the stopper, being careful not to trap an air bubble and shake vigorously, holding on to the top. If oxygen is present, a brownish-orange floc will form.

Note:

If you see any air bubbles trapped in the sample bottle during steps 2 and 3, discard the sample and start over.

4. Allow the sample to stand until the floc settles halfway. Shake the bottle a second time and allow the floc to settle halfway again.
5. Remove the stopper and slowly add the contents of D.O. powder pillow #3 (sulfamic acid), taking care not to displace any floc.
6. Stopper and shake vigorously to dissolve the floc. Wait until all the floc is dissolved. The yellow color is from iodine. This is called the prepared sample. Prepared samples can be stored in the dark for a short time if it is more convenient or comfortable to return to your home/school to complete the analysis. Check with you teacher, if time enough remains at this station you may continue with the dissolved oxygen test.

Determining Dissolved Oxygen

7. Transfer two plastic measuring tubes full of prepared sample to the square glass mixing bottle. Using two measuring tubes allows you to determine D.O. to the nearest 0.5 mg/L.

   a.) Holding the dropper vertically, add one drop at a time of sodium thiosulfate standard solution titrant to the square mixing bottle, and count each drop.

   b.) Swirl the solution after each drop.

   c.) Continue adding sodium thiosulfate drops until the sample is a very light yellow.

   d.) Add 3 to 4 drops of starch solution. The prepared sample will turn blue from the added starch solution.

   e.) Continue adding drops of sodium thiosulfate, mixing and counting until the prepared sample turns from blue to colorless (the end point). Often this is just one or two more drops, so be careful.

8. The dissolved oxygen content of the water in mg/L is the total number of drops of titrant used to get to the endpoint divided by two if two measuring tubes of prepared sample were used. If only one measuring tube of prepared sample was used, the dissolved oxygen content is equal to the number of drops of titrant. Example: If you used two tubes of sample, you need to divide by two (13 drops divided by two tubes = 6.5 mg/L). If you only used one tube of sample, it's the actual number of drops of titrant used (6 drops with one tube = 6 mg/L).

9. Report the number of measuring tubes and the number of drops you used, and the calculated mg/L on your data sheet.

10. Tell your results to your station leader.

Station 4: STREAM FLOW

Learning Objectives:

- Students will assess the volume of water flowing by a point in time (i.e., stream flow) of the stream and record information on their data sheets.

Stream flow bin contents:

- 6 pairs hip boots
- 2 tape measures
- 2 yardsticks or marked poles
- 12 surveying flags
- 2 tennis balls
- 2 stopwatches or digital watches
- 2 calculators
- 1 box pencils
- string (optional)
- stakes (optional)

PROCEDURE:

Safety considerations

You will need to enter the stream channel to make width and depth measurements and to calculate velocity. Be aware of stream velocity, water depth and bottom conditions at your stream-monitoring site. Do not attempt to measure stream flow if water velocity appears to be fast enough to knock you down when you are working in the stream. If you are unsure of water depth across the width of the stream, be sure to proceed with caution as you move across the stream, or choose an alternate point from which to measure stream flow.

Site location

1. At your monitoring site, locate a straight section of stream that is at least 20 feet in length and has a uniform width. The water should be at least 6 inches deep, and have some movement. Try to avoid areas with undercut banks. Unobstructed runs or riffles are ideal sites to choose.

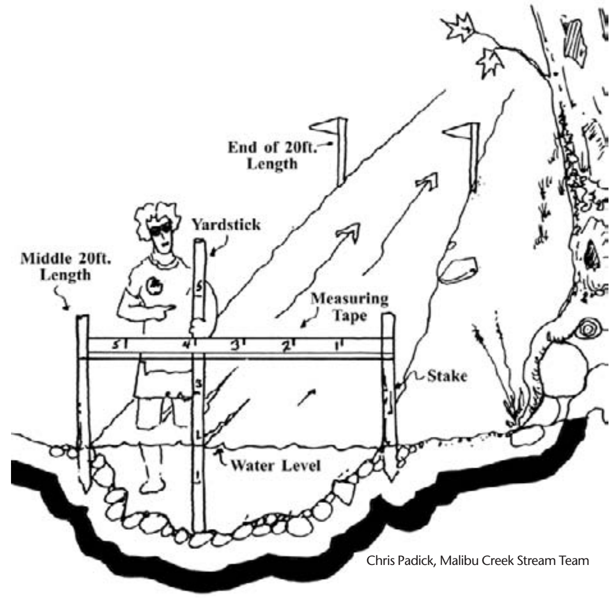
2. Measure 20 feet along the length of your chosen stream segment with your measuring tape and mark both the up and downstream ends of the section with flagging. Record this length on your data sheet.

Width and depth measurements

3. Working with a partner, measure stream width (from water's edge to water's edge) by extending a measuring tape across the stream at the midway point of your marked stream segment. Record the width in feet on your data sheet. (Using a tape measure graduated in tenths of feet will make calculations easier.)

4. Hold or secure the measuring tape to both shores so that the tape is taut and above the surface of the water. You might choose to secure the tape using shoreline vegetation or to attach the tape or a length of string to two stakes secured on opposite banks to create a transect line across the stream if it is impractical to hold the tape.

5. Using your engineer's ruler or pre-marked (in tenths of feet) pole, measure the water depth (ft) at one-foot intervals across the stream where you measured width (and secured the measuring tape). Be sure to measure depth in tenths of feet, not in inches. Record depth measurements (ft) on the data sheet. If your stream is greater than 20 feet wide, measure the depth in 20 equal intervals across the stream.



Chris Padick, Malibu Creek Stream Team

Velocity measurement

6. Velocity will be measured by tracking the time it takes a floating object to move the marked 20-foot length of stream. You will time the floating object (in seconds) a total of four times, at different locations across the stream. Repeating your measurements across the stream, in both slower and faster areas, will help to ensure the closest approximation to the stream's true velocity. This in turn will make your flow calculations more accurate. However, be sure your float travels freely downstream (during every float trial) without catching in slack water areas of the stream. For narrower streams (less than 10 feet), you can conduct only three float trials to assess velocity.

7. Position the person who will release the float upstream from the upper flag. Position the timekeeper with the stopwatch on the streambank (or out of the main flow path) at the downstream flag. Position the person who will catch the float downstream from the timekeeper. (Note: Unless velocity is very fast, the timekeeper should be able to catch the float with a net after they have finished timing its run down the stream.)

8. The float-releaser will gently drop the float into the stream a few feet upstream from the upper flag, and will alert the timekeeper to begin timing as the float passes the upstream flag (the float should have time to get up to speed by the time it passes the upper flag into the marked length of stream). If the float gets stuck on a log, rock or other obstruction, it should be released from the starting point again.

9. The timekeeper should stop the stopwatch as the float passes the downstream flag and retrieve the float using the net.

10. Record the float time for the first trial on the data sheet.

11. Repeat steps 8 and 9 for each of the remaining float time trials in different sections of the stream. Record the float time (seconds) for each trial on your data sheet.

Station 5: HABITAT ASSESSMENT

Habitat Bin Contents:

- 4 measuring tapes
- 8 surveying flags
- 4 stopwatches or digital watch
- 1 box pencils
- 4 clipboards

Safety:

Water appearance and odor can indicate water pollution. However, it can also indicate a possible safety hazard. If you notice any unusual water characteristics, DO NOT ENTER THE WATER and contact your local DNR office to report it. Your safety is important to us.

Here is a list of normal and possibly hazardous characteristics of water:

Clear – Colorless, transparent.

Turbid – Cloudy brown. May be due to suspended silt or organic materials suspended in the water.

Milky – Cloudy-white or gray, not transparent. May be natural or due to pollution.

Foamy – May be natural or caused by excessive nutrients or detergents from pollution. (Foam that is several inches high and does not brush apart easily is generally due to some sort of pollution.)

Dark brown – Tea-colored. May indicate that a naturally occurring, harmless acid is being released into the stream.

Oily sheen – A multicolored reflection. Can occur naturally or it may indicate oil or other petro chemicals floating in the stream.

Orange/Reddish – May indicate acids draining into the water or iron bacteria.

Green – Caused by algae. May indicate excess nutrients are being released into the stream. No smell or a natural odor.

Sewage – May indicate the release of human waste material, livestock manure flow from an upstream feed lot. If you smell sewage/manure or rotten eggs come from the stream, please do not enter the water. Notify the nearest DNR Service Center.

Chlorine – May indicate that a sewage treatment plant is over-chlorinating its effluent or may be from swimming pool discharge. Also component of milk house cleaning.

Fishy – May indicate the presence of excessive algae growth or dead fish.

Rotten eggs – A sulfurous smell may indicate muck soils or sewage/manure pollution, as hydrogen sulfide gas is a product of organic decomposition.

Petroleum – May indicate an oil spill from boats, land or storm drains.

PROCEDURE:

1. Determine if your stream is a rocky-bottom or soft-bottom stream.
2. Measure and mark a 300 ft. section of the stream.
3. Obtain the appropriate Habitat Checklist (i.e., rocky-bottom or soft-bottom stream) and answer the questions on that sheet.
4. Total the habitat score for your stream.
5. Provide your results to your station leader.

Station 6: MACROINVERTEBRATE COLLECTION

Macroinvertebrate Collection Bin Contents

- 8 pairs hip boots
- 4 D-frame kick nets
- 4 stopwatches or digital watches
- 4 white dishpans

PROCEDURE:

1. At least two people in each group should put on hip boots. (It's great if everyone is able to wear them if possible.)
2. Follow the procedures below to select sampling sites and to collect macroinvertebrates properly in the type of habitat you are sampling.
3. Collect three sub-samples within the 300-foot stream section where you are monitoring. Combine them into one bin for a complete biotic index sample.

Selecting Sampling Sites

Rocky-bottom and soft-bottom streams support different kinds of organisms, so be sure to choose sites based on your stream type. Your goal is to collect as many different kinds of aquatic macroinvertebrates from different habitats to ensure an accurate site assessment. Be aware that different habitat types may have different sampling protocols and some have a greater diversity of organisms than others. If you have many habitats from which to choose, first collect two sub-samples from the habitat with the most diversity, then choose one other habitat from which to sample (see chart below). For example, if your stream has a rocky bottom, sample at two separate riffle areas and at one other habitat. If your stream has a soft bottom or does not have riffles, collect samples at undercut banks, submerged logs or snags before considering sampling from a leaf pack.

Habitat Type	Stream Type	Habitat
Riffles	Rocky bottom	Most diverse
Undercut banks	Rocky, soft bottoms	Diverse
Snag areas, tree roots	Rocky, soft bottoms	Less diverse
Leaf packs	Rocky, soft bottoms	Least diverse

MACROINVERTEBRATE RIFFLE SAMPLING PROCEDURE

1. Rinse the net and check to make certain it doesn't contain any debris from the last time it was used.
2. Fill your basins or buckets with about one inch of clean stream water.
3. Place the net firmly on the bottom of the stream so that the water flows into the net. Stand next to the net.
4. Have your partner position themselves upstream of the net as the kicker. They should not begin kicking until the timer tells them to begin.
5. The third student in the group (or one of the two if working in pairs), will need a stopwatch and will time the sample collection.
6. When the timer starts the stopwatch, the kicker will disturb the bottom substrate and dislodge macroinvertebrates by kicking for two minutes. Alternately, they can use their hands to pick up each rock immediately above to about 18 inches upstream of the net and rub each of them thoroughly to remove all critters clinging to it. They should gently replace the rocks in the stream after rubbing them. They should continue to pick up, rub and remove rocks for two minutes.
7. When sampling, if you find you have too much water in your bucket or if the water is too muddy, pour the excess/muddy water through your net. Then allow stream water to flow through the net to rinse the sample within it, being careful not to lose anything from within the net. Add some clean water to the basin and empty the contents of the net into it.
8. Carry the net to shore and dump the contents into one basin or bucket with water and/or organisms and debris from other habitats' sub-samples.
9. All organisms clinging to the net should be removed and placed in the basin.
10. When you have added three sub-samples to your basin, you have collected a complete biotic index sample. Return to shore with your basin.

MACROINVERTEBRATE SNAG SAMPLING PROCEDURE

(Snag areas are accumulations of debris caught on logs, stumps or other obstruction in the water.)

1. Rinse the net and check to make certain it doesn't contain any debris from the last time it was used.
2. Fill your basins or buckets with about one inch of clean stream water.
3. Select about a three-foot by three-foot area (for uniform comparisons) around the snag, tree roots, logs or other debris.
4. Scrape the surface of the tree roots, logs or other debris with your net. You can also disturb the surfaces by scraping them with the net, your hands or your foot, or you can pull off some of the bark to get at organisms hiding underneath.
5. Twenty jabs equals one sample.
6. To remove sediment, allow water to flow through the net while holding it in the stream. Be careful to keep the opening facing upstream so you don't lose any organisms.
7. Carry the net to shore and dump the contents into one basin or bucket with water and/or organisms and debris from other habitats' sub-samples.

8. All organisms clinging to the net should be removed and placed in the basin.

9. When you have added three sub-samples to your basin, you have collected a complete biotic index sample. Return to shore with your basin.

MACROINVERTEBRATE UNDERCUT BANK SAMPLING PROCEDURE

(Undercut banks have scooped-out areas just below the surface of the water. This creates a bank that slightly overhangs on the surface of the water, and provides habitat for many kinds of organisms underneath).

1. Rinse the net and check to make certain it doesn't contain any debris from the last time it was used.

2. Fill your basins or buckets with about one inch of clean stream water.

3. Facing the bank, move the net in a bottom-to-surface motion along the undercut bank to dislodge organisms. Jabbing the net about 20 times should provide enough organisms for your sample.

4. Carry the net to shore and dump the contents into one basin or bucket with water and/or organisms and debris from other habitats' sub-samples.

5. All organisms clinging to the net should be removed and placed in the basin.

6. When you have added three sub-samples to your basin, you have collected a complete biotic index sample. Return to shore with your basin.

MACROINVERTEBRATE LEAF PACK SAMPLING PROCEDURE

1. Rinse the net and check to make certain it doesn't contain any debris from the last time it was used.

2. Fill your basins or buckets with about one inch of clean stream water.

3. Look for old leaf packs that are dark brown, slimy and slightly decomposed.

4. Working in pairs, position the dip net downstream from the leaf pack. Use your feet or hands to (or have your partner) gently move the leaf pack into the net.

5. Carry the net to shore and dump the contents into one basin or bucket with water and/or organisms and debris from other habitats' sub-samples.

6. All organisms clinging to the net should be removed and placed in the basin.

7. When you have added three sub-samples to your basin, you have collected a complete biotic index sample. Return to shore with your basin.

Station 7: MACROINVERTEBRATE IDENTIFICATION

Macroinvertebrate Identification Bin contents

- 4 white ice cube trays
- 12 white plastic spoons
- 4 tweezers
- 4 magnifying glasses
- 4 plastic cups
- 1 box pencils
- 1 box gloves
- 4 laminated Keys to Macroinvertebrate Life in the River

MACROINVERTEBRATE IDENTIFICATION PROCEDURE:

1. You will be assigned a dishpan to examine.
2. Examine leaves, sticks and other large objects in the sample for any macroinvertebrates that might be hiding.
3. After examining this debris, place it in another container to check later for organisms that may crawl out.
4. Fill the ice cube tray half-full of water.
5. Use plastic spoons to sort out the macroinvertebrates and place macroinvertebrates that look alike together in their own ice cube tray compartments. Sorting and placing similar looking macroinvertebrates together will help insure that you find all varieties of species in the sample.
6. Refer to the *Key to Macroinvertebrate Life in the River,* the macroinvertebrate wild cards and the citizen monitoring biotic index data sheet to identify the aquatic macroinvertebrates.
7. On the citizen monitoring biotic index data sheet, circle the animals on the data sheet that match those found in your sample.
8. Count the number of types of animals that are checked in each group and write that number in the box for each group on your data sheet. (Note: Do not count individual animals that you collected. Only count the number of types of animals found in each group.)
9. Report the number you circled for each group to your station leader for his/her data sheet.
10. Safely return all macroinvertebrates to the stream after sorting and identifying them.

OPTIONAL ACTIVITIES FROM OTHER SOURCES

Suggested Optional Activities from Project Wild Aquatic

- Water Canaries (This is like Stations 6 and 7 regarding macroinvertebrates) – "Students will investigate stream or pond using sampling techniques."
- Watershed (This is an alternative to the Finding Your Watershed Station) – "Students will measure the area of a small watershed, calculate the amount of water it receives each year, and discuss the varied roles the watershed plays in human and wildlife habitat."
- Suggestions within Shrinking Habitat (another topographical map exercise) – Students will compare old and new maps in the area to compare historic wetlands to present-day wetlands, and formulate ideas about human activities that may have played a role in changing the landscape.

Suggested Optional Activities from Project WET

- Restoration Nation – Students will work in small teams to develop a creek restoration plan and present their results to the class.
- Stream Sense – Students will use multiple senses to observe a stream.

Suggested Optional Activities from Hook, Line & Thinker

- Which Fish is This – Students will use morphological characteristics to group unlabeled fish from the order Perciformes into families and present their groupings to the class. Students will check their work using a fish identification website and dichotomous key.
- Water of Life – Students will watch a demonstration of summer lake stratification. Students will discuss oxygen and temperature changes in lakes during other seasons and work in partners to design an experiment.
- Home Sweet Home – Students will create a "travel brochure" for a particular fish species' spawning habitat and present it to the class. The travel brochure will include a detailed description of the environment, a description of the amenities that the fish requires for spawning, and graphics from the internet or another source.
- Shared Interests – Students will read a scenario and take on the roles of characters in the story as they develop a land use proposal, argue the merits of their proposal and attempt to compromise on a decision.
- Taking Stock – Students will study and take part in a model of the factors affecting fishery populations in Lake Michigan. Through a game, they will investigate how decisions by commercial fishermen, recreational anglers, fisheries biologists and lawmakers influence and are influenced by economics and by the abundance and scarcity of fish.

Suggested Optional Activity from Give Water A Hand Action Guide

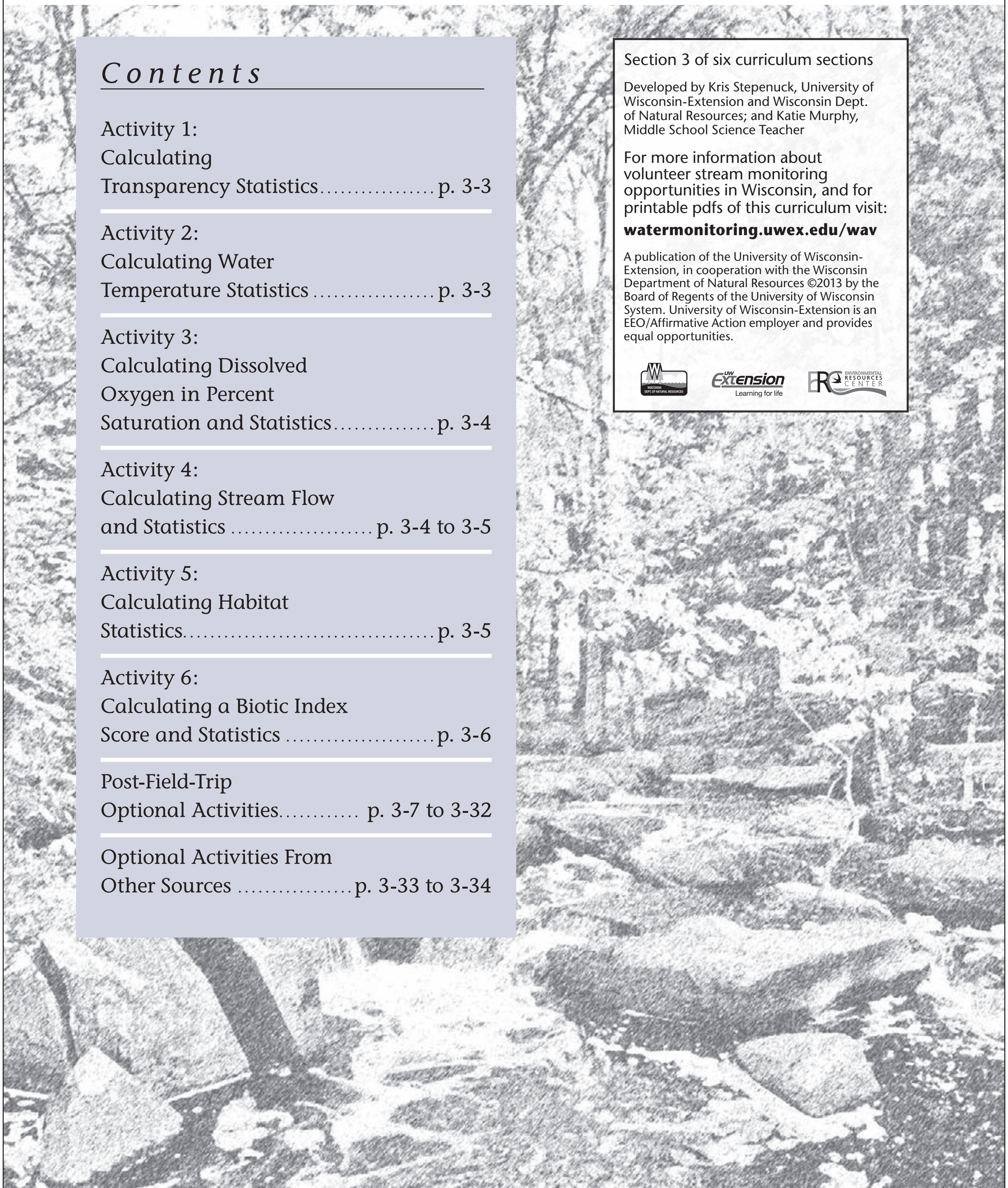
- Map Your Watershed – Students will learn that we all live in watersheds, and all water in a watershed drains to the same location. They will discover where water goes and how it gets there by working with a watershed map.

Suggested Optional Activities from Holding onto the GREEN Zone

- River Profiles – Students will locate the major landforms in a photo and a diagram of a river valley.
- Where is My Watershed? – Students will locate the riparian areas in their community watershed on street or topographical maps and will identify how people and animals use these areas.

▶ SECTION 3: POST FIELD TRIP

(CALCULATION OF RESULTS AND DATA INTERPRETATION)



Contents

Activity 1:
Calculating
Transparency Statistics .... p. 3-3

Activity 2:
Calculating Water
Temperature Statistics .... p. 3-3

Activity 3:
Calculating Dissolved
Oxygen in Percent
Saturation and Statistics .... p. 3-4

Activity 4:
Calculating Stream Flow
and Statistics .... p. 3-4 to 3-5

Activity 5:
Calculating Habitat
Statistics.................................... p. 3-5

Activity 6:
Calculating a Biotic Index
Score and Statistics .... p. 3-6

Post-Field-Trip
Optional Activities........... p. 3-7 to 3-32

Optional Activities From
Other Sources .... p. 3-33 to 3-34

Section 3 of six curriculum sections

Developed by Kris Stepenuck, University of Wisconsin-Extension and Wisconsin Dept. of Natural Resources; and Katie Murphy, Middle School Science Teacher

For more information about volunteer stream monitoring opportunities in Wisconsin, and for printable pdfs of this curriculum visit:

watermonitoring.uwex.edu/wav

HANDS-ON LEARNING ABOUT STREAMS WITHIN & OUTSIDE THE CLASSROOM – *FOR MIDDLE & HIGH SCHOOL TEACHERS & STUDENTS*

POST FIELD TRIP

Learning Objectives:

- Students will use the data they collected to complete any necessary calculations to determine results of their monitoring, including completing the data tables in the student booklet.
- Students will analyze the data and write conclusions for each test completed.

Standards:

Environmental Education A.8.4, A.8.5, A.12.4, B.8.5; Mathematics: Measurement D.8.4, D.12.3 Mathematics: Statistics and Probability E.8.2, E.8.4; Science Inquiry C.8.4, C.8.5, C.8.6, C.8.7, C.12.3, C.12.4

Materials:

- Data collected on the field trip
- Calculators
- Student workbook (see Section 4)
- Pen or pencil

Time:

Two class periods

Background:

Students will calculate mean, median, mode and range to give them a more comprehensive picture of the data they collected as a group during the field trip. If the class is reporting results to the Water Action Volunteers' online database (see page 3-26), please report the median score for a site, as this will minimize reporting erroneous results due to poor student performance.

PROCEDURE:

1. Photocopy the summarized data from the station leader forms onto an overhead and project them for students to copy. This will ensure that all students have all the raw data necessary to complete the calculations.
2. Students should complete the calculations for each test as specified in post-field trip activities 1-7. (High school students should also try to determine the degree of precision).
3. Students should also answer any post calculation questions and write a conclusion paragraph for each test. It is suggested that in the conclusion paragraph they state whether or not their hypotheses were correct and explain why or why not. They should state the final results of the test and what those results tell us about the stream quality. They can also address any sources of error that may have influenced their results. This is also a good place to raise any further questions on each subject and suggest needed improvements.

▶ POST FIELD TRIP

Activity 1: CALCULATING TRANSPARENCY STATISTICS

PROCEDURE:

1. Record all groups and their average transparency measurements (cm) in your Student Workbook (Table A).
2. For each average transparency measurement (cm), use the turbidity value conversion chart (page 4-4) to determine the turbidity value in Nephelometric Turbidity Units (NTU). Record the turbidity values in your student workbook (Table A).
3. Then rewrite both lists in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.
4. Determine the average, median and mode (optional) for transparency (cm) and turbidity (NTU), and record those in your student workbook (Table C). Use 9 to represent <10 NTU.
5. Determine the ranges of your transparency (cm) and turbidity measurements (NTU) by noting the lowest and the highest measurements recorded during the field trip. Indicate these ranges in your student workbook (Table C).
6. Answer the questions below Workbook Table C and write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results.

▶ POST FIELD TRIP

Activity 2: CALCULATING WATER TEMPERATURE STATISTICS

PROCEDURE:

1. Record all groups and their measured air and water temperatures (° C) in your student workbook (Table A).
2. Then rewrite the lists in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.
3. Determine the average, median and mode (optional) for water and air temperatures and record those in your student workbook (Table C).
4. Determine the range of water and air temperatures by noting the lowest and the highest water and air temperatures recorded during the field trip. Indicate these ranges in your student workbook (Table C).
5. Use the conversion chart on page 4-15 to convert the average, median, mode (if determined) and low and high water and air temperatures to ° F. Record this information in your student workbook (Table C).
6. Write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results.

▶ POST FIELD TRIP

Activity 3: CALCULATING DISSOLVED OXYGEN IN PERCENT SATURATION AND STATISTICS

PROCEDURE:

1. Record all groups and their dissolved oxygen measurements (mg/L) and water temperature (° C) measurements in your student workbook (Table A).
2. Determine dissolved oxygen percent saturation for each pair of dissolved oxygen and water temperature measurements using the Level of Oxygen Saturation Chart and following directions in step 3.
3. Using a straight edge, find the water temperature and align that with the oxygen mg/L scale for the oxygen measurement for that water temperature. The percentage of saturation is found on the line inbetween the temperature and oxygen lines. For example, 5° C with 10 mg/L of oxygen aligns with 75% saturation.
4. Record each dissolved oxygen percent saturation measurement in your student workbook (Table A).
5. Then rewrite the lists of dissolved oxygen in mg/L and percent saturation in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.
6. Determine the average, median and mode (optional) for dissolved oxygen in mg/L and in % saturation and record these in your student workbook (Table C).
7. Determine the range of dissolved oxygen measurements in mg/L and in % saturation by noting the lowest and the highest measurements recorded during the field trip. Indicate these ranges in your student workbook (Table C).
8. Write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Describe results in terms of both mg/L and percent saturation. Also address any sources of error that may have influenced your results.

▶ POST FIELD TRIP

Activity 4: CALCULATING STREAM FLOW AND STATISTICS

PROCEDURE:

1. Obtain your original stream flow data sheet from your teacher.
2. Transfer your data onto the data sheet below (see student workbook page 4-27).
3. Determine stream flow in cubic feet per second using the data you collected by following instructions in the data sheet below, or steps 4 to 9 below.
4. If you measured depth in inches, use the conversion chart to determine each depth in tenths of feet, or simply divide each depth by 12 to convert to tenths of feet.
5. Determine the average depth at your monitoring site and record this in the appropriate location on your data sheet.

6. Next, multiply your average depth by the stream width. This is the cross-sectional area (ft^2) of the stream. Record this in the appropriate box on your data sheet.

7. Determine the average float time (seconds) and record it on your data sheet.

8. Divide the length of your stream segment (i.e., 20 feet) by the average float time (seconds) to determine the average surface velocity at the site. Record the average surface velocity (ft/sec) on your data sheet.

9. Determine the correction factor below that best describes the bottom of your stream and multiply it by the average surface velocity measurement to account for the effects of friction with the stream bottom on water velocity. Record your corrected average surface velocity on your data sheet.
   a) Correction factor for rough, loose rocks, coarse gravel or weeds: 0.8
   b) Correction factor for smooth mud, sand or bedrock: 0.9

10. Multiply the average cross-sectional area ($ft.^2$) by the corrected average surface velocity (ft/sec) to determine stream flow. Record stream flow ($ft.^3$/sec or cfs) in the space provided on your data sheet.

11. Report this result to your teacher so other students in the class can obtain this information.

12. Once you have a complete list of stream flow measurements in cfs from everyone in your class, record these measurements in your student workbook (Table A). Then rewrite them in order from lowest to highest in Table B. Using a spreadsheet such as Excel may be helpful.

13. Determine the average, median and mode (optional) for stream flow for all samples collected and record this in your student workbook.

14. Determine the range of stream flow measurements by noting the lowest and the highest measurements recorded during the field trip and indicate this information in your student workbook.

15. Answer any remaining questions in your student workbook and then write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results.

▶ POST FIELD TRIP

Activity 5: CALCULATING HABITAT ASSESSMENT STATISTICS

PROCEDURE:

1. Record all groups and their total habitat scores in your student workbook (Table A).
2. Then rewrite the list in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.
3. Determine the average, median and mode (optional) for the habitat scores and record these in your student workbook (Table C).
4. Determine the range of habitat scores by noting the lowest and the highest measurements recorded during the field trip and indicate this in your student workbook (Table C).
5. Answer any remaining questions in your student workbook and then write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode, and type of bottom substrate (i.e., rocky or soft)) and what those results tell us about stream quality. Also address any sources of error that may have influenced your results. Tip: You can use the individual questions' scores on the Station Leader data sheet to assist with your assessment of habitat at the site.

Activity 6: CALCULATING A BIOTIC INDEX SCORE AND STATISTICS

PROCEDURE:

1. Obtain your biotic index data sheet from your teacher.
2. Calculate your biotic index score for your site by following the directions below:
   - a.) Count the number of animals circled in each group and write these in the work area below.
   - b.) Multiply the entered number from each group by the group value.
   - c.) Do this for all groups.
   - d.) Total the number of animals circled for all groups.
   - e.) Total the calculated scores for all groups.
   - f.) Divide the total score by the total number of types of animals that were found.
   - g.) Record this number. This is your Biotic Index Score.

