



LESSON 3.2: AQUATIC MACROINVERTEBRATES

(Part of the HEALTHY WATERSHED, HEALTHY SALMON Lesson Plan Series)

GRADE LEVEL: Grades 3-9 *(this can be adapted for the appropriate grade level)*

OBJECTIVES

- Students will be able to:
 - Use a dichotomous key to identify common aquatic macroinvertebrates
 - Learn which macroinvertebrates are found in that particular stream section
 - Determine the health of the stream based on the macroinvertebrates collected there
 - Infer whether or not that portion of the stream would make a good salmon habitat

OVERVIEW

Students will learn that salmon require a high-quality habitat to survive, how macro-invertebrates can be used as an indicator of habitat quality, and how the micro-habitats along a stream can be influenced by our activities. They will use a dichotomous key to identify macroinvertebrates, then determine a possible collection site for their sample based on the macroinvertebrates collected from the stream and some information about the stream.

BACKGROUND INFORMATION

Aquatic macroinvertebrates are small animals that live in water, are big enough to see with the naked eye, and have no backbone. These animals include many types of insects as well as other animals such as worms, mollusks, and crustaceans. Most aquatic macroinvertebrates make their homes in rocks, leaves, and the sediment of streambeds.

These organisms have many special adaptations allowing them to live in demanding environments. Macroinvertebrates that live in riffles and fast-moving water may have features that help them hold on to rocky or hard substrates such as hooked feet or suction cups; or flat, streamlined bodies that can handle rapid water velocities. Macroinvertebrates that house themselves deep in muddy substrates may have different sets of adaptations for low oxygen environments such as air tubes or oxygen trapping red hemoglobin in their tissue. These bugs are important because they are an integral part of the food chain. They provide food for fish and other aquatic organisms. Many of them are also key indicator species. They can tell us about the quality of the water where they are found. Bugs that have a low tolerance to pollution tell us that the water they are found in is relatively healthy. If we do not find these bugs, then it could possibly be due to some sort of pollutant or other impairment to the water body



Macroinvertebrates as Water Quality Indicators

In streams and ponds, the presence or absence of certain macroinvertebrates, called indicator species, reveals much about water quality. These creatures make up a biotic index (number of living organisms found in an ecosystem). The absence or presence of these organisms is an indicator of water quality. Water with numerous aquatic species is usually a healthy environment, whereas water with just a few different species usually indicates conditions that are less than healthy. The word healthy is used to indicate an environment supportive of life. Pollution generally reduces the quality of the environment and, in turn, the diversity of life forms. In some cases, the actual biomass will increase because of pollution, but the diversity inevitably goes down.

Macroinvertebrates are found in all freshwater systems such as lakes, streams, ponds and wetlands. They help maintain the health of the water ecosystem by eating bacteria and dead or decaying plants and animals. Overall water quality effects which types of organisms can survive in a body of water. "Water quality" may include the amounts of dissolved oxygen and the levels of algal growth, pollutants which may be present and the pH level. Some macroinvertebrates such as stoneflies, mayflies and water pennies require a high level of dissolved oxygen and their abundance is an indication of good water quality.

Other macroinvertebrates can survive at a lower dissolved oxygen level because they can come to the surface to get oxygen through a breathing or "snorkel" tube or carry a bubble of air with them around their bodies or under their wings. Several species of macroinvertebrates are indicative of water systems with lower dissolved oxygen levels and include aquatic worms and leeches. Lower dissolved oxygen levels are often associated with polluted waters while higher levels indicate good quality water.

Pollution Tolerance Categories

Group 1 – Pollution Intolerant. These macroinvertebrates are very sensitive to water pollution. Insects in this group cannot live in polluted water. As the amount of pollution rises, the number of these insects go down.

Group 2 – Somewhat Pollution Tolerant. These macroinvertebrates are somewhat sensitive to water pollution. Insects in this group can be found in either very clean or mildly polluted water.

Group 3 – Pollution Tolerant. These macroinvertebrates are found in poor water quality. Insects and animals in this group are very tolerant of polluted water, but they can still be found in clean water. As pollution worsens, tolerant insects and animals become more abundant.

