Lesson 1: Build an Island

Summary
Students will work in groups to construct small islands of substrate and subject them to artificial rain to study patterns of erosion. Each group will manipulate one of four variables; substrate type, slope, rainfall, and water dispersion with 2-3 treatments of each variable. They must make predictions beforehand and observations after a first dose of water and again after a second. They will then compare results with other groups to get an overall picture of how these variables result in different environmental conditions.

Objectives
- Students will be able to explain differences they see in the Hawaiian Islands and relate these to freshwater habitats.
- Students will identify and account for important environmental characteristics of Hawaiian watersheds such as waterfalls, floods, and droughts.

Materials
This lab is done with 9 groups and ideally 2+ students in each.
- 9 large trays with sides
- 18 6 oz plastic cups
- 1 misting spray bottle
- Approximately:
  - 70 oz sand
  - 10 oz cinder
  - 10 oz dry dirt
- water
- 1 measuring cup (approximately 10oz)
- Build an Island worksheet (1 per student)

Making Connections
This activity is the first in the freshwater curriculum and helps students understand the diversity of freshwater ecosystems in Hawaii. This lab will be referred to repeatedly in future activities.

Teacher Prep for Activity
1) Gather the necessary materials. 7 of the plastic cups need to be lightly perforated at the bottom. A finish nail heated with a lighter works well. In addition, 1 cup needs to be more heavily perforated (larger holes) for the “Heavy” water dispersion treatment group. The spray bottle is “Light.”
2) Ensure a good location (perhaps outside) to carry out this lab.
3) Print out sufficient student worksheets for the class size.
4) Prepare the trays for each treatment group. Each treatment group needs the following:

- **Substrate type**: 3 treatment groups
  - 1 tray
  - 1 scoop dirt/sand/cinder
  - 1 medium perforated cup
  - 1 non-perforated cup

- **Slope**: 2 treatment groups
  - 1 tray
  - 1 scoop sand
  - 1 medium perforated cup
  - 1 non-perforated cup
  *(students build a steep/flat island)*

- **Rainfall**: 2 treatment groups
  - 1 tray
  - 1 scoop sand
  - 1 medium perforated cup/spray bottle
  - 1 non-perforated cup
  *(students use ½ or 2x normal volume of water)*

- **Dispersion**: 2 treatment groups
  - 1 tray
  - 1 scoop sand
  - 1 heavily perforated cup/spray bottle
  - 1 non-perforated cup

**Background**

While many students in Hawaii have grown up in the ocean and can name dozens of the plant and animals that inhabit salt water, they are often less familiar with the freshwater ecosystems that are in their backyard. Since this curriculum is designed for use in teaching life science, it focuses on the endemic animals—and noxious invasive species—that inhabit the diverse freshwater habitats found in the Hawaiian Islands. However, to understand these animals and the ways that they interact, it is important to first understand the how environmental variables can influence freshwater ecosystems.

In this lab, the first in the freshwater ecosystem curriculum, students approach the subject from the ground up and begin by investigating the importance of differences in the underlying substrate type (geology), the shape or slope of the land (topography), and the patterns and characteristics of rainfall and water levels (hydrology). Hawaii is unique in containing a tremendous diversity of environmental conditions within a relatively small area, which results in a diversity of habitats and ecosystems. To understand this interaction, students rigorously and scientifically investigate each variable as a first step towards understanding freshwater ecosystems. In doing so they will learn good experimental design by isolating and investigating each variable through a series of treatments.

In future labs, students will be asked to look more closely at how environmental differences can directly influence freshwater organisms and communities. Initially, however, they need to understand how differences in substrate type, slope, rainfall, and water dispersion can create different radically different environmental conditions. For this reason, in this lab they will focus primarily on changes to the physical landscape through erosion.
Vocabulary
Aquatic: This refers to things that live in water.
Marine: Refers particularly to things that live in the ocean.
Freshwater: Water that is not salty. In contrast to marine, “freshwater” refers to things that live in streams, rivers, ponds, lakes, puddles, etc.
Brackish: Water that has some salt in it but less than the ocean. Most commonly found where streams or rivers enter the ocean. If large enough, these areas of brackish waters are called “estuaries” but these are uncommon in Hawaii. The salinity, though less than the ocean is more than most freshwater species can tolerate.
Variable: This is something that can change and in science this is usually what is being studied in an experiment or what changes to bring about an observed difference. For example, some variables that affect erosion are substrate type and rainfall patterns.
Treatment: In a well designed experiment we study a particular variable by setting up different levels or treatments, such as low/medium/high and determine the effect of the variable by comparing them.
Substrate: The underlying “stuff” in a given place. Examples are dirt, lava rock, and sand.
Erosion: Movement of surface substrate due to water, or more simply, changes in the land surface following rainfall.

Procedure
1) Briefly discuss the difference between freshwater and saltwater and have the students brainstorm where they’ve seen freshwater in Hawaii. Examples might be puddles, streams, taro fields, anchialine ponds (in Kona). Help them out if necessary until there is a good diversity of locations.

2) Brainstorm with the students about what accounts for these differences. Focus on the 4 variables to be tested here—substrate type, slope, rainfall, and rain dispersion—and give contrasting examples for each, such as Hilo/Kona for substrate type (dirt/lava) and rainfall patterns and between Big Island/Oahu for island shape. The difference between a short heavy rain and an extended, light rain with the same total rainfall can probably be understood in any single location.

3) Describe the overall purpose of the lab and how, as scientists, it’s often useful to study one variable at a time. Define the relevant vocabulary on the board and write out the 4 variables with the treatments for each. It may work well to map out the variables under a larger question such as “why are these places different?”
   Substrate type (dirt, sand, gravel)
   Slope (flat, steep)
   Rainfall (low, high)
   Water dispersion (light, heavy).

4) Demonstrate how to make an island and subject it to rainfall.
   1) Building the island: place approximately 9 oz of substrate (dirt, sand, or cinder) in the middle of the tray and form into a mound.
   2) Applying rain: place a perforated cup within of a non-perforated one and fill half full
with water. Remove the inside (perforated) cup and hold over the mound of substrate.

5) Briefly walk the students through the lab worksheet. Specifically, discuss each variable group and what will be different between treatments (that variable being tested) versus what will be the same (all the other variables).

6) Assign each student to a variable/treatment group. The number of students in each group will depend on the class size. 2 per group is ideal.

7) Give the students a few minutes to write out a sentence or summary of what they will be testing (which variable) and how they will do it (which treatments). These are the first 2 questions on the handout.

8) When they have demonstrated a clear understanding, give each group the following materials:
   - Small tray to contain island and water
   - Scoop of appropriate substrate
   - Appropriate volume of water
   - Appropriate water disperser (perforated cup or spray bottle)

   **NOTE:** The specific volumes of substrate and water used in this lab can be altered to fit within space or availability constraints.

9) Give the students the remainder of the class period to complete the experiment and worksheet.  
   **Optional:** save the last 10 minutes of class for group discussion of results or sharing.

10) As students finish, have them return their materials and meet within their variable groups to summarize what they learned about that variable.

11) When each variable group has discussed what they learned, have them write a summary sentence on the board of what they discovered. Examples might be “dirt erodes faster than cinder,” or “heavy rainfall causes more erosion than light rainfall.”  
   **NOTE:** For a group discussion, have the students share their summary with the class and give a brief description of why they came to this conclusion.

**Assessments**
Completion of the activity and accompanying worksheet.
Build an Island Worksheet

Name:

Date:

Period:

Variable group:

Treatment:

1) **Summarize:**
In one sentence summarize what you will be studying in this experiment. Make sure to include the variable.

2) **Predict:**
List the different treatments in your variable group and make a prediction of which will have the most and least erosion.

3) **Observe: 1st Application**
Build an island and apply rain. How did the shape of the island change? What does the water look like that ran off the island? Make careful observations below.
4) **Observe: 2nd Application**
Without changing the island, apply another dose of water. Was the effect the same as the first time or were there any differences? Make careful observations below.

5) **Draw conclusions**
Compare the island that you made against the other treatments in your variable group. What can you conclude about the effect of that variable on erosion? Write this on the board

What did your classmates learn about the other variables?

How did **Substrate Type** affect erosion?

How did **Rainfall** affect erosion?

How did **Dispersion** affect erosion?

How did **Slope** affect erosion?
6) **Understand Implications:**
The different variables that you looked at in this lab have important effects on the freshwater environments.

Circle one of the treatments listed next to each variable below to create a unique freshwater environment.

At this location,
- the substrate is DIRT -- SAND -- CINDER,
- the slope is FLAT -- STEEP,
- the dispersion is HEAVY -- MEDIUM -- LIGHT,
- and the rainfall is HIGH -- MEDIUM -- LOW.

Now describe this place. What happens when it rains here? Are there big storms or just light sprinkles? Do the rivers flood and get muddy like in Hilo, or does the water just flush through like in Kona? Mention each variable.

How might these conditions affect a freshwater organism living in this location? What will it need to do to survive? Will it have to climb waterfalls? Survive droughts or heavy flooding? Live in muddy water?