SHOW ALL MATH (Use space below to do your math computations)

Group Number	Number of Animals	Group Value		Scoring
Group 1	________________	x4	=	____________________________
Group 2	________________	x3	=	____________________________
Group 3	________________	x2	=	____________________________
Group 4	________________	x1	=	____________________________
Total Number =	[ ]	Total Score =		[ ]

Total Score [ ] / Total Number [ ] = [ ]

(3.6+=Excellent, 2.6-3.5=Good, 2.1-2.5=Fair, 1.0-2.0=Poor) Biotic Index Score

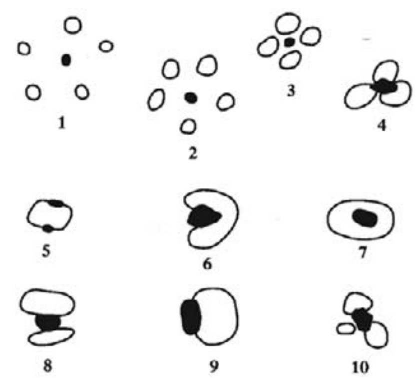
3. Report this result to your teacher so other students in the class can obtain this information.
4. Once you have a complete list of biotic index scores, record these measurements in your student workbook (Table A)
5. Then rewrite the list in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.
6. Determine the average, median and mode (optional) for biotic index and record it in your student workbook (Table C).
7. Determine the range of biotic index scores by noting the lowest and the highest measurements recorded during the field trip and indicate this in your student workbook (Table C).
8. Answer any remaining questions in your student workbook and then write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results.

E. COLI SAMPLE INCUBATION, COLONY COUNTING AND CALCULATING *E. COLI* STATISTICS

CLASSROOM PROCEDURE FOR *E. COLI* BACTERIA MONITORING AFTER 24 HOUR INCUBATION OF 3M™ PETRIFILM™ PLATES:

These procedures are also described in the E. coli section of the student workbook.

1. After 24 hours, wearing nitrile or other lab gloves, remove the plates from the incubator and count blue and blue-purple colonies that have associated gas bubbles and are within the circle. Holding the plates up to light can help distinguish colonies with gas bubbles.
2. On your data sheet record the number of colonies you counted.
3. Since you used just 1 mL of sample, multiply the number of colonies counted by 100 to determine the number of colony forming units per 100 mL of sample.
4. After you have counted colonies, place all of the Petrifilm plates in a Ziploc bag that has had about two tablespoons of bleach added to it. Seal the bag and throw it away in the regular rubbish. The bleach will disinfect the plates.



All 10 examples depict various bubble patterns associated with gas-producing colonies. Each numbered picture would be counted as one colony. (From 3M™ Petrifilm™ interpretation guide)

STATISTICS CALCULATIONS PROCEDURE:

1. Record all groups and their *E. coli* scores in your student workbook (Table A).
2. Then rewrite the list in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.
3. Determine the average, median, and mode (optional) for the *E. coli* scores and record these in your student workbook (Table C).
4. Determine the range of *E. coli* scores by noting the lowest and the highest measurements recorded during the field trip and indicate this in your student workbook (Table C).
5. Answer any remaining questions in your student workbook and write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode, and what those results tell us about the stream quality). Also address any sources of error that may have influenced your results.

Note:

Petrifilm *E. coli* plates with colonies that are too numerous to count (TNTC) have one or more of the following characteristics: many small colonies, many gas bubbles, and deepening of the gel color. High concentrations of *E. coli* will cause the growth area to turn blue, while high concentrations of coliforms (non-*E. coli*) will cause the growth area to turn dark red. When any of these occur, you will not be able to count the sample – and should write TNTC on your data sheet.

ASSESSMENT

Learning Objectives:

- Students will show their understanding of streams and stream water quality

Materials:

- Test (see page 3-9)
- Writing instrument

Time:

25 minutes

PROCEDURE:

1. Students complete the test questions to the best of their ability.
2. Teachers score the tests.
3. Teachers and students can compare the pre-test score to the post-test score to measure learning of the individual student during this mini-unit.

Name: ____

Date: ____

Period: ____

Stream Water Monitoring Test

Matching: Write the letter for the correct vocabulary word on the line next to the definition.

A. Turbidity
B. Respiration
C. Macroinvertebrates
D. Substrate
E. Watershed
F. Riparian zone
G. Photosynthesis
H. Riffle
I. Impervious surface
J. Transparency

_____1. Cloudiness in the water caused by suspended particles

_____2. A measure of water clarity

_____3. The stream bottom surface on which plants and animals attach or live

_____4. Small animals without backbones that are visible to the human eye

_____5. An area of land that drains to a main body of water

_____6. Shallow area in stream where water flows swiftly over rocks

_____7. The cellular process in which plants and animals use oxygen and release carbon dioxide

_____8. The land between the water's edge and the upper edge of the floodplain

_____9. The process in which green plants convert carbon dioxide and water, using the sun's energy, into simple sugars and oxygen

_____10. A surface that does not allow water to pass through it

Multiple Choice: Choose the best answer for each question and write the corresponding letter on the line.

_____11. Warm water holds _____________ dissolved oxygen than/as cold water.

A. Less
B. More
C. The same amount of

_____12. Streams with greater turbidity will likely

A. Be colder
B. Have less light penetration
C. Have more dissolved oxygen

_____13. Water clarity can be a useful indicator of

A. Industrial discharges
B. Runoff from construction sites or fields
C. Both A and B

_____14. The biotic index is

A. A list of macroinvertebrates found in the back of a book
B. A reference book often used when studying biology
C. A scale used to evaluate stream health based on its macroinvertebrate population

_____15. Food sources, spawning areas and migration paths of fish and other wildlife are all affected and defined by:

A. Substrate
B. Stream flow and velocity
C. Riffle zone
D. Both B and C

_____16. Signs of fish stress include

A. Faster scale growth
B. Increased respiration
C. Death
D. Both B and C

_____17. Streams that are healthy will have

A. A large population of pollution-tolerant macroinvertebrates
B. A large population of pollution-sensitive macroinvertebrates
C. A wide variety of both pollution-tolerant and pollution-sensitive macroinvertebrates

______18. What types of habitats would support a more diverse fish and insect population?

A. Riffles
B. Pools
C. Runs
D. A combination of A, B and C

_____19. What can the shape and condition of the streambank provide clues to

A. Land uses in the adjacent watershed
B. How much water to expect during snowmelt season
C. The number of animals living nearby

Short Answer: Answer the following to the best of your ability. Use complete sentences.

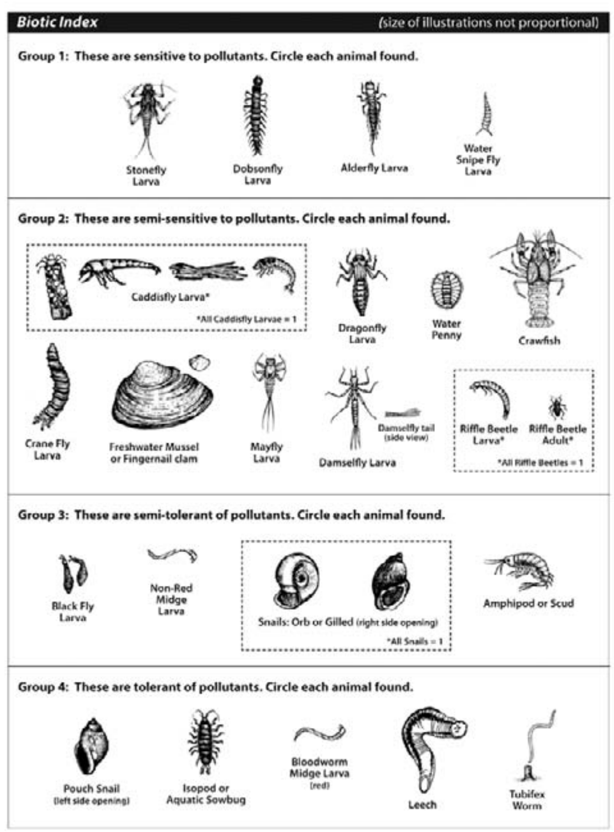
20. If you collected caddisflies, mayflies, riffle beetles, amphipods, and both non-red midges and bloodworms, what would your biotic index score be?

Group Number total)	Number of Animals		Scoring (add the 4 groups for
Group 1	______________	x4	= ______________________
Group 2	______________	x3	= ______________________
Group 3	______________	x2	= ______________________
Group 4	______________	x1	= ______________________

Total Number = [ ] Total Score = [ ]

Total Score [ ] / Total Number [ ] = [ ]

(3.6+=Excellent, 2.6-3.5=Good, 2.1-2.5=Fair, 1.0-2.0=Poor) Biotic Index Score



21. List at least three factors that can influence stream flow and velocity. (Complete sentences are not necessary on this question).

22. Explain why dissolved oxygen levels may be higher in the day than they are at night.

23. What are some advantages to using macroinvertebrates to identify water quality as compared to studying other physical or chemical aspects of water quality?

24. What impact(s), if any, might a cheese factory have on a nearby stream?

25. What would you expect to find in a healthy riparian zone? What purpose does the riparian zone serve for the health of the stream?

Name: ____

Date: ____

Period: ____

Stream Water Monitoring Test (KEY)

Matching: Write the letter for the correct vocabulary word on the line next to the definition.

A. Turbidity
B. Respiration
C. Macroinvertebrates
D. Substrate
E. Watershed
F. Riparian zone
G. Photosynthesis
H. Riffle
I. Impervious surface
J. Transparency

__ __1. Cloudiness in the water caused by suspended particles

__ _2. A measure of water clarity

__ __3. The stream bottom surface on which plants and animals attach or live

__ __4. Small animals without backbones that are visible to the human eye

__ _5. An area of land that drains to a main body of water

__ __6. Shallow area in stream where water flows swiftly over rocks

__ __7. The cellular process in which plants and animals use oxygen and release carbon dioxide

__ _8. The land between the water's edge and the upper edge of the floodplain

__ __9. The process in which green plants convert carbon dioxide and water, using the sun's energy, into simple sugars and oxygen

__ _10. A surface that does not allow water to pass through it

Multiple Choice: Choose the best answer for each question and write the corresponding letter on the line.

__ __11. Warm water holds _____________ dissolved oxygen than/as cold water.

A. Less
B. More
C. The same amount of

__ __12. Streams with greater turbidity will likely

A. Be colder
B. Have less light penetration
C. Have more dissolved oxygen

__ __13. Water clarity can be a useful indicator of

A. Industrial discharges
B. Runoff from construction sites or fields
C. Both A and B

__ __14. The biotic index is

A. A list of macroinvertebrates found in the back of a book
B. A reference book often used when studying biology
C. A scale used to evaluate stream health based on its macroinvertebrate population

__ __15. Food sources, spawning areas and migration paths of fish and other wildlife are all affected and defined by:

A. Substrate
B. Stream flow and velocity
C. Riffle zones

__ __16. Signs of fish stress include

A. Faster scale growth
B. Increased respiration
C. Death
D. Both B and C

__ __17. Streams that are healthy will have

A. A large population of pollution tolerant macroinvertebrates
B. A large population of pollution sensitive macroinvertebrates
C. A wide variety of both pollution tolerant and pollution sensitive macroinvertebrates

__ ___18. What types of habitats would support a more diverse fish and insect population?

A. Riffles
B. Pools
C. Runs
D. A combination of A, B and C

__ __19. What can the shape and condition of the streambank provide clues to

A. Land uses in the adjacent watershed
B. How much water to expect during snowmelt season
C. The number of animals living nearby

Short Answer: Answer the following to the best of your ability. Use complete sentences.

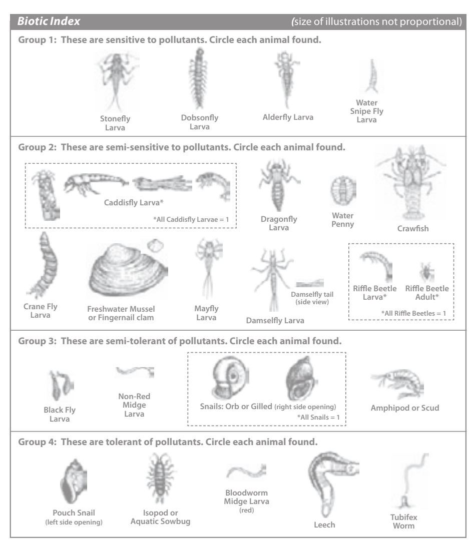
20. If you collected caddisflies, mayflies, riffle beetles, amphipods, and both non-red midges and bloodworms, what would your biotic index score be?

Group Number	Number of Animals				Scoring (add the 4 groups for total)	
Group 1	________	_______	x4	=	_____________	_______________
Group 2	________	_______	x3	=	_____________	_______________
Group 3	________	_______	x2	=	_____________	_______________
Group 4	________	_______	x1	=	_____________	_______________

Total Number = [ ] Total Score = [ ]

Total Score [ ] / Total Number [ ] = [ ]

(3.6+=Excellent, 2.6-3.5=Good, 2.1-2.5=Fair, 1.0-2.0=Poor) Index Score



21. List at least three factors that can influence stream flow and velocity. (Complete sentences are not necessary on this question).

22. Explain why dissolved oxygen levels may be higher in the day than they are at night.

23. What are some advantages to using macroinvertebrates to identify water quality as compared to studying other physical or chemical aspects of water quality?

24. What impact(s), if any, might a cheese factory have on a nearby stream?

25. What would you expect to find in a healthy riparian zone? What purpose does the riparian zone serve for the health of the stream?

COMPUTER GRAPHING AND PRESENTATIONS

Learning Objectives:

- Students will learn to use computer software to organize their data in an appropriate type of graph or chart.
- Students will compare their results to previous data collected for that same stream (if available).
- Students will look for trends and patterns existing in the data and explain their observations to an audience.

Standards:

Environmental Education A.8.6, A.12.5; Information and Technology Literacy A.8.1, A.12.1, B.8.1, B.8.2, B.8.3, B.8.4, B.8.5, B.8.6, B.8.7; Mathematics: Statistics and Probability E.8.1, E.8.2, E.12.1; Science Inquiry C.8.8, C.8.9, C.8.10, C.8.11, C.12.5, C.12.6

Materials:

- Completed student workbook (Section 4)
- Computers with graphing software and Internet access (if data have been entered to WAV database)
- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #1 (optional)
- Field Manual for Water Quality Monitoring (optional)
- Computer (to access Internet) and/or library access

Time:

Two class periods on the computers, one class period to present with a group to an audience

PROCEDURE:

1. Have students produce appropriate graphs to represent the available data. If previous data are available, it is suggested to create one graph for each of the tests with the parameter's value plotted on the y-axis and date on the x-axis. If multiple sites have been monitored, graphs might be made that demonstrate the value of the parameter at the various locations. Note: If past years' data have been entered to the WAV database, the database can automatically develop graphs and table of data to compare a site over time or to compare between sites. See the User's Guide for Searching the Data in the WAV Database at: http://www.uwex.edu/erc/wavdb/help/docs/SearchManual2009.pdf for explicit instructions. Graphs produced by the database can be displayed in student presentations by having the students use the "print screen" button and pasting the graphs into their presentation program. Student use of Excel or other spreadsheet program will allow more manipulation of output graphs for use in presentations.

2. Have students research one or two parameters and develop a presentation to share their findings and make suggestions about why the results were as they were found to be. Questions they might address include: What do the results suggest about the quality of the water at the site? What land uses may have affected the results? Has water quality changed over time? What possible sources of error may have been introduced during the monitoring? Note: Depending on age and ability of the students, it may work best to have students present in small groups and to have each group focus on presenting one aspect of the data (e.g., one group presents information on macroinvertebrates, one group on dissolved oxygen, etc.).

3. Have students present their findings to an audience and field any questions. Optional: You may wish to ask students to develop a poster to explain their results, which they will use to support their presentation.

Note:

Resources students might use to find out more about the parameters include the "Understanding Your Data" video available on the Water Action Volunteers DVD Set disc #1 (from the main menu on Disc 1, choose "Understanding Your Data," Run time: 5:19) and the Field Manual for Water Quality Monitoring as well as countless other resources available online and through the library.

COMMUNITY OUTREACH: LETTER TO THE EDITOR

Learning Objectives:

- Students will write a letter to a community leader or newspaper explaining results of their monitoring, how land use affects water quality, and possible effects of the resulting water quality on humans.

Standards:

Environmental Education A.8.4, A.8.5, A.8.6, A.12.4, A.12.5, B.8.5., B.8.10, B.8.15, B.8.17, B.8.18, B.8.21, B.12.3, D.8.1, D.8.5, D.12.5, E.12.3; Information and Technology Literacy B.8.1, B.8.2, B.8.3, B.8.4, B.8.5, B.8.6, B.8.7; Science in Personal and Social Perspectives: H.8.2, H.8.3, H.12.1, H.12.4, H.12.5, H.12.6, H.12.7

Materials:

- Completed Student Workbook (Section 4)
- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #1
- Field Manual for Water Quality Monitoring or other resources for students to learn more about the data they collected
- Computer with Internet access
- Local newspapers and news resources

Time:

One or two class periods and/or homework or extra credit assignment

---

PROCEDURE:

1. Have students review their conclusions in their student workbook.
2. Have students use additional resources such as Understanding Your Data video available on the Water Action Volunteers DVD Set disc #1 (from the main menu on Disc 1, choose “Understanding Your Data,” Run time: 5:19), the Field Manual for Water Quality Monitoring, or other print or web resources to research their findings in more depth.
3. In addition, have students review local news (either in print, online or on television) to assess environmental issues in your area and make linkages between current issues and their findings.
4. Next, have students locate and review guidelines for sending a letter to the editor in your local newspaper.

5. Finally, have students write a letter to the editor of your local newspaper about one aspect of their results they feel is particularly important in relation to local environmental issues in your area. Within the letter have students advocate a solution or combination of solutions to a problem they identified through their monitoring. The following tips, prepared by UW-Madison graduate student Elizabeth Goers, may be useful to the students as they prepare their letters:

    - Keep letters short. Ideally a letter to the editor is 100-200 words long, and does not exceed 250 words.
    - Submit your letter in the format that is preferred by your local newspaper – whether that is using an email submission form, or sending a direct email to the editorial staff or a hard copy via mail.
    - Use your real name. Most newspapers no longer accept anonymous submissions.
    - Include contact information in case the editor has any questions.
    - Try to make the letter relevant or timely to an issue at hand (e.g., start of monitoring season, construction on a stream, pollution problem, focusing on positive activities to protect a stream in your community, or an event such as Earth Day (April 22)
    - Use spell check and have a friend or a family member proofread your letter.
    - Do not generalize; rather use a specific instance and/or data to get your points across.

COMMUNITY OUTREACH: VIDEO/POWERPOINT PRESENTATION OF PROJECT

Developed based on suggestions from Ann Kronke, Platteville School District

Learning Objectives:

- Students will share results of their monitoring efforts, including what monitoring they conducted, their findings, and how those results relate to land use and possible effects on human health.
- They will present possible solutions to problems they may have discovered.

Standards:

Agricultural Education B.8.3, E.8.2; Environmental Education A.8.4, A.8.5, A.8.6, A.12.4, A.12.5, B.8.5, B.8.8, B.8.10, B.8.15, B.8.17, B.8.18, B.8.21; Information and Technology Literacy A.8.1, A.12.1; Science in Personal and Social Perspectives: H.8.2, H.8.3, H.12.1, H.12.4, H.12.5, H.12.6, H.12.7

Materials:

- Video or digital camera (to take on field trip)
- Computer (to which video and photos can be downloaded, videos and photos can be edited as needed, and video or PowerPoint presentation can be developed)
- LCD projector or TV
- Water Action Volunteers Volunteer Stream Monitoring DVD Set Disc #1 (optional)
- Field Manual for Water Quality Monitoring (optional)

Time:

Several class periods and/or as a homework assignment

PROCEDURE:

1. Have students take a camera and/or video camera on the field trip to record events from the day.
2. Have the students use these videos and photos to summarize the procedures they followed, and activities that occurred.
3. Have students include data results in a PowerPoint/video presentation summarizing the day and their findings. Note: Resources that students might use to find out more about the parameters include the “Understanding Your Data” video available on the Water Action Volunteers DVD Set disc #1 (from the main menu on Disc 1, choose “Understanding Your Data,” Run time: 5:19) and the Field Manual for Water Quality Monitoring.
4. Have students share their presentations with local community groups.

COMMUNITY ISSUE-BASED RESEARCH AND ROLE PLAY

Learning Objectives:

- Students will research a local water resources issue, assess current proposals being discussed in the community, and weigh possible resulting outcomes based on the various viewpoints.
- They will present a proposed solution to the situation at-hand.
- Students will role play the situation to experience difficulties in decision-making that result from competing interests (e.g., environmental, economic, health and safety) in community development.

Standards:

Agricultural Education B.8.3, E.8.2; Environmental Education: C.8.3, C.12.1; Information and Technology Literacy B.8.1, B.8.2, B.8.3, B.8.4, B.8.5, B.8.6, B.8.7; Life and Environmental Science F.12.7, F.8.10 Science in Personal and Social Perspectives: H.8.2, H.8.3, H.12.1, H.12.2, H.12.3, H.12.4, H.12.5, H.12.6, H.12.7

Materials:

- Local news sources
- Computer (to access web resources to learn about the situation) and/or access to library

Time:

A homework assignment and one class period

PROCEDURE:

1. Assign students the task of researching a current local water resource issue. This can be an issue you allow them to identify and choose on their own, or an issue you know is happening in the community.
2. Each student should identify the following in their research: the issue; the primary players involved in the community discussion; the main viewpoints being presented; the potential health, environmental and economic outcomes of each viewpoint.
3. Each student should prepare a 2-3 page paper to present this information, and conclude with a proposed decision on the issue. They should state why they support the decision being proposed.
4. Following completion of their research and report, hold an in-class role playing period. If students chose their own topic, a generic situation (see below) can be used during the role playing period. If you assign a topic, identify players involved in the situation and have students play those specific roles.
    a. Each 1-3 students will represent a specific player or group of players in the discussion.
    b. Hand out role assignments randomly.

c. Instruct students to take five minutes to review their assignment and prepare to play the role of the person or group they have been assigned.

d. Begin the role playing session by explaining the setting (e.g., a town board meeting where a crisis that has arisen based on a water resource issue that needs to be dealt with within a matter of hours) and have students introduce themselves (in their roles) to the group. Explain that the goal of the meeting is to make a decision about the issue at hand, and that each player should express his/her opinion as the role they have been assigned.

e. For younger students, a facilitated discussion will likely work best. Each student or group of students (depending on class size and time available) should be given the opportunity to present their side. For older students, small group conversations can take place between the various players, with interim pauses for a town crier (an assigned role) to present the current state of discussions and opinions that have been shared among players.

f. Assist as needed to facilitate development of a plan of action which the group can come to consensus upon to move forward to address the issue at hand (or a proposition that can be voted upon by the group.)

g. After all sides have had the opportunity to share their opinions with the group, ask the students to vote or decide upon a plan of action.

h. Following the decision, discuss the outcome of the vote with the students. How may the decision affect health, economics and the environment? How did various students feel in their roles? Did they feel their voice was heard during discussions? What challenges arose during the discussion? Do they have suggestions for improving the outcome so that health, environmental or economic issues could be better addressed?

Generic Scenario and Roles

Scenario: The Town of Pleasantville has a crystal clear babbling brook meandering through it from northwest to southeast. Numerous Town parks provide access for villagers to swim in and gain access to the brook for fishing, and kayaking, canoeing and tubing. The brook's headwaters begin towards the northwest edge of town with a cluster of springs. Most townsfolk have private wells from which they obtain drinking water. A farm is being proposed that will operate in the entire northwestern land area of the town. The farm will bring in at least 50 jobs to the community that has been suffering economically since the grain mill shut down and the train tracks that serviced the mill were removed from the area. Not only will be farm itself bring jobs, but there is hope that the farm, a beef operation, will promote need for a meat packaging plant, which would spark additional job opportunities, and bring families to the community. This would help schools grow and bring job opportunities for teachers, as well as numerous jobs in local restaurants and stores. Home builders are also hopeful the influx to the area will mean more new homes will be built.

Other local farmers are also supportive as they may be able to assist with producing grain the new farm may need. Currently the town relies heavily upon money earned by those in the tourism industry. The recreational opportunities the brook provides brings people from hundreds of miles to fish, boat and swim in its waters. This supports a small but thriving bed and breakfast industry and a few long-time restaurants. Tourism officials are worried that the farm, slated to have at least 1,000 head of cattle, will produce so much manure that the brook will become polluted with manure and the fish populations will be at risk. Plus, the crystal clear nature of the stream will be put in jeopardy due to cattle entering it and causing erosion along its banks. This may hurt the recreational industry. The farm plans to grow crops on hundreds of acres to feed the cattle. Although nutrient management plans will be followed, there is concern that nitrogen levels will greatly increase both in the brook as well as in groundwater in the community. High levels of nitrogen are known to be dangerous to infants, so a group of young mothers has begun campaigning against the farm in the name of their children's safety. The Town Board must decide upon whether to approve the farm or not. They must weigh environmental, health and economic factors in their decision.

The Players:

- Town Board Chair and members
- Farmers (local and ones proposing the new farm)
- Home Builders Association
- Meat packaging Plant Operator (who has been out of work for 11 months)
- Restaurant Operators Association
- Realtors
- Farm Bureau representative
- Tourism Office Director
- News Reporter
- Fish Forever, a local nonprofit group that supports the fishing opportunities and habitat protection efforts in the area
- Nutrient Management Specialist
- Friends of the Brook, a local nonprofit group that supports recreational use of the brook
- Landowners along the brook who have private wells for drinking water
- Unemployed teacher
- Bed and Breakfast Association

SCIENTIFIC REPORTS

Activity developed by Rebecca Bestul, Eau Claire Area School District

Learning Objectives:

- Students will prepare a laboratory report about their monitoring, including what monitoring they conducted, their findings, and how those results relate to land use and possible effects on human health.
- They will present possible solutions to problems they may have discovered.

Standards:

Agricultural Education B.8.3, E.8.2; Environmental Education A.8.4, A.8.5, A.12.4, B.8.5, B.8.10, B.8.15, B.8.17, B.8.18, B.8.21, B,12.18, C.8.3, C.12.1, D.8.1; Information and Technology Literacy B.8.1, B.8.2, B.8.3, B.8.4, B.8.5, B.8.6, B.8.7; Life and Environmental Science F.8.8, F.8.9, F.8.10; Science in Personal and Social Perspectives: H.8.2, H.8.3, H.12.1, H.12.4, H.12.5, H.12.6, H.12.7

Materials:

- Completed Student Workbook (Section 4)
- Water Action Volunteers Volunteer Stream Monitoring DVD Set (optional)
- Field Manual for Water Quality Monitoring or other printed resources to aid student learning
- Computer (to access web-based resources to aid student learning) and/or library

Time:

A homework assignment

PROCEDURE:

1. Have students prepare lab reports following common protocol that includes a title, background, introduction, site description, methods, results, discussion, conclusion and references. In their discussion, have students discuss possible solutions to problems they may have discovered through their monitoring in their discussion as well as possible sources of error in their data.

The following page can be printed and distributed to students as guidance for preparing their reports.

Tip:

Resources students might use to find out more about the parameters include the "Understanding Your Data" video available on the Water Action Volunteers DVD Set disc #1 (from the main menu on Disc 1, choose "Understanding Your Data," Run time: 5:19), or any of the presentations from Disc 2 of that set.

DEVELOPING A SCIENTIFIC PAPER/LAB REPORT

All scientific studies are written up in essentially the same format. We will be writing our papers similar to the way they need to be written for the Journal of Ecology (with a few minor differences).

Title Page

Write a brief title that describes the main point of the study. List all authors underneath the title.

Abstract

This is a summary of the entire report. It should be no longer than 250-300 words. Write this after you have completed the report.

Background

Introduce the main topic of study starting with the broadest and most general ideas and descriptions. Give a general overview of the area/organism/process being studied, as well as a description of the habitat/behaviors that are most common.

Introduction

What was the purpose of your study? What were you looking for? What did you measure? Why is this study important? Why would scientists find it interesting? What unresolved issues are addressed? What problem are you trying to find an answer to? **Note: Many times, the background and introduction sections are combined, as is the case for the *Journal of Ecology*.

Site Description

This is an opportunity for you to share regional or geographic information about your site. Describe the location where you collected your data. What stream was it? What larger watershed(s) is it a part of? What part of the state is it in? This is the section where a map of the area should be included.

Methods

Describe the methods you used to collect the data and the equipment you used to do this. Describe the way you chose to analyze the data you collected. If you collected more than one kind of data, break it up into sections.

Results

Provide a written description of the data results you obtained for each parameter monitored. This is the section in which you should include tables, charts, diagrams of results, and/or graphs. All of these should be labeled and described in the written description. In this section, you can describe what you found, but do NOT draw any conclusions from the data. Note: If you broke the methods into sections, report the results using the same breakdown.

Discussion

What do your results mean (explain each finding)? What do they tell you about the area/organism/process being studied? What do they suggest about the overall quality of the stream? This section is where you draw conclusions about the data you collected. Start with the most important, general point from the results, then move on to more specific points. Is there anything that was unexpected in your findings? Is there anything you cannot interpret or explain? Are there shortcomings of your study? How do your results compare with others?

Conclusion

Summarize your field study. Who else might benefit from the information you found (who can use these data)? What did you learn? If you had to do this again, what would you change? What recommendations would you make for next year? Note: Many times the discussion and conclusion sections are combined.

References

Make note of any resources you used to help develop your report. These should be listed in alphabetical order using the following formats for various types of resources:

- Books: Last name, First initial of first author; Last name, first initial of next author; etc. (year). Title. Page number(s). Publisher. City of publication.
- Journal Articles: Last name, First initial of first author; Last name, first initial of next author; etc. (year). Article title. Journal title. Volume: pages.
- Websites: Name of publisher, if listed. Title of website. (year). Web address

DATA ENTRY TO THE WATER ACTION VOLUNTEERS ONLINE DATABASE

Learning Objective:

- Students will learn to use an online database to enter their results.

Note to teachers:

This only needs to be done once per field trip.

Standard:

Information and Technology Literacy B.8.5

Materials:

- Calculated medians from compiled classroom set of data
- Computer with Internet access
- Volunteer Monitors' User Manual for the Water Action Volunteers Online Database (accessible for download at: http://www.uwex.edu/erc/wavdb/help/)

Time:

10 minutes

PROCEDURE:

1. Go to http://www.uwex.edu/erc/wavdb
2. Follow directions in the Volunteer Monitors' User Manual to register the site (if not previously registered). Note: It may take several days for the registration process to be complete, as action is necessary on the part of the Water Action Volunteers Database Administrator.
3. Once the site is registered, follow directions in the Volunteer Monitors' User Manual to enter median data results for the field trip to the online database.

