Lesson 2: Home, Home in a Stream

Lesson Summary:
Students will create a model stream ecosystem that focuses on the differences between riffle, run, and pool ecosystems. Students will hypothesize about which macroinvertebrates they would expect to find living in the different stream environments based on their various adaptations.

Materials:
- Baking tins
- Crafters foam, Styrofoam, or clay
- Potatoes
- Egg cartons
- Food coloring
- Rocks, gravel
- Pieces of wood
- Tinfoil to cover models

Knowledge and Skills developed:
- Students will learn about the characteristics of a stream ecosystem
- Students will understand the difference between a pool, run, and riffle
- Students will hypothesize about where they would expect to find different macroinvertebrates in the stream based on various adaptations

Next Generation Science Standards

Practices	**Crosscutting Concepts**
□Asking questions	□ Patterns
X Developing and using models	□ Cause and effect: Mechanism / explanation
□ Planning / carrying out investigations	□ Scale, proportion, and quantity
□Analyzing / interpreting data	□ Systems and system models
□Math / computational thinking	□ Energy / matter: Flows, cycles, conservation
□ Constructing explanations	X Structure and function
□Engaging in argument from evidence	□Stability and change
□Obtaining / evaluate / communicate	

Disciplinary Core Ideas and Concepts

3-LS4.C: Adaptation
- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.

LS2.A: Interdependent Relationships in Ecosystems
- Organisms and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.

ETS1.C: Optimizing the Design Solution
- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.

Environmental Literacy Strands

2. Physical, living and human systems
    b. Structure, function, interaction and change in living systems. Explain the dynamic and interconnected nature of Earth's living systems

Teacher Background Information:
When water falls onto areas of high elevation or melts from snowy peaks it is carried by gravity to the lowest points of the area, and then downhill. As the water builds up it creates brooks; the brooks then combine to create streams – which then combine to create rivers. Rivers eventually feed into lakes or the ocean.

The geomorphology of a stream is generally based on precipitation, landforms or geology, and elevation. Land processes, such as floods, erosion, earthquakes, etc., cause channels and patterns of channels to develop. Channels form into different types or reaches, thus forming different aquatic habitats.

Riffles, runs, and pools are three micro-environments, which vary greatly. **Riffles** are usually shallow areas in a stream where water moves very swiftly, and usually travels over substrate such as gravel, rocks, and boulders causing the surface to be rough or broken. Riffles tend to have the greatest diversity of macroinvertebrate species. The organisms that inhabit these areas must be able to cling to the substrate, such as caddisflies, stoneflies, and some mayflies, who are also able to hide in the rocky substrate.The predominant macroinvertebrate populations that live in riffle areas of the stream are shredders and collectors.

When the stream falls over large fallen logs, or a set of boulders, the force of the water falling on the other side carves out a **pool**. Pools are slow moving, deep areas of the stream where many of the macroinvertebrates are either collectors or grazers, such as snails, worms, or clams who eat the debris that settles here. Pools are a favorite place for trout to hang out too.

Runs are the main body of water that smoothly runs downstream. Small fishes like minnows, that cannot compete for pools, often end up in runs. It may be harder to find macroinvertebrates here because they may be moved downstream quickly, unless you are able to safely reach the bottom to look for species such as water penny larva that can resist the pull of the current with their flattened bodies. Stoneflies tend to be strong swimmers and may be found in runs.

The headwaters of a river or stream contain different features than the lower, wider reaches. Usually, upper reaches are more complex with riparian vegetation, substrate, woody debris, and lower temperatures. Aquatic life may differ depending on where they are found in the stream. For example, the headwaters attract more shredders because of the abundance of organic litter. Bull trout, steelhead, spring Chinook salmon, and other cool water fish species often dwell in this habitat. These upper areas are sometimes classified as first or second order streams. Mid reaches generally contain the greatest diversity of species and act as a transition zone, having features from both the upper and lower reaches. Like the headwaters, all four functional feeding groups are typically found here.

However, there will be fewer shredders and more of the others. Fish like summer Chinook salmon might also be in this third order section. The lower reach or mainstream river, where the vegetation canopy lessens and sun has a more pronounced effect, grows algae harvested by collectors. Thus, they dominate the area along with northern pikeminnow, white fish, and other slower water fish.

