Artificial Leaf Packs

Adapted from: Leaf Pack Experiments, Stream Ecology Kit, Instructor's Manual. LaMotte Company aned Stroud Water Research Center.

Grade Level: Basic, intermediate

Duration: 2-6 weeks
Class time: 45 min - one hour

Setting: Streamside and Classroom

Summary: Students will collect macroinvertebrates using Leaf Packs and analyze their findings.

Objectives: Students will learn about different feeding habits of macroinvertebrates.

Vocabulary:
Organic matter, decomposer, detritus, Coarse particulate organic matter, fine particulate organic matter, shredders, collectors, grazers, predator,

Related Module Resources:
- Multi-plate Sampling Activity
- Micro-Habitats Activities

Materials (Included in Module):
- Fact sheets / books
- Leaf Pack bags
- Strong, nylon twine
- Garbage twist ties
- Ziploc bags
- Leaf Pack Field Data Sheets
- D-frame nets (optional)
- White sorting trays
- Sorting equipment: Forceps, spoons, eyedroppers, magnify glasses, magnify boxes
- Labeled Identification Bug Cups
- Macroinvertebrate Identification Resources

Additional Materials (NOT Included in Module):
- Dry leaves
- Bucket
- Scissors

ACADEMIC STANDARDS:

7th Grade
4.1.7.C Explain the effects of water on the life of organisms in a watershed.
-Explain how the physical components of aquatic systems influence the organisms that live there in terms of size, shape, and physical adaptations.

10th Grade
4.1.10.C Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.
-Describe the physical factors that effect a stream and organisms living there.
-Identify terrestrial and aquatic organisms that live in a watershed.
-Categorize aquatic organisms found in a watershed continuum from headwater to mouth (e.g. shredder, predator, decomposer).
-Identify the types of organisms that would live in a stream based on the stream's physical characteristics.
-Explain the habitat needs of specific aquatic organisms.

12th Grade
4.1.12.C Analyze the parameters of a watershed.
-Interpret physical, chemical, and biological data as a means of assessing the environmental quality of a watershed.

ACADEMIC STANDARDS (SCIENCE AND TECHNOLOGY)

7TH Grade
3.3.7.A. Describe the similarities and differences that characterize diverse living things.
- Explain how to use a dichotomous key to identify plants and animals.

BACKGROUND:

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. The leaves have a new name now…**detritus.** Actually, any organic matter that is dead and being decomposed is called detritus, even animal matter.

The detritus, now stuck between rocks and covered with microorganisms, becomes the dream house of some everyday macroinvertebrates**.** The detritus can also be habitat for some aquatic organisms, providing a safe place to stay, keep away from predators, or keep out of the stream flow. The clump of leaves also provides a welcome break from the stream current, allowing the macroinvertebrates to rest in comfort. The leaves allow a small flow of water through them however, giving the macroinvertebrates their needed supply of oxygenated water. This is important because the large populations of bacteria produce large amounts of carbon dioxide that displaces the oxygen.

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 first step is to break down the large leaf matter, called **CPOM** (**coarse particulate organic matter**), into **fine particulate organic matter**, or **FPOM**. This is accomplished by **shredders**, a group of macroinvertebrates with specially adapted anatomy, such as pinchers, to tear apart and eat the fibrous leaves. Examples of shredders are cranefly larvae, casebuilding caddisfly larva, stonefly nymphs, scuds, and sowbugs. As they feed on the CPOM, the FPOM produced floats downstream and eventually into the devices of **collectors**. Collecters filter the water in the stream for FPOM by using hairy gills or legs, or in other cases by spinning a web. Gatherer collectors obtain the FPOM from the stream bottom. Examples of collectors are mussels, brush-legged mayfly larvae, net-spinning caddisfly larvae, midges, and blackfly larvae.

As mentioned before, the bacteria feeding on the leaves convert some compounds into ammonia, and others convert the ammonia into nitrites and nitrates that plants and algae use to grow. Another group of macroinvertebrates, called **grazers** or scrapers, feed on this algae that grow on nearby rocks and other hard surfaces. The grazers crawl along the creek bottom scraping rocks for any algae. These organisms typically have a flat, oval body to protect them against the current. Examples of scrapers include snails, flathead mayfly larvae, waterpenny beetle larvae, and stone case-building caddisfly larvae.

All the mentioned macroinvertebrates above are in turn food sources for the 4^{th} class of macroinvertebrates, **predators,** which include dobsonfly and fishfly larvae, crayfish, beetles, water bugs, dragonfly nymphs, and some stoneflies.