THANK YOU NOTES

Learning Objectives:

- Students will recollect one aspect of the field trip in which they learned about stream ecology and/or one reason (related to stream monitoring) for which the station leader will remember them.
- Students will recognize the importance of saying thank you.

Materials:

- Blank paper
- Markers, colored pencils, or crayons

Time:

20 minutes

PROCEDURE:

1. Ask students to address thank you notes to station leaders from their field trip and to draw something they learned about and liked from the event.
2. Collect thank you notes and send to field trip assistants.

STORM DRAIN STENCILING

Educate your community about stormwater pollution by stenciling the message: "Dump no Waste – Drains to Stream" (or River or Lake) next to storm drains. You may choose to distribute or create fliers that educate the community about stormwater pollution.

Learning Objectives:

- Students will learn about the sources of stormwater pollution.
- Students will understand why stormwater pollution is a threat to the environment.
- Students will stencil messages next to storm drains to encourage others to be more aware of stormwater pollution.

Standards:

Agricultural Education A.6-8.3, A.9-12.3; Environmental Education D.8.5, E.12.3

Materials: For each group of 4 to 6:

- 1 or 2 stencils
- Door hanger cards/fliers
- A map of the stenciling area
- Parent/guardian permission slips
- A letter of authorization from the Department of Public Works for stenciling
- 2 cans of spray paint – preferably inverted-tip white traffic zone latex paint.
- A wire brush to clean the gutter before painting
- Whisk broom and dust pan
- 1 or 2 pairs of work gloves
- 1 or 2 bright orange safety vests, or have students wear brightly colored clothing
- 2 garbage bags – 1 for wet stencils and 1 for garbage such as tape used on the stencils and debris cleaned out of the gutter
- Paper towels or rags*
- Traffic cones or flags for use on busy streets*
- Duct tape and scissors*
- Cardboard box the size of stencil*

Note:

One can of latex paint is enough to paint approximately 10 drains.

**optional*

Time:

It will take approximately one hour for a team of four to six people to stencil 15 storm drains.

Background:

Why should people be concerned about what enters a storm drain?

Because anything that is flushed down a storm drain is not “treated” before it reaches a stream or river. This means that oil, antifreeze, paint, grass clippings, household waste, pet wastes or any other waste on streets and sidewalks goes directly into a nearby stream, river or lake.

The next time you wash your car on your driveway, consider where the water goes. The soapy, dirty water runs down the street into the storm sewer. This sewer carries the wash water to a waterbody. In the water, the soap acts like a fertilizer for aquatic plants and causes too much plant growth, which creates problems for fish.

You can help increase awareness of the storm drain connection. Educate your community about stormwater pollution by stenciling the street next to storm drains and distributing door hanger cards.

PROCEDURE:

Before You Stencil

1. Get permission to stencil storm drains from the Department of Public Works in your city, village or town. Be sure to ask for a letter of authorization to provide proof if you are questioned by a road crew or police officer.

   To stencil on private property, contact the landowner, whether the property is a home, business or apartment complex.

2. Weather conditions are important for the success of this project. You should choose a day when the pavement is dry and warm. Windy days are not good because the spray paint can drift onto nearby automobiles and debris can be blown onto the painted surface.

3. Using a neighborhood map, carefully consider the area your group will stencil. Divide the area into routes and assign a team to each route.

4. A day or two before you plan to paint, distribute door hanger cards or fliers explaining the stenciling program. If you can’t distribute the information ahead of time, have one or two team members distribute the cards and fliers while others paint.

   Examples of a door hanger card and a flier are posted on the Water Action Volunteers website. If your group is participating in a large storm drain stenciling project, you may want to make your own door hangers, fliers or posters, using the opportunity to conduct an all-out education campaign.

How to Stencil

1. Scrub the street area surrounding the storm drain with the wire brush, and use the whisk broom to sweep dirt into the dust pan. Use your garbage bags to take debris away. Do not sweep dirt and debris into the drain.

2. Position the stencil in the gutter next to the storm drain inlet where the message will be most visible. Tape or hold the stencil in place. You might place a cardboard box with its bottom removed over the stencil to create a "wall" to contain drifting paint.

3. Spray paint the stencil message, making sure paint doesn't get into the storm drain. Two light coats of paint will work better than one heavy coat. Allow the first coat of paint to dry before applying the second coat. The stenciled messages last for approximately two years on a paved surface.

4. When you're done with the project, have one team member check that all storm drains in your area have been stenciled. It's easy to miss one.

5. Place the used stencils in a plastic bag for transportation. When storing used stencils, allow the paint to dry before stacking the stencils. A stencil's lifespan is determined by use. Discard the stencil when the message is blurred by excess paint build-up (typically about ten separate events, depending on the material used to make the stencil).

RIVER CLEANUP

Help the environment by removing garbage from a stream or river.

Learning Objectives:

- Students will improve the water quality of a stream or river.
- Students will work with others to clean up a section of a stream or river.
- Students will record the amount of garbage removed from the waterway.
- Students will work cooperatively with city-works departments to coordinate garbage pickup.

Standards:

Agricultural Education A.6-8.3, A.9-12.3; Environmental Education D.8.5, E.12.3

Materials:

- Stream Walk Worksheet
- Topographic map of the area
- Parent/guardian permission slip
- First aid kit
- Orange cones at any trash collection site along a road
- Life jackets for very young volunteers (optional)
- Camera
- Work gloves
- Trash bags
- Rakes, shovels, and/or pitchforks
- Waders, high rubber boots, old shoes or other sturdy footwear
- Insect/tick repellent
- Refreshments

Note:

Ask local grocery stores, soft drink distributors or restaurants to donate snacks, lunches or a picnic after the job is done. Local hardware stores, discount stores or other businesses may be willing to donate items such as gloves and trash bags.

Time:

Planning may take several weeks; the actual cleanup will take one afternoon.

Background

When you survey your stream or river site before the actual cleanup, you may notice two kinds of debris: human-made and natural. Both kinds of debris can have negative impacts on a stream or river. Human waste such as litter can be especially harmful to aquatic animals that may view this waste as food or a suitable place to live. Natural debris such as logs, leaves and soil can be good for wildlife, but too much of a good thing can restrict water flow. Normally, natural debris such as trees or branches are not removed during stream cleanups. This debris may provide fish habitat, so you should consult your local Department of Natural Resources fish manager before removing it.

During a cleanup, it's important to record the amount of garbage collected. You can use this information to educate people in your community about the amount of garbage found in local streams. Many communities have stream and river cleanup campaigns each spring. You might consider having your class join an established cleanup effort or you may opt to organize a new effort.

PROCEDURE:

Planning a Clean Up

1. Pick a cleanup date.
2. Choose a stream or river. The site you choose for your cleanup should reflect the size and abilities of your group. Small groups may want to focus on a stretch of stream in a park or neighborhood. A large group may want to develop a major cleanup effort. Contact your local parks department or area DNR office for information about existing stream and river cleanup projects in the area. Organizers of large-scale efforts need to plan at least six months in advance for fundraising, permits, safety concerns and solicitation of volunteers. Union approval from city workers may even be necessary.
3. Before you begin to clean up, get permission from landowners who live along the streambank.
4. Use the worksheet in the Stream Walk Survey activity to collect information about the stream or river you've chosen. The survey will help to identify any areas that need cleanup. It will also help you identify any areas along the stream or river that are not safe for volunteers. Area topographic maps that include the stream or river can be found online.
5. If you have a large group, organize into several teams with team or area leaders (one for every 6-8 volunteers). Each team leader should know what section of the stream to clean and where the waste pickup sites are, and keep track of how much waste is collected.

6. Because students will be working near water and may be carrying items, safety is an important consideration. Advise your students to wear heavy gloves, thick pants, sturdy shoes and safety goggles (when appropriate). Only adults should pick up hazardous items such as broken glass and syringes. First aid kits should be available at the cleanup site and someone there should know how to administer first aid. If needed, contact the highway department to provide warning cones, signs or flags for sites where volunteers will be leaving garbage for pickup.

7. Parents or guardians may need to give written permission for your students to participate in a cleanup effort. A permission slip should include an emergency phone contact and permission to seek medical assistance. Contact you school's insurance agent for information on liability insurance.

8. Contact the city public works department to arrange for garbage removal or to find out where the garbage can be taken. Local government agency contacts or developers may be willing to help with removal. Locate nearby recycling centers for the recyclable products.

9. Notify local newspapers, radio and television stations about your project. Point out your project's contribution to improving water quality and to enhancing community pride.

On the Cleanup Day

1. Group leaders should keep track of how much garbage has been collected by either measuring the number of bags collected or the weight of the garbage.

2. Be sure to take photos of your students in action! You can use "before" and "after" photographs to show people what your group has accomplished.

3. Arrange for volunteers to help with returning borrowed materials and disposing of garbage or recyclables.

4. Celebrate! Reward yourself, your students and your volunteers with a picnic or party.

After the Cleanup

1. Thank everyone who participated, including property owners, merchants, local government staff, elected officials and other people who contributed to the success of your project.

2. Tell your community how much garbage was collected from local streams and rivers. Encourage them to "Make WAVes" through pollution prevention.

3. Enjoy the results! Thanks to your efforts, another Wisconsin waterway will be more enjoyable to view, safer to swim in, and will provide more suitable habitat for wildlife.

OPTIONAL ACTIVITIES FROM OTHER SOURCES

Suggested Optional Activities from Project Wild Aquatic

Overall Experience

- Aquatic Times – "Students will investigate, write and produce a newspaper that features aquatic information and issues."
- To Dam or Not to Dam – "Students will role play individuals representing differing perspectives and concerns related to a complex issue."
- Alice in Waterland – "Students will use a simulated field trip, lecture-discussion and student-gathered data to explore water use and its effects on wildlife habitat."

Other

- Where Have All The Salmon Gone? – "Students will graph and interpret actual fish population data in relation to historical events."

Community Connections

- Watered Down History – "Students will investigate the history of a chosen waterway through standard reference sources as well as taped personal interview and public records, where available, and then display their findings on a mural."
- Living Research: Aquatic Heroes and Heroines – "Students will identify people through news media, current events or other means who have made contributions to conserving or preserving aquatic environments; research their contributions, including by interviewing them; and write a biography."
- Wild Bill's Fate (listed in "Aquatic Extensions to Project WILD Activities" found in the indices in the back of the Project WILD Aquatic guide) – "Students will investigate pending legislation affecting wildlife."
- Wildlife issues: Community Attitude Survey (listed in "Aquatic Extensions to Project WILD Activities" found in the indices in the back of the Project WILD Aquatic guide) – "Students will develop a questionnaire and conduct a community survey."

Habitat

- Riparian Retreat – "Students will build awareness of a riparian zone through the use of a simulated field trip and art work."
- Wetland Metaphors – "Students are presented with a selection of hands-on objects for investigation as metaphors for natural functions of wetlands."
- Blue Ribbon Niche – "Students will create a variety of representations of animals that live in riparian habitats."

Suggested Optional Activities from Project WET

Overall Experience

- wAteR in moTion – Students will create artwork that simulates the movement and sounds of water in nature.
- Water: Read All About It – Students will develop a Special Edition on water.
- Water Write – Students will explore feelings about and perceptions of water topics through writing exercises.
- Who's Problem Is It? – Students will analyze the scope and duration of water issues to determine personal and global significance.
- Humpty Dumpty – Students will simulate a restoration project by putting pieces of an ecosystem back together.

Suggested Optional Activities from Hook, Line & Thinker

- Taking Stock – Students will study and take part in a model of the factors affecting fishery populations in Lake Michigan. Through a game, they will investigate how decisions by commercial fishermen, recreational anglers, fisheries biologists and lawmakers influence and are influenced by economics and by the abundance and scarcity of fish.
- Making Decisions – Students will brainstorm ideas about "Hot Topics" in natural resources and work together to craft a resolution on a natural resources policy they would like to see changed. Students will present their resolutions to each other, and, if the class finds a resolution compelling, introduce that resolution at a hearing.
- Great Conservationists – Students will write a reflective one-page paper on a quote by a conservation leader – samples are provided to help get them started.

Suggested Optional Activities from Give Water A Hand Action Guide

- Ask an Expert – Students will learn about water experts in their community and share their findings with these people.
- Choose a Service Project – Students will learn to match their skills with their ideas in order to implement a water service project
- Plan for Action – Students will outline steps of what and when they will complete activities to carry out their chosen service project.
- Keep on Track – Students will learn how to be sure their work is most effective and how to measure their successes.
- Celebrate Success – Students will evaluate their service project and celebrate their successes.

▶ SECTION 4: STUDENT WORKBOOK

STUDENT NAME

____

GROUP

____

Contents

Transparency..................... p. 4-2 to 4-9

Temperature................... p. 4-10 to 4-15

Dissolved Oxygen............ p. 4-16 to 4-24

Stream Flow....................p. 4-25 to 4-30

Habitat ....p. 4-31 to 4-40

Biotic Index .... p. 4-41 to 4-46

E. coli ....p. 4-47 to 4-57

Glossary ....p. 4-58 to 4-60

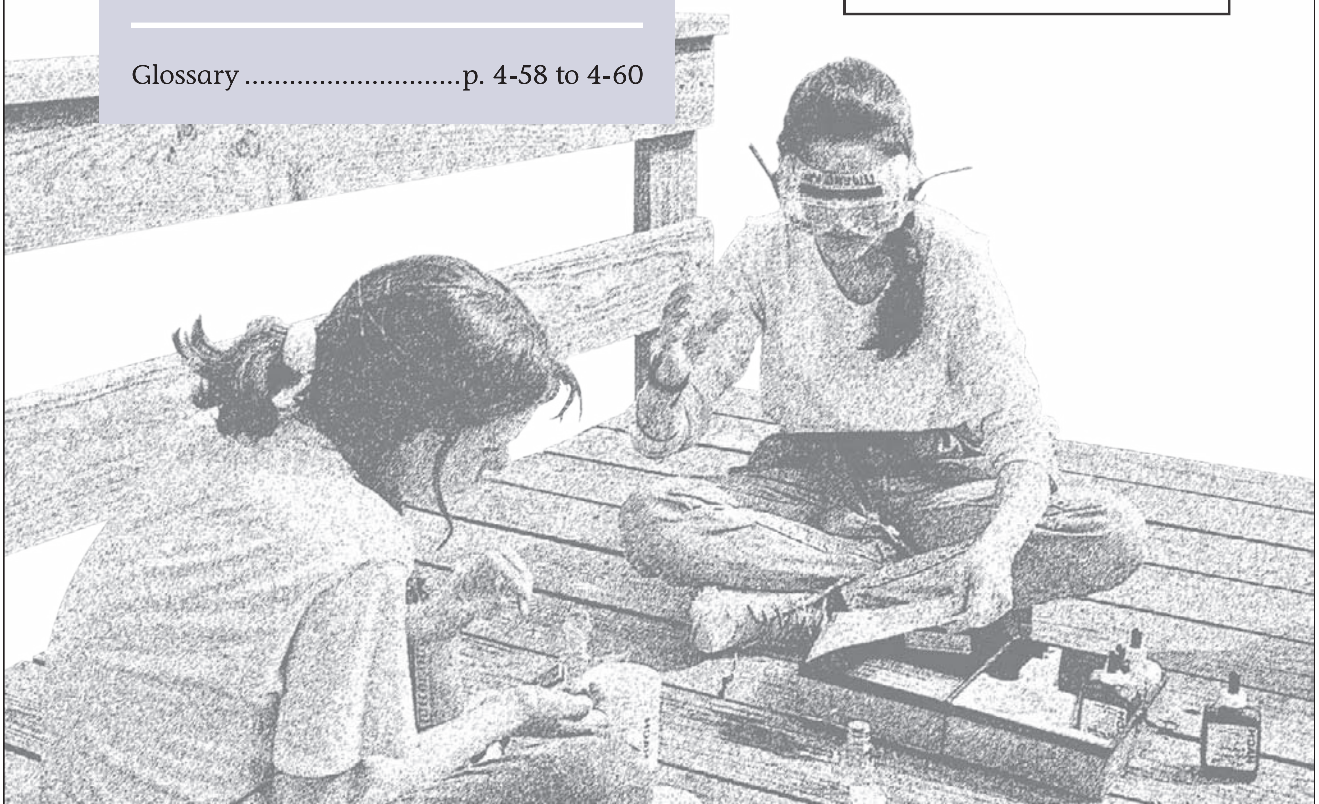
Section 4 of six curriculum sections

Developed by Kris Stepenuck, University of Wisconsin-Extension and Wisconsin Dept. of Natural Resources; and Katie Murphy, Middle School Science Teacher

For more information about volunteer stream monitoring opportunities in Wisconsin, and for printable pdfs of this curriculum visit:

watermonitoring.uwex.edu/wav

A publication of the University of Wisconsin-Extension, in cooperation with the Wisconsin Department of Natural Resources



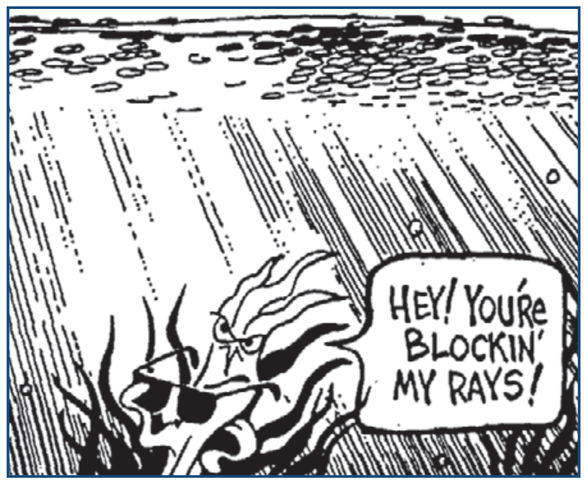
HANDS-ON LEARNING ABOUT STREAMS WITHIN & OUTSIDE THE CLASSROOM – *FOR MIDDLE & HIGH SCHOOL TEACHERS & STUDENTS*

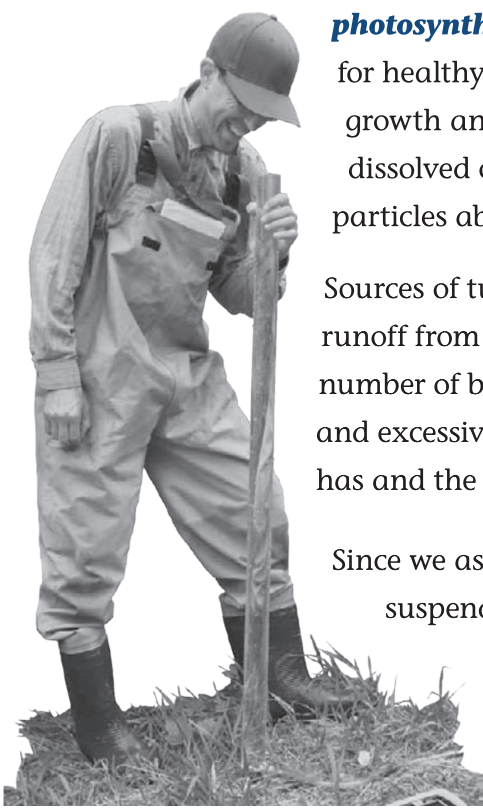
Terms in the glossary appear in ***bold blue italic type*** where first used.

TRANSPARENCY

- *Water clarity is one of the most obvious measures of water quality.*
- *Water clarity can be a useful indicator of runoff from construction sites, fields, logging activity, industrial discharges and other sources.*
- *Monitoring transparency before, during and immediately after rain can provide a useful picture of potential runoff problems.*

Murky water is easily seen as unhealthy. However, natural substances which are not harmful to the water can sometimes make water appear brown and murky. How do we know if the murky water is a cause for concern? Scientists have found a way to quantify the cloudiness of water by measuring its ***turbidity,*** which relates to the amount of suspended particles in the water. These small particles of soil, algae or other materials generally range in size from the microscopic level to about one millimeter, (about as thick as a pencil lead). More free-floating particles cause greater turbidity, resulting in less light penetration through the water. This hinders ***photosynthesis,*** necessary for healthy aquatic plant growth and production of dissolved oxygen. The water also becomes warmer because the suspended particles absorb heat.

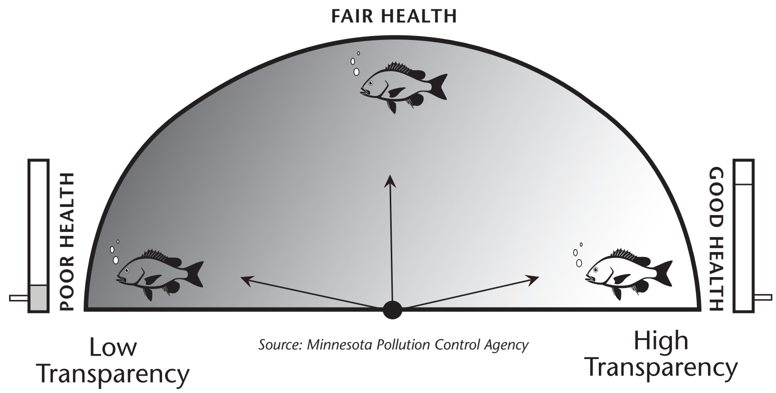




Sources of turbidity include: erosion from fields, construction sites, urban runoff from rainstorms and melting snow, eroding streambanks, large number of bottom feeders (such as carp) which stir up bottom sediments and excessive algal growth. The faster a stream flows, the more energy it has and the more sediment it can carry.

Since we assess water clarity visually, we don't directly measure how many suspended particles are in the water. Instead we measure the transparency of the water, which takes into account both color and suspended particles. You will measure water clarity in centimeters (cm) using a transparency tube that is approximately 120 cm long. There is a black and white disc in the bottom of the tube that you will look down – through the water sample – to attempt to see. If you cannot see the disc in the bottom of the tube, your monitoring partner will open a release valve to allow water to flow out of the tube. Your job is to alert your partner to close the valve when you can just see the contrast between black and white on the disc. However, if you can see the disc in the bottom of the tube when the tube is full, you will report a transparency value of 120 cm. It's important to note that you cannot determine the exact transparency if you can see the disc with the tube full, you only know that transparency is greater than 120 cm. This high transparency indicates good water quality (shown above).

LOW WATER TRANSPARENCY INFLUENCES FISH HEALTH



All streams have background turbidity/transparency, or a baseline standard for a natural amount of turbidity/transparency. Fish and aquatic life that are native to streams have evolved over time to adapt to varying levels of background water clarity. For example, some native fish and aquatic life in the Mississippi River are very happy with their murky environment. What causes problems in any stream or river are unusual concentrations of suspended particles and how long the water clarity stays at a deviated level.

When you collect transparency samples, it is important to note any fluctuations in values, which can help detect trends in water quality. Time is probably the most influential factor in determining how turbidity affects the aquatic environment. The longer the water remains at unusually high values, the greater effect it has on fish and other aquatic life. Fish can become very stressed in waters that remain highly turbid for a long time. Signs of stress include increased ***respiration*** rate, reduced growth and feeding rates, delayed hatching and in severe cases, death. Fish eggs are ten times more sensitive to turbidity than adult fish.

Turbidity is measured in Nephelometric Turbidity Units ***(NTU)*** when scientists use a special meter, called a nephelometer, to assess this parameter. This type of meter shines light through a water sample and measures how much light is scattered by ***suspended material*** in the sample. We have a conversion chart for transparency measurements (which assess both particles in the water and water color) to NTU which can allow scientists to roughly compare transparency results obtained with a tube to those obtained with a nephelometer *(See conversion chart at right)*. This conversion also allows you to assess potential impacts of water clarity on organisms in the stream you sampled.

To further understand how time and turbidity impact fish, look at the graph below. The graph shows that the longer time turbidity levels are elevated, the greater the impact on aquatic life. High turbidity levels affect humans too. An acceptable turbidity level for recreation is 5 NTU and an acceptable level for human consumption ranges from 1-5 NTU.

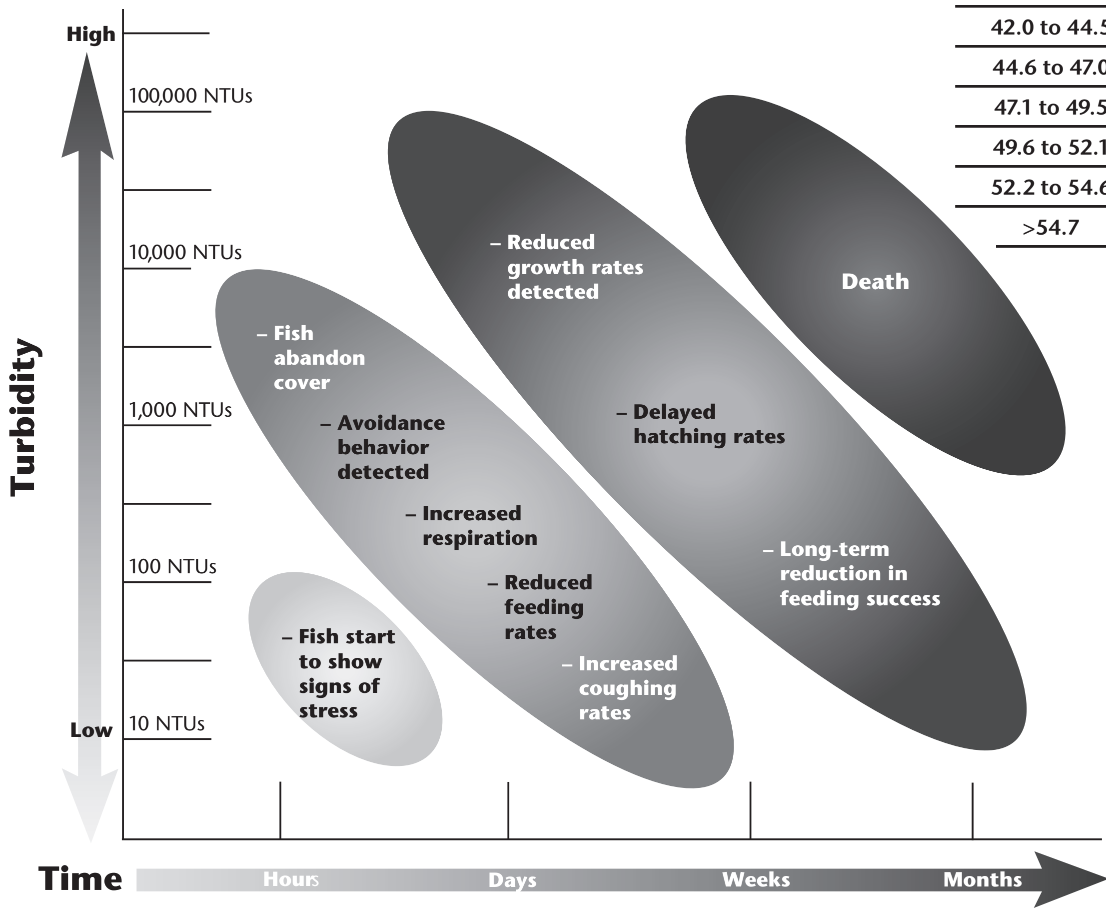
For additional information about monitoring transparency visit this website:

http://watermonitoring.uwex.edu/wav/monitoring/transparency.html

TRANSPARENCY VALUE CONVERSION CHART

Centimeters	Turbidity (NTUs)
6.4 to 7.0	240
7.1 to 8.2	185
8.3 to 9.5	150
9.6 to 10.8	120
10.9 to 12.0	100
12.1 to 14.0	90
14.1 to 16.5	65
16.6 to 19.1	50
19.2 to 21.6	40
21.7 to 24.1	35
24.2 to 26.7	30
26.8 to 29.2	27
29.3 to 31.8	24
31.9 to 34.3	21
34.4 to 36.8	19
36.9 to 39.4	17
39.5 to 41.9	15
42.0 to 44.5	14
44.6 to 47.0	13
47.1 to 49.5	12
49.6 to 52.1	11
52.2 to 54.6	10
>54.7	<10

RELATIONAL TRENDS OF FRESH WATER FISH ACTIVITY TO TURBIDITY VALUES AND TIME



1. High turbidity hinders plant _____________________ and the production of which gas? ______________________

2. List four factors that can make water more turbid:

____

____

3. Turbid waters often have a higher temperature because the suspended particles absorb _______________.

4. Turbidity is measured in what units? _______________

5. Would you more likely find more smallmouth bass or trout in waters that are very turbid? Give at least three reasons to support your hunch.

____

____

____

6. How might a large change in the turbidity of stream water over a long period of time affect aquatic organisms?

____

____

____

____

7. What might increased turbidity or lower transparency tell us about human activities within the watershed?

____

____

____

____

(CONTINUED ON NEXT PAGE)

8. When assessing transparency, you will take two measurements with the transparency tube and then calculate the average transparency (cm). Then you will convert the average transparency (cm) to turbidity (NTU). If your transparency tube readings were 106 cm and 98 cm, what is the average transparency? What turbidity does that convert to?

____

____

____

9. You will soon be assessing the transparency of a stream near your school. Do you think that your stream will be very transparent or not? Why? Note your hypothesis for your stream site and your plan of how to research that hypothesis here:

____

____

____

____

____

____

____

____

____

____

STOP HERE STOP Go on field trip!!

Back in the Classroom

Calculating Transparency Statistics

PROCEDURE:

1. Record all groups and their average transparency measurements (cm) in your student workbook (Table A).

2. For each average transparency measurement (cm), use the transparency value conversion chart (page 4-4) to determine the turbidity value in Nephelometric Turbidity Units (NTU). Record the turbidity values in your student workbook (Table A).

3. Then rewrite both lists in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.

4. Determine the ***average, median and mode*** (optional) for transparency (cm) and turbidity (NTU), and record those in your student workbook (Table C). Use 9 to represent <10 NTU.

5. Determine the ranges of your transparency (cm) and turbidity measurements (NTU) by noting the lowest and the highest measurements recorded during the field trip. Indicate these ranges in your student workbook (Table C).

6. Answer the questions on the following page and write a conclusion paragraph or two about this ***parameter.*** You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results.

