STREAM PATTERNS

What patterns do we see in data on stream life? How can we design an investigation to test our hypotheses about streams in urban and forested sites?

HAWAIʻI DOE STANDARD BENCHMARKS

Math 9: Patterns, Functions, and Algebra: PATTERNS AND FUNCTIONAL RELATIONSHIPS

- **MA.5.9.1** Analyze patterns and functions and use generalizations to make reasonable predictions.

Science 1: The Scientific Process – SCIENTIFIC INVESTIGATION

- **SC.5.1.1** Identify the variables in scientific investigations and recognize the importance of controlling variables in scientific experiments.

NĀ HONUA MAULI OLA

- **NHMO 8-4** Apply cultural and traditional knowledge of the past