Watershed Experience Lesson 6:

Biotic Stream Assessment

ACTIVITY TYPE: *Lab-style classroom activity*

AUDIENCE: *High School*

TIME FRAME: *1.5 hours*

SUMMARY:

This lesson introduces students to benthic macroinvertebrates and how biotic assessments are used to indicate water quality. Students will identify macroinvertebrates brought into the classroom in leaf packs. The goals are to learn an important water quality protocol used across the country and to understand our impacts on the watershed and the stream ecosystem.

MATERIALS:

- *Lab data sheets*
- *Sample of macros*
  - *Leaf packs or d-nets for collection*
  - *Bucket & aerator to bring them back*
- *Magnifying glasses*
- *Several sizes of containers*
- *Spoons, paintbrushes, tweezers (for transferring macros)*
- *Macro ID keys*
  - *Here's a popular one: https://www.tu.org/wp-content/uploads/2019/04/Macroinvertebrate_Key.pdf*
- *Microscopes (optional)*

PREPARE AHEAD:

For this lesson, you'll bring in macroinvertebrates from a site along a river in your watershed. You can use leaf packs or go out and collect macros on the day of the lesson.

Leaf packs are a method of collecting macroinvertebrates using mesh bags filled with leaves that are tied to a rock at the stream bottom for 2-3 weeks. You can read more about leaf packs in the background section. The important thing to note here is for leaf packs to be effective at collecting a diversity of insects they need to be put out a couple of weeks in advance and collected the day of the lesson.

Alternatively, you can use a d-net or kick seine to collect macros on the day of the lesson. Either way, be sure to bring a bucket with an aerator (aquarium ones work fine) to keep them alive until your lesson.

Prepare your classroom by setting up chairs at tables with macro keys, containers, magnifiers, and tools.

ENGAGE:

Ask students: how can you tell if water in a stream is clean? They'll likely say by chemical testing or by visual assessment. Share that those are two ways scientists use, but they also use bugs called benthic macroinvertebrates.
Write this on the board and ask them to define the words
Benthic: bottom dwelling
Macro: large enough to see without a microscope
Invertebrate: No backbone
Explain that they will do a bioassessment.
Bio: living
Assessment: test
Explain that some macros are very sensitive to pollution and if the water is not clean, they will die. Other macros are very tolerant of pollution and can live in dirty water. Ask them what it

would mean if they found lots of very sensitive macros in an area. It means the water must be clean, because if it wasn't clean, those sensitive macros couldn't live there. On the other hand, if they only find tolerant species, it might mean the water is polluted. The reason we use macros rather than fish or other larger animals, is because the macros, who are mostly insect larvae, can't travel very far. Many insects lay their eggs in the stream, and the larvae hatch out there. If the water isn't clean enough for them, they will not survive.

PROCEDURE:

Place the students in groups around tables. Give them the tools listed above. Scoop a bunch of macros into their container and have them separate them by species and identify them by using the dichotomous key. On their data sheet they will count how many sensitive, less sensitive, and tolerant species they found. They will then use the biotic index to determine how clean the water is.

When they are done identifying the insects, they should place them back in the aerated bucket so that you can return them to the stream. You can explain that many scientists kill the insects to do this type of assessment, but we have no need to do that and can return them to their home.

BACKGROUND:

With increasing awareness of water pollutants in the 1960's, scientists developed bioassessment methods to monitor stream health. These bioassessments were based on the presence of certain aquatic benthic macroinvertebrates (macros). With this new method, anyone who could learn to identify these stream creatures could assess water quality without expensive chemical test kits. Macroinvertebrates are effective indicators, as they are sensitive to the amount of oxygen in their habitats, which is altered by pollution. They cannot easily relocate if their habitat

becomes degraded, so their presence or absence can tell us about the area they are in.

Oxygen in streams is depleted by several types of pollutants in different ways. Organic pollutants like sewage, agricultural runoff, and food waste decrease oxygen because microbes use it in breaking down these organic compounds. Nutrients like phosphates and nitrates can also deplete dissolved oxygen because they create excessive algae that dies and is decomposed by microbes. Oxygen can also be depleted by rising water temperatures, increased salinity, and reduced flow rate. These issues are caused by humans through development, construction, and climate change.

Macroinvertebrate tolerance to low oxygen levels varies greatly. These creatures are taxonomically diverse and have developed a variety of adaptations to living in streams. For example, Diptera (flies), an order with many tolerant species, may have breathing tubes that allow them to attain oxygen from the air, making them less dependent on dissolved oxygen in the water. On the other hand, Plecoptera (stoneflies) have gills that process enough oxygen only under high concentrations, making them very sensitive. The diversity in macroinvertebrate adaptive strategies is incredible, making them both exciting to study and useful in creating a spectrum of water quality levels in streams.

The way scientists develop a water quality assessment from a collection of macro is with a biotic index. They create calculations from extensive research in testing water quality and surveying macros, take the data from the macro survey and formulate a stream quality result. We use a biotic index that labels each species as pollution sensitive, less sensitive and tolerant.

Sensitive	**Less Sensitive**	**Tolerant**
___ Stoneflies ___ Caddisflies ___ Water Pennies ___ Riffle Beetles ___ Mayflies ___ Gilled Snails (with operculum) ___ Dobsonflies	___ Crayfish ___Watersnipe ___ Aquatic flies ___ Sowbugs ___Crane Flies ___ Scuds ___ Beetle ___ Alderflies larva ___ Fishflies ___ Dragon Flies ___ Damselflies ___Clams ___ Flat Worms (Planaria)	___ Aquatic Worms ___ Midge Flies ___ Black Flies ___ Leeches ___ Pond or Lunged Snails ___ Orb Snails ___ Limpet Snails
___ # of ✔ s multiplied by 3 =	___ # of ✔ s multiplied by 2 =	___ # of ✔ s multiplied by 1 =
Add the three totals from each column = ☐		
Water Quality Rating ___ Excellent (>22) ___ Good (17-22) ___ Fair (11-16) ___Poor (< 11)		