TRANSPARENCY TABLE A

Group (Students' Names)	Average Transparency (cm)	Turbidity Value (NTU)

TRANSPARENCY TABLE B

Ordered List of Transparency Measurements (cm)	Ordered List of Turbidity Values (NTU)

TRANSPARENCY TABLE C

	Transparency (cm)	Turbidity (NTU)
Average		
Median		
Low		
High		
Mode		

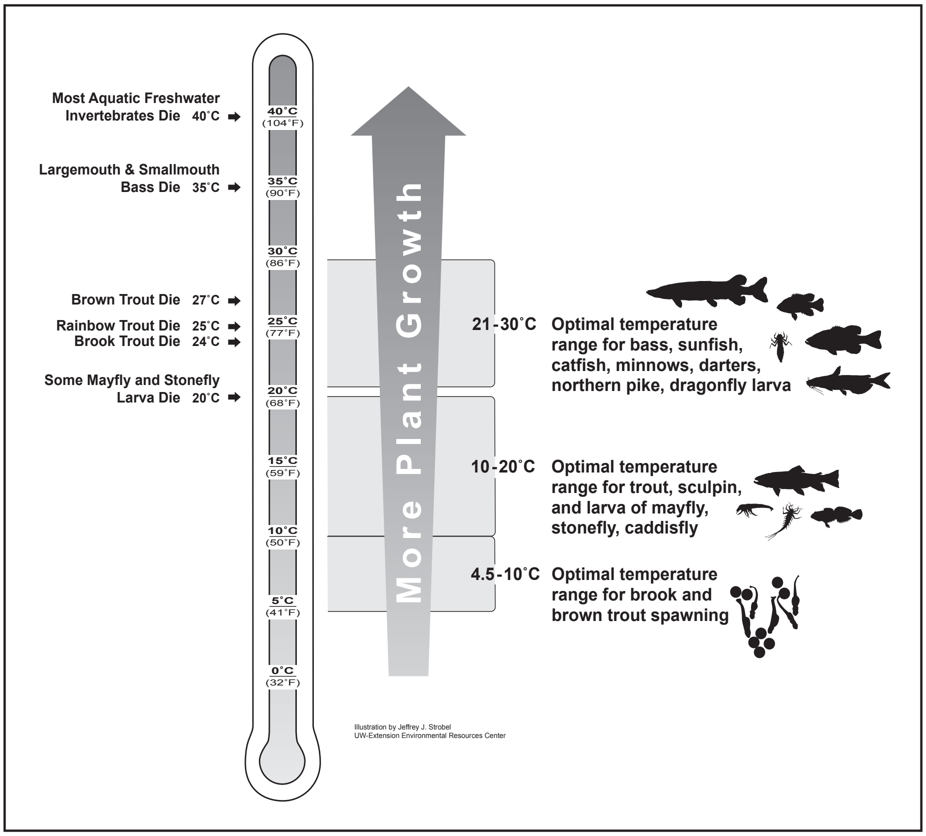
Does this stream meet the NTU requirements for human recreation? Consumption?

Conclusions:

TEMPERATURE

- *Although most aquatic life has adapted to survive within a range of water temperatures, some fish species (e.g., trout) require cooler waters. The metabolic rate of organisms, or the rate at which they convert food into energy, also increases with higher water temperatures, resulting in even greater demands on oxygen.*
- *Research also shows that extreme temperature fluctuations can make fish and insects more susceptible to disease, parasites and the harmful effects of toxic waste.*

Stable water temperature is a critical factor in maintaining the health of a stream and its inhabitants. Temperatures over 75° F (24° C) for example, are usually fatal to brook trout, which need waters in the range of 55°-65° F (12.8°-18.3° C) in order to thrive. Other fish such as the smallmouth bass can survive to 90° F (35° C) and carp can live in even warmer waters. So as temperature increases, cold water species will gradually be replaced by warm water ones.



THERMAL CRITERIA FOR COLD, COOL AND WARM WATER STREAMS IN WISCONSIN

Thermal regime	Maximum instantaneous temperature	Maximum daily mean temperature
Cold water stream	<25°C (77°F)	<22°C (72°F)
Cool water stream	25-28°C	22-24°C
Warm water stream	>28°C (82°F)	>24°C (75°F)

The table to the left shows temperature ranges for cold, cool and warm streams.

One of the most drastic ways that stream temperature is increased is by thermal pollution. Thermal pollution occurs when warm water is added to the stream. Industries such as power plants, paper mills and cheese factories may discharge heated water used in the manufacturing process into streams. Runoff, in a more indirect way, can also add warm water to streams. Rainwater running off warmed surfaces, especially parking lots, roof tops and roads, increases stream temperatures.

Mill ponds and impoundments also increase water temperature because they contain a large surface area of slow-moving water which is warmed by the sun, affecting water temperature downstream.

Removing all overhanging trees that shade and cool the stream can also negatively impact stream temperatures. Another factor contributing to higher stream temperatures is eroding soil. Turbid water that results from eroded soil heats up quickly because the suspended sediments absorb the sun's radiant heat. Sediment also makes stream channels shallow. A shallow stream warms up faster than deep waters.

Temperature changes can affect all aquatic life. For example, warm water holds less dissolved oxygen than cold water and triggers higher plant growth and respiration rates. The lowered oxygen levels of warmer waters are further reduced when plants and animals die and decay.

For additional information about water temperature, visit this website:
http://watermonitoring.uwex.edu/wav/monitoring/temp.html

1. Warm water holds less _________ than cold water.

2. Increased temperatures trigger _______ plant growth and ______ rates.

3. ____________ decisions and stream _____________ are often closely tied to water temperatures.

4. The water temperature of Stream X measured 27° C. What type of fish might you expect to find living here? What factors may be impacting the temperature of this stream? Explain.

____

____

____

5. If you were a developer in a local community, what are some things you might do to minimize changes in stream water temperature?

____

____

____

(CONTINUED ON NEXT PAGE)

6. What impacts would drastic fluctuations in water temperature have on life in the stream?

7. You will soon be measuring water temperature at a stream near your school. What water temperature do you expect to find? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

STOP HERE STOP Go on field trip!!

Back in the Classroom

Calculating Temperature Statistics

PROCEDURE:

1. Record all groups and their measured air and water temperatures (°C) in your student workbook (Table A).
2. Then rewrite the lists in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.
3. Determine the average, median and mode (optional) for water and air temperatures and record those in your student workbook (Table C).
4. Determine the range of water and air temperatures by noting the lowest and the highest water and air temperatures recorded during the field trip. Indicate these ranges in your student workbook (Table C).
5. Use the conversion chart on page 4-15 to convert the average, median, mode (if determined) and low and high water and air temperatures to °F. Record this information in your student workbook (Table C).
6. Write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results.

TEMPERATURE TABLE A

Group (Students' Names)	Water Temperature (˚C)	Air Temperature (˚C)

TEMPERATURE TABLE B

Ordered List of Water Temperatures (˚C)	Ordered List of Air Temperatures (˚C)

TEMPERATURE CONVERSION CHART

˚F	˚C
33	.6
34	1.1
35	1.7
36	2.2
37	2.8
38	3.3
39	3.9
40	4.4
41	5
42	5.6
43	6.1
44	6.7
45	7.2
46	7.8
47	8.3
48	8.9
49	9.4
50	10
51	10.6
52	11.1
53	11.7
54	12.2
55	12.8
56	13.3
57	13.9
58	14.4
59	15
60	15.6
61	16.1
62	16.7
63	17.2
64	17.8
65	18.3
66	18.9
67	19.4
68	20
69	20.6
70	21.2
71	21.7
72	22.2
73	22.8
74	23.3
75	23.9
76	24.4
77	25
78	25.6
79	26.1
80	26.7
81	27.2
82	27.8
83	28.3
84	28.9
85	29.4
86	30
87	30.6
88	31.1

TEMPERATURE TABLE C

	Water Temperature (˚C)	Water Temperature (˚F)	Air Temperature (˚C)	Air Temperature (˚F)
Average				
Median				
Low				
High				
Mode				

Conclusions:

____

____

____

____

____

____

____

____

____

____

____

____

____

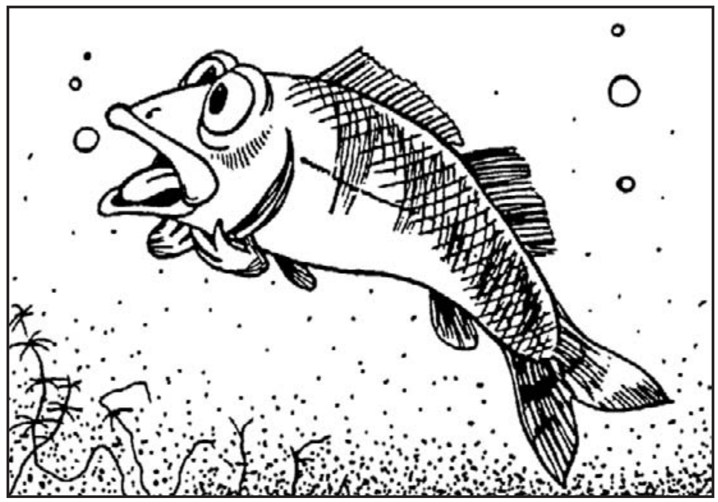
____

____

DISSOLVED OXYGEN

- *All plants and animals require oxygen for survival.*
- *Dissolved oxygen levels in streams fluctuate over the course of 24 hours.*
- *Cold water can hold more dissolved oxygen than warmer water.*

Oxygen is a clear, colorless, odorless and tasteless gas that dissolves in water. Small but important amounts of it are dissolved in water. It is supplied by ***diffusion*** of atmospheric (air) oxygen into the water and by production of oxygen from photosynthesis by aquatic plants. Wind, waves and tumbling water in fast-moving streams increase the rate of diffusion.



Both plants and animals depend on dissolved oxygen for survival. Lack of dissolved oxygen can cause aquatic animals (e.g., fish, macroinvertebrates) to quickly leave the area or face death. Under low oxygen conditions, the aquatic animal community changes quickly. Under extreme conditions, lack of oxygen can kill aquatic plants and animals. Measuring dissolved oxygen is probably the most significant water quality test to determine the suitability of a stream for fish and many other aquatic organisms. However, these measures only provide a snapshot of the oxygen levels at that particular time. Levels can fluctuate widely throughout the day and year. Fish and other organisms have to live and breathe in that water all year long. A short time without oxygen can be fatal.

Dissolved oxygen (D.O.) is reported as milligrams of oxygen per liter of water (mg/L) which can also be called parts per million (ppm) by weight. Different aquatic organisms have different oxygen needs. Trout and stoneflies, for example, require high dissolved oxygen levels. Trout need water with at least 6 mg/L D.O. Warm water fish like bass and bluegills survive nicely at 5 mg/L D.O. and some organisms such as carp and bloodworms can survive in streams with less than 1 mg/L of D.O. Based on this, there are stream classifications in Wisconsin that define the minimum amount of oxygen that must be maintained in a stream with a given classification (see charts on the next page).

The oxygen demand of aquatic plants and ***cold-blooded*** animals also varies with water temperature. A trout uses five times more oxygen while resting at 80° F (26.7° C) than at 40° F (4.4° C).

There are many factors that affect the amount of dissolved oxygen in the water (see chart below). A major one is photosynthesis. Aquatic plants produce oxygen by photosynthesis during daylight hours, but they also use oxygen for respiration. High day-time levels of D.O. are often countered with low night-time levels (see a sample diel cycle for dissolved oxygen on the next page). This is due to respiration of living organisms, including fish, bacteria, fungi and protozoans, as well as the cessation of photosynthesis. Wide daily fluctuations of D.O. stress fish and other aquatic animals. Oxygen depletion can occur because of heavy plant growth. Complete depletion of D.O. can sometimes be detected with your nose. Anaerobic decay results in a rotten egg smell (hydrogen sulfide gas).

MINIMUM DISSOLVED OXYGEN LEVELS ALLOWED FOR WATERS WITH VARIED CLASSIFICATIONS IN WISCONSIN

Stream Classification	Minimum Dissolved Oxygen Allowed
Trout waters	6 mg/l (out of spawning season) and 7 mg/L (during spring/fall spawning season)
Fish or aquatic life-designated waters	5 mg/L
Limited forage fish waters	3 mg/L
Limited aquatic life waters	1 mg/L

DISSOLVED OXYGEN REQUIREMENTS OF AQUATIC PLANTS AND ANIMALS

Very High D.O.	Moderately High D.O.	Low D.O.
ANIMALS		
Brook or rainbow trout	Brown trout	Carp
Mottled sculpin	Redbelly dace	Green sunfish
	Bass	Fathead minnow
PLANTS		
Much plant variety	Moderate plant variety	Little plant variety

Source: Dane County Water Watchers

Factors That Could **Increase** The Amount of Dissolved Oxygen in Water	Factors That Could **Decrease** The Amount of Dissolved Oxygen in Water
• High atmospheric pressure • Clear water • Photosynthesis • Much turbulence/wave action • Cold water • Presence of excessive amounts of plants (during daytime)	• Respiration of animals and plants living in the water • Chemical reactions of the decaying process • Low atmospheric pressure • High levels of turbidity (such as from erosion) • Warm water • Presence of excessive amounts of plants (during nighttime) • Excessive organic materials (such as sewage, manure or fertilizers)

However, oxygen levels can be improved with good management practices such as planting or maintaining vegetation that filters rainwater runoff and shades the water, and protecting the stream channel in other ways to maintain or increase turbulence.

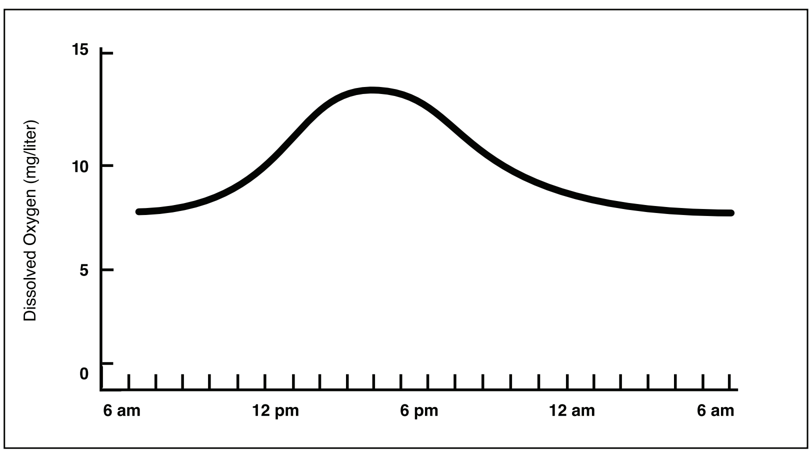
Recording dissolved oxygen differs from other tests in that it requires two distinct calculations. We are interested in both the absolute amount of D.O. and how close the value is to the equilibrium value for that temperature and air pressure (known as the percentage of saturation). Values between 91% and 110% of saturation are excellent. ***Supersaturated*** (over 100%) values may sound good but they can also indicate problems, such as excessive plant growth.

You can assess the range of dissolved oxygen levels that aquatic plants and animals at your stream site must withstand by monitoring twice in one day – early in the morning just before sunrise, and later in the afternoon when plants have been exposed to the most direct sunlight for an extended period.

For additional information about monitoring dissolved oxygen visit this website:

http://watermonitoring.uwex.edu/wav/monitoring/oxygen.html

SAMPLE DIEL FLUCTUATION OF DISSOLVED OXYGEN IN A STREAM



Dissolved Oxygen Levels (% Saturation)
Excellent: 91-110
Good: 71-90
Fair: 51-70

SOURCE: Field Manual for Water Quality Monitoring (13th Edition)

1. How does oxygen get into the water?

____

____

____

____

____

2. What factors affect the levels of dissolved oxygen in the water?

____

____

____

3. When is oxygen consumed in streams?

____

____

____

4. What is the problem with wide fluctuations in dissolved oxygen?

____

____

____

____

____

5. The dissolved oxygen level of the water in Stream Z was recently tested. It was found to have a dissolved oxygen level of 4 ppm. Is this considered low or high?

____

(CONTINUED ON NEXT PAGE)

6. Which organisms might you expect to find thriving in Stream Z?

____

____

____

7. Based on this dissolved oxygen level (of 4 ppm), what might you expect to be true about the transparency and temperature of the stream?

____

____

____

8. Explain why dissolved oxygen levels may be higher in the day and lower at night. What other variables can cause changes in the dissolved oxygen levels?

____

____

____

____

____

____

9. You will soon be testing the dissolved oxygen content of a stream near your school. Make a hypothesis. Do you think that your stream will have high or low levels of dissolved oxygen? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

____

____

____

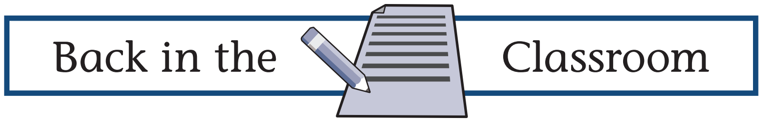
____

____

____

____

STOP HERE **STOP** Go on field trip!!

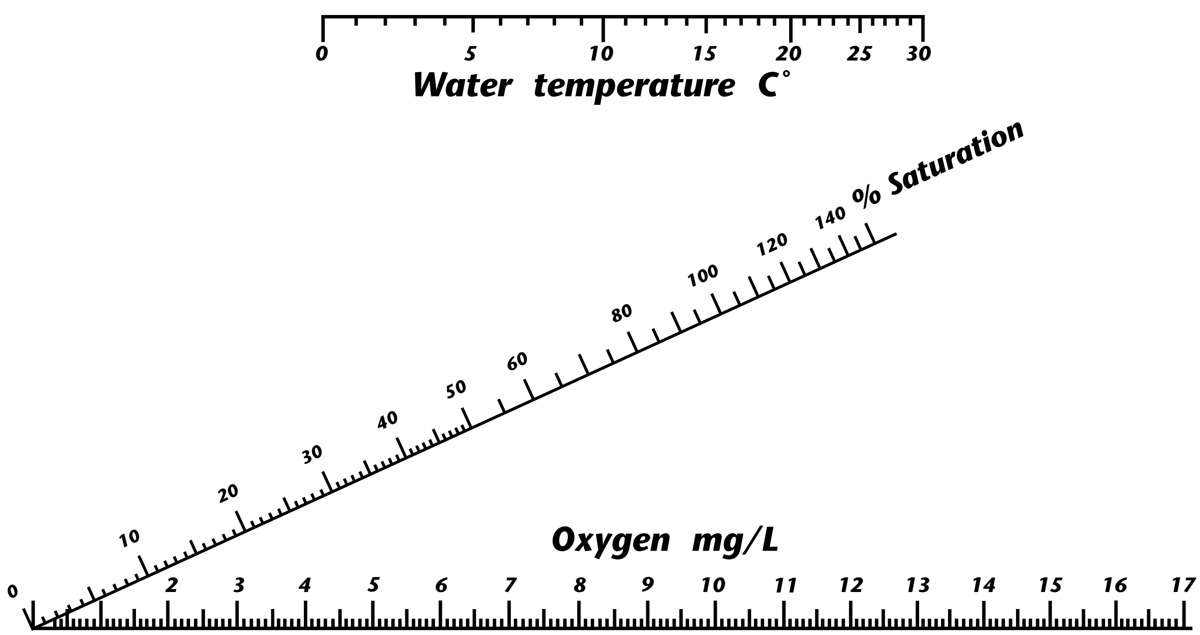


Calculating Dissolved Oxygen Statistics

1. Record all groups and their dissolved oxygen measurements (mg/L) and water temperature (°C) measurements in your student workbook (Table A).

2. Determine dissolved oxygen percent saturation for each pair of dissolved oxygen and water temperature measurements using the Level of Oxygen Saturation Chart and following directions in step 3.

LEVEL OF OXYGEN SATURATION CHART



3. Using a straight edge, find the water temperature and align that with the oxygen mg/L scale for the oxygen measurement for that water temperature. The percentage of saturation is found on the line inbetween the temperature and oxygen lines. For example, 5°C with 10 mg/L of oxygen aligns with 75% saturation.

4. Record each dissolved oxygen percent saturation measurement in your student workbook (Table A).

5. Then rewrite the lists of dissolved oxygen in mg/L and percent saturation in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.

(CONTINUED ON NEXT PAGE)

6. Determine the average, median and mode (optional) for dissolved oxygen in mg/L and in % saturation and record these in your student workbook (Table C).
7. Determine the range of dissolved oxygen measurements in mg/L and in % saturation by noting the lowest and the highest measurements recorded during the field trip. Indicate these ranges in your student workbook (Table C).
8. Write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Describe results in terms of both mg/L and percent saturation. Also address any sources of error that may have influenced your results.

DISSOLVED OXYGEN TABLE A

Group (Students' Names)	Dissolved Oxygen (mg/L)	Air Temperature (˚C)	Dissolved Oxygen (% saturation)

DISSOLVED OXYGEN TABLE B

Ordered List of Dissolved Oxygen Measurements (mg/L)	Ordered List of Dissolved Oxygen Measurements (% saturation)

DISSOLVED OXYGEN TABLE C

	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)
Average		
Median		
Low		
High		
Mode		

Conclusions:

____

____

____

____

____

____

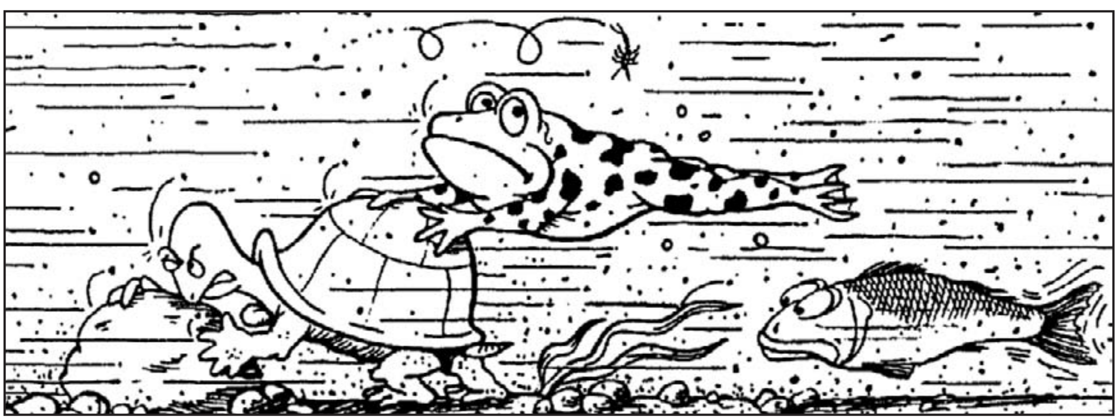
____

____

STREAM FLOW

- *Stream flow is a measure of the volume of water moving past a point during a span of time.*
- *Stream flow is affected by runoff of rain or snowmelt to the stream from the surrounding* ***watershed,*** *and also by groundwater inputs.*

Stream flow, or ***discharge,*** is the volume of water moving past a cross-section of a stream over a set period of time. It is usually measured in cubic feet per second (cfs). Stream flow is affected by the amount of water within a watershed – increasing with rainstorms or snowmelt, and decreasing during dry periods. Flow is also important because it defines the shape, size and course of the stream. It is integral not only to water quality, but also to habitat. Food sources, spawning areas and migration paths of fish and other wildlife are all affected and defined by stream flow and velocity. Velocity and flow together determine the kinds of organisms that can live in a stream (some need fast-flowing areas; others need quiet, low-velocity pools). Different kinds of vegetation require different flows and velocities as well.

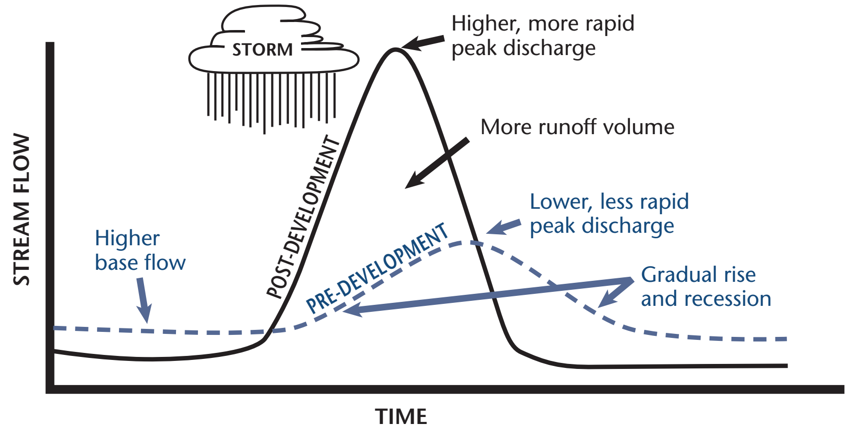


Stream flow is affected by both forces of nature and by humans. In undeveloped watersheds, soil type, vegetation and slope all play a role in how fast and how much water reaches a stream. In watersheds with high human impacts, water flow might be depleted by withdrawals for irrigation, domestic or industrial purposes. Dams used for electric power generation may affect flow, particularly during periods of peak need when stream flow is held back and later released in a surge. Drastically altering landscapes in a watershed, such as with development, can also change ***flow regimes.*** For instance, increasing areas of ***impervious surface*** causes faster runoff during storm events and higher peak flows. These altered flows can negatively affect an entire ecosystem by upsetting habitats and organisms dependent on natural flow rates.

Tracking stream flow measurements over a period of time can give us baseline information about the stream's natural flow rate.

For more information about stream flow, visit this website:

http://watermonitoring.uwex.edu/wav/monitoring/flow.html



A hydrograph is a graph that shows stream flow over time. This hydrograph shows how stream flow changes as a watershed goes from a natural land cover (pre-development) to an urbanized land cover (post-development).

1. What is stream flow?

____

2. What units are used to measure stream flow? ___________________

3. Name at least three ways that humans can alter stream flow:

____

____

4. Name at least four ways that changes in stream flow can affect fish:

____

____

5. Why would a stream in the forest have lower peak flows following a rain storm than a stream of the same size in a city?

____

____

6. You will soon be measuring stream flow at a stream near your school. What flow do you expect to find? Why? Note your hypothesis for your stream site here:

____

____

____

STOP HERE STOP Go on field trip!!

Back in the Classroom

Calculating Stream Flow Statistics

PROCEDURE:

1. Obtain your original stream flow data sheet from your teacher.
2. Transfer your data onto the data sheet below.
3. Determine stream flow in cubic feet per second using the data you collected by following instructions in the data sheet below, or steps 4 to 9.

(CONTINUED ON NEXT PAGE)

Depth Conversion Chart

Inches	Tenths of ft.
⅜-⅞	0.05
1-1½	0.1
1⅝-2	0.15
2⅛-2⅝	0.2
2¾-3¼	0.25
3⅜-3⅞	0.3
4-4⅜	0.35
4½-5	0.4
5⅛-5⅝	0.45
5¾-6¼	0.5
6⅜-6⅞	0.55
7-7⅜	0.6
7½-8	0.65
8⅛-8⅝	0.7
8¾-9¼	0.75
9⅜-9⅞	0.8
10-10⅜	0.85
10½-11	0.9
11⅛-11⅝	0.95
11¾-12	1.0

1. SITE LOCATION

Length Assessed: ______ ft.

2. STREAM WIDTH & DEPTH

If stream ≤ 20 ft. wide, measure depth every foot across the width. If stream > 20 ft. wide, measure depth at 20 equal intervals across the entire width.

Stream Width: ______ ft.

Interval	Depth (ft./in.)	Depth (10ths ft.)	Interval	Depth (ft./in.)	Depth (10ths ft.)
1	0	0	11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		
		______ ft. (sum)	←Add together→		______ ft. (sum)

______ ft. (sum of depths) ÷ ______ (# of intervals) = ______ ft. Average Depth

Compute Average Cross-Sectional Area:

______ ft. (average depth) x ______ (width) = ______ ft.² Cross-Sectional Area

3. VELOCITY MEASUREMENT

Float Trials	Time (seconds)
1	
2	
3	
4	

______ (sum) ÷ ______ (# of trials) = ______ sec. Average Float Time

______ ft. (length assessed) ÷ ______ sec. (average float time) = ______ ft./sec. Average Surface Velocity

4. CALCULATING STREAM FLOW

Correction value for rough, loose, coarse, weedy bottom.......... 0.8

Correction value for smooth bottom.......... 0.9

______ (correction value) x ______ ft./sec. (average surface velocity) = ______ ft./sec. Corrected Surface Velocity

______ ft.² (cross-sectional area) x ______ ft./sec. (corrected surface velocity) = **STREAM FLOW:** ______ cubic feet per sec. (round to nearest tenth)

4. If you measured depth in inches, use the conversion chart to determine each depth in tenths of feet, or simply divide each depth by 12 to convert to tenths of feet.

5. Determine the average depth at your monitoring site and record this in the appropriate location on your data sheet.

6. Next, multiply your average depth by the stream width. This is the cross-sectional area (ft^2) of the stream. Record this in the appropriate box on your data sheet.

7. Determine the average float time (seconds) and record it on your data sheet.

8. Divide the length of your stream segment (i.e., 20 feet) by the average float time (seconds) to determine the average surface velocity at the site. Record the average surface velocity (ft/sec) on your data sheet.

9. Determine the correction factor below that best describes the bottom of your stream and multiply it by the average surface velocity measurement to account for the effects of friction with the stream bottom on water velocity. Record your corrected average surface velocity on your data sheet.

    a) Correction factor for rough, loose rocks, coarse gravel or weeds: 0.8

    b) Correction factor for smooth mud, sand or bedrock: 0.9

10. Multiply the average cross-sectional area ($ft.^2$) by the corrected average surface velocity (ft/sec) to determine stream flow. Record stream flow ($ft.^3$/sec or cfs) in the space provided on your data sheet.

11. Report this result to your teacher so other students in the class can obtain this information.

12. Once you have a complete list of stream flow measurements in cfs from everyone in your class, record these measurements in your student workbook (Table A). Then rewrite them in order from lowest to highest in Table B. Using a spreadsheet such as Excel may be helpful.

13. Determine the average, median and mode (optional) for stream flow for all samples collected and record these in your student workbook.

14. Determine the range of stream flow measurements by noting the lowest and the highest measurements recorded during the field trip and indicate this information in your student workbook.