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 macroionvertebrates 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. Other methods may be used to measure other types of aquatic insects (see *Multiplate* and *Kicknet* activities.)

OVERVIEW:

Students will be collecting various macroinvertebrates by installing artificial leaf pack bags into various stream locations or other experiment design situation. They will then remove the leaf packs after insects have colonized and analyzing their findings.

PROCEDURE:

Teacher Preparation:

This activity takes anywhere from 2-6 weeks to complete. You may opt to have students take part in all of the experiment, or just in the final results.

1. Collect dry leaves for your experiment (approximately 20g of leaves for each leaf pack bag). Remember to gather leaves before they have had a chance to become damp.

2. There may be two different types of leaf pack bags included in this module – ones with label tags attached at the top or ones without this label tag. If enclosed bags have tags, use a waterproof marker to fill out the tag. If the leaf pack bags do not have tags, you may want to create a waterproof note with the following information to include with the bag:

   Date placed in stream — Class / Period
   Date Collected from stream — Experimental Conditions
   Location in stream — (i.e. willow leaves, riffle area, etc.).

This information could be written on the ziploc bag that you will use to collect the bugs a few weeks later.

Student Experiment or Activity:

Instructions - Preparing your leaf pack bag:

1. To be consistent in experimentation, have the students place the same amount of leaves in each leaf pack bag. For instance, they can use a scale to weigh 20g of dry leaves for each mesh bag. You may want to have students record this information on the enclosed LEAF PACK FIELD DATA SHEET.

2. Tie leaf pack bag shut using strong twine or garbage twist ties.

3. Insert a length of strong twine through the mesh of the bag so that the bag can be secured to something in the stream. That object can either be natural like a large rock, a fallen log, tree roots along the end of the stream OR you can tie the bag to a brick, cinder block, or something else to anchor it.

Instructions - Placing your leaf packs in the stream:

1. Find a position in the stream where a leaf clump would naturally form, such as between two stationary objects or in front of a large rock or log. Place the leaf pack in the stream on the upstream side of the object so that as much surface area of the bag possible is facing the current.

2. Attach the leaf pack bag to the object (large rock, log, brick or cinder block etc.) using the strong twine. Make sure that all of the leaves are submerged and that the leaf pack is securely tied to the weight so it does not become loose and float away.

3. You or the students may want to make a map for each location in the stream where the leaf packs were placed (do this on the enclosed LEAF PACK FIELD DATA SHEET) You may also tie some flagging tape to some vegetation along the stream bank directly across from or beside the leaf pack location. However, if other people visit your stream, the flags may be incidentally torn down.

4. Have the students fill out the remainder of the enclosed LEAF PACK FIELD DATA SHEET.

5. Leave the leaf packs in the stream for about 3-4 weeks. Without disturbing the leaf packs, you may want to check them every few days or after storms to make sure they remain submerged. **Note**: Leaf packs can be lost during floods and should be removed early if floods are predicted.

Instructions - Collecting the leaf packs from the stream:

1. Collect a few inches of stream water in the bottom of a gallon size ziploc bag or other type of plastic bag.

2. Gently hold onto the submerged leaf pack and cut the twine that is securing it to the object.

3. Pick up the leaf pack bag quickly and gently. Some of the insects are very quick to escape so do your best to minimize moving the leaf pack around. If you have D-frame nets (included in module), place them downstream of the leaf pack bags before cutting the twine and removing it from the stream. The net will catch bugs that escape.

4. Place the leaf pack bag into the ziploc bag with the stream water and then seal.

5. Collect additional stream water in a bucket or other container. This will be used during freshwater macroinvertebrate sorting.

6. If not sorting through the leaf pack bags right away, place the ziploc bags into a refrigerator or ice-filled cooler. Most aquatic insects can be refrigerated or iced in coolers overnight. Do not leave the bugs in the ziploc bags for more than 24 hours or

they will die. If you need to keep them longer before sorting, consider placing the contents of each leaf pack bag into a separate container of water, which is kept cool and ideally aerated.

Instructions - Preparing the leaf packs for bug sorting:

1. Make sure you keep your leaf pack bags separated and do not combine contents if you are trying to keep their results separated for your experimental design.

2. Fill the white flat sorting trays enclosed in the module or some other containers with the creek water (DO NOT USE TAP WATER BECAUSE IT HAS CHLORINE IN IT). Empty the leaf pack from the ziploc bag and place in the sorting tray. Carefully untie the twine or twist tie that was keeping the mesh bag closed.

3. Students should sift through the contents of the leaf pack bag looking for insects – make sure they check the undersides of all leaves and keep their eyes peeled for anything moving. They need to look closely because the macroinvertebrates may be small and well camouflaged.

