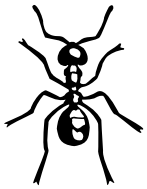


Activity #2

Raindrops and Watersheds: Size Matters!

Length:
One class period

Prerequisite Activity:
None

Objectives:
- Demonstrate how a plant's leaf shape can affect watershed functionality and promote erosion.
- Understand the impact of alien invasion on biodiversity.

Vocabulary:

Aquifer	Kinetic	Watershed
Erosion	Hydrology	Understory
Disdrometer	Throughfall	

● ● ● Class Period One: *Measuring the Drop*

Materials & Setup

For each student
- Student Pages "Water Droplet Lab Worksheet" (p. 16)

For each group of 3-5 students
- A sampling of large and small leaves picked from around the school grounds or brought from home. For large leaves, the bigger the better (example: ginger, *ti,* or banana leaves). For small leaves, leaves averaging three inches long are ideal.
- Flour (2-3 cups)
- Plate
- Spray bottle
- Ruler
- Mesh metal strainer, such as an extra large tea strainer

Note: Use the information in the Teacher Background "Raindrops and Hydrology" (p. 15) to familiarize yourself with the miconia hydrology research. Also, moderating the speed and number of water droplets falling from the leaf can be tricky. Do the experiment once in front of the class to demonstrate how to allow only one droplet to fall into the flour at a time.

Instructions:

1) For context about miconia and its effects on native Hawaiian forests, show the *Miconia Threatens Maui* video included in this curriculum.
(Also available on the web at http://youtu.be/eSwVnIUtGcM.)

2) Tell students that they will be replicating a scientific study that identifies one way that miconia alters the ecosystem.

3) Break the class into groups of 3-5 students. Tell them they will be simulating rain falling from large and small leaves in the forest, and comparing the size of drops.

4) Have each group pour a layer of flour in the plate (roughly 1-2 inches deep) and level it off with the ruler.

5) Spray a leaf with fifteen squirts of water from a spray bottle. Do this away from the flour.

6) Quickly tilt the tip of the leaf over the flour and allow 4-5 raindrops to roll off the tip of the leaf and into the flour. Make sure each droplet has its own clear space on the flour. Droplets will join together on the leaf, but try not to let two droplets fall in the same spot. After five individual droplets fall onto the flour, remove the leaf.

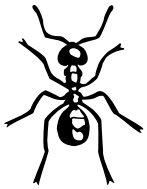
7) Your flour should now be dotted with individual rain droplets. Flour will congeal around each rain droplet. Carefully separate each rain droplet.

8) Sift the droplets from the plate by pouring the flour through a strainer. (You may want to gently roll each droplet into a ball.) Measure the diameter of each droplet in millimeters. If droplets are oblong shapes, measure both sides and record the average size.

9) Have students repeat instructions 2-6 twice, using large leaves and small leaves. They will record the measurements for ten drops from a large leaf and ten drops from a small leaf on the Student Page "Water Droplet Lab Worksheet."

10) Have students compare the sizes of the droplets that resulted from the larger leaves to those from the smaller leaves.

11) Engage students in discussion: were there significant differences in the size of raindrops falling from the different leaves? How might larger or smaller raindrops make a difference in the functions of the rain forest? Did the shape of the leaves make a difference? Use Teacher Background "Raindrops and Hydrology" to explain context of experiment.



● ● ● Class Period Two: *Understory*

Materials & Setup

- A sampling of large and small leaves picked from around the school grounds or brought from home
- Twigs, small rocks, moss and other leaf litter
- Flour, diatomaceous earth, or soil
- Flat tray or baking sheet
- Spray bottle

Instructions

1) Construct a simulated "healthy forest understory," using flour, diatomaceous earth or actual soil, small rocks, sticks, moss, and leaves. Arrange the components on a flat tray. Elevate one side of your forest to represent the gentle rise in elevation typical of the mountain rainforests of Maui. Place a bin on the downhill side of your tray to collect debris.