15. Write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results.

STREAM FLOW TABLE A

Group (Students' Names)	Stream Flow (cfs)

STREAM FLOW TABLE B

Ordered List of Stream Flows (cfs)

STREAM FLOW TABLE C

	Stream Flow (cfs)
Average	
Median	
Low	
High	
Mode	

Consider factors that would influence stream flow. Were there any notable events that would make you believe that this stream flow measurement is higher or lower than the average for this stream? (For example: recent rain or drought, recent snow melt, dam release, etc.):

____

____

____

____

____

____

Conclusions:

____

____

____

____

____

____

____

____

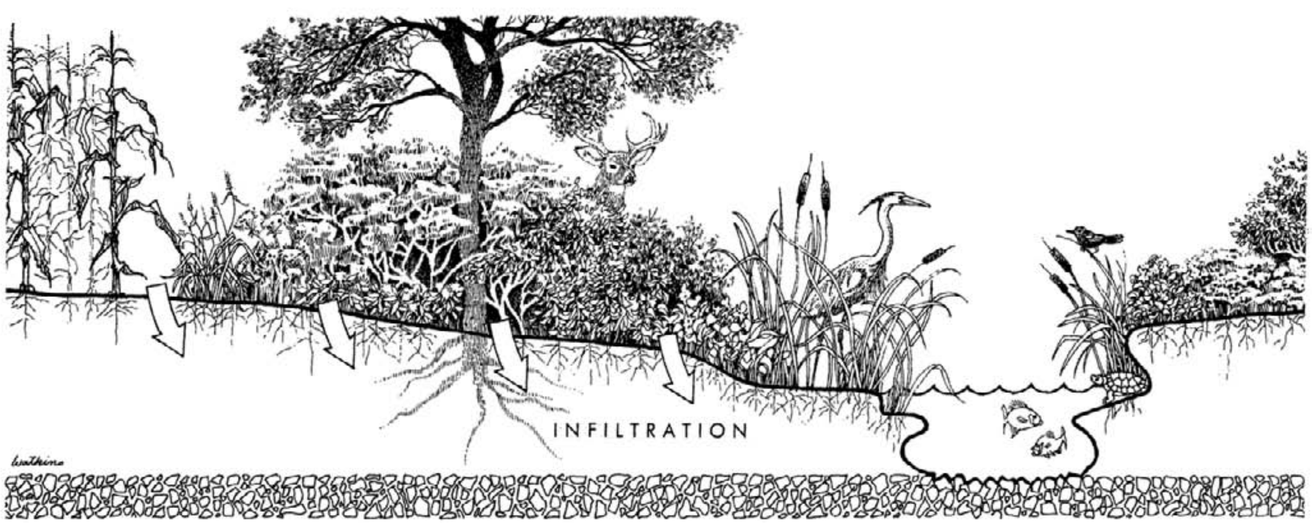
HABITAT ASSESSMENT

- *The habitat functions holistically, so any changes to a part may affect the entire habitat.*
- *Certain land uses affect habitat quality and stream health.*
- *The Habitat Checklist uses visual measurements of land and water conditions to help pinpoint land uses affecting water quality.*

A healthy stream is a busy place. Wildlife find shelter and food near and in its waters. Vegetation grows along its banks, shading the stream and filtering pollutants before they enter the stream. Within the stream are fish, insects and other tiny creatures with specific needs: dissolved oxygen to breathe; rocks, overhanging tree limbs, logs and roots for shelter; vegetation and other tiny animals to eat; and special places to breed and hatch their young. For any of these activities, organisms might also need water of specific velocity, depth and temperature. Many land-use activities can alter these characteristics, causing problems within the entire habitat. The Habitat Assessment is an easy-to-use approach for identifying and assessing the elements of a stream's habitat. This assessment is useful as: 1) a screening tool to identify habitat stressors and 2) a method for learning about stream ecosystems and environmental stewardship.

A stream with a healthy riparian zone.

Taking stock of the habitat's characteristics may begin at the ***riparian zone*** where land is making a transition into water. Within healthy stream corridors, this area generally has certain



This healthy vegetated buffer in the riparian zone allows runoff water to infiltrate into the ground instead of rushing into the stream unfiltered. Note the vegetated undercut bank on the right, which provides animal habitat and is resistant to erosion.

kinds of vegetation that act as a buffer between land and water, soaking up many pollutants carried in runoff. Moving on, the stream assessment will then focus on the condition of the upper and lower banks and finally the stream channel and stream itself. In order to help prepare you to fill out the Habitat Checklist, certain stream and river characteristics and concepts are defined in the following text.

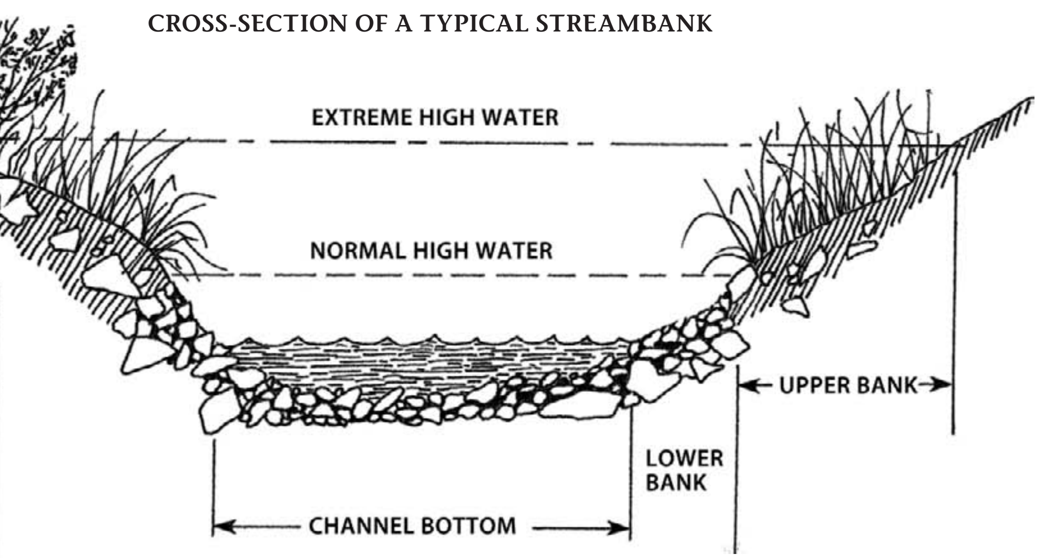
RIPARIAN ZONE

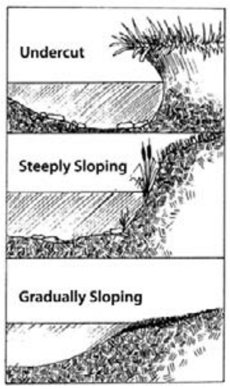
The healthy riparian zone is characterized by trees, bushes, shrubs and tall grasses that help to buffer the stream from polluted runoff and create habitat for fish and wildlife. These plants also provide stream shading (or overhead canopy) and serve several important functions in the stream habitat. The canopy helps keep water temperatures cool by shading the water from the sun, while offering protection and refuge for animals.

Certain conditions in the riparian zone can negatively affect the stream's habitat. Lawns maintained to the water's edge are abrupt transitions from land to water, offering very little or no buffering protection for the stream. In these cases, lawn care products and grass clippings could be entering the stream. Short-grassed streambanks also provide poor habitat for animals. Bare soil and pavement provide no buffering action from runoff.

Features to note in riparian zones:

- Evergreen trees (conifers) – cone-bearing trees that do not lose their leaves in winter.
- Hardwood trees (deciduous) – in general, trees that shed their leaves at the end of the growing season.
- Bushes – short conifers or deciduous shrubs less than 15 feet high.
- Tall grass, ferns, etc. – includes tall, natural grasses, ferns, vines and mosses.
- Lawn – cultivated and maintained short grass.
- Boulders – rocks larger than 10 inches.
- Gravel/cobbles/sand – rocks smaller than 10 inches in diameter; sand.
- Bare soil
- Pavement or structures – any structures or paved areas, including paths, roads, bridges, houses, etc.
- Garbage or junk adjacent to the stream – note the presence of litter, tires, appliances, car bodies or other large objects.





STREAM BANKS CHARACTERISTICS

The streambank consists of the ***upper bank*** and ***lower bank***. The shape and condition of the streambank can give many clues to the types of land uses in the adjacent watershed. For example, sometimes the channel may be altered by too much water flooding the stream in a short time. This may indicate a nearby urban area with many impervious surfaces, so the rain or melting snow cannot naturally soak into the ground. Large volumes of runoff then flood the nearest stream with too much water, which erodes and distorts the stream channel. Sometimes it is obvious that the banks have been eroded by excessive water because the normal flow does not reach the new shoreline which has been pushed back.

A **vertical** or **undercut bank** rises vertically (at an approximate 90-degree angle) or overhangs the stream. This type of bank generally provides good cover for aquatic invertebrates (small animals without backbones) and fish, and is resistant to erosion. This bank usually has a good vegetative cover that helps to stabilize the bank. If seriously undercut, however, the bank could collapse.

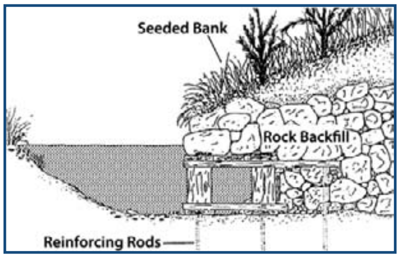

A stream with a gradually sloping bank.

A **steeply sloping bank** (right) slopes at more than a 45-degree angle. This type of bank is very vulnerable to erosion.

A **gradually sloping bank** (left) has a slope of about 30 degrees or less. Although this type of streambank is highly resistant to erosion, it does not provide much streamside cover.


A steeply sloping bank with severe erosion.

Artificial bank modifications include ditching and other changes such as concrete embankments and gabions to stem further erosion due to the action of the water. Also included are LUNKER structures which are wooden underwater habitats set into the bank and designed for trout and other game fish. Rock rip rap placed at bends and other areas subject to erosion serve to improve fish habitat and stabilize stream meanders.



LUNKER structure.

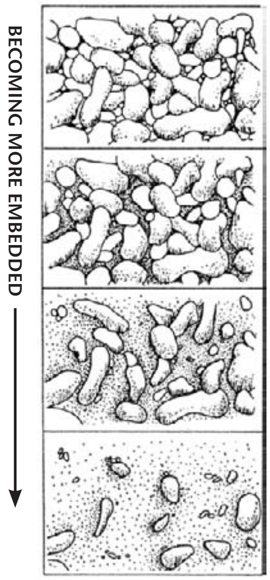
A stream with a fortified concrete embankment.

Poor streambank conditions can include the loss of natural plant cover. Erosion can occur when streamside vegetation is trampled or missing or has been replaced by poorly designed landscaping or pavement. More severe cases of streambank erosion include washed away banks or banks that have collapsed. Excessive mud or silt entering the stream from erosion can distort the stream channel, and interfere with beneficial plant growth, dissolved oxygen levels and the ability of fish to sight prey. It can also irritate fish gills and smother fish eggs in spawning areas. Often it is the result of eroding streambanks, poor construction site practices, urban area runoff, silviculture (forestry practices) or ditches that drain the surrounding landscape.

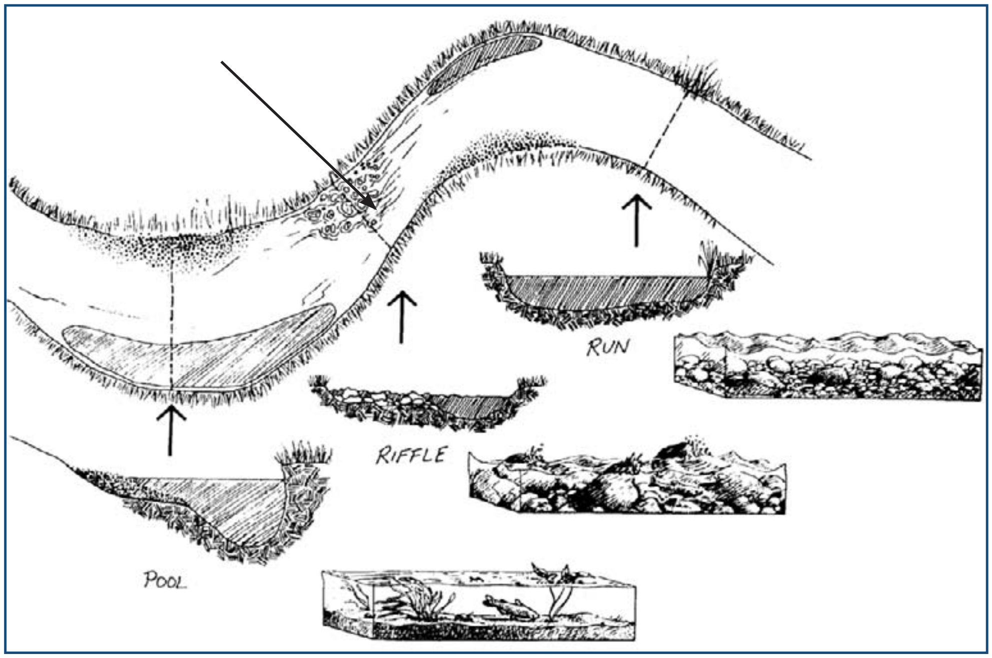
A rocky-bottom stream with lots of riffles and fast, turbulent shallow water.

IN-STREAM CHARACTERISTICS

Stream bottoms (substrate) are classified according to the material that they are made of. Rocky-bottom streams are defined as those made up of gravel, cobbles and boulders in any combination. They usually have definite ***riffle*** areas. Soft-bottom streams have naturally muddy, silty or sandy bottoms that lack riffles. Usually, these are slow-moving, low-gradient streams (i.e., streams that flow along flat terrain). A different questionaire for each type of stream bottom has been designed for you to use.



A rocky-bottom stream becomes embedded with sand. As sand settles on the streambed, spaces between the rocks fill up.



A stream with a mixture of pools, riffles and runs. Varying flows and depths create a variety of habitats for macroinvertebrates.

Substrate types include:

Silt/clay/mud – This substrate has a sticky feeling. The particles are fine. The spaces between the particles hold a lot of water, making the sediments feel like ooze.

Sand (up to 0.1 inch) – A sandy bottom is made up of tiny, gritty particles of rock that are smaller than gravel but coarser than silt (gritty, particles are smaller than a grain of rice).

Gravel (0.1-2 inches) – A gravel bottom is made up of stones ranging from tiny quarter-inch pebbles to rocks of about 2 inches (fine gravel is rice size to marble size; coarse gravel is marble to ping pong ball size).

Cobbles (2-10 inches) – Most rocks on this type of stream bottom are between 2 and 10 inches (between a ping pong ball and a basketball in size).

Boulders (greater than 10 inches) – Most of the rocks on the bottom are greater than 10 inches (between a basketball and a car in size).

Bedrock – This kind of stream bottom is solid rock (or rocks bigger than a car).

Embeddedness is the extent to which rocks (i.e., gravel, cobbles and boulders) are buried by silt, sand or mud on the stream bottom. Generally, the more embedded the rocks, the less rock surface or space between rocks there is available for ***aquatic macroinvertebrate*** habitat and for fish spawning. Excessive silty runoff from erosion can increase a stream's embeddedness. To calculate embeddedness, estimate the amount of silt or finer sediments overlying, inbetween, and surrounding the rocks (see diagram on previous page).

Presence of logs or woody debris in streams can provide important fish habitat. Be sure to differentiate between logs or woody debris and naturally occurring or moderate amounts of organic material in streams, which includes leaves and twigs.

WATER CHARACTERISTICS

Streams are made up of ***pools, riffles and runs.*** A mixture of flows and depths creates a variety of habitats to support fish and invertebrate life.

- Riffles are shallow with fast turbulent water running over rocks.
- Runs are deeper with fast-moving water with little or no turbulence.
- Pools are deep with slow water.

Stream velocity influences the health, variety and abundance of aquatic animals. If water flows too quickly, some organisms might be unable to maintain their hold on rocks and vegetation, and they may be flushed downstream. If water flows too slowly, oxygen ***diffusion*** might be insufficient for species needing high levels of dissolved oxygen. Dams, channelization or straightening out the stream's natural bends (sinuosity), certain kinds of terrain, runoff and other factors can also affect stream velocity.

Rooted aquatic plants provide food and cover for aquatic organisms. They can also indicate water quality problems. Sometimes, excess nutrients may flush into the stream and stimulate unnatural aquatic plant growth. To decide if there are too many plants, compare the amount of plants in your stream to other streams in the area with varied land uses in their watersheds.

Algae are simple plants that do not grow true roots, stems or leaves, and that mainly live in water, providing food for animals low on the food chain. Algae may be green or brown, grow on rocks, twigs or other submerged materials, or float in the water. Excessive algal growth may indicate excessive nutrients (e.g., organic matter or a pollutant such as fertilizer) in the stream.

What do Habitat Assessments Mean? Each stream will have a unique habitat assessment value ranging between 13 (worst) and 52 (best). This value is an important baseline measure for future comparisons. By comparing specific habitat parameter scores (between years at one site or between sites in small watersheds) the connection between land use and aquatic habitat may be better understood.

For more information about habitat, visit this website:

http://watermonitoring.uwex.edu/wav/monitoring/habitat.html

1. Why do you think it is important to include a quantitative habitat assessment when evaluating the health of a stream?

2. Why is it important for a stream to have a healthy riparian zone?

3. What types of habitat would support a more diverse fish and aquatic insect population?

4. You will soon be assessing habitat at a stream near your school. What habitat score do you expect to find? Why? (A total score of between 13 and 52 is possible, the higher the score, the healthier the stream.) Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

STOP HERE STOP Go on field trip!!

Back in the Classroom

Calculating Habitat Statistics

PROCEDURE:

1. Record all groups and their total habitat scores in your student workbook (Table A).
2. Then rewrite the list in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.
3. Determine the average, median and mode (optional) for the habitat scores and record these in your student workbook (Table C).
4. Determine the range of habitat scores by noting the lowest and the highest measurements recorded during the field trip and indicate this in your student workbook (Table C).
5. Write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode, and type of bottom substrate (i.e., rocky or soft)) and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results. Tip: You can use the individual questions' scores on the Station Leader data sheet to assist with your assessment of habitat at the site.

HABITAT TABLE A

Group (Students' Names)	Habitat Score

HABITAT TABLE B

Ordered List of Habitat Scores

HABITAT TABLE C

	Habitat Score
Average	
Median	
Low	
High	
Mode	

What evidence of human impact on this environment did you observe?

____

____

____

____

____

____

Conclusions:

____

____

____

____

____

____

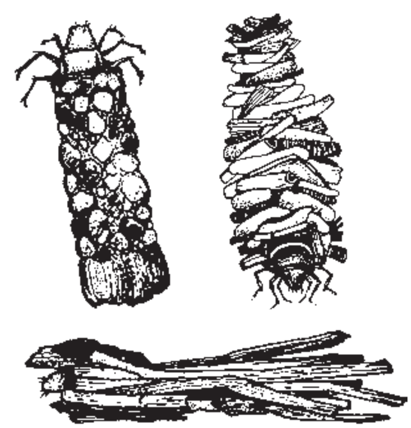
____

____

BIOTIC INDEX

- *Aquatic macroinvertebrates are small animals without backbones. Their presence or absence can reflect a stream's general condition.*
- *Certain macroinvertebrates respond differently to the physical, chemical and biological conditions within a stream.*
- *Aquatic macroinvertebrates are relatively immobile, so they can't escape either short-term or long-term pollution exposure. This is important when assessing long-term pollution events within the stream.*

From the crayfish burrowing in the streambed to the tiny aquatic insects skirting the water's surface, streams and rivers swarm with life. The inhabitants of this living place are affected by poor water quality just like humans are affected by an unhealthy environment. However, scientists have found that not all aquatic organisms react the same to poor water quality. Some species are pollutant-tolerant while some are very pollutant-sensitive. From this knowledge, a scale was developed to determine water quality based on the types of life found in the water.

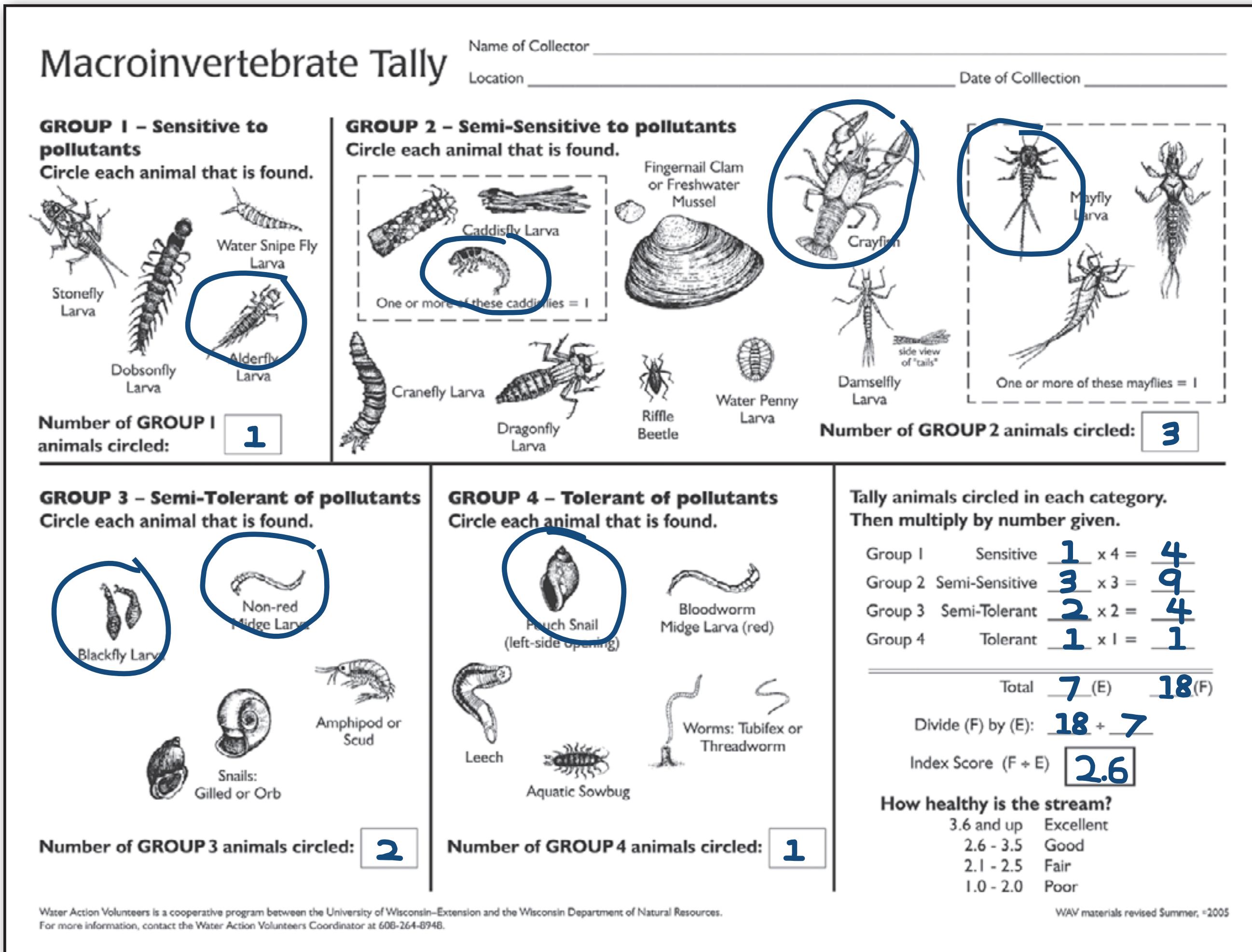


Caddisfly larva inside cases they make from pebbles, sticks and other stream materials.

For example, streams with primarily pollutant-tolerant organisms generally have poorer water quality than those streams with many pollutant-sensitive animals. This is because streams that become more polluted gradually lose pollutant-sensitive animals until only the pollutant-tolerant species are left. A healthy stream will have many different organisms, both pollutant-tolerant and those sensitive to pollution.

Although relatively accurate in assessing stream conditions, the ***Citizen Monitoring Biotic Index*** does have its limitations. The biotic index can indicate a problem, but it cannot specify what that problem might be. For example, manure, sewage, fertilizers, sediment and organic materials all negatively impact water quality. In order to pinpoint these possible pollutant sources, other monitoring such as the habitat assessment, dissolved oxygen and temperature needs to be conducted. The biotic index is useful for identifying long-term pollution problems, since these organisms carry out a portion or all of their life cycle in streams. Most of the other parameters you will monitor (except habitat) only indicate the water quality conditions at the time of testing.

To determine a biotic index score, you will collect organisms, identify them, and rate them based on their tolerance to pollution, using a chart like the one below. The most tolerant organisms will get a score of 1; the least tolerant get a score of 4. Review the example below to see how a biotic index score is determined:



Macroinvertebrate Tally

Name of Collector ______

Location ______ Date of Colllection ______

GROUP 1 – Sensitive to pollutants
Circle each animal that is found.

Stonefly Larva, Dobsonfly Larva, Water Snipe Fly Larva, Alderfly Larva

Number of GROUP 1 animals circled: 1

GROUP 2 – Semi-Sensitive to pollutants
Circle each animal that is found.

Caddisfly Larva (One or more of these caddisflies = 1), Fingernail Clam or Freshwater Mussel, Crayfish, Mayfly Larva (One or more of these mayflies = 1), Cranefly Larva, Dragonfly Larva, Riffle Beetle, Water Penny Larva, Damselfly Larva (side view of "tails")

Number of GROUP 2 animals circled: 3

GROUP 3 – Semi-Tolerant of pollutants
Circle each animal that is found.

Blackfly Larva, Non-red Midge Larva, Amphipod or Scud, Snails: Gilled or Orb

Number of GROUP 3 animals circled: 2

GROUP 4 – Tolerant of pollutants
Circle each animal that is found.

Pouch Snail (left-side opening), Bloodworm Midge Larva (red), Leech, Aquatic Sowbug, Worms: Tubifex or Threadworm

Number of GROUP 4 animals circled: 1

Tally animals circled in each category.
Then multiply by number given.

Group 1	Sensitive	1	x 4 =	4	
Group 2	Semi-Sensitive	3	x 3 =	9	
Group 3	Semi-Tolerant	2	x 2 =	4	
Group 4	Tolerant	1	x 1 =	1	
	Total	7	(E)	18	(F)

Divide (F) by (E): 18 ÷ 7

Index Score (F ÷ E) 2.6

How healthy is the stream?

3.6 and up	Excellent
2.6 - 3.5	Good
2.1 - 2.5	Fair
1.0 - 2.0	Poor

Water Action Volunteers is a cooperative program between the University of Wisconsin–Extension and the Wisconsin Department of Natural Resources.
For more information, contact the Water Action Volunteers Coordinator at 608-264-8948.

WAV materials revised Summer, ©2005

For additional information about macroinvertebrates, visit these websites:

http://watermonitoring.uwex.edu/wav/monitoring/biotic.html

http://watermonitoring.uwex.edu/wav/monitoring/coordinator/ecology/macro.html

3. What are aquatic macroinvertebrates?

____

3. Give some examples of aquatic macroinvertebrates.

____

3. What are some advantages to using macroinvertebrates to identify water quality as compared to studying other physical or chemical aspects of water quality?

____

____

4. After sampling the macroinvertebrate population at Stream X in Central Wisconsin that had low gradient and a muddy bottom, you noticed that there were not very many different types of organisms present. Before filling out the biotic index sheet, what would you speculate about the water quality of Stream X? Why?

____

____

5. If you were standing on the edge of a stream planning where to go within it to collect aquatic macroinvertebrates, where would you try looking for them?

____

6. If you collected caddisflies, mayflies, riffle beetles, amphipods and both non-red midges and bloodworms, what would your biotic index score be?

Group Number	Number of Animals	Group Value		Scoring
Group 1	____________	x4	=	____________
Group 2	____________	x3	=	____________
Group 3	____________	x2	=	____________
Group 4	____________	x1	=	____________
Total Number =		Total Score =		

Total Score [ ] / Total Number [ ] = [ ]

(3.6+=Excellent, 2.6-3.5=Good, 2.1-2.5=Fair, 1.0-2.0=Poor) Biotic Index Score

7. You will soon be determining a biotic index score at a stream near your school. What water quality do you expect to find? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

____

____

STOP HERE STOP Go on field trip!!

Back in the Classroom

Calculating a Biotic Index Score and Statistics

PROCEDURE:

1. Obtain your biotic index data sheet from your teacher.
2. Calculate your biotic index score for your site by following the directions below:
    a. Count the number of animals circled in each group and write those in the work area below.
    b. Multiply the entered number from each group by the group value.
    c. Do this for all groups.
    d. Total the number of animals circled for all groups.
    e. Total the calculated scores for all groups.
    f. Divide the total score by the total number of types of animals found.
    g. Record this number. This is you Biotic Index Score.

SHOW ALL MATH (Use space below to do your math computations)

Group Number	Number of Animals	Group Value		Scoring
Group 1	________________	x4	=	____________________________
Group 2	________________	x3	=	____________________________
Group 3	________________	x2	=	____________________________
Group 4	________________	x1	=	____________________________
Total Number =		Total Score =		

Total Score [ ] / Total Number [ ] = [ ]

(3.6+=Excellent, 2.6-3.5=Good, 2.1-2.5=Fair, 1.0-2.0=Poor) Biotic Index Score

3. Report this result to your teacher so other students in the class can obtain this information.
4. Once you have a complete list of biotic index scores, record these measurements in your student workbook (Table A).
5. Then rewrite the list in order from lowest to highest (Table B). Using a spreadsheet such as Excel maybe be helpful.
6. Determine the average, median and mode (optional) for the biotic index scores and record these in your student workbook (Table C).
7. Determine the range of biotic index scores by noting the lowest and the highest measurements recorded during the field trip and indicate this in your student workbook (Table C).
8. Write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode) and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results.

BIOTIC INDEX TABLE A

Group (Students' Names)	Biotic Index Score

BIOTIC INDEX TABLE B

Ordered List of Biotic Index Scores

BIOTIC INDEX TABLE C

	Biotic Index Score
Average	
Median	
Low	
High	
Mode	

What was the average score for your stream? _____________

What does that mean? (circle one) **Excellent 3.6+, Good 2.6-3.5, Fair 2.1-2.5, Poor 1.0-2.0**

What reasons can you think of to support why this stream scored the way that it did?

____

____

____

What suggestions do you have for the future health of this stream?

____

____

____

Conclusions:

____

____

____

____

____

____

____

____

E. COLI BACTERIA MONITORING

- *Most bacteria do not cause human health problems; some, including E. coli, can be used as indicators of possible pollution in surface waters.*
- *Runoff from land is the leading cause of surface water pollution in the United States.*
- *Sources of fecal coliform bacteria in surface waters include manure spread on land that has run off into surface waters, failed septic systems, pet wastes, and wildlife and bird feces.*

Bacteria are microscopic, single-celled organisms that are the most numerous organisms on earth. They are so small that over five million could be placed on the head of a pin. Bacteria can live in numerous environments and perform many complex actions, some of which are beneficial and some harmful. Most bacteria, however, are not harmful and do not cause human health problems. Those that are disease producing are referred to as pathogenic. Viruses and some protozoans can also be pathogenic.

Coliform bacteria are part of the Enterobacteriaceae family and individual cells cannot be seen with the naked eye due to their small size (but colonies can be seen.) While some coliform bacteria can be naturally found in soil, the type of coliform bacteria that live in the intestinal tract of warm-blooded animals and originate from animal and human waste are called fecal coliform bacteria.

Angie Tilton (both photos)

Escherichia coli (E. coli) is one subgroup of fecal coliform bacteria. Even within this species, there are numerous different strains, some of which can be harmful. However, the release of these naturally-occurring organisms into the environment is generally not a cause for alarm. However, other disease causing bacteria, which can include some pathogenic strains of *E. coli,* or viruses may also be present in these wastes and pose a health threat.

E. COLI AS INDICATOR BACTERIA

Trying to detect disease-causing bacteria and other pathogens in water is expensive and may pose potential health hazards. Further, testing for pathogens requires large volumes of water, and the pathogens can often be difficult to grow in the laboratory and isolate. *E. coli* bacteria are good indicator organisms of fecal contamination because they generally live longer than pathogens, are found in greater numbers, and are less risky to collect or culture in a laboratory than pathogens. However, their presence does not necessarily mean that pathogens are present, but rather indicate a potential health hazard may exist.

