

**Beth Oehler**

## **Water Quality and Human Activities**

**Overview:** In this lesson, students will collect data about the levels of dissolved oxygen, temperature, pH, and macroinvertebrates and use this data to determine the health of a stream or river. Next, students will divide into small groups to brainstorm the impacts that a proposed development would have on the water quality and present their “Environmental Impact Statement” to the group.

### **National Geography Standards:**

**#8** The characteristics and spatial distribution of ecosystems and biomes on Earth’s surface

**#14** How human actions modify the physical environment

### **Oregon Geography Content Standards:**

**6.15** Explain how people have adapted to or changed the physical environment in the Western Hemisphere.

### **Oregon Science Content Standard:**

**MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystems affect populations.

### **Connections to Common Core:**

**6-8 WH.1** Write arguments focused on discipline-specific content.

**6-8 WH.9** Draw evidence from informational texts to support analysis, reflection, and research.

### **Objectives:**

In completing this activity, students should be able to

- gather evidence of stream quality by collecting data and sampling macroinvertebrates.
- use a key to identify aquatic organisms.
- explain how human’s actions and land use practices could affect stream health.

**Grade Levels:** 6 - 8

**Time:** 2 hours (plus travel time)

## **Materials:**

Taxonomic keys or identification books for aquatic macroinvertebrates (available online at <http://www.stroudcenter.org/education/MacroKeyPage1.shtm> or <http://www.creekfreaks.net/sites/default/files/attachments/key%20to%20stream%20macroinvertebrates.pdf> )

Sampling equipment (such as seine nets, sieves, fish nets) (Directions on how to build your own can be found here: <http://www.creekfreaks.net/sites/default/files/attachments/How%20To%20nets.pdf>)

Assorted containers (such as tubs, ice cube trays or buckets)

Eye droppers

Forceps or tweezers

Magnifying lenses

Thermometers

Water quality test kits (for dissolved oxygen, pH, and nitrates) – usually available from your local watershed education council or university or from a scientific supply store.

Worksheets #1, #2, Role Sheets and hints (*found at the end of this lesson*).

## **Background for the teacher:**

The teacher will need to determine the stream site before the lesson to make sure it is appropriate. He/she should have some knowledge about how streams are affected by changes in temperature, dissolved oxygen, pH, soil compaction, erosion, and pollution. The teacher should have a basic understanding of life stages of insects. This website has Great background for teachers as to how DO, pH, temperature and turbidity affect the health of a stream:

[http://www.longwood.edu/cleanva/world\\_water\\_monitoring\\_va/resized%20images/water\\_quality\\_parameter\\_info\\_acb.pdf](http://www.longwood.edu/cleanva/world_water_monitoring_va/resized%20images/water_quality_parameter_info_acb.pdf). This one explains how the different measurements collected can

indicate the health of a stream: <http://www.hawaii.edu/gk-12/evo/erinb.streams.factors.htm>.

Another great resource is Stream Scene: Watersheds, Wildlife and People, which is published by the Oregon Department of Fish and Wildlife and is available as a PDF file at this website:

<http://www.fs.fed.us/outdoors/naturewatch/implementation/Curricula/Stream-Scene.pdf>

## **Background for the student:**

Students should have background knowledge about pH (specifically the scale and what the numbers mean generally) before going out to collect stream data.

It would be helpful, but not necessary, for students to understand that aquatic insects go through life stages (egg/larva/pupa/adult) and can look very different in the larval stage versus the adult stage.

## Vocabulary for students:

- macroinvertebrates
- aquatic
- riparian
- organisms
- erosion
- sediments
- organic matter (detritus)
- microorganisms
- migration
- biodiversity
- pH
- dissolved oxygen (BOD = biological oxygen demand)

