

Lesson 4: Biodiversity in a Leaf Pack

Lesson Summary:

Students will make artificial leaf packs to create a model habitat for freshwater macroinvertebrates. Students will place leaf packs in riffles and pools of a local stream in hopes to determine which organisms are present in each microhabitat.

Materials:

- Empty leaf pack (mesh bag)
- One or two different types of leaves (e.g. maple, oak, pine needles)
- Rocks to add weight to bags
- Scale to weigh leaves or cup to measure volume
- Graphing paper if measuring leaf area
- Waterproof tags to label leaf packs or ziplock bags to place labels in
- String to close bags
- Rope to attach leaf packs in stream

Knowledge and Skills developed:

- Students will be introduced to biodiversity
- Students will learn about abiotic and biotic parts of a stream ecosystem
- Students will hypothesize about how the different conditions of riffles and pools might affect the types and amounts of macroinvertebrates they will find in their leaf packs

Next Generation Science Standards

<p>Practices</p> <ul style="list-style-type: none"> <input type="checkbox"/> Asking questions <input type="checkbox"/> Developing and using models <input checked="" type="checkbox"/> Planning / carrying out investigations <input type="checkbox"/> Analyzing / interpreting data <input type="checkbox"/> Math / computational thinking <input type="checkbox"/> Constructing explanations <input type="checkbox"/> Engaging in argument from evidence <input type="checkbox"/> Obtaining / evaluate / communicate 	<p>Crosscutting Concepts</p> <ul style="list-style-type: none"> <input type="checkbox"/> Patterns <input type="checkbox"/> Cause and effect: Mechanism / explanation <input type="checkbox"/> Scale, proportion, and quantity <input type="checkbox"/> Systems and system models <input type="checkbox"/> Energy / matter: Flows, cycles, conservation <input checked="" type="checkbox"/> Structure and function <input type="checkbox"/> Stability and change
<p>Disciplinary Core Ideas and Concepts</p> <p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> • Organisms and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. 	

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:

Throughout late summer and fall, leaves fall from trees and shrubbery found by the sides of creeks.

Many of these leaves will end up floating down the creek while others will sink to the bottom. Once dead organic matter (once living material) sinks into the water, it starts to be attacked by bacteria and aquatic fungi, known as decomposers and detritivores. These leaves can start to become slimy from this attack. These microorganisms break down the organic matter into its primary components, such as nitrogen rich ammonia by nitrogen-fixing bacteria. Other microorganisms transform these primary components into compounds that plants and algae can use to grow, such as nitrites or nitrates.

The leaves flowing in the current get caught between rocks and logs and gradually build up into clumps called detritus. Any organic matter that is dead and being decomposed, including animal matter, is called detritus. Detritus provides an excellent habitat for macroinvertebrates by providing a safe place to stay, keep away from predators, or keep out of the stream flow.

Detritus is important to the stream ecosystem because it provides a food source directly or indirectly for a multitude of organisms. Not all creatures eat the leaves directly because they are low on nutritional value and can be difficult to digest. The fungi and bacteria that decompose the leaves provide their own byproducts with nutritional value to supplement what the leaves lack. The detritus and microorganism supply is processed by different groups of macroinvertebrates in a series of steps.

The artificial leaf packs are used to emulate the natural occurrence of the leaf clumps that form in between rocks and logs in a stream. Placing these leaf packs into a stream creates a quantitative way to measure the amount of certain insects (especially the shredders) that are in a creek or stream. The shredders can not distinguish the difference between the natural clump and the leaf pack, so they colonize it. The relative abundance and diversity of these insects can reveal stream health, water quality, and habitat quality.

However, leaf packs are just one way to collect macroinvertebrates and can yield only selective results because they are primarily designed to capture shredders. Other classes of macroinvertebrates will not be seen in the leaf pack collection results. This is a good introduction to biodiversity. The leaf pack serves as one very small environment that may collect only a limited number of species from the larger environment of the stream. Many living organisms depend upon the stream including humans, fish, birds, coyotes, and macroinvertebrates, to name a few.

Preparation:

1. Before beginning this activity, select a convenient stream where students can place their leaf packs for at least 1 week. If the students are not familiar with the location, you may want to show some pictures or draw a sketch of the area and major features on a piece of poster paper.

2. Before you begin this activity, ask the students to gather some leaves from the ground and bring them in a plastic bag.

Introduction:

Let students know that now that they have learned about streams and the macroinvertebrates that live in them, they are going to conduct an experiment on a local stream. Explain that they will do this by creating a model habitat that macroinvertebrates can live in and placing these habitats into the waterway for at least 1 week. They will then collect them to see which macroinvertebrates they find and what kind of biodiversity they find in their leaf packs

1. Remind students of what they have already learned about the stream ecosystem. Revisit ideas from the stream models that students built in lesson two. Ask students which areas of the creek might be easiest to place a leaf pack? **Head waters can be good if they are easily accessible because the leaf packs will mimic the many leaves and plant debris that often accumulate here. Riffles or river banks are good too because we can often safely reach them and they too often offer different habitat areas, such as rocks and gravel. As students learned from their model streams, where water falls and is able to accumulate-a pool is formed. This is a good area to catch different types of macroinvertebrates if we can safely reach one from the stream-side because it offers yet another habitat to those macroinvertebrates that need slower moving water.**

Procedure:

1. Show students some of the leaves that have been brought in and ask: What happens to leaves that fall in a stream? **Tell the students that in a stream ecosystem, leaves become the base of the food web. When leaves fall into streams they often cluster together in "packs" behind rocks and woody debris. Leaves will begin to rot and break down into small pieces of food by the speed and force of the water (abiotic), may begin to do so faster if they are exposed to more sunlight and/or warmer temperatures (abiotic), and/or may be eaten right away by bugs and fish (biotic).**
2. Have students use their Lesson 3 data sheet to draw and label a stream food web that starts with leaves. Remind them about the different areas they attempted to make in their stream models: riffles, runs, and pools, and how these areas offer different habitat, and feeding options.
3. Ask students to imagine a stream that they have been to, what did they see? Encourage them to think more deeply about what might be there by prompting them to add more to their drawings. At first glance we see trees and plants, and the water itself. If we look a little closer and are quiet, we might see much more.
 - If you put plants, trees, or water in your drawing, what you would find living on or in them? A bird, fish or a frog? Who might depend on these organisms?
 - If you were to sit still by the stream for a long period of time, what might you see? A dragonfly? Snake?
 - What if you looked even closer, what might you see? A worm or macroinvertebrate under a rock or in the gravel?

- What else might be there? If we look even closer with a microscope we can even see hundreds to thousands of bacteria that are also part of the species biodiversity within a stream.
4. Have students share their ideas and then introduce the concept of biodiversity to them. **What their drawings represent is the biodiversity that can be found in a stream ecosystem. Biodiversity is the variety of life on earth and is most often thought of as species. A species is a group of organisms that can interbreed and live in the same ecosystem. Examples of species are tree frogs, coho salmon, water beetle, white-tailed deer, douglas fir trees, or red-winged blackbird. We can think about biodiversity on a big scale, such as every living species on planet earth, or we can break it down into smaller scales, and think about one area or ecosystem.**
 5. Tell the students that they are going to learn more about the biodiversity of macroinvertebrates in a local stream by putting leaf packs out and investigating what types and amounts of macroinvertebrates are attracted to them.
 6. Show students an example leaf pack; scientists use this method to better understand biodiversity of a stream, by studying the community of organisms. Explain to students that they are going to use the leaf packs to get a picture of macroinvertebrate biodiversity within a local stream.
 7. Explain to the students that their leaf packs will go into two different stream environments (pool and riffle) in order to explore whether the types and numbers of macroinvertebrates will vary depending on the stream characteristic. The guiding question of this study is “Do different types and amounts of macroinvertebrates live in pools versus riffles?” Ask students:
 - What are the characteristics of these microhabitats that might affect what lives there? **Students should be able to name biotic vs. abiotic factors. Abiotic factors include: water temperature, dissolved oxygen, speed of the water, and substrate.**
 - Talk about temperature: How does one portion of the stream become cooler than another? **Trees and shade are one way that water is cooled in a stream; this is an important example of how a biotic factor (trees) may affect an abiotic condition (temperature).**
 8. Hand out materials (including Lesson 3 datasheet) and have students work in small groups to create their own leaf packs. Designate half of the class as “riffles” and half as “pools” and let them know that this is the area of the stream where their leaf packs will be placed.
 9. Have students measure and record everything that they put into their leaf packs. Students can also find area of leaves by tracing onto graphing paper and counting squares.
 10. After leaf packs are finished have students soak them in water and weigh them before they go out the stream. This will help with a more accurate pre post comparison of leaf packs since they will be wet when students get them back from the stream.
 11. If you are able to, take students out to the stream site have them work in teams to identify riffles and pools to place their leaf packs. Submerge half of the leaf packs in a riffle and the other half in a pool and use rope to securely attach them to a tree or rock. If you take the leaf packs to a creek yourself, make sure to take pictures to share with students.

12. Let students know that the leaf packs will remain in the stream for at least 1 week, and after they are collected they will have an opportunity to examine them and see what's there.

Extension:

Have students create leaf litter bags that can go in the terrestrial habitat:

<http://blog.growingwithscience.com/2009/10/tree-leaf-science-activities/>

Resources:

Biodiversity: Diversity in a Leaf Pack, Pathways: Doherty, Harris, Hartley

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

Leaf Pack Experiments, Stream Ecology Kit, Instructor's Manual. LaMotte Company and Stroud Water Research Center.

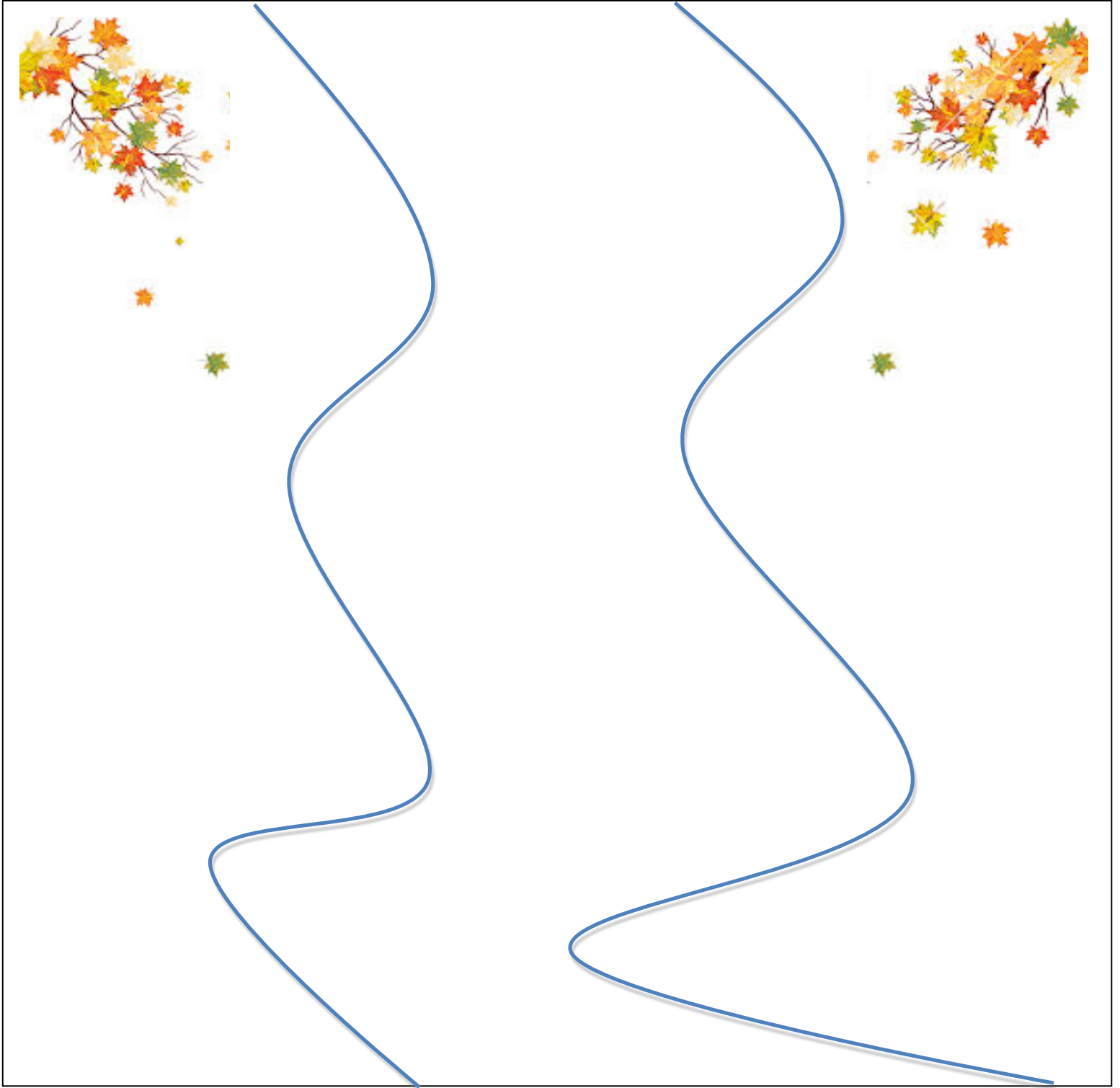
An Inquiry-Based Field & Laboratory Investigation of Leaf Decay: A Critical Aquatic Ecosystem Function: Jessica M. Hopkins, Rosemary J. Smith

Bugs Help Measure Impact of New Transoceanic Highway on Amazon:

<http://news.nationalgeographic.com/news/2012/05/120518-leaf-packs-transoceanic-highway-amazon-water-quality/>

Lesson 4: Biodiversity of a Leaf Pack Worksheet

Draw a stream food web that starts with falling leaves and includes macroinvertebrates. Make sure to label and use arrows to show relationships between organisms.



Guiding Question: "Do different macroinvertebrates feeding groups live in pools vs. riffles?"
Make a guess or hypothesis about what you would expect to see in each microhabitat.

Pool	Riffle

What are the characteristics of pools and riffles that might affect what lives there? Think about both living (biotic) and non-living (abiotic).

List all of the materials that went into your leaf packs. Include specific measurements and the final weight of your leaf pack.

Pool	Riffle