The Environmental Protection Agency (EPA) has determined that *E. coli* are one of the best indicators for the presence of potentially pathogenic bacteria (US EPA, 2002). Because *E. coli* monitoring does not measure the actual pathogens, the assessment is not foolproof, however, it is a good approach for assessing the likelihood of risks to human health. Monitoring for these indicator organisms is an easy and economical method for citizens or professionals to assess health risks due to bacterial contamination of surface waters.

COMMON SOURCES OF *E. COLI*

Bacteria in water can originate from the intestinal tracts of both humans and other warm-blooded animals. Human sources include failing septic tanks, leaking sewer lines, wastewater treatment plants, sewer overflows, boat discharges, swimming "accidents" and urban storm water runoff. In urban watersheds, fecal indicator bacteria are significantly correlated with human density (Frenzel and Couvillion, 2002). Animal sources of fecal coliform bacteria in surface waters include manure that has been spread on the land, livestock defecating in streams, pet wastes (e.g., dogs, cats), wildlife (e.g., deer, elk, raccoons) and birds (e.g., geese, pigeons, ducks, gulls).

If you are sampling in a watershed area without significant human impact and are finding *E. coli,* the source may be birds or wildlife. In a study comparing *E. coli* concentrations in waters from agricultural and "pristine" sites, contamination was found in both settings. The researchers deduced that the levels of *E. coli* at the pristine site likely came from wildlife, such as deer and elk, living the area (Niemi and Niemi, 1991).

Another source of bacterial pollution to stream waters comes from Combined Sewer Overflows (CSOs). Some sewer and storm water pipes are not separated. When a large storm event occurs, the wastewater treatment plants cannot handle the excess volume of water being pumped to them. As a result, untreated sewage along with storm water is dumped directly into rivers and streams.

Remember, the presence and levels of *E. coli* in a stream do not give an indication of the source of the contamination. However, monitoring them can be a good first step in investigating a watershed for potential sources.

COMMON ROUTES OF BACTERIA TO STREAMS

Polluted water runoff from the land is the leading cause of water quality problems nationwide (US EPA, 2002). Fecal material as well as other pollutants can be transported to waterways through runoff. How quickly they are transported partially depends on the type of land use. Non-developed lands including grasses and other vegetation tend to soak up rainfall, thereby increasing infiltration into the ground and reducing runoff to waterways. Developed lands such as streets, rooftops, sidewalks, parking lots, driveways and other hard surfaces that are impervious to infiltration cause runoff to increase. Lands that support domesticated animals, such as cattle, hogs or horses, can also be a source of bacteria, particularly if animals enter the water for drinking or if heavy rains wash manure from the land into receiving waters.

RISKS TO HUMAN HEALTH

Most people are concerned about the risk that bacteria may pose to human health. When bacterial counts are above health standards, people exposed to water that contains bacteria may exhibit fever, diarrhea, abdominal cramps, chest pain or hepatitis. While *E. coli* by itself is not generally a cause for alarm, other pathogens of fecal origin that are health threats include *Salmonella, Shigella* and *Psuedomonas aeruginosa.* Non-bacterial pathogens that may be present with fecal material include protozoans, such as *Cryptosporidium* and *Giardia,* and viruses.

There are some strains of *E. coli* that are pathogenic themselves. One that has received much attention is the *E. coli* strain named 0157:H7 that lives in the intestinal tract of cattle. This strain is primarily spread to people who eat contaminated, undercooked beef or drink unpasteurized milk and is not generally found in surface waters.

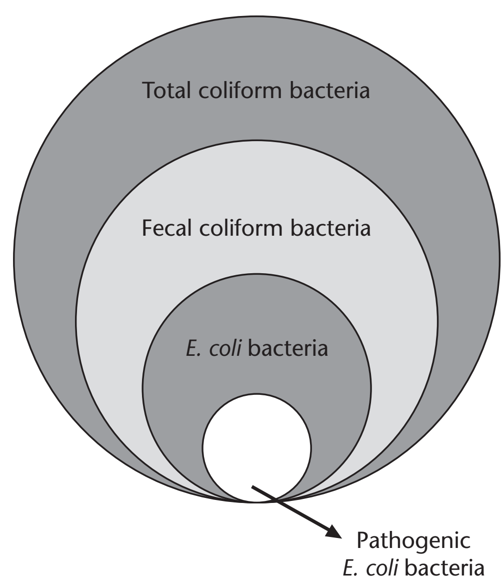
EXAMPLES OF AT-RISK CONCENTRATION LEVELS

Criteria for acceptable concentrations of indicator bacteria in recreational waters have been developed by the US EPA (1986). Initially, total coliform bacteria were used as the benchmark. However, because it was shown that *E. coli* were more closely correlated with swimming-related illnesses, the US EPA later recommended that *E. coli* be used as the indicator in freshwater recreational areas (US EPA, 2002).

Many states have since adopted this recommendation; however, some such as Wisconsin, still use total fecal coliform bacteria when determining acceptable concentrations for recreating in surface waters. For *E. coli* the EPA mandates that the acceptable risk level for total body contact recreation, which involves activities such as swimming or water skiing, is 126 colonies of organisms (referred to as colony forming units or cfu) per 100 milliliters (ml) of water or less, based on a ***geometric mean*** (calculated over 30 days with at least 5 samples) or a one-time concentration of 235 cfu/100 ml. The risk of getting sick increases as total numbers of colonies are exceeded.

The number of colony forming units of *E. coli* organisms per 100 ml of water and the method of determination may vary slightly by state, based on state public health codes and water quality Standards. The EPA recommends a set of standards for *E. coli* in freshwater bodies as a single maximum allowable count. These rates correspond to an acceptable risk level of 8 people out of 1,000 getting sick. In Wisconsin, these guidelines are used for swimming beaches, but a fecal coliform standard (of which *E. coli* is a subset) is used for other recreational waters. The fecal coliform standard is 400 cfu/100 mL for a single event.

Even with good watershed management measures, there will always be fecal material in the environment. If you find unusually high levels of *E. coli* on a long-term, regular basis in your stream samples, you should alert and work with your local health agency.



Fecal coliform bacteria which include *E. coli* are part of a larger group of colifom bacteria. (Figure not to scale.)

WEATHER AND SEASONAL INFLUENCES

The number of bacteria colonies can be influenced by weather and seasonal effects. This variability makes the bacterial concentrations in natural water difficult to predict at any one time. Bacteria counts often increase following a heavy storm, snow melt or other excessive runoff. *E. coli* bacteria are often more prevalent in turbid waters because they live in soil and can attach to sediment particles. Bacteria can also remain in streambed sediments for long periods of time. If the streambed has been stirred up by increased flow or rainfall, your sample could have elevated bacteria levels. This is why you should avoid disturbing the streambed as you wade out into the stream to collect your sample. You should also collect the water sample upstream from you. If you are collecting at several sites within the stream, collect the furthest downstream sample first and proceed upstream.

A number of other weather influences may affect bacteria levels in the stream. Higher *E. coli* counts may be found in warmer waters because *E. coli* survive more easily in these waters. (*E. coli* typically live in the warm environment of the intestines of warm-blooded animals.) Ultraviolet rays of sunlight, however, can kill bacteria, so a warm sunny day may produce counts lower than expected.

For more information about *E. coli* bacteria monitoring visit this website:

http://www.usawaterquality.org/volunteer/EColi/Manual.htm

References

Frenzel, S.A. and C.S. Couvillion (2002) Fecal-indicator bacteria in streams along a gradient of residential development. *Journal of the American Water Resources Association*. 38:265-273.

Niemi, R.M. and J.S. Niemi (1991) Bacterial pollution of waters in pristine and agricultural lands. *Journal of Environmental Quality*. 20:620-627.

US EPA (1986). Ambient Water Quality Criteria for Bacteria. EPA 440/5-84-002. Office of Water.

US EPA (2002). Implementation Guidance for Ambient Water Quality Criteria for Bacteria (Draft). May 2002 (www.epa.gov/waterscience/standards/bacteria/bacteria.pdf).

1. What are three sources of *E. coli* in surface waters?

2. Disease-causing bacteria are called ________________________ bacteria.

3. Are the majority of bacteria disease-causing? _____________

4. What are some advantages to using *E. coli* bacteria to monitor water quality?

5. What symptoms might humans infected with water-borne pathogens display?

6. In what units are *E. coli* measured? __________________________

7. What is the EPA-recommended one-time concentration limit for *E. coli* for total body contact activities such as swimming?

8. What factors can influence the concentration of bacteria in surface waters?

9. You will soon be monitoring the *E. coli* bacteria level in a stream near your school. What water quality do you expect to find? Why? Note your hypothesis for your stream site and your plan for how to research that hypothesis here:

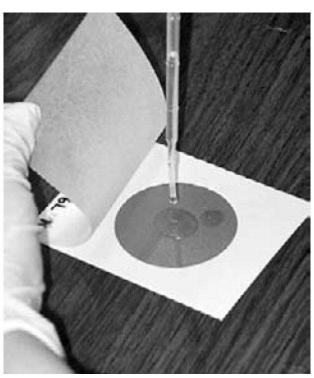
STOP HERE STOP Go on field trip!!

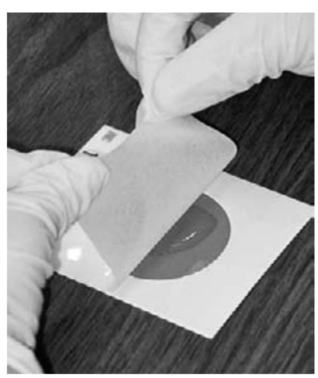
Back in the Classroom

Classroom Procedure for *E. coli* Bacteria Monitoring:

During your class field trip, you will collect your sample from a stream near your school using methods outlined in the Wisconsin State Lab of Hygiene video, and transport your sample on ice to your classroom. You will then use 3M™ Petrifilm™ to monitor *E. coli*. It is essential that you maintain sterile conditions while plating your sample, since this is the time with the greatest potential for external contamination of the samples. Follow these steps to process the sample:

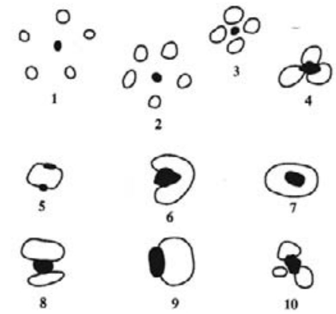
1. Remove 3M™ Petrifilm™ from refrigerator and allow the package to come to room temperature before opening. This will take at least 10-15 minutes.
2. Sanitize your working surface by spraying or wiping it with a dilute bleach solution.
3. Wash your hands thoroughly with soap and water.
4. Label the back side of three 3M™ Petrifilm™ plates with the date, time, sampling site and replicate number (1 to 3).
5. Always shake your sample bottle before extracting a sample with a pipette.
6. Place a 3M™ Petrifilm™ plate on a level surface.
7. Lift the top film and dispense 1 mL of sample in the upper portion of the pink portion of the plate.





8. Slowly roll the top film down onto the sample to prevent trapping air bubbles.
9. If needed, with the smooth side down, place the plastic spreader over the closed plate and distribute the sample evenly across the pink area of the plate by *gently* tapping with one finger on the center of the plastic spreader.

10. If used, remove the spreader and leave the plate undisturbed for at least one minute to permit the gel to solidify.
11. Repeat this process for your other two replicate samples.
12. Incubate the plates in a horizontal position, with the clear side up in stacks of up to 20 plates.
13. Incubate for 24 hours at 35˚C.
14. After 24 hours, wearing nitrile or other lab gloves, remove the plates from the incubator and count blue and blue-purple colonies that have associated gas bubbles and are within the pink circle. Holding the plates up to light can help distinguish colonies with gas bubbles.
15. On the data sheet below record the number of colonies you counted.
16. Since you used just 1 mL of sample, multiply the number of colonies counted by 100 to determine the number of colony-forming units per 100 mL of sample.
17. After you have counted colonies, place all of the Petrifilm plates in a Ziploc bag that has had about two tablespoons of bleach added to it. Seal the bag and throw it away in the regular rubbish. The bleach will disinfect the plates.



All 10 examples depict various bubble patterns associated with gas-producing colonies. Each numbered picture would be counted as one colony. (From 3M™ Petrifilm™ interpretation guide)

Note:

Petrifilm *E. coli* plates with colonies that are too numerous to count (TNTC) have one or more of the following characteristics: many small colonies, many gas bubbles, and deepening of the gel color. High concentrations of *E. coli* will cause the growth area to turn blue, while high concentrations of coliforms (non-*E. coli*) will cause the growth area to turn dark red. When any of these occur, you will not be able to count the sample – and should write TNTC on your data sheet.

Names: ____________________________ Incubation temperature: _________˚C

Date: ______________________________ Times samples place in incubator: __________

	Number of *E. coli* colonies counted at 24 hours	Number of *E. coli* (calculated) cfu/100 mL at 24 hours
Replicate 1		
Replicate 2		
Replicate 3		

Average: ___________________cfu/100mL

Calculating *E. coli* Statistics

PROCEDURE:

1. Record all groups and their *E. coli* scores in your student workbook (Table A).
2. Then rewrite the list in order from lowest to highest (Table B). Using a spreadsheet such as Excel may be helpful.
3. Determine the average, median and mode (optional) for the *E. coli* scores and record these in your student workbook (Table C).
4. Determine the range of *E. coli* scores by noting the lowest and the highest measurements recorded during the field trip and indicate this in your student workbook (Table C).
5. Answer any remaining questions in your student workbook and then write a conclusion paragraph or two about this parameter. You should state whether or not your hypotheses were correct and why or why not. You should also state the final results of the test (including average, median, range and mode, and what those results tell us about the stream quality. Also address any sources of error that may have influenced your results.

E. COLI TABLE A

Group (Students' Names)	*E. coli* Score (cfu/100mL)

E. COLI TABLE B

Ordered List of *E. coli* Scores (cfu/100mL)

E. COLI TABLE C

	E. coli Score (cfu/100mL)
Average	
Median	
Low	
High	
Mode	

Following the EPA recommended guidelines for beaches, did you find that your average *E. coli* results were above or below the 235 cfu/100 mL standard?

____

What does that mean in regards to human safety and potential for illness if someone were to swim at your monitoring location on the day you sampled?

____

____

What reasons can you think of to support why this stream scored the way that it did?

____

____

____

What suggestions do you have for the future health of this stream?

____

____

____

Conclusions:

____

____

____

____

____

____

GLOSSARY

Aquatic Macroinvertebrates: Small animals without backbones that live in water and are visible to the human eye.

Average: The arithmetic average is determined by adding together all the measurements and dividing by the total number of samples collected.

Citizen Monitoring Biotic Index: Water Quality Index for Wisconsin wadable streams using aquatic macroinvertebrates.

Cold-blooded: Animals whose body temperatures match that of their surroundings. Fish, invertebrates, snakes, frogs and toads are cold-blooded.

Diffusion: The movement of molecules, for example oxygen molecules, from an area of higher concentration (e.g., the air) to an area of lower concentration (e.g., the water).

Flow Regime: The pattern of stream flow over time, including increases with stormwater runoff inputs and decreases to a base-flow level during dry periods.

Geometric Mean: A type of mean (average) that helps reduce the effect of a few extreme values.

Impervious Surface: A surface that does not allow water (e.g., rain) to pass through (infiltrate).

Lower Bank: The intermittently submerged portion of the bank from the normal water line to the high water line, or beginning of the upper bank.

Median: This is the middle number in an ordered list of measurements. If there was an even number of measurements made, the average of the two middle numbers is the median.

Mode: The mode is the most commonly recorded value in the dataset. It is possible that more than one number may be the mode.

NTU: Nephelometric Turbidity Units, which is a measure of the amount of light scattered by suspended material in the sample.

Parameter: The stream characteristic to be measured.

Photosynthesis: The process in which green plants convert carbon dioxide and water, using the sun's energy, into simple sugars and oxygen.

Respiration: The cellular process in which plants and animals use oxygen and release carbon dioxide. Basically, it is the reverse of photosynthesis because carbon dioxide, water and energy are released in the process.

Riffle: Shallow area in stream where water flows swiftly over rocks.

Riparian Zone: The land between the water's edge and the upper edge of the flood plain; transition zone between water and land.

Run: An area of a stream that has swift water flow and is slightly deeper than a riffle (a run will be about knee/thigh deep).

Sediment: Soil or other bits of eroded material that run off land and settle in still water.

Supersaturation: An indication that more oxygen is dissolved in water than would be in a state of equilibrium. Supersaturation could indicate that some processes are affecting the water's natural balance found in the state of equilibrium.

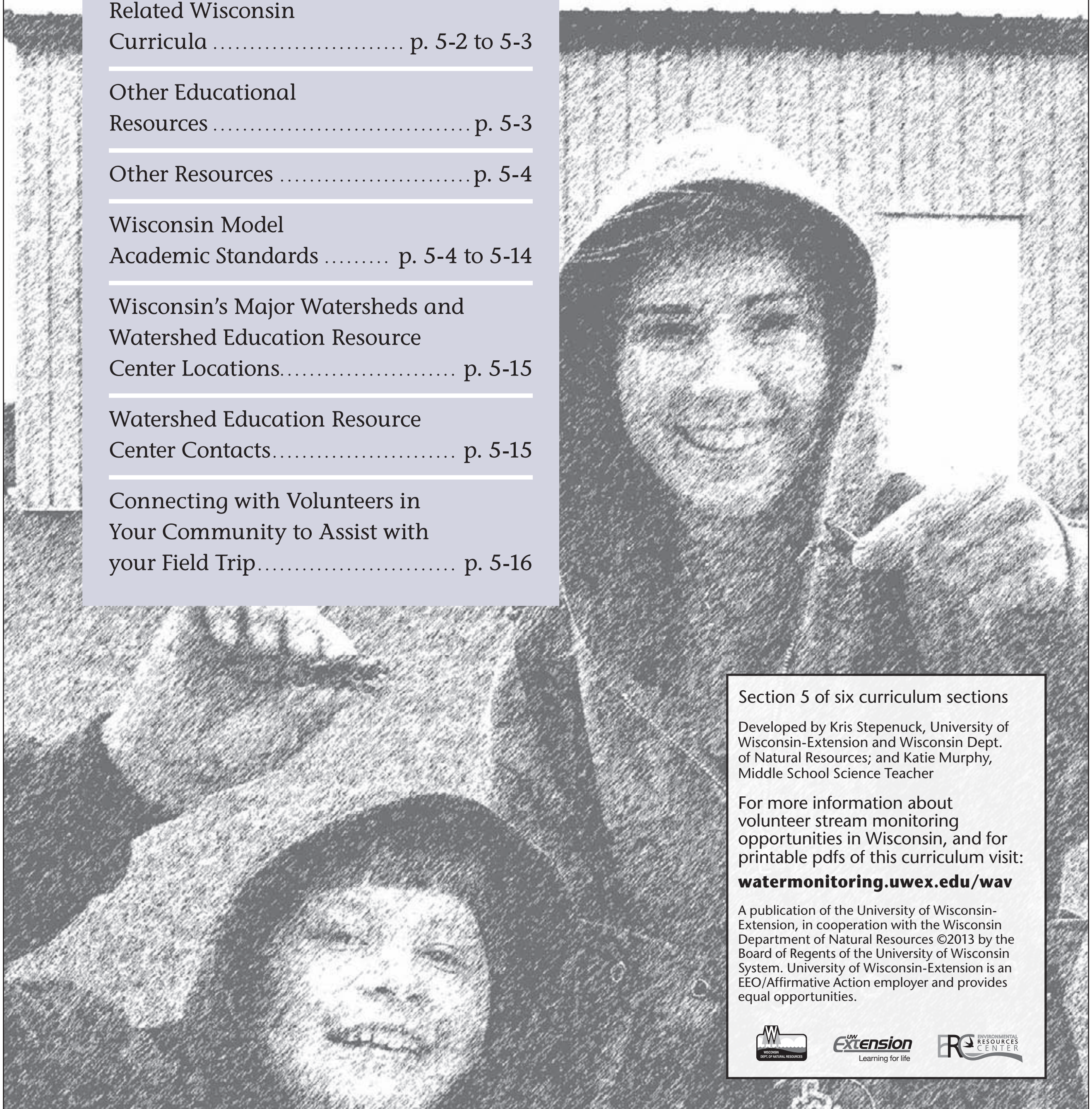
Suspended Material: Small particles floating in the water.

Turbidity: The amount of suspended particles in the water.

Upper Bank: The portion of the bank from the beginning of the high water line to the extreme high water line.

Watershed: An area of land that drains to a main water body.

▶ SECTION 5: RESOURCES



Contents

Water Action Volunteers' Education Materials .... p. 5-2

Related Wisconsin Curricula .... p. 5-2 to 5-3

Other Educational Resources .... p. 5-3

Other Resources .... p. 5-4

Wisconsin Model Academic Standards .... p. 5-4 to 5-14

Wisconsin's Major Watersheds and Watershed Education Resource Center Locations........................ p. 5-15

Watershed Education Resource Center Contacts......................... p. 5-15

Connecting with Volunteers in Your Community to Assist with your Field Trip.......................... p. 5-16

Section 5 of six curriculum sections

Developed by Kris Stepenuck, University of Wisconsin-Extension and Wisconsin Dept. of Natural Resources; and Katie Murphy, Middle School Science Teacher

For more information about volunteer stream monitoring opportunities in Wisconsin, and for printable pdfs of this curriculum visit:

watermonitoring.uwex.edu/wav

HANDS-ON LEARNING ABOUT STREAMS WITHIN & OUTSIDE THE CLASSROOM – *FOR MIDDLE & HIGH SCHOOL TEACHERS & STUDENTS*

WATER ACTION VOLUNEERS' EDUCATION MATERIALS

- Water Action Volunteers' Stream Monitoring DVD Set: In addition to the video trainings and presentations mentioned throughout this curriculum, other content may be useful as background for teachers or older students. These are available upon request from the WAV Coordinator.
- Water Action Volunteers' Stream Monitoring Fact Sheets:

  http://watermonitoring.uwex.edu/wav/monitoring/methods.html
- Water Action Volunteers' More Information About "What's Monitored":

  http://watermonitoring.uwex.edu/wav/monitoring/monitored.html
- Wonderful, Wacky, Water Critters (classroom sets available upon request from the WAV Coordinator):

  http://watermonitoring.uwex.edu/pdf/level1/WWWC.pdf
- Key to Life in the River (classroom sets available upon request from the WAV Coordinator):

  http://watermonitoring.uwex.edu/pdf/level1/riverkey.pdf
- Aquatic Macroinvertebrate Wisconsin Wildcards:
  Not currently available for download. Classroom sets available upon request from the WAV Coordinator.

RELATED WISCONSIN CURRICULA

For links to the following resources visit: watermonitoring.uwex.edu/wav

- Climate Change: A Wisconsin Activity Guide – Grades 7-12
- Educating Young People About Water Curricula Database
- Give Water a Hand Action Guide: A Youth Program for Environmental Education
- Hook, Line & Thinker: An Angler's Perspective on Life Sciences and Related Social Issues – Grades 7–12
- Wisconsin Project WET
- Wisconsin Project WILD Aquatic

OTHER EDUCATIONAL RESOURCES

For links to the following resources visit: watermonitoring.uwex.edu/wav

- *Build a Bug Activity,* Utah 4H
- *Citizens Monitoring Bacteria Manual* – a three-year multi-state project in the upper Midwest initially funded by USDA to develop *E. coli* bacteria monitoring methods for use by volunteers
- *Field Manual for Water Quality Monitoring,* by Mark Mitchell available from Kendall/Hunt Publishing Company (ISBN#: 978-0-7575-5546-6).
- *Holding onto the GREEN Zone: A Youth Program for the Study and Stewardship of Community Riparian Areas*
- National Project WET
- National Project WILD Aquatic
- *Stream Side Science: Lesson Plans and Water Related Activities for Utah 9th Grade Earth Systems Science*
- *University of Arizona GLOBE.* This site includes a very helpful description of the Hach dissolved oxygen kit chemistry
- Natural Resources Conservation Service's *How to read a topographic map and delineate a watershed*

- Online source for obtaining U.S. Geological Survey topographical maps
- U.S. Geological Survey *Topographic Map Symbols* brochure
- 3M™ (for Petrifilm™, *E. coli*/coliform count plates, and spreaders for *E. coli* monitoring)
- Micrology Labs (for 1 mL droppers and 30 mL bottles for *E. coli* monitoring)

WISCONSIN MODEL ACADEMIC STANDARDS

These standards will be addressed when students complete the student workbook and the stream monitoring stations. As this curriculum was developed during the shift to Common Core State Standards, an addendum has been developed to aid teachers in understanding how these new standards align with each activity. (Visit: **http://watermonitoring.uwex.edu/wav** for printable pdfs of this curriculum and addendum.) Additional information about these standards may be available through the Wisconsin Department of Public Instruction at:

http://dpi.wi.gov/standards/stds.html

I. Agricultural Education

- A.6-8.3 Recognize the importance of community service
- A.9-12.3 Participate actively in community service
- B.8.3 Access and apply information in the evaluation of natural resource use
  - access and apply information in the study of water pollution causes and remediation (surface water, groundwater)
- E.8.2 Describe and give examples of how land use impacts the environment
  - explain how urbanization has impacted native ecosystems
  - explain how agricultural use of land has impacted native ecosystems
  - explain how urbanization has impacted agricultural land

II. English

- A.8.1 Use effective reading strategies to achieve their purposes in reading
  - use knowledge of sentence and word structure, word origins, visual images and context clues to understand unfamiliar words and clarify passages of text
  - use knowledge of the visual features of texts, such as headings and bold face print, and structures of texts, such as chronology and cause-and-effect, as aids to comprehension
  - establish purposeful reading and writing habits by using texts to find information, gain understanding of diverse viewpoints, make decisions and enjoy the experience of reading
  - select, summarize, paraphrase, analyze and evaluate, orally and in writing, passages of texts chosen for specific purposes

- A.8.4 Read to acquire information: Interpret and use technical resources such as charts, tables, timelines and manuals; Compare, contrast and evaluate the relative accuracy and usefulness of information from different sources; identify and explain information, main ideas and organization found in a variety of informational passages; distinguish between the facts found in documents, narratives, charts, maps, tables and other sources and the generalizations and interpretations that are drawn from them.

III. Environmental Education

- A.8.4 Use critical-thinking strategies to interpret and analyze gathered information
- A.8.5 Use the results of their investigations to develop answers, draw conclusions and revise their personal understanding
- A.8.6 Communicate the results of investigations by using a variety of media and logically defend their answers
- A.12.4 State and interpret their results accurately and consider other explanations for their results
- A.12.5 Communicate the results of their investigations to groups concerned with the issue
- B.8.5 Give examples of human impact on various ecosystems
- B.8.8 Explain interactions among organisms or populations of organisms
- B.8.10 Explain and cite examples of how humans shape the environment
- B.8.15 Analyze how people impact their environment through resource use
- B.8.17 Explain how human resource use can impact the environment; e.g., erosion, burning fossil fuels
- B.8.18 Identify major air, water or land pollutants and their sources
- B.8.19 Distinguish between point and nonpoint source pollution
- B.8.21 Identify and analyze individual, local, regional, national and global effects of pollution on plant, animal and human health
- B.12.2 Describe the value of ecosystems from a natural and human perspective; e.g., food, shelter, flood control, water purification
- B.12.3 Evaluate the stability and sustainability of ecosystems in response to changes in environmental conditions
- B.12.11 Assess how changes in the availability and use of natural resources (especially water and energy sources) will affect society and human activities; such as, transportation, agricultural systems, manufacturing

- B.12.17 Explain the concept of exported/imported pollution; e.g., smokestacks, watersheds and weather systems
- B.12.18 Analyze cause and effect relationships of pollutants and other environmental changes on human health
- C.8.2 Use environmental monitoring techniques such as observations, chemical analysis and computer mapping software to collect data about environmental problems
- C.8.3 Use questioning and analysis skills to determine beliefs, attitudes and values held by people involved in an environmental issue
- C.12.1 Compare the effects of natural and human-caused activities that either contribute to or challenge an ecologically and economically sustainable environment
- D.8.1 Identify options for addressing an environmental issue and evaluate the consequences of each option
- D.8.5 Explain how personal actions can impact an environmental issue; e.g., doing volunteer work in conservation
- D.12.5 Develop a plan to maintain or improve some part of the local or regional environment, and enlist support for the implementation of that plan
- E.12.3 Take action in regard to environmental issues in the home, school or communities

IV. Information and Technology Literacy

- A.8.1 Use common media and technology terminology and equipment
  - identify and define computer and networking terms (e.g., modem, file server, client station, LAN, Internet/Intranet, data storage device)
  - demonstrate the correct operation of a computer system on a network
  - demonstrate touch keyboarding skills at acceptable speed and accuracy levels (suggested range 20-25 wpm)
  - organize and backup files on a computer disk, drive, server or other storage device
  - recognize and solve routine computer hardware and software problems
  - use basic content-specific tools (e.g., environmental probes, measurement sensors) to provide evidence/support in a class project)
  - scan, crop, and save a graphic using a scanner, digital camera or other digitizing equipment
  - use simple graphing calculator functions to solve a problem
  - capture, edit, and combine video segments using a multimedia computer with editing software or a video editing system

- A.12.1 Use common media and technology terminology and equipment
  - identify and define basic on-line and telecommunications terminology or concepts (e.g., bandwidth, satellite dish, distance learning, desktop conferencing, listserv, downlink, teleconference, virtual reality)
  - demonstrate proper keyboarding mechanics and touch type accurately (suggested range 30-35 wpm)
  - use a camcorder, VCR, multimedia computer or editing equipment to produce a short video program
  - identify common graphic, video and sound file formats (e.g., JPEG, GIF, MPEG, QUICKTIME, WAV)
  - use desktop or video conferencing equipment and systems
- B.8.1 Define the need for information
  - identify the information problem or question to be resolved
  - relate what is already known to the information need
  - formulate general and specific research questions using a variety of questioning skills
  - revise and narrow the information questions to focus on the information need
- B.8.2 Develop information seeking strategies
  - identify relevant sources of information including print, non-print, electronic, human and community resources
  - evaluate possible sources of information based on criteria of timeliness, genre, point of view, bias and authority
  - select multiple sources that reflect differing or supporting points of view
  - identify and select keywords and phrases for each source, recognizing that different sources use different terminology for similar concepts
  - organize ideas, concepts and phrases using webbing, outlines, trees or other visual or graphic tools
  - focus search strategies on matching information needs with available resources
- B.8.3 Locate and access information sources
  - identify the classification system used in the school library media center, public library and other local libraries
  - locate materials using the classification systems of the school library media center and the public library
  - use an on-line catalog and other databases of print and electronic resources

- recognize differences in searching bibliographic records, abstracts or full text databases
- search for information by subject, author, title and keyword
- use Boolean operators with human or programmed guidance to narrow or broaden searches
- use biographical dictionaries, thesauri, and other common reference tools in both print and electronic formats
- use a search engine to locate appropriate Internet or Intranet resources

▶ B.8.4 Evaluate and select information from a variety of print, non-print and electronic formats