## Procedures:

1. Select a nearby stream to conduct the sampling which is accessible for the group size and abilities. Be sensitive to the impact your students will have on the stream. Discuss safety with students and show them how to use the sampling equipment ethically and safely. (Adult supervision for each of the tests is recommended.)
2. Start by observing the water, looking for organisms that might be on the surface or in the depth. Using the sampling equipment, have the students collect as many different forms of animal life as possible. Ask them to look under rocks, in the riffles as well as in the pools. Place the organism caught in one of the trays for observation after mentally noting the location where it was found.
3. Have the students identify and sketch each different species of animal collected. (Assign each student or student pair one animal to sketch and identify). They should do this on worksheet #1 (*found at the end of this lesson*).
4. Ask them to count the total number of their species collected by the entire group and record that on worksheet #1 as well. Then, ask them to figure out how many different species the group collected and record that on the worksheet. Carefully return all of the organisms to the stream, in the same location that they were found (as close as possible).
5. Assign each group of students a test to complete – dissolved oxygen, pH, nitrates, temperature. Have one person be the “Project Manager” and each sampling group should report their findings to that person who will record on worksheet #2 (*found at the end of this lesson*).
6. Gather the group together and discuss their findings. Help the students understand that the values for pH, water temperature, dissolved oxygen and nitrates affect the diversity of life forms found in aquatic environments. Ranges that support aquatic life can be found in the Aquatic Project Wild (or Project Wet) Education Activity Guide in the activity titled “Water Canaries”. (Workshops for teachers are offered at <http://projectwild.org/>)
7. Together as a class, determine how healthy this stream is. Discussion questions could include:

**pH:** What organisms have a limited pH range? What do you think would happen if the pH of this stream increased? What might cause this to happen?

**Temperature:** What organisms do well in really cold water? Did we find any of these in this stream? What might cause the water to become warmer? Is it the same temperature all year?

**Dissolved Oxygen:** Why do organisms need oxygen? Is it possible to have too much oxygen?

**Biodiversity:** Are there many different types of organisms, or mostly all of the same species?

**Other:** What other factors might affect these organisms? (run-off, erosion, flooding, pollution, etc.)

8. In teams of 2 – 3, students will brainstorm the impacts that a proposed development would have on the water quality. Hand each group a role sheet (*found at the end of this lesson*) and have them discuss how the water quality would change if this development occurred upstream of this spot. Give them ten or fifteen minutes to work before passing out the “hints” sheet to each group.
9. Students groups present their ideas to the whole class. (This can be done back in the classroom).

## **Assessment:**

Students will be able to list things that humans do that decrease water quality in streams as well as explain how these actions affect the organisms that live in the ecosystem. Assessment and scoring rubric can be found at the end of this lesson.

## **Extensions:**

1. Have students read the essay “Putting the Dead Trees Back Where They Belong” in the Level 6 Forest Essays booklet available from Oregon Forest Resource Institute (<http://oregonforests.org>). A digital copy of this essay can be found at [http://learnforests.org/sites/default/files/OFRI\\_essaybooklet\\_gr6\\_WEB.pdf](http://learnforests.org/sites/default/files/OFRI_essaybooklet_gr6_WEB.pdf)
2. Have students work on a stream restoration project with a local conservation group.
3. Have students map the habitat of the stream from the perspective of one of the animal’s that they captured. What are the important parts of its habitats and where are they located?
4. Students could research “extremophile” which are organisms that live in extreme environments (like fish that live in highly acidic or alkaline water) and answer questions such as: If the stream environment changed, would other organisms move in? Is this a bad thing? Why or why not?

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# Worksheet #1: Macroinvertebrate Identification

Group Members: \_\_\_\_\_

Use the key to identify your organism:

Where in the stream was this organism found?

Sketch your organism here:

How many total of **these** organisms were caught by the entire class? \_\_\_\_\_

How many **different** species of organism were caught by the entire group? \_\_\_\_\_

## Worksheet #2

Water Quality Data for \_\_\_\_\_  
(stream name and/or sampling location)

Test Conducted	Sample #1	Sample #2
Water Temperature		
Air Temperature		
pH		
Dissolved O <sub>2</sub>		
Nitrates		

## **Role Card #1: Hydroelectric Company**

You are an hydroelectric company that wants to build a dam at a site upstream of this spot. You'll need to complete an environmental impact statement before you build your dam. Work together with your group to brainstorm what this statement might say.

What are some reasons people build dams?

What impacts do you think your activities will have on the water quality of the stream? List as many as you can.

Which of these impacts will make the stream healthier? Put a smiley face by each of these.

Which of these impacts will negatively affect the health of the stream? Circle each of these.