SKEENA WATERSHED
AQUATIC MACROINVERTEBRATES
 POLLUTION TOLERANCE INDEX

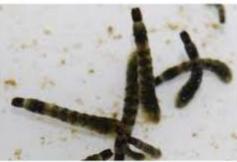
Group 1: Pollution Intolerant (Can Only Live in Clean Water)

<input type="radio"/> Caddisfly Larva 	<input type="radio"/> Stonefly Larva 	<input type="radio"/> Mayfly Larva 	<input type="radio"/> Dobsonfly Larva 
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Group 2: Somewhat Pollution Tolerant

<input type="radio"/> Dragonfly Nymph 	<input type="radio"/> Damselfly Nymph 	<input type="radio"/> Scud/Sideswimmer 	<input type="radio"/> Water Mite 
<input type="radio"/> Water Penny 	<input type="radio"/> Freshwater Mussel 	<input type="radio"/> Predaceous Diving Beetle 	<input type="radio"/> Right-handed Snail (Gilled) 

Group 3: Pollution Tolerant (Can Live in Polluted & Clean Water)

<input type="radio"/> Aquatic Earthworm 	<input type="radio"/> Leech 	<input type="radio"/> Left-handed Snail (Lunged) 	<input type="radio"/> Water Boatman 
<input type="radio"/> Giant Water Bug 	<input type="radio"/> Water Strider 	<input type="radio"/> Black Fly Larva 	<input type="radio"/> Planaria (Flat Worm) 

ACTIVITY 1: Aquatic Macroinvertebrate Investigation in the Classroom

Grade Level: K-6

Duration: 1 hour

Purpose: To introduce students to aquatic macroinvertebrates in a classroom setting.

Summary: Students will collect live macroinvertebrates from a river or stream. They will then classify them using a dichotomous key and SkeenaWild's Pollution Tolerance Index.

Background: Many macroinvertebrates make their homes in riffles and pools of gravel-bed streams. By turning over stones and examining the underside, you may find aquatic macroinvertebrates.

Materials:

- Flash cards of aquatic macroinvertebrates (can be borrowed from SkeenaWild or you can make your own)
- Aquatic Macroinvertebrate Poster / Book (can be borrowed from SkeenaWild purchased or downloaded from various websites – see resources at end of lesson plan)
- Dichotomous key (can be downloaded – see resources at end of lesson plan)
- Skeena Watershed Pollution Tolerance Index (can be downloaded – see resources at end of lesson plan)
- Magnifying glasses
- Collection of preserved macroinvertebrates (can be borrowed from SkeenaWild)

Procedure:

1. Ask the students if they know what the words "aquatic macroinvertebrate" mean. Break down the different words... Aquatic = water, Macro = big enough to see with the naked eye, Invertebrate = no backbone.
2. Talk about the life cycle stages of macroinvertebrates.
3. Distribute flash cards, dichotomous key and the pollution tolerance index to students, and have them identify the macroinvertebrates on their cards and their pollution tolerance category.

Extension:

This activity can be done in conjunction with the classroom water quality testing activity (refer to Lesson Plan 3.1 Water Quality Testing).

ACTIVITY 2: Macroinvertebrate Investigation at a Local Stream

**This activity is part of SkeenaWild's Stream Explorations field experience, and is led by our Environmental Educator. It takes place usually at Howe Creek in Terrace, but any local water body would work as well. To book a workshop, contact SkeenaWild.*

Grade Level: K-6

Duration: 2-4 hours

Purpose: To introduce students to living aquatic macroinvertebrates in a field setting.

Summary: Students will collect live macroinvertebrates from a river or stream. They will then classify them using a dichotomous key and SkeenaWild's Pollution Tolerance Index.

Background: Many macroinvertebrates make their homes in riffles and pools of gravel-bed streams. By turning over stones and examining the underside, you may find aquatic macroinvertebrates.

Aquatic macroinvertebrates are often used as an indicator of water quality. The orders of *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Tricoptera* (caddisflies) are generally sensitive to pollution. Water Quality Biologists use these three orders to determine the quality of a water body. If we find families from these three orders of invertebrates living in a stream or river the water is most likely not impacted from pollution. However, it is important to remember that the absence of these families does not always mean the quality is poor. There could be other reasons these families are not present.