- examine selected resources for pertinent information using previewing techniques to scan for major concepts and keywords
- differentiate between primary and secondary sources
- distinguish between fact and opinion; recognize point of view or bias
- determine if information is timely, valid, accurate, comprehensive and relevant
- analyze and evaluate information presented in charts, graphs and tables
- locate indicators of authority for all sources of information
- select resources in formats appropriate to content and information need and compatible with their own learning style

▶ B.8.5 Record and organize information

- use note taking strategies including summarizing and paraphrasing
- record concise notes in a prescribed manner, including bibliographic information
- cite the source of specific quotations or visuals using footnotes, endnotes or internal citation formats
- organize and compare information using graphic organizers, storyboarding and other relational techniques
- organize information in a systematic manner appropriate to question, audience and intended format of presentation
- record sources of information in a standardized bibliographic format

▶ B.8.6 Interpret and use information to solve the problem or answer the question

- compare and integrate new information with prior knowledge

- analyze information for relevance to the question
- analyze findings to determine need for additional information
- gather and synthesize additional information as needed
- draw conclusions to address the problem or question

▶ B.8.7 Communicate the results of research and inquiry in an appropriate format

- determine the audience and purpose for the product or presentation
- identify possible communication or production formats
- select a presentation format appropriate to the topic, audience, purpose, content and technology available
- develop an original product or presentation which addresses the information problem or question

▶ D.8.1 Participate productively in workgroups or other collaborative learning environments

- collaborate with others to identify information needs and seek solutions
- demonstrate acceptance to new ideas and strategies from workgroup members
- determine workgroup goals and equitable distribution of individual or subgroup responsibilities and tasks
- plan for the efficient use and allocation of time
- complete workgroup projects on time
- evaluate completed projects to determine how the workgroup could have functioned more efficiently and productively

▶ D.12.1 Participate productively in workgroups or other collaborative learning environments

- collaborate with others to design and develop information products and solutions
- incorporate effective group processes and shared decision-making in project development
- specify and detail workgroup goals and individual and subgroup responsibilities
- finalize workgroup strategies, resources, budget and timeline
- allocate time for a project based on an inventory of the responsibilities of workgroup members
- complete specific projects within a timeline and budget
- critique completed projects and workgroup processes for future improvement

V. Mathematics: Measurement

- D.8.3 Determine measurement directly using standard units (metric and U.S. Customary) with these suggested degrees of accuracy
  - lengths to the nearest mm or 1⁄16 of an inch
  - weight (mass) to the nearest 0.1 g or 0.5 ounce
  - liquid capacity to the nearest ml
  - angles to the nearest degree
  - temperature to the nearest °C or °F
  - elapsed time to the nearest second
- D.8.4 Determine measurements indirectly using
  - estimation
  - conversion of units within a system (e.g., quarts to cups, millimeters to centimeters)
  - ratio and proportion (e.g., similarity, scale drawings)
  - geometric formulas to derive lengths, areas, volumes of common figures (e.g., perimeter, circumference, surface area)
  - the Pythagorean relationship
  - geometric relationships and properties for angle size (e.g., parallel lines and transversals; sum of angles of a triangle; vertical angles)
- D.12.2 Select and use tools with appropriate degree of precision to determine measurements directly within specified degrees of accuracy and error (tolerance)
- D.12.3 Determine measurements indirectly, using
  - estimation
  - proportional reasoning, including those involving squaring and cubing (e.g., reasoning that areas of circles are proportional to the squares of their radii)
  - techniques of algebra, geometry and right triangle trigonometry
  - formulas in applications (e.g., for compound interest, distance formula)
  - geometric formulas to derive lengths, areas, or volumes of shapes and objects (e.g., cones, parallelograms, cylinders, pyramids)

- geometric relationships and properties of circles and polygons (e.g., size of central angles, area of a sector of a circle)
- conversion constants to relate measures in one system to another (e.g., meters to feet, dollars to Deutschmarks

VI. Mathematics: Statistics and Probability

▸ E.8.1 Work with data in the context of real-world situations by

- formulating questions that lead to data collection and analysis
- designing and conducting a statistical investigation
- using technology to generate displays, summary statistics and presentations

▸ E.8.2 Organize and display data from statistical investigations using

- appropriate tables, graphs and/or charts (e.g., circle, bar or line for multiple sets of data)
- appropriate plots (e.g., line, stem-and-leaf, box, scatter)

▸ E.8.4 Use the results of data analysis to

- make predictions
- develop convincing arguments
- draw conclusions

▸ E.12.1 Work with data in the context of real-world situations by

- formulating hypotheses that lead to collection and analysis of one- and two-variable data
- designing a data collection plan that considers random sampling, control groups, the role of assumptions, etc.
- conducting an investigation based on that plan using technology to generate displays, summary statistics and presentations

VII. Science A, Science Connections

▸ A.8.1 Develop their understanding of the science themes by using the themes to frame questions about science-related issues and problems

▸ A.8.6. Use models and explanations to predict actions and events in the natural world

- A.12.2 Show how conflicting assumptions about science themes lead to different opinions and decisions about evolution, health, population, longevity, education and use of resources, and show how these opinions and decisions have diverse effects on an individual, a community and a country, both now and in the future

VIII: Science B, Nature of Science

- B.8.6 Explain the ways in which scientific knowledge is useful and also limited when applied to social issues

IX: Science C, Science Inquiry

- C.8.1 Identify questions they can investigate using resources and equipment they have available
- C.8.2 Identify data and locate sources of information including their own records to answer the questions being investigated
- C.8.3 Design and safely conduct investigations that provide reliable quantitative or qualitative data, as appropriate, to answer their questions
- C.8.4 Use inferences to help decide possible results of their investigations, use observations to check their inferences
- C.8.5 Use accepted scientific knowledge, models and theories to explain their results and to raise further questions about their investigations
- C.8.6 State what they have learned from investigations, relating their inferences to scientific knowledge and to data they have collected
- C.8.7 Explain their data and conclusions in ways that allow an audience to understand the questions they selected for investigation and the answers they have developed
- C.8.8 Use computer software and other technologies to organize, process and present their data
- C.8.9 Evaluate, explain and defend the validity of questions, hypotheses and conclusions to their investigations
- C.8.10 Discuss the importance of their results and implications of their work with peers, teachers and other adults
- C.8.11 Raise further questions which still need to be answered
- C.12.1 When studying science content, ask questions suggested by current social issues, scientific literature and observations of phenomena; build hypotheses that might answer some of these questions; design possible investigations; and describe results that might emerge from such investigations

- C.12.2 Identify issues from an area of science study, write questions that could be investigated, review previous research on these questions, and design and conduct responsible and safe investigations to help answer the questions
- C.12.3 Evaluate the data collected during an investigation, critique the data-collection procedures and results, and suggest ways to make any needed improvements
- C.12.4 During investigations, choose the best data-collection procedures and materials available, use them competently, and calculate the degree of precision of the resulting data
- C.12.5 Use the explanations and models found in the earth and space, life and environmental, and physical sciences to develop likely explanations for the results of their investigations
- C.12.6 Present the results of investigations to groups concerned with the issues, explaining the meaning and implications of the results, and answering questions in terms the audience can understand

X. Science F, Life and Environmental Science

- F.8.2 Show how organisms have adapted structures to match their functions, providing means of encouraging individual and group survival within specific environments
- F.8.8 Show through investigations how organisms both depend on and contribute to the balance or imbalance of populations and/or ecosystems, which in turn contribute to the total system of life on the planet
- F.8.9 Explain how some of the changes on the earth are contributing to changes in the balance of life and affecting the survival or population growth of certain species
- F.8.10 Project how current trends in human resource use and population growth will influence the natural environment, and show how current policies affect those trends
- F.12.5 Understand the theory of evolution, natural selection, and biological classification
- F.12.7 Investigate how organisms both cooperate and compete in ecosystems.
- F.12.8 Using the science themes, infer changes in ecosystems prompted by the introduction of new species, environmental conditions, chemicals, and air, water or earth pollution

XI. Science H, Science in Personal and Social Perspectives

- H.8.2 Present a scientific solution to a problem involving the earth and space, life and environmental, or physical sciences and participate in a consensus-building discussion to arrive at a group decision
- H.8.3 Understand the consequences of decisions affecting personal health and safety
- H.12.1 Using the science themes and knowledge of the earth and space, life and environmental, and physical sciences, analyze the costs, risks, benefits and consequences of a proposal concerning resource management in the community and determine the potential impact of the proposal on life in the community and the region
- H.12.2 Evaluate proposed policy recommendations (local, state, and/or national) in science and technology for validity, evidence, reasoning and implications, both short and long-term
- H.12.3 Show how policy decisions in science depend on social values, ethics, beliefs and time-frames as well as considerations of science and technology
- H.12.4 Advocate a solution or combination of solutions to a problem in science or technology
- H.12.5 Investigate how current plans or proposals concerning resource management, scientific knowledge, or technological development will have an impact on the environment, ecology and quality of life in a community or region
- H.12.6 Evaluate data and sources of information when using scientific information to make decisions
- H.12.7 When making decisions, construct a plan that includes the use of current scientific knowledge and scientific reasoning

XII. Social Studies

- A.8.1 Use a variety of geographic representations, such as political, physical and topographic maps; a globe; aerial photographs and satellite images, to gather and compare information about a place
- A.12.2 Analyze information generated from a computer about a place, including statistical sources, aerial and satellite images and three-dimensional models

WISCONSIN'S MAJOR WATERSHEDS AND WATERSHED EDUCATION RESOURCES CENTER LOCATIONS

Use the map to get an idea of where Watershed Education Resource Centers (lending libraries for monitoring equipment) are located, then look on the following pages to find the contact information for the WERC based on the number in the star.

Each of the major watersheds above contains many intermediate watersheds, and many of those contain smaller local watersheds.

For contact information for each WERC location, visit:

http://watermonitoring.uwex.edu/wav/monitoring/coordinator/werc-locations.html

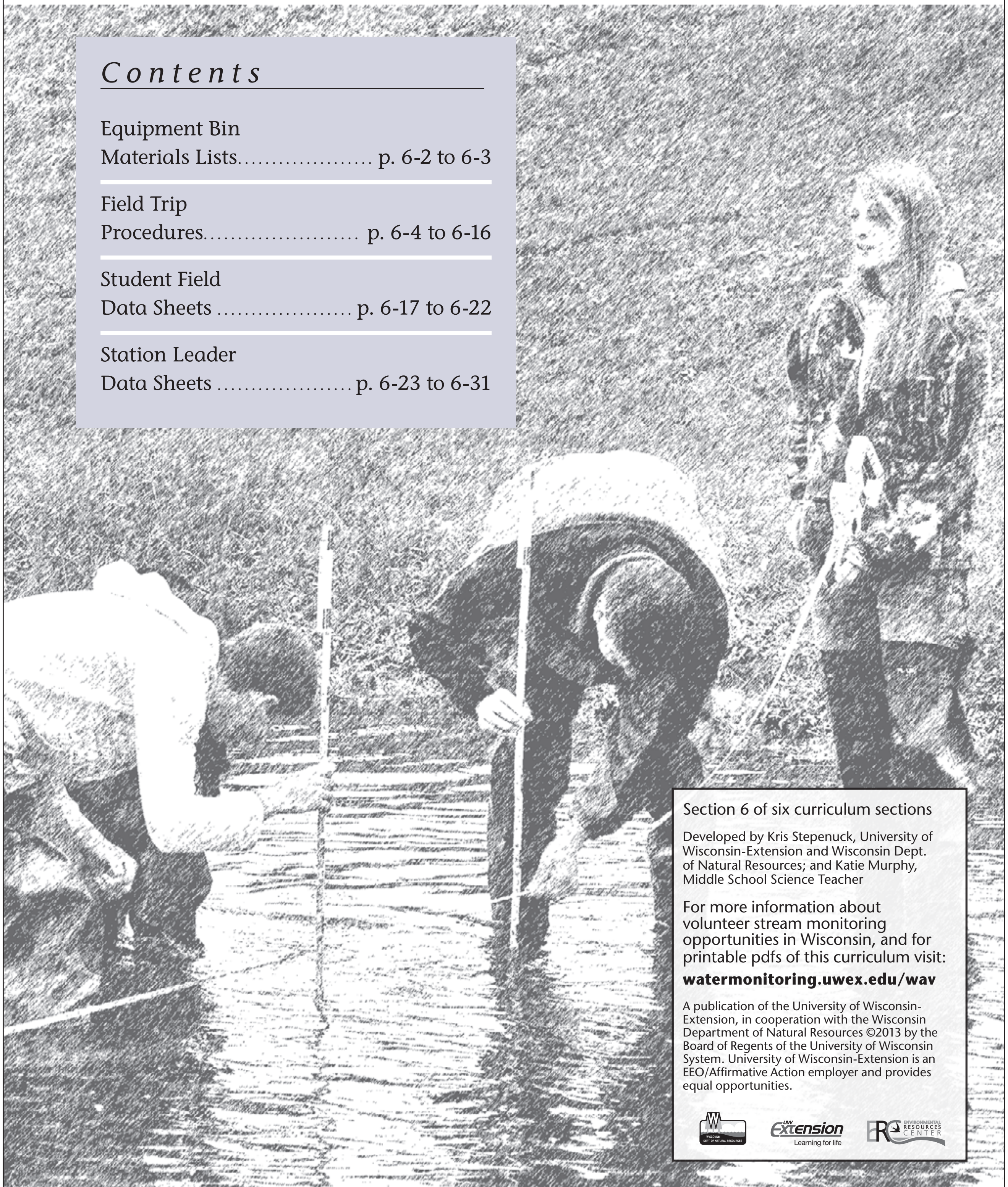
1	Superior
2	Baldwin
3	Park Falls
4	Marinette
5	Sturgeon Bay
6	Two Rivers
7	Manitowoc
8	Menasha
9	Shiocton
10	Stevens Point
11	Fall Creek
12	LaCrosse
13	Sheboygan
14	Newberg
15	Milwaukee
16	Milwaukee
17	Waukesha
18	Jefferson
19	Janesville
20	Beloit
21	Madison
22	Mazomanie
23	Platteville

CONNECTING WITH VOLUNTEERS IN YOUR COMMUNITY TO ASSIST WITH YOUR FIELD TRIP

When planning for your field trip, you will need to recruit between two and six volunteers to act as station leaders. These individuals might be fellow teachers, other school staff (e.g., guidance counselors, administrators), parents, advanced placement biology or chemistry students, or students from your school's ecology club. Other human resources to consider when making preparations for your field trip include:

- Volunteer Stream Monitors
    - The Water Action Volunteers (WAV) Stream Monitoring Program has volunteers who monitor the exact same parameters as your students will monitor on their field trips. These WAV volunteers may be available and willing to act as station leaders for your field trips. Contact the WAV coordinator (see http://watermonitoring.uwex.edu/wav) to obtain a list of contacts in your area.
- Local college students
    - For instance, at UW-Madison, the Biocore Outreach Ambassadors Program is an award winning intercollegiate honors program. The program is designed to have students work side by side with classroom teachers to improve science education in rural Wisconsin. Contact the Program Advisors (see http://watermonitoring.uwex.edu/wav) to make arrangements for Biocore Outreach Ambassadors to assist with your field trip.
    - In the Stevens Point area, the student chapter of the American Water Resources Association has assisted as station leaders for school stream monitoring field trips over the years. Contact the student chapter (see http://watermonitoring.uwex.edu/wav) to make arrangements for these students to assist with your field trip.

▶ SECTION 6: FIELD TRIP MATERIALS



Contents

Equipment Bin Materials Lists .... p. 6-2 to 6-3

Field Trip Procedures....................... p. 6-4 to 6-16

Student Field Data Sheets .... p. 6-17 to 6-22

Station Leader Data Sheets .... p. 6-23 to 6-31

Section 6 of six curriculum sections

Developed by Kris Stepenuck, University of Wisconsin-Extension and Wisconsin Dept. of Natural Resources; and Katie Murphy, Middle School Science Teacher

For more information about volunteer stream monitoring opportunities in Wisconsin, and for printable pdfs of this curriculum visit:

watermonitoring.uwex.edu/wav

A publication of the University of Wisconsin-Extension, in cooperation with the Wisconsin Department of Natural Resources

HANDS-ON LEARNING ABOUT STREAMS WITHIN & OUTSIDE THE CLASSROOM – *FOR MIDDLE & HIGH SCHOOL TEACHERS & STUDENTS*

A. EQUIPMENT BIN MATERIALS LISTS

Station 1a - Topographical Maps:

- Copy of Major Watersheds of Wisconsin map
- Copies of a topographical map(s) showing the stream being studied and the school
- Copies of a topographical map of a different location
- Copies of USGS brochure "Topographic Map Symbols"
- Rulers (1 per group of three students)

Station 1b - Transparency bin contents:

- 4 pairs hip boots (share with temperature monitoring station)*
- 4 transparency tubes

Station 2 - Temperature/Water Sampling bin contents:

- 4 pairs hip boots (share with transparency monitoring station)*
- 4 thermometers
- 4 Hach dissolved oxygen sampling bottles and stoppers
- 4 clear plastic cups
- Optional – only if doing *E. coli* monitoring:
  - Antibacterial hand wipes
  - Sharpie permanent marker
  - Sterile 30 mL collection bottle
  - Nitrile or latex gloves
  - Cooler with ice

Station 3 - Dissolved Oxygen bin contents:

- 4 Hach test kits
- 8 pairs safety goggles
- 1 box gloves

Station 4 - Stream flow bin contents:

- 4 pairs hip boots*
- 4 tape measures
- 4 yardsticks or marked poles
- 24 surveying flags
- 4 tennis balls
- 4 stopwatches or digital watches
- 4 calculators

Station 5 - Habitat bin contents:

- 4 measuring tapes
- 8 surveying flags

Station 6 - Macroinvertebrate Sampling bin contents:

- 8 pairs hip boots*
- 4 D-frame kick nets
- 4 white dishpans

Station 7 - Macroinvertebrate Identification bin contents:

- 4 laminated Keys to Macroinvertebrate Life in the River
- 4 white ice cube trays
- 12 white plastic spoons
- 4 tweezers
- 4 magnifying glasses
- 4 plastic cups

*Note: Hip boots may not be part of a station bin, depending on resources available. The number of pairs of hip boots indicated is recommended for groups of 8-12 individuals.

B. FIELD TRIP PROCEDURES

OVERALL FIELD TRIP PROCEDURES (Provide a copy of these to each Station Leader)

1. Students should be divided into six groups. At each station, students will work in pairs or groups of three.

2. Student groups will rotate through the following stations:

   Station 1: Transparency/Topographical Maps
   Station 2: Water Sample Collection/Temperature/Language Arts
   Station 3: Dissolved Oxygen
   Station 4: Stream flow
   Station 5: Habitat
   Station 6: Macroinvertebrate Collection
   Station 7: Macroinvertebrate Identification

   If only a few volunteers are available to lead station activities, the stations could be condensed as follows:

   1. Water sample/Dissolved Oxygen/Temperature
   2. Macroinvertebrate Collection and Identification/Transparency
   3. Habitat/Stream Flow

   If this option is chosen, each station will take approximately one hour to complete.

   In this situation, neither the Magic Spots Language Arts Activity nor the Topographical Maps activity would be part of a set station. These could be offered as an additional station or used by a station leader if they had extra time after completing regular station activities.

   Teachers may also opt to offer additional stations from suggested Extension Activities (page 2-25) to reduce group size if there is a large number of students to accommodate.

   No students should initiate the field trip at Station 7, as macroinvertebrates need to be collected prior to a group working at that station.

   It is recommended that the transparency station be located most upstream at your field location if possible to avoid students upstream from contaminating the transparency samples.

   The temperature and dissolved oxygen stations should be located near the transparency station to facilitate sharing of hip boots and delivering the water sample, respectively.

   Methods for each station should be used as a guideline for station leaders, but since students have prepared in advance, in general, methods are not designed to be handed out to the students (except for dissolved oxygen).

3. Allow approximately 30 minutes to complete each station. An additional 10 minutes should be allowed for students to move between stations and to act as a buffer for stations where students that may need a few extra minutes to complete their tasks.

4. One teacher, parent or volunteer should be assigned to blow a whistle or horn when there are five minutes left in each session, so station facilitators are aware of the time.

5. The lead teacher should collect student data sheets at the end of the field trip. However, for Middle School students or students who require more guidance; after students have completed the data collection at a station, station leaders can record student data on a station leader data sheet for the appropriate parameter (page 6-23). Station leaders should provide this completed data sheet to the lead teacher at the end of the field trip. There is no data sheet to complete at the macroinvertebrate collection station.

STATION 1: TOPOGRAPHICAL MAPS (FINDING YOUR WATERSHED AND TRANSPARENCY

TOPOGRAPHICAL MAP PROCEDURE:

1. Ask students to gather around a topographical map (not the one they'll use for their activity) for a general explanation of what the map shows and how to read it.
2. Explain what a topographical map shows (i.e., topography or a graphical representation of the earth's surface including elevation) and what that means in terms of watersheds and water flowing downhill to form streams, rivers and lakes.
3. Explain to students how to find the scale, legend and contour lines on the map. Talk through how to determine contour interval and steepness of slope based on the contour lines (the closer together the contour lines are, the steeper the slope).
4. Observe a watershed on the map with them, outlining (with your finger) watershed edges, and viewing streams and their direction of flow down gradients.
5. Explain that students will now be given topographical map(s) of the location of the field trip. They will be asked to answer several questions about the stream and the surrounding landscape.
6. Have students break into groups of three to complete the activity.
7. Students should study the map/images and locate their stream.
8. Students should complete the Finding Your Watershed worksheet.

TRANSPARENCY PROCEDURE:

Collecting the sample:

1. Collect the sample away from the river bank in the main flow area upstream from where you are standing. Enter the water downstream from the sampling location. Be careful not to stir up the bottom sediment upstream of your sampling location.
2. Face upstream (into the current).
3. Collect your water sample by holding your transparency tube horizontally and plunging it 8-12 inches beneath the surface or halfway down from the surface. Scoop away from your body and into the current.
4. Scoop water into the tube so it is filled to the top, or use a bucket to collect additional water from the stream at the site to fill the tube to the top.
5. Be careful not to collect water that has sediment from bottom disturbances (toss out the sample and try again if you get bottom sediment in your sample).
6. Return to shore with the sample.

Assessing transparency:

7. Remove large objects from the water sample. (Filter through nylon stocking if necessary.)

8. If the sample has settled, use a stirring stick to stir the sample, or pour the sample into a clean bucket and back into the transparency tube to suspend all materials.
9. Stand out of direct sunlight. If you cannot get to a shady place, use your body to cast a shadow on the tube.
10. If you are wearing sunglasses, remove them. Then look for the target (black and white) disc on the bottom of the tube. If the disc is visible, record the length of the tube (e.g., 120 cm) on the data sheet.
11. If the target disc is not visible, have your partner let water out a little at a time using the valve at the bottom until the disc is just visible. Have them stop letting water out immediately when you can just see the contrast between black and white on the disc.
12. Read the height of water in the tube using the measuring tape on its side.
13. Record the measurement on your data sheet in cm.
14. Dump contents of the tube on the ground.
15. Repeat steps 1 through 14. Record the second measurement in cm on your data sheet.
16. Add both of the readings, divide by 2, and record the average transparency on your data sheet.
17. Tell your results to your station leader.

STATION 2: TEMPERATURE/WATER SAMPLE/ MAGIC SPOTS

WATER SAMPLING PROCEDURE FOR DISSOLVED OXYGEN (for each pair or group of students):

1. One person per group should put on a pair of hip boots (or tall rubber boots).
2. Use a Hach dissolved oxygen sampling bottle (glass bottle with the stopper) to collect a sample in normally moving water.
3. Facing upstream, slowly lower the bottle so the opening of the bottle faces away from you, and water current is entering the bottle.
4. Allow the bottle to fill with water gradually, turning it to allow air bubbles to float out.
5. Cap the bottle while still submerged, and leave extra water in the neck of the bottle.
6. When lifting out of water, look for bubbles. If you see any, pour out the sample and collect another using the same procedure.
7. Immediately pass this sample on to the dissolved oxygen station for analysis.

TEMPERATURE MONITORING PROCEDURE (for each pair or group of students):

1. Use the thermometer to measure the air temperature. Record the temperature on your data sheet. Be careful to hold the thermometer away from its base, as that is where the sensor is located.
2. To measure water temperature, test in the middle of the stream where the water is moving, not in pools or backwater areas. Test near where the water samples were gathered.
3. Lower the thermometer about four inches below the surface, as close as possible to the middle of the stream.
4. Leave the thermometer immersed until the reading has stabilized. This usually takes about two minutes. Try to take the reading with the base of the thermometer still immersed. You can fill a clear plastic cup with water and raise it to eye level to read the temperature.
5. Record your measurement on your data sheet. If you measured in ° F, use the chart on the front to convert and record your measurement in ° C.
6. Tell your air and water temperature results to your station leader.

(Optional) *E. COLI* BACTERIA WATER SAMPLE COLLECTION PROCEDURE (for each pair or group of students):

1. One person should put on a pair hip boots (or tall rubber boots).
2. Wash hands with antibacterial hand wipes.
3. Put on nitrile or latex gloves.
4. Obtain a 30 mL collection bottle.
5. Label the sample bottle with student group number or names, location and date with a permanent marker.

6. With the bottle in hand, gently wade into the stream to the main area of flow. Walk slowly to avoid suspending sediments at the sampling site which could lead to false high *E. coli* counts.
7. Remove the bottle cap carefully so as to avoid touching the inside of the cap or bottle.
8. Sampling upstream from your location, face the open mouth of the bottle downward and immerse it 6-12 inches below the surface (or about midway down through the water column if the water depth does not allow sampling at this depth). While keeping it the same distance under the surface, turn and sweep the bottle in the direction of its opening, then turn it upright and remove it from the water.
9. After bringing the bottle above the surface, pour out a few centimeters of water so that there is a little bit of air space that will allow the sample to be mixed, then replace the lid on the bottle.
10. Place the sample in a cooler with ice packs to be transported back to your school.

MAGIC SPOTS, A LANGUAGE ARTS ACTIVITY PROCEDURE:

1. Explain to students that they will be making observations of their surroundings and recording those on their data sheet.
2. Explain that they will have about five minutes to sit quietly in a location on their own and assess what they see, hear, smell and feel in that area.
3. Also explain that they will have the opportunity to write a paragraph or a poem (Haiku) about the spot where they will sit.
4. Have students move to locations at least 10 feet from any other student. (If the teacher feels comfortable, and the group is mature enough, students can be asked to find a location out of sight of all other students. This can also be done in pairs.)
5. Begin timing this quiet activity and assisting students having difficulties with the assignment.
6. After the allotted time has passed, have the students come back to a central area and form a circle.
7. Ask each student to share something they observed during the activity. They can read a Haiku or a paragraph they wrote about their location, or they can share something they remember that was special or unique about the place where they sat.

STATION 3: DISSOLVED OXYGEN

FIXING THE DISSOLVED OXYGEN SAMPLE PROCEDURE:

These directions, with some minor modifications, are written for the Hach water testing kit for dissolved oxygen. Remember that photosynthesis and respiration will continue after a sample is collected, so water can gain or lose oxygen while sitting in the sample bottle. Therefore, you should ***BEGIN D.O. TESTING IMMEDIATELY UPON RECEIVING THE WATER SAMPLE.***

1. Put on protective gloves and safety goggles. If your skin comes in contact with any powder or titrant, rinse the area liberally with water.
2. Remove the stopper and add the contents of D.O. powder pillow #1 (manganous sulfate powder) and D.O. powder pillow #2 (alkaline iodide azide powder) to the sample.
3. Insert the stopper, being careful not to trap an air bubble and shake vigorously, holding on to the top. If oxygen is present, a brownish-orange floc will form.

Note:

If you see any air bubbles trapped in the sample bottle during steps 2 and 3, discard the sample and start over.

4. Allow the sample to stand until the floc settles halfway. Shake the bottle a second time and allow the floc to settle halfway again.
5. Remove the stopper and slowly add the contents of D.O. powder pillow #3 (sulfamic acid), taking care not to displace any floc.
6. Stopper and shake vigorously to dissolve the floc. Wait until all the floc is dissolved. The yellow color is from iodine. This is called the prepared sample. Prepared samples can be stored in the dark for a short time if it is more convenient or comfortable to return to your home/school to complete the analysis. Check with you teacher, if time enough remains at this station you may continue with the dissolved oxygen test.

Determining Dissolved Oxygen

7. Transfer two plastic measuring tubes full of prepared sample to the square glass mixing bottle. Using two measuring tubes allows you to determine D.O. to the nearest 0.5 mg/L.
    a.) Holding the dropper vertically, add one drop at a time of sodium thiosulfate standard solution titrant to the square mixing bottle, and count each drop.
    b.) Swirl the solution after each drop.
    c.) Continue adding sodium thiosulfate drops until the sample is a very light yellow.
    d.) Add 3 to 4 drops of starch solution. The prepared sample will turn blue from the added starch solution.
    e.) Continue adding drops of sodium thiosulfate, mixing and counting until the prepared sample turns from blue to colorless (the end point). Often this is just one or two more drops, so be careful.
8. The dissolved oxygen content of the water in mg/L is the total number of drops of titrant used to get to the endpoint divided by two if two measuring tubes of prepared sample were used. If only one measuring tube of prepared sample was used, the dissolved oxygen content is equal to the number of drops of titrant. Example: If you used two tubes of sample, you need to divide by two (13 drops divided by two tubes = 6.5 mg/L). If you only used one tube of sample, it's the actual number of drops of titrant used (6 drops with one tube = 6 mg/L).
9. Report the number of measuring tubes and the number of drops you used, and the calculated mg/L on your data sheet.
10. Tell your results to your station leader.

STATION 4: STREAM FLOW

PROCEDURE:

Safety considerations

You will need to enter the stream channel to make width and depth measurements and to calculate velocity. Be aware of stream velocity, water depth and bottom conditions at your stream-monitoring site. Do not attempt to measure stream flow if water velocity appears to be fast enough to knock you down when you are working in the stream. If you are unsure of water depth across the width of the stream, be sure to proceed with caution as you move across the stream, or choose an alternate point from which to measure stream flow.

Site location

1. At your monitoring site, locate a straight section of stream that is at least 20 feet in length and has a uniform width. The water should be at least 6 inches deep, and have some movement. Unobstructed runs or riffles are ideal sites to choose.

2. Measure 20 feet along the length of your chosen stream segment with your measuring tape and mark both the up and downstream ends of the section with flagging. Record this length on your data sheet.

Width and depth measurements

3. Working with a partner, measure stream width (from water's edge to water's edge) by extending a measuring tape across the stream at the midway point of your marked stream segment. Record the width in feet on your data sheet. (Using a tape measure graduated in tenths of feet will make calculations easier.)

4. Hold or secure the measuring tape to both shores so that the tape is taut and above the surface of the water. You might choose secrure the tape using shoreline vegetation or to attach the tape or a length of string to two stakes secured on opposite banks to create a transect line across the stream if it is impractical to hold the tape.