What do you think could be done to minimize the negative impacts?

## **Role Card #2: Lumber Company**

You are a lumber company that wants to log trees at a site upstream of this spot. You'll need to complete an environmental impact statement before you cut down any trees. Work together with your group to brainstorm what this statement might say.

What are some reasons people cut down trees?

What impacts do you think your activities will have on the water quality of the stream? List as many as you can.

Which of these impacts will make the stream healthier? Put a smiley face by each of these.

Which of these impacts will negatively affect the health of the stream? Circle each of these.

What do you think could be done to minimize the negative impacts?

### **Role Card #3: Cattle Rancher**

You are a cattle rancher that wants to let your cattle graze at a site upstream of this spot. You'll need to complete an environmental impact statement before you are allowed to have cows range on the land. Work together with your group to brainstorm what this statement might say.

What are some reasons people raise cattle?

What impacts do you think your activities will have on the water quality of the stream? List as many as you can.

Which of these impacts will make the stream healthier? Put a smiley face by each of these.

Which of these impacts will negatively affect the health of the stream? Circle each of these.

What do you think could be done to minimize the negative impacts?

## **Role Card #4: City Planner**

You are a city planner that wants to build a wastewater treatment plant at a site upstream of this spot. You'll need to complete an environmental impact statement before you build your plant. Work together with your group to brainstorm what this statement might say.

What are some reasons cities need wastewater treatment plants?

What impacts do you think your activities will have on the water quality of the stream? List as many as you can.

Which of these impacts will make the stream healthier? Put a smiley face by each of these.

Which of these impacts will negatively affect the health of the stream? Circle each of these.

What do you think could be done to minimize the negative impacts?

## **Role Card #5: Recreation Enthusiast**

You are a recreation enthusiast that wants to build a campground at a site upstream of this spot. You'll need to complete an environmental impact statement before you build your campground. Work together with your group to brainstorm what this statement might say.

What are some reasons people build campgrounds?

What impacts do you think your activities will have on the water quality of the stream? List as many as you can.

Which of these impacts will make the stream healthier? Put a smiley face by each of these.

Which of these impacts will negatively affect the health of the stream? Circle each of these.

What do you think could be done to minimize the negative impacts?

## **Role Card #6: Civil Engineer**

You are a civil engineer that wants to build a bridge at a site upstream of this spot so that cars can cross the stream. You'll need to complete an environmental impact statement before you build your bridge. Work together with your group to brainstorm what this statement might say.  
What are some reasons people build bridges?

What impacts do you think your activities will have on the water quality of the stream? List as many as you can.

Which of these impacts will make the stream healthier? Put a smiley face by each of these.

Which of these impacts will negatively affect the health of the stream? Circle each of these.

What do you think could be done to minimize the negative impacts?

## **Hints! These activities might affect the streams by....**

### **#1 Dams**

Dams are important to control flooding, provide water for irrigation during dry seasons, and to produce electricity. However, they can also interrupt the natural cycles of the river, which might change the riparian vegetation. Dams remove sediments (and therefore nutrients) from the river because they cause the water upstream to slow and drop their sediment loads. Dams can increase or decrease the temperature of the water, depending on whether the water is released from the top or the bottom of the dam. Warm water holds less dissolved oxygen and promotes bacteria growth. Dams block fish migration (although a fish ladder can be added to enable fish to still move upstream). When water is released in large amounts (to produce electricity or to prevent future flooding), there may be increased erosion of the riverbanks downstream. More erosion may mean that there are more sediments in the stream, which reduces light for the aquatic plants so that they produce less oxygen. In addition, filtering macro-invertebrates can be harmed by the increased amount of sediments.

### **#2 Logging**

Wood and wood products are important because we use them for building our homes as well as making paper. Trees are considered a renewable resource, as they can be replanted and grown relatively quickly. Harvesting timber often requires building roads so that the lumber can be removed via logging trucks. In addition, the removal of trees can increase soil erosion as tree roots are important to keep soil in place. More erosion may mean that there are more sediments in the stream, which reduces light for the aquatic plants so that they produce less oxygen. In addition, filtering macroinvertebrates can be harmed by the increased amount of sediments. Because trees provide shade, the removal of trees might increase the temperature of the stream (especially in the summer). Warm water holds less dissolved oxygen and promotes bacteria growth. Logging removes organic matter (such as leaves, needles, branches), which are a food source for macro-invertebrates.