Introduction:
Remind students that they have already learned a lot about macroinvertebrates and their specific adaptations. In this lesson, they will build on what they know by learning about the stream ecosystems where macroinvertebrates live and the characteristics of the streams that drive these adaptations. Tell students that in this lesson they are going to become stream engineers. Their job will be to create a stream ecosystem where all of the macroinvertebrates that they learned about in the previous lesson would be able to survive.

Procedure:

1. Have students brainstorm what kinds of things that would need to include in their stream for the different macroinvertebrates to live there. Have students think about a stream or river they have been to before (or project a picture of one). What are some things that they would expect to see as part of a stream ecosystem? Think back to some of the macroinvertebrate adaptations, do they all like slow water? Fast water? Deep water? Shallow water?

2. Use the board or poster paper to create a large class stream. Pose the following questions and as students respond add to the drawing.

    - What features would we want to include in the stream so that all of the macroinvertebrates would be able to survive?
        - ✓ Source- or headwaters-where the water originates from;
        - ✓ Mouth-where the water exits into another body of water
        - ✓ Trees and plants
        - ✓ Rocks & woody debris
        - ✓ Riffles, runs, and pools.

    - Would we expect all of the areas of our stream be the same? How might they be different? Streams are dynamic systems always moving, carrying debris, and changing their shape and course.
        - ✓ Streams tend to be somewhat curvy
        - ✓ Some areas will be slow shallow
        - ✓ Some will be faster and deeper,
        - ✓ Streams might steer off as a smaller creek or have a small creek join in
        - ✓ Streams have varying levels of vegetation along the side (big trees, shrubs, grass, etc.)
        - ✓ Different area have different levels of woody debris and substrate (pebbles, rocks, boulders)

3. Let students know that they are now going to work in teams and use what they know to engineer a stream ecosystem that provides places for all of the macroinvertebrates to live. Tell students that their model streams must include the following features:
    - Source and mouth
    - Pools, riffles, and a run
    - Pieces of woody debris, rocks, &/or vegetation

4. Break students into groups of 3-4 and introduce them to the resources available for building their streams. Have students take a few minutes to discuss what materials would best demonstrate the different environments. Have students think about what they can do to make the water flow faster through riffles, and slower through pools? If time permits, have students sketch out a plan before starting to build.

5. After the students have finished creating their model streams, have each group present their design to the class. Have them demonstrate how water flows through their stream by spraying or slowly pouring water at the headwaters. Use colored water and encourage students to control the water flow so it is easy to see movement.

6. **Discuss:**
    - Where would macroinvertebrates find food in your model stream? How does food enter the stream? From algae on the rocks, eating and shredding wood or leaves from plants and trees, finding other small prey organisms to eat.

    - Based on water flow you observed, if we were to add leaves and twigs, where would they accumulate? This will depend on the model but most likely in the pools, and at the bottom of the stream if students are tipping their pans up to make water movement easier to see.
    - Where would you expect to find macroinvertebrates in the stream ecosystem? In the riffles and pools, bottom of the stream, surface of the stream, under rocks, in the gravel, on the wood.

    - How will a difference in water speed affect the macroinvertebrates that live there? Would you expect to see different types of organisms in different regions of the stream? Have students think about what they learned about adaptations. Macroinvertebrates all have different adaptations, feeding styles, and habitat needs.
    - How might the distribution of leaves, sticks, or rocks determine the types of macroinvertebrates that live in the different areas? The distribution would affect what they could eat, whether or not they had anything to hang onto in faster water, and whether or not the appropriate habitat was present. Rocks and gravel may also protect macroinvertebrates from predators; many also need algae on the rocks to scrape off and eat. Some macroinvertebrates even spin nets to collect and filter food from rotting leaf and twig debris, or to catch other organisms if they are a predator.

7. Have students think back to the previous lesson and what they learned about macroinvertebrates. Pass out Macroinvertebrate Identification cards to students and have them think about where in the stream it would live. Have them write the name of the macroinvertebrate on a sticky note and attach it to the class drawing of the stream.

Resources:

Kids n the Creek: Invert Investigator
http://cascadiacd.org/files/documents/CD-KIC2InvertInvest.pdf

How to: Build a Model Watershed

"A River Continuum" taken from Streamkeeper's Field Guide Tom Murdoch and Martha Cheo with Kate O'Laughlin. Adopt-A-Stream Foundation, Everett, WA. (425) 316-8592. Pp 7-9.