Materials:

- Fine mesh dip nets of various sizes, D-Frame Net, Kick Net
- Plastic tubs
- Plastic ice cube trays
- Bug viewers, magnifying glasses
- Dichotomous keys
- Waders, rubber boots
- Tweezers, transfer pipettes

*(*Note: materials are available for loan at SkeenaWild)*

Procedure:

1. Choose your sample site. Be sure to take into account the safety of your students.
2. Explain to your students how to collect a macroinvertebrate sample.

Using Kick Nets:

- Two students will wade into the stream and hold each end of the kick net, placing it so the mouth of the net is perpendicular to and facing the flow of water.
- Another student will stand upstream from the net and disturb the stream bottom with his/her feet and hands.
- Students carefully pick up and rub stones directly in front of the net to remove attached animals. The stream bottom materials and organisms will be carried into the net by the current.
- Tell the students to continue this process until they see no more organisms being washed into the net.

Using Dip Nets:

- Each student uses their own small dip net to 'sweep' in the water, focusing on the sides of the bank and the direct stream flow.

Using a D-Frame Net:

- For muddy-bottom stream sampling, a long-handled D-frame or dip net is recommended for reaching into vegetation that grows along stream banks or is attached to the stream bottom, and for sweeping up macroinvertebrates dislodged from woody debris.
3. Have the students hold the sample over a plastic tub, and use a bucket of stream water to wash the organisms into the tub.
 4. Have students sort and identify the macroinvertebrates using the tweezers and transfer pipettes, bug viewers, magnifying glasses, ice cube trays and dichotomous keys.
 5. Using the Skeena Watershed Pollution Tolerance List, students will check off the species found in the stream sampled.
 6. Discuss the different invertebrates the students found and what their findings indicate about the health of the stream.

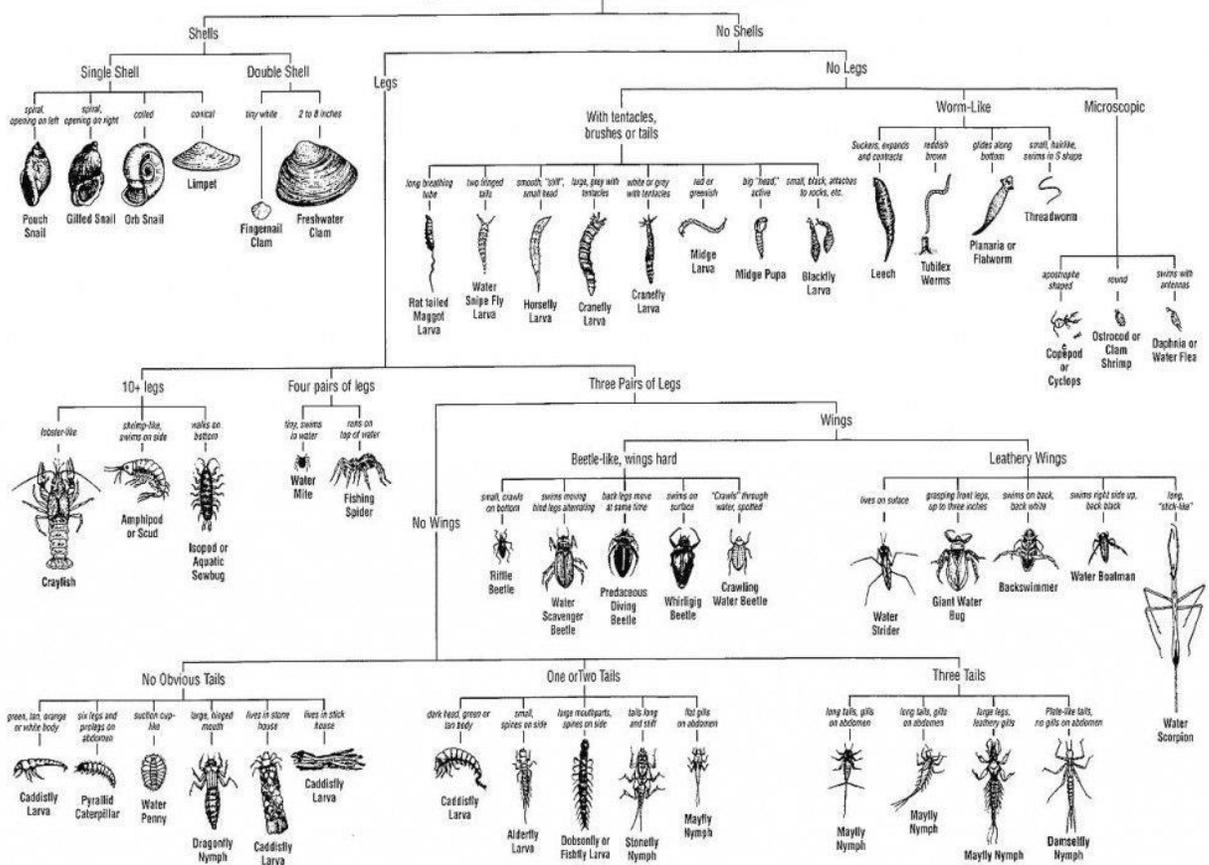
Extension:

This activity can be done in conjunction with the water quality testing activity at a local stream (refer to Lesson Plan 3.1 Water Quality Testing).

Dichotomous Keys

A dichotomous key is an important scientific tool used to identify different organisms, based on the organism's observable traits. Dichotomous keys consist of a series of statements with two choices in each step that will lead to the correct identification. At each step, you choose between two mutually exclusive statements about a characteristic. The key starts with the choice between "shells" and "no shells". After you make that choice, you move to the next pair of choices in the key. Continue until you arrive at an identification.

Key to Macroinvertebrate Life in the River



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EDUCATIONAL RESOURCES

Online Resources

- **Pacific Streamkeepers – “The Streamkeepers Handbook”**. An excellent resource for learning the methods of evaluating streams, including macroinvertebrate sampling and water quality testing.
<http://www.pskf.ca/publications/Handbook%20and%20Modules.pdf>
- **Skagit Fisheries Enhancement Group - “Junior Stream Stewards”** – A good resource on learning the methods of evaluating streams, including macroinvertebrate sampling and water quality testing that is targeted at students.
<http://www.skagitfisheries.org/wpcontent/uploads/2010/08/FinalJSSLessonPlan2016.pdf>
- **Salmonids in the Classroom Primary and Intermediate Handbooks (Department of Fisheries and Oceans Canada)** – Primary and Intermediate Lesson Plans and resources for studying the biology, habitat and stewardship of pacific salmon. Used in conjunction with DFO’s Salmonids in the Classroom Program in BC elementary schools.
<http://www.pac.dfo-mpo.gc.ca/education/resources-ressources-eng.html>
- **“Bugs Don’t Bug Me Handbook”** – This handbook contains a series of lesson plans to assist educators in teaching about water quality and aquatic macroinvertebrates. A publication of Utah State University’s Water Quality Extension.
<https://extension.usu.edu/waterquality/files-ou/Publications/Bugs-dont-bug-me.pdf>
- **Dichotomous Key to Common Aquatic Macroinvertebrates**
<https://dep.wv.gov/WWE/getinvolved/sos/Documents/MacroID/DichotomousKey.pdf>
- **Dichotomous Key to Macroinvertebrate Life in the River**
<http://midmichigannatureandscience.blogspot.com/2013/04/aquatic-ecology-and-mother-earth-week.html>
- **Dichotomous Key to Macroinvertebrate Life in the Pond**
<http://midmichigannatureandscience.blogspot.com/2013/04/aquatic-ecology-and-mother-earth-week.html>
- **Dynamic Aqua Supply** – If you are looking to order your own supplies and equipment for water quality testing or macroinvertebrate sampling, this company is located in Surrey, BC and has an easy online catalogue and order system. (SkeenaWild orders its water quality testing and macroinvertebrate sampling supplies from this company).
<https://dynamicaquasupply.com/>



SkeenaWild Resources

- SkeenaWild can provide free classroom or outdoor workshops on aquatic macroinvertebrates, as well as water quality testing, invasive species, watersheds, salmon, and stream assessment.
- SkeenaWild also has aquatic macroinvertebrate sampling equipment and supplies, as well as preserved macroinvertebrates, available for loan to teachers and their classes.

Contact christine@skeenawild.org, call 250-638-0998 or visit www.skeenawild.org/education for more information.