### **#3 Grazing**

Cattle are important for food. Most people enjoy steaks and hamburgers – both of which come from cows. Feeding cows in a pasture can be expensive, so ranchers often get permission to let their cattle graze on federal lands. When cows graze on an open range, they need to drink water. Therefore, they may walk into a creek. Cows can cause the soil to become compacted, so that the riparian plants have a harder time growing and rainwater can run-off faster. This may cause erosion. More erosion may mean that there are more sediments in the stream, which reduces light for the aquatic plants so that they produce less oxygen. In addition, filtering macroinvertebrates are harmed by an increased amount of sediments. Cows can cause destruction of riparian vegetation. Their wastes might increase the amount of nitrogen in the streams, which could initially cause an increase in algae, but eventually the algae dies, settles, and uses up dissolved oxygen.

### **#4 Wastewater Treatment Plants**

It is important that people have wastewater treatment plants to clean the sewage and remove the wastes from where they live. However, treatment plants often release warm water back into the stream, thus changing the temperature. Warm water holds less dissolved oxygen and promotes bacteria growth. The large amounts of organic matter might mean there will be less dissolved oxygen for macroinvertebrates that live downstream. Treatment plants may increase the amount of nitrogen in the streams, which could initially cause an increase in algae, but eventually the algae dies, settles, and uses up dissolved oxygen. The treatment plants may change the pH of the stream, and some use chlorine to treat the water.

## **#5 Campgrounds**

Campgrounds are important to get people out into nature and have fun with their friends and family. A campground built on the banks of a river or stream may cause the soil to become compacted when people access the stream for recreation activities, such as swimming or boating. If the soil becomes compacted, the riparian plants have a harder time growing and rainwater can run-off faster. Fewer streamside plants may increase the water temperature of the stream. Warm water holds less dissolved oxygen and promotes bacteria growth. Humans may cause pollution (from dishwashing, campfires or pet wastes) or drop litter, which could enter the stream and harm the aquatic organisms. There will most likely be an increase in fishing if a campground is built, so there will be a change in the fish population, which might affect the food chain. Increased noise from a campground could also impact the wildlife.

## **#6 Bridges**

Bridges are important so that people can travel easily from one place to another. They increase the access for humans to use the river for recreation activities, such as boating, swimming and fishing. Construction of the bridge will increase the amount of erosion. More erosion may mean that there are more sediments in the stream, which reduces light for the aquatic plants so that they produce less oxygen. In addition, filtering macroinvertebrates are harmed by the increased amount of sediments. Once the bridge is built, it may block the nutrients that are coming from upstream or stop migration of organisms upstream, especially if it is routed through a culvert. In addition, human activities may cause the soil to become compacted. If the soil becomes compacted, the riparian plants have a harder time growing and rainwater can run-off faster. The cars that cross the bridge may cause pollution from their exhaust or leaking oil.

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

### Assessment: Water Quality and Human Activities

What are some human activities that could negatively affect the water quality of a stream?

Complete the chart below with as many examples as you can.

Human Activity that Decreases Water Quality	What is the negative effect of this activity? (Identify at least two for each activity).	How does this affect the organisms that live in the stream?
1.		
2.		
3.		
4.		
5.		

**Bonus:** Explain ways that humans can *improve* the water quality of a stream.

## Scoring Rubric for Water Quality and Human Activities

	Mastery	Proficient	Not Yet Proficient
List Human Activities	Student is able to list 3 or more human activities that could decrease the water quality of a stream.	Student is able to list 2 human activities that could decrease the water quality of a stream.	Student is <b>not</b> able to list at least 2 human activities that could decrease the water quality of a stream.
Identify Negative Impact	<p>Student is able to identify at least two negative effects for each activity listed.</p> <p><b>AND</b></p> <p>Student is able to explain why the effect negatively impacts the organism.</p>	Student is able to identify at least two negative impacts for each activity listed.	Student is <b>not</b> able to identify at least two negative impacts for each activity listed.