5. Using your engineer's ruler or pre-marked (in tenths of feet) pole, measure the water depth (ft) at one-foot intervals across the stream where you measured width (and secured the measuring tape). Be sure to measure depth in tenths of feet, not in inches. Record depth measurements (ft) on the data sheet. If your stream is greater than 20 feet wide, measure the depth in 20 equal intervals across the stream.

Velocity measurement

6. Velocity will be measured by tracking the time it takes a floating object to move the marked 20-foot length of stream. You will time the floating object (in seconds) a total of four times, at different locations across the stream. Repeating your measurements across the stream, in both slower and faster areas, will help to ensure the closest approximation to the stream's true velocity. This in turn will make your flow calculations more accurate. However, be sure your float travels freely downstream (during every float trial) without catching in slack water areas of the stream. For narrower streams (less than 10 feet), you can conduct only three float trials to assess velocity.

7. Position the person who will release the float upstream from the upper flag. Position the timekeeper with the stopwatch on the streambank (or out of the main flow path) at the downstream flag. Position the person who will catch the float downstream from the timekeeper. (Note: Unless velocity is very fast, the timekeeper should be able to catch the float with a net after they have finished timing its run down the stream.)

8. The float-releaser will gently drop the float into the stream a few feet upstream from the upper flag, and will alert the timekeeper to begin timing as the float passes the upstream flag (the float should have time to get up to speed by the time it passes the upper flag into the marked length of stream). If the float gets stuck on a log, rock or other obstruction, it should be released from the starting point again.

9. The timekeeper should stop the stopwatch as the float passes the downstream flag and retrieve the float using the net.

10. Record the float time for the first trial on the data sheet.

11. Repeat steps 8 and 9 for each of the remaining float time trials in different sections of the stream. Record the float time (seconds) for each trial on your data sheet.

STATION 5: HABITAT ASSESSMENT

Safety:

Water appearance and odor can indicate water pollution. However, it can also indicate a possible safety hazard. If you notice any unusual water characteristics, DO NOT ENTER THE WATER and contact your local DNR office to report it. Your safety is important to us.

Here is a list of normal and possibly hazardous characteristics of water:

Clear – Colorless, transparent.

Turbid – Cloudy brown. May be due to suspended silt or organic materials suspended in the water.

Milky – Cloudy-white or gray, not transparent. May be natural or due to pollution.

Foamy – May be natural or caused by excessive nutrients or detergents from pollution. (Foam that is several inches high and does not brush apart easily is generally due to some sort of pollution.)

Dark brown – Tea-colored. May indicate that a naturally occurring, harmless acid is being released into the stream.

Oily sheen – A multicolored reflection. Can occur naturally or it may indicate oil or other petro chemicals floating in the stream.

Orange/Reddish – May indicate acids draining into the water or iron bacteria.

Green – Caused by algae. May indicate excess nutrients are being released into the stream. No smell or a natural odor.

Sewage – May indicate the release of human waste material, livestock manure flow from an upstrea feed lot. If you smell sewage/manure or rotten eggs come from the stream, please do not enter the water. Notify the nearest DNR Service Center.

Chlorine – May indicate that a sewage treatment treatment plant is over-chlorinating its effluent or may be from swimming pool discharge. Also component of milk house cleaning.

Fishy – May indicate the presence of excessive algae growth or dead fish.

Rotten eggs – A sulfurous smell may indicate muck soils or sewage/manure pollution, as hydrogen sulfide gas is a product of organic decomposition.

Petroleum – May indicate an oil spill from boats, land or storm drains.

PROCEDURE:

1. Determine if your stream is a rocky-bottom or soft-bottom stream.
2. Measure and mark a 300 ft. section of the stream.
3. Obtain the appropriate Habitat Checklist (i.e., rocky-bottom or soft-bottom stream) and answer the questions on that sheet.
4. Total the habitat score for your stream.
5. Provide your results to your station leader.

STATION 6: MACROINVERTEBRATE COLLECTION

PROCEDURE:

1.At least two people in each group should put on hip boots. (It's great if everyone is able to wear them if possible.)

2. Follow the procedures below to select sampling sites and to collect macroinvertebrates properly in the type of habitat you are sampling.

3. Collect three sub-samples within the 300-foot stream section where you are monitoring. Combine them into one bin for a complete biotic index sample.

Selecting Sampling Sites

Rocky-bottom and soft-bottom streams support different kinds of organisms, so be sure to choose sites based on your stream type. Your goal is to collect as many different kinds of aquatic macroinvertebrates from different habitats to ensure an accurate site assessment. Be aware that different habitat types may have different sampling protocols and some have a greater diversity of organisms than others. If you have many habitats from which to choose, first collect two sub-samples from the habitat with the most diversity, then choose one other habitat from which to sample (see chart below). For example, if your stream has a rocky bottom, sample at two separate riffle areas and at one other habitat. If your stream has a soft bottom or does not have riffles, collect samples at undercut banks, submerged logs or snags before considering sampling from a leaf pack.

Habitat Type	Stream Type	Habitat
Riffles	Rocky bottom	Most diverse
Undercut banks	Rocky, soft bottoms	Diverse
Snag areas, tree roots	Rocky, soft bottoms	Less diverse
Leaf packs	Rocky, soft bottoms	Least diverse

MACROINVERTEBRATE RIFFLE SAMPLING PROCEDURE

1. Rinse the net and check to make certain it doesn't contain any debris from the last time it was used.

2. Fill your basins or buckets with about one inch of clean stream water.

3. Place the net firmly on the bottom of the stream so that the water flows into the net. Stand next to the net.

4. Have your partner position themselves upstream of the net as the kicker. They should not begin kicking until the timer tells them to begin.

5. The third student in the group (or one of the two if working in pairs), will need a stopwatch and will time the sample collection.

6. When the timer starts the stopwatch, the kicker will disturb the bottom substrate and dislodge macroinvertebrates by kicking for two minutes. Alternately, they can use their hands to pick up each rock immediately above to about 18 inches upstream of the net and rub each of them thoroughly to remove all critters clinging to it. They should gently replace the rocks in the stream after rubbing them. They should continue to pick up, rub and remove rocks for two minutes.

7. When sampling, if you find you have too much water in your bucket or if the water is too muddy, pour the excess/muddy water through your net. Then allow stream water to flow through the net to rinse the sample within it, being careful not to lose anything from within the net. Add some clean water to the basin and empty the contents of the net into it.
8. Carry the net to shore and dump the contents into one basin or bucket with water and/or organisms and debris from other habitats' sub-samples.
9. All organisms clinging to the net should be removed and placed in the basin.
10. When you have added three sub-samples to your basin, you have collected a complete biotic index sample. Return to shore with your basin.

MACROINVERTEBRATE SNAG SAMPLING PROCEDURE

(Snag areas are accumulations of debris caught on logs, stumps or other obstruction in the water.)

1. Rinse the net and check to make certain it doesn't contain any debris from the last time it was used.
2. Fill your basins or buckets with about one inch of clean stream water.
3. Select about a three-foot by three-foot area (for uniform comparisons) around the snag, tree roots, logs or other debris.
4. Scrape the surface of the tree roots, logs or other debris with your net. You can also disturb the surfaces by scraping them with the net, your hands or your foot, or you can pull off some of the bark to get at organisms hiding underneath.
5. Twenty jabs equals one sample.
6. To remove sediment, allow water to flow through the net while holding it in the stream. Be careful to keep the opening facing upstream so you don't lose any organisms.
7. Carry the net to shore and dump the contents into one basin or bucket with water and/or organisms and debris from other habitats' sub-samples.
8. All organisms clinging to the net should be removed and placed in the basin.
9. When you have added three sub-samples to your basin, you have collected a complete biotic index sample. Return to shore with your basin.

MACROINVERTEBRATE UNDERCUT BANK SAMPLING PROCEDURE

(Undercut banks have scooped-out areas just below the surface of the water. This creates a bank that slightly overhangs on the surface of the water, and proivdes habitat for many kinds of organisms underneath).

1. Rinse the net and check to make certain it doesn't contain any debris from the last time it was used.
2. Fill your basins or buckets with about one inch of clean stream water.
3. Facing the bank, move the net in a bottom-to-surface motion along the undercut bank to dislodge organisms. Jabbing the net about 20 times should provide enough organisms for your sample.

4. Carry the net to shore and dump the contents into one basin or bucket with water and/or organisms and debris from other habitats' sub-samples.

5. All organisms clinging to the net should be removed and placed in the basin.

6. When you have added three sub-samples to your basin, you have collected a complete biotic index sample. Return to shore with your basin.

MACROINVERTEBRATE LEAF PACK SAMPLING PROCEDURE

1. Rinse the net and check to make certain it doesn't contain any debris from the last time it was used.

2. Fill your basins or buckets with about one inch of clean stream water.

3. Look for old leaf packs that are dark brown, slimy and slightly decomposed.

4. Working in pairs, position the dip net downstream from the leaf pack. Use your feet or hands to (or have your partner) gently move the leaf pack into the net.

5. Carry the net to shore and dump the contents into one basin or bucket with water and/or organisms and debris from other habitats' sub-samples.

6. All organisms clinging to the net should be removed and placed in the basin.

7. When you have added three sub-samples to your basin, you have collected a complete biotic index sample. Return to shore with your basin.

STATION 7: MACROINVERTEBRATE IDENTIFICATION

MACROINVERTEBRATE IDENTIFICATION PROCEDURE:

1. You will be assigned a dishpan to examine.
2. Examine leaves, sticks and other large objects in the sample for any macroinvertebrates that might be hiding.
3. After examining this debris, place it in another container to check later for organisms that may crawl out.
4. Fill the ice cube tray half-full of water.
5. Use plastic spoons to sort out the macroinvertebrates and place macroinvertebrates that look alike together in their own ice cube tray compartments. Sorting and placing similar looking macroinvertebrates together will help insure that you find all varieties of species in the sample.
6. Refer to the *Key to Macroinvertebrate Life in the River,* the macroinvertebrate wild cards and the citizen monitoring biotic index data sheet to identify the aquatic macroinvertebrates.
7. On the citizen monitoring biotic index data sheet, circle the animals on the data sheet that match those found in your sample.
8. Count the number of types of animals that are checked in each group and write that number in the box for each group on your data sheet. (Note: Do not count individual animals that you collected. Only count the number of types of animals found in each group.)
9. Report the number you circled for each group to your station leader for his/her data sheet.
10. Safely return all macroinvertebrates to the stream after sorting and identifying them.

C. STUDENT FIELD DATA SHEETS

Student Name ______________________________________ Date ______________________ Time _____________

Stream ____ Location ______________________________________

Parameter to find	Your Group's Results			Units
Transparency	trial 1	trial 2	average	cm
Water Temperature				˚C
Air Temperature				˚C
Weather	☐ sunny ☐ partly sunny ☐ mostly cloudy ☐ raining ☐ snowing			--
Dissolved Oxygen	# drops of thiosulfate / 2 = ________			mg/L
Habitat Score	Total of all scores from Habitat Checklist _______			--

Stream Flow

Length assessed ______________

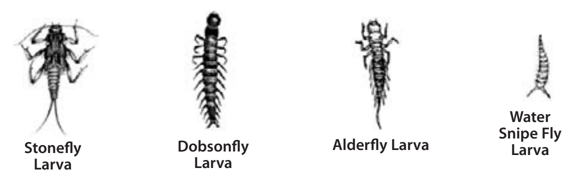
Stream width ________________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

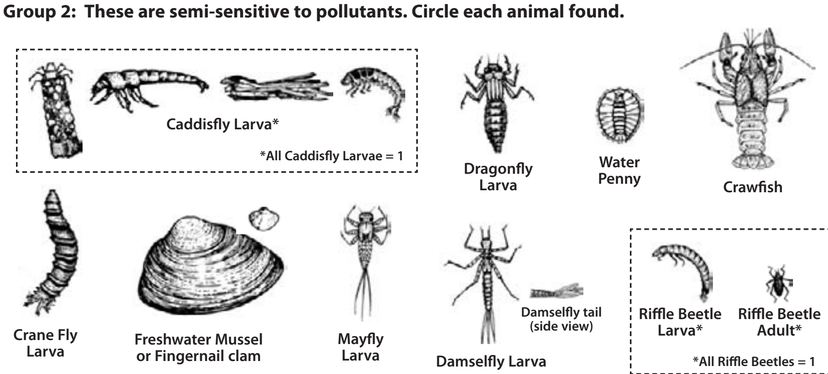
Velocity float trials	Time (seconds)
1	
2	
3	
4	

Biotic Index (size of illustrations not proportional)

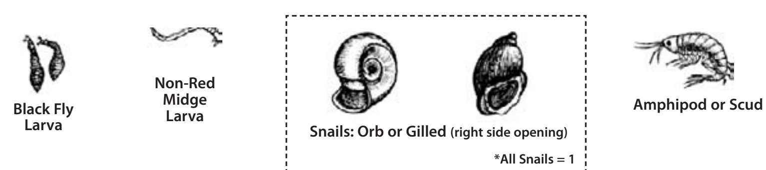
Group 1: These are sensitive to pollutants. Circle each animal found.



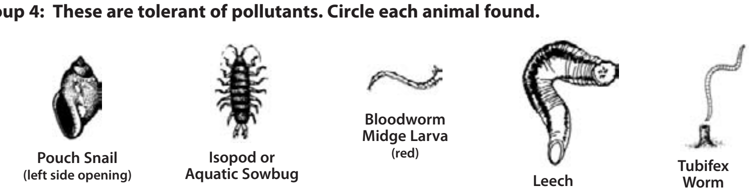
Group 2: These are semi-sensitive to pollutants. Circle each animal found.



Group 3: These are semi-tolerant of pollutants. Circle each animal found.



Group 4: These are tolerant of pollutants. Circle each animal found.



Finding Your Watershed

Refer to your map and answer the following questions:

1. **What is the scale on this map?** ______________________________

2. **Locate the stream you are studying. Now locate your school. What is the straight-line distance from stream to your school? (Estimate the distance if your school and the stream site are not located on the same map.)**

____

3. **What bodies of water flow into the stream you are studying?** ______________________________

4. **Are the contour lines close together or far apart near the stream at your monitoring site?** ______________

5. **What does this tell you about the slope of the land alongside the stream?**

____

6. **Describe the watershed surrounding this stream (e.g., How is the land used?, What is the topography like?, etc.)**

____

____

7. **What body of water does this stream flow into?** ______________________________

8. **What else can you say about this stream and the land nearby it, by studying this map?**

____

____

Magic Spot

Take a moment to observe your surroundings using four of your senses. List descriptive words for each:

SIGHT	HEARING	SMELL	TOUCH
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________

Now use some of those descriptive words to write about this location/experience/habitat, etc. You might choose to write a few Haikus (three lines consisting of 5-7-5 syllables, respectively) or a descriptive paragraph.

____

____

____

____

____

Student Name ______________________________________ Date ______________________ Time ______________

Stream ____ Location ____

Habitat Assessment for ROCKY-Bottom Streams

Directions: Each parameter is listed in the column along the left-hand side, starting with riparian vegetation. Read each numbered category in the row to find the best match for your stream. Circle the number in that category. Add up your scores for both left and right banks (or one total score) and enter total at left under parameter description. **Determine left or right banks by looking upstream (where water is coming from).**

Habitat Parameter	4	3	2	1
1. Riparian Vegetation Estimate width of riparian vegetation along each bank. Score entire 300 ft. Left Bank: ____________ Right Bank ____________ Total Score: ____________	Width of riparian vegetation is more than 50 feet; no evidence of human activities (e.g. parking lots, roadbeds, mowed areas, crops, clearcuts) within the zone. Left Bank: 4 Right Bank: 4	Width of riparian vegetation is 36-50 feet. Left Bank: 3 Right Bank: 3	Width of riparian vegetation is 20-35 feet. Left Bank: 2 Right Bank: 2	Width of riparian vegetation is less than 20 feet. Left Bank: 1 Right Bank: 1
2. Bank Vegetation Estimate percentage of vegetation along each bank. Score entire 300 ft. Left Bank: ____________ Right Bank: ____________ Total Score: ____________	More than 90% of the streambank surfaces covered by natural vegetation, including trees, shrubs, or other plants. No evidence of grazing or mowing; almost all plants allowed to grow naturally. Left Bank: 4 Right Bank: 4	Seventy to 90% of the streambank surfaces covered by natural vegetation; plant variety limited to one or two species. Slight vegetative disruption evident. Left Bank: 3 Right Bank: 3	Fifty to 69% of the streambank surfaces covered by vegetation. Patches of bare soil or closely cropped vegetation more common. Left Bank: 2 Right Bank: 2	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very common; vegetation has been cut to 2 inches or less; resembles a lawn. Left Bank: 1 Right Bank: 1
3. Bank Stability Estimate stability of each bank. Note: artificial embankments are classified as channel alterations in #4. Score entire 300 ft. Left Bank: ____________ Right Bank ____________ Total Score: ____________	Banks stable – no evidence of erosion or bank slumping (less than 5%). Left Bank: 4 Right Bank: 4	Moderately stable; infrequent, small areas of erosion mostly healed over with new vegetation evident. Left Bank: 3 Right Bank: 3	Moderately unstable; over half of banks in site have areas of erosion; high erosion potential during floods (no vegetation, steeply sloping banks). Left Bank: 2 Right Bank: 2	Unstable; many eroded areas; bare areas frequent along straight sections and bends; obvious bank collapse or failure; half to all of the bank has erosional scars. Left Bank: 1 Right Bank: 1
4. Channel Alteration Estimate extent of channel modification for entire 300 ft. Total Score: ____________	Stream with normal or meandering pattern. No channelization, dredging or artificial embankments (e.g., riprap). 4	Some stream straightening, artificial embankments or dams are present, (usually in area of bridge abutments) no evidence of recent channel alteration activity. 3	Artificial embankments present on both banks and more than half of stream site straightened, dredged or otherwise altered. 2	Banks shored with gabions (a fortified embankment) or concrete; over 80% of the site straightened or disrupted. 1
5. Channel Flow Status Assess water level within stream channel for entire 300 ft. Total Score: ____________	Water reaches base of both shorelines and a minimal amount of channel substrate is exposed. 4	Water fills more than 75% of the channel; some channel substrate is exposed. 3	Water fills about half of the channel and/or riffle substrates are mostly exposed. Water is shallow (less than 18 inches deep). 2	Very little water in channel. 1

Flip over for more

(continued from other side)

Habitat Assessment for ROCKY-Bottom Streams

Habitat Parameter	4	3	2	1
6. Streamvelocity/depth To estimate velocity, time how long it takes a stick to float 20 ft. Repeat five times. Divide average time into 20 to get feet per second. Slow is less than one foot per second. Shallow is <18".	All four velocity/depth combinations are present: A. slow/deep B. fast/deep C. slow/shallow D. fast/shallow	Three of the four velocity/ depth combinations are present. Circle three that are present: A. slow/deep B. fast/deep C. slow/shallow D. fast/shallow	Only two of the four velocity/ depth combinations are present. Circle two that are present: A. slow/deep B. fast/deep C. slow/shallow D. fast/shallow	Dominated by one velocity/ depth category. Circle one that is present: A. slow/deep B. fast/deep C. slow/shallow D. fast/shallow
Total Score: ____________	4	3	2	1
7. In-stream habitat for fish Assess available habitat structure for fish within the stream. Score entire 300 ft.	Over 50% of the site has submerged logs, undercut banks, large rocks/cobble or other stable habitat.	Thirty percent to 50% of site has submerged logs, undercut banks, large rocks/cobble or other stable habitat.	Less than 30% of site has submerged logs, undercut banks, rocks/cobble or other stable habitat.	Less than 10% of site has any fish habitat; lack of habitat obvious.
Total Score: ____________	4	3	2	1
8. Sediment Deposition Sediments are naturally deposited in slow-flow parts of streams. High levels of deposition create an unstable, continually changing bottom.	Very little of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars.	Less than half of the bottom affected; moderate accumulation; substantial sediment/sand movement only during major storm event; some new increase in bar formation.	More than half of bottom affected with major deposits; pools shallow, heavily silted; large deposits may be present on both banks; sediment deposits are an obstruction to the water flow.	Heavy deposits of fine material. Increased bar development. More than 50% of the bottom changing frequently. Pools almost absent due to substantial sediment/ sand deposition.
Total score: ____________	4	3	2	1
9. Embeddedness Estimate how much sand or sediment is burying rocks in stream bottom. Assess only at riffle or run areas (fast, turbulent waters).	Rocks are easy to move, very little surrounding sediment.	Rocks are half buried by fine sediment, more difficult to move.	Rocks mostly covered by fine sediment and need to be dislodged.	Fine sediment covering rocks; mostly buried. Rocks will not dislodge without digging out.
Total score: ____________	4	3	2	1
10. Attachment Sites for Macroinvertebrates Assess riffle size and substrate as habitat for macroinvertebrates. Assess only at riffle areas (fast, turbulent waters).	Riffle is as wide as stream and length is twice as long; cobble predominates; boulders and gravel are common.	Riffle is as wide and as long as stream width. Cobble less abundant; boulders and gravel common.	Riffle is not as wide as stream and length is less than the width. Run area may be lacking. Gravel or large boulders and bedrock prevalent; some cobble present.	Riffle is virtually non-existent; large boulders and bedrock prevalent; cobble lacking.
Total score: ____________	4	3	2	1

Grand total score for 1-10 ___________

Student Name ______________________________ Date ____________________ Time ____________

Stream ________________________________ Location ______________________________

Habitat Assessment for SOFT-Bottom Streams

Directions: Each parameter is listed in the column along the left-hand side, starting with riparian vegetation. Read each numbered category in the row to find the best match for your stream. Circle the number in that category. Add up your scores for both left and right banks (or one total score) and enter total at left under parameter description. **Determine left or right banks by looking upstream (where water is coming from).**

Habitat Parameter	4	3	2	1
1. Riparian Vegetation Estimate average width of riparian vegetation along each bank for entire 300 ft. Left Bank: ________ Right Bank ________ Total Score: ________	Width of riparian vegetation is more than 50 feet; no evidence of human activities (e.g. parking lots, roadbeds, mowed areas, crops, clearcuts) within the zone. Left Bank: 4 Right Bank: 4	Width of riparian vegetation is 36-50 feet. Left Bank: 3 Right Bank: 3	Width of riparian vegetation is 20-35 feet. Left Bank: 2 Right Bank: 2	Width of riparian vegetation is less than 20 feet. Left Bank: 1 Right Bank: 1
2. Bank Vegetation Estimate percentage of vegetation along each bank for entire 300 ft. Left Bank: ________ Right Bank: ________ Total Score: ________	More than 90% of the streambank surfaces covered by natural vegetation, including trees, shrubs, or other plants. No evidence of grazing or mowing; almost all plants allowed to grow naturally. Left Bank: 4 Right Bank: 4	Seventy to 90% of the streambank surfaces covered by natural vegetation; plant variety limited to one or two species. Slight vegetative disruption evident. Left Bank: 3 Right Bank: 3	Fifty to 69% of the streambank surfaces covered by vegetation. Patches of bare soil or closely cropped vegetation more common. Left Bank: 2 Right Bank: 2	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very common; vegetation has been cut to 2 inches or less; resembles a lawn. Left Bank: 1 Right Bank: 1
3. Bank Stability Assess bank stability/ erosion for entire 300 ft. Left Bank: ________ Right Bank ________ Total Score: ________	Banks stable – no evidence of erosion or bank slumping (less than 5%). Left Bank: 4 Right Bank: 4	Moderately stable; infrequent, small areas of erosion mostly healed over with new vegetation evident. Left Bank: 3 Right Bank: 3	Moderately unstable; over half of banks in site have areas of erosion; high erosion potential during floods (no vegetation, steeply sloping banks). Left Bank: 2 Right Bank: 2	Unstable; many eroded areas; bare areas frequent along straight sections and bends; obvious bank collapse or failure; half to all of the bank has erosional scars. Left Bank: 1 Right Bank: 1
4. Channel Alteration Estimate extent of channel modification for entire 300 ft. Total Score: ________	Stream with normal or meandering pattern. No channelization, dredging or artificial embankments (e.g., riprap). 4	Some stream straightening, artificial embankments or dams are present, (usually in area of bridge abutments) no evidence of recent channel alteration activity. 3	Artificial embankments present on both banks and more than half of stream site straightened, dredged or otherwise altered. 2	Banks shored with gabions (a fortified embankment) or concrete; over 80% of the site straightened or disrupted. 1
5. Channel Flow Status Assess water level within stream channel for entire 300 ft. Total Score: ________	Water reaches base of both shorelines and a minimal amount of channel substrate is exposed. 4	Water fills more than 75% of the channel; some channel substrate is exposed. 3	Water fills about half of the channel and/or riffle substrates are mostly exposed. Water is shallow (less than 18 inches deep). 2	Very little water in channel; banks blown out by excessive erosion and the normal flow does not reach the new shorelines. 1

Flip over for more

(continued from other side)

Habitat Assessment for SOFT-Bottom Streams

Habitat Parameter	4	3	2	1
6. Channel Sinuosity Assess how bends in the stream affect its length for entire 300 ft.	The bends in the stream increase the stream length by three or four times if the channel were straightened out.	The bends in the stream increase the stream length more than two to three times if the channel were straightened out.	The bends in the stream increase the stream length one to two times if the channel were straightened out.	Channel is straight; waterway has been straightened for a long distance.
Total Score: ____________	4	3	2	1
7. Sediment Deposition Sediments are naturally deposited in slow-flow parts of streams. High levels of deposition create an unstable, continually changing bottom.	Very little of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of islands or point bars.	Less than half of the bottom affected; moderate accumulation; substantial sediment/sand movement only during major storm event; some new increase in bar formation.	More than half of bottom affected with major deposits; pools shallow, heavily silted; large deposits may be present on both banks; sediment deposits are an obstruction to the water flow.	Heavy deposits of fine material. Increased bar development. More than 50% of the bottom changing frequently. Pools almost absent due to substantial sediment/sand deposition.
Total score: ____________	4	3	2	1
8. Pool Variability Assess pool size and depth. Shallow=less than 18 inches deep. Score pools within entire 300 ft.	All size/depth combinations present: A. large-shallow B. large-deep C. small-shallow D. small-deep	Majority of pools: A. large-deep	Majority of pools: A. shallow	Majority of pools: A. small-shallow or B. absent
Total score: ____________	4	3	2	1
9. Pool Substrate Assess bottom materials within pools. Score pool areas only.	Mixture of substrate materials with gravel and firm sand prevalent. Root mats, submerged vegetation or other fish cover common.	Mixture of soft sand, mud, or clay; mud may be dominant. Some root mats, submerged vegetation or other fish cover present.	All mud, clay or sand bottom. Little or no root mat, submerged vegetation, or other fish cover.	Hardpan clay or bedrock; no cover of any kind for fish or other aquatic life.
Total score: ____________	4	3	2	1
10. Attachment Sites for Macroinvertebrates; Shelter for Fish Assess habitat structure for fish and macroinvertebrates. Score entire 300 ft.	Over half of the site has submerged logs, snags, undercut banks or other stable habitat that provides cover for fish and aquatic life.	One-third to one-half of the site has submerged logs, undercut banks or other stable habitat.	Less than one-third of the site has submerged logs, undercut banks or other stable habitat.	Very little fish habitat; lack of habitat for fish and aquatic life obvious.
Total score: ____________	4	3	2	1

Grand total score for 1-10 ___________

D. STATION LEADER DATA SHEETS

Station Leader Worksheet

BIOTIC INDEX

Station Leader: ____

Please use this form to record the requested data from each pair/group of students who visit your station today. Provide this completed form to the lead teacher at the end of the field trip.

	# ANIMALS CIRCLED			
FIELD TEAM (Student Names)	Group 1	Group 2	Group 3	Group 4

 # ANIMALS CIRCLED

FIELD TEAM (Student Names)	Group 1	Group 2	Group 3	Group 4

DISSOLVED OXYGEN

Station Leader: ____

Please record requested data from each pair/group of students who visits your station today, then provide the completed data sheet to the lead teacher at the end of the field trip.

FIELD TEAM (Student Names)	mg/L

HABITAT ASSESSMENT

Station Leader: ____

Please indicate whether studenst are assessing a rocky-bottom or soft-bottom stream. All students on a given field trip should use the same form. Record the requested data from each pair/group of students who visit your station today. Please report total scores for each habitat question and the overall total score for each group, then provide the completed data sheet to the lead teacher at the end of the field trip.

Rocky-bottom stream _____________ ***Soft-bottom stream***_________

Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______
Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______
Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______
Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)__________ ________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______

Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______
Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team(Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______
Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______
Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______
Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______
Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______	Field Team (Student Names)___________ __________________________________ 1 ____ 6 ____ 2 ____ 7 ____ 3 ____ 8 ____ 4 ____ 9 ____ 5 ____ 10 ____ Total ______

TRANSPARENCY

Station Leader: ____

Please record requested data from each pair/group of students who visit your station today, then provide the completed data sheet to the lead teacher at the end of the field trip.

FIELD TEAM (Student Names)	TRIAL 1 cm above target	TRIAL 2 cm above target	AVERAGE cm above target

TEMPERATURE

Station Leader: ____

Please record requested data from each group of students who visit your station today, then provide the completed data sheet to the lead teacher at the end of the field trip.

FIELD TEAM (Student Names)	AIR TEMP. °C	WATER TEMP. °C

STREAM FLOW

Station Leader: ____

Please record requested data from each group of students who visit your station today, then provide the completed data sheet to the lead teacher at the end of the field trip.

Stream Flow

Field Team (Student Names):
____
____

Length assessed ___________

Stream width _____________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Velocity float trials	Time (seconds)
1	
2	
3	
4	

Stream Flow

Field Team (Student Names):
____
____

Length assessed ___________

Stream width _____________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Velocity float trials	Time (seconds)
1	
2	
3	
4	

Stream Flow

Field Team (Student Names):
____
____

Length assessed ___________

Stream width _____________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Velocity float trials	Time (seconds)
1	
2	
3	
4	

Stream Flow

Field Team (Student Names):
____
____

Length assessed ___________

Stream width _____________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Velocity float trials	Time (seconds)
1	
2	
3	
4	

Stream Flow

Field Team (Student Names):

____

____

Length assessed __________

Stream width ____________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Velocity float trials	Time (seconds)
1	
2	
3	
4	

Stream Flow

Field Team (Student Names):

____

____

Length assessed __________

Stream width ____________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Velocity float trials	Time (seconds)
1	
2	
3	
4	

Stream Flow

Field Team (Student Names):

____

____

Length assessed __________

Stream width ____________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Velocity float trials	Time (seconds)
1	
2	
3	
4	

Stream Flow

Field Team (Student Names):

____

____

Length assessed __________

Stream width ____________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Velocity float trials	Time (seconds)
1	
2	
3	
4	

Stream Flow

Field Team (Student Names):

____

____

Length assessed __________

Stream width ____________

Interval	Depth (indicate units)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Velocity float trials	Time (seconds)
1	
2	
3	
4	

Copy for as many groups there will be monitoring stream flow on the field trip.