2) Have each group of students select a nozzle setting on the sprayer, ranging from mist to stream.

3) Spray for two minutes and record the volume of erosional debris that has washed from the tray.

4) Construct a "miconia understory," using only flour or soil and several large sticks. (The sticks represent miconia's shallow roots.) Omit mosses and leaves. Repeat the exercise above, record measurements, and share results in class discussion.

5) Discuss the results as a class. What might this mean for Hawaiian forests that have been invaded by miconia?

Journal Ideas

- What were your expectations prior to conducting the lab? Did you think the leaf size would affect the water droplet size? Why or why not?
- How could soil health in Hawaiian forests affect coral reefs? Agriculture? Public safety?

Assessment Tools

- Lab results
- Participation in class discussion
- Journal entries

Further Enrichment

- Show "Hydrology" powerpoint and discuss. (Included in this curriculum.)
- Read the Robert Hobdy's essay, "The Many Faces of *Koa*." (Included in the appendix.)
- Have students design a lab to test the variance between slender, medium, and thick *koa* phyllodes as described in Hobdy's essay.

Teacher Background

"Raindrops and Hydrology"

Miconia is widely considered the worst weed currently invading Pacific island rain forests. The South American tree has invaded over 60 percent of the island of Tahiti, where sunless, single-species groves have replaced native forest, encouraged erosion, and caused landslides. In Hawai'i, miconia has infested huge swaths of rain forest on Maui and Hawai'i Island. Comprehensive campaigns to control its spread have been underway since the 1990s.

Scientists have known for decades that miconia infestations reduce watershed function in tropical Pacific rain forests. Recently, some hydrologists set out to demonstrate exactly how. They started by measuring the size of raindrops falling in Hawaiian rain forests. Most raindrops average 1-2 mm in size. The world's largest recorded raindrops were 8mm and fell over Hilo, Hawai'i. Bigger drops usually break apart as they fall through the air.

Rainwater that hits trees or other obstructions on its way to the earth is called "throughfall." When the scientists measured the size of throughfall falling from miconia's large leaves, as compared to the size of throughfall falling from the smaller leaves of native plants, they discovered a big difference. The drops falling from miconia leaves were consistently larger.

Large water droplets possess greater kinetic energy than small drops as they fall onto the forest floor. They promote greater erosion, resulting in exposed roots, large ruts in the soil, and diminished water retention. The scientists were able to show that the size of the leaves played a role in reducing watershed function. This lab is a replication of their experiments—only instead of using an expensive laser disdrometer to measure the raindrop size, you'll use flour, water, and a lot of patience.

Miconia's umbrella-like leaves negatively affect watershed function in other ways, too. Small plants cannot grow beneath the shade of giant miconia leaves. In a miconia-dominated forest, the multitude of ferns, small shrubs, lichens and mosses sponge that characterizes native Hawaiian forests disappears. Understory plants wither and die, to be replaced by hundreds of miconia seedlings, exposed roots, and, ultimately, bare soil. Rainwater that would have soaked into the sponge-like understory instead washes off a hard surface, carrying precious topsoil away.

Other large-leafed plants such as banana and *ti* plants don't cause the damage that miconia does in Hawai'i. Large leaves aren't the only weapon miconia unleashes on the rain forest. It also matures rapidly, dispersing millions of microscopic seeds per year, and growing in tightly packed single-species groves. Its shallow root system increases the likelihood of erosion and landslide. Add these components up and you've got a severely impaired watershed.

Rain forests are critical reservoirs of water for island communities. Rainfall recharges underground aquifers, which are tapped by local communities. Without healthy rain forests, we risk losing our primary source of drinking water. Additionally, when eroded forest soils wash down from the mountain into the ocean, they smother coral reefs. Combating invasive species in our forests is critical to maintaining the integrity of island ecosystems.