4. Have the students remove the insects from the tray with forceps, eyedroppers, or spoons.

5. Place the insects found in any of the following filled with creek water (You may want to place similar looking creatures together in one container):
   labeled identification bug cups (included in module)
   petri dishes
   small plastic containers

6. Have the students identify the insects using resources included in the module. View them closer using magnifying glasses or microscopes.

7. You may want to create a class data sheet to record results or use the enclosed LEAF PACK FIELD DATA SHEET.

DISCUSSION:

List the different species of macroinvertebrates collected using the leaf packs, and include the quantity of each.

What category of feeders do these species fall into?

What category was predominant? What reasons explain why they are more numerous?
The predominant category should be shredders. The leaves are CPOM which the shredders feed on. Other groups of macroinvertebrates would not find this food source as appealing. Predators may also be found in the pack, because they feed on the shredders.

In what types of streams would these organisms be most abundant? In what types of streams would they be scarce? *Streams with a large riparian zone and leafy foliage would have plenty of CPOM, and so plenty of shredders. Streams low on CPOM or FPOM would have few shredders, such as streams with a gravelly bottom and few trees on the side at the site or upstream. Rivers that are mainly muddy bottom would not be a good spot to find CPOM or shredders either.*

Why are leaves important to all insects, not just the shredders? *Important to a hungry fish? The leaves are important part of the base of the food chain/web. Leaves and CPOM are broken down by bacteria, and shredders, into FPOM eaten by collectors. The nutrients from these leaves can be used by algae eaten by grazer insects. All of these insects can be eaten by predator insects. Hungry fish may then eat insects as well.*

EVALUATION:

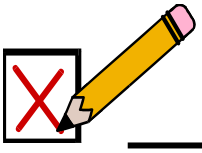
- Identify the types of macroinvertebrates residing in a stream's leaf packs
- Correctly conducted sampling procedures.
- Correctly completed data sheet
- List the food sources for the different classes of macroinvertebrates.
- Discussion questions above.

EXTENSIONS AND MODIFICATIONS:

- Have the students design leaf pack bag experiments that study a variety of variables. Make sure students understand experiment design – controls, constants, and variables. Possible experiments can try to determine:1) habitat preference (different streams or location within the same); 2) food preference (what type of leaves or vegetation); 3) seasonal differences / fluctuations. Specific ideas follow:

- *Stream vs. Stream:* A stream in a DE-FORESTED (meadow, agricultural field, urban) area vs. a stream running through a FORESTED area; A stream with poor water chemistry vs. stream with good water chemistry.
- *Location in Stream:* Riffle area (shallow) vs. pool area (deep); Along bank vs. center of stream; Attached to fallen logs vs. attached to rocks; muddy bottom vs. rocky bottom
- *Leaf type(same total weight of leaves):* mix or variety of leaves vs. one type of leaf; grasses vs. tree leaves; one type of tree leaf vs. another type of tree leaf; green leaves vs. dried, brown leaves; construction paper cut outs of leaves vs. real leaves
- *Amount of Leaves:* A small amount of leaves in leaf pack bag vs. a large amount.
- *Time* Fall vs. Spring; Fall before the leaves fall off the trees vs. fall after leaves fall off trees; 2 weeks vs. 6 weeks

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):



DATA SHEET: ARTIFICIAL LEAF PACKS

Class _____Your Name _____

Stream Name

_____

Approximate location of sampling site (i.e., 60 meters upstream from Rt. 19 bridge):

_____

_____

Stream Observations (flow rate, appearance, size, plant life, animal life)

_____

_____

_____

_____

Description of Vegetation along Stream at your Sample Location (forested, types of trees, shrubs, cropland, grassland, lawn, dense vegetation or sparse, diverse or similar, etc.)

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Sketch of Sample Location. Include the location and number of leaf pack bags you placed in the stream. Note any identifiable natural features in or near the stream (fallen tree, large rock, pine tree, etc.) or unnatural features (pipe, sidewalk, etc). Exact or approximate measurements may be useful. This map may be useful in finding the bags a few weeks later, so show details.

Leaf Pack Bag Information Table

Bag #	Leaf Type	Leaf Mass (g) *(if determined)*	Experimental Condition *(if applicable)*	Date put in stream	Time	Date out of stream	Time	Weather during bag's time in stream

Macroinvertebrates Collected Table

	Number of insects found								
List Insects found below	Bag 1	Bag 2	Bag 3	Bag 4	Bag 5	Bag 6	Bag 7	Bag 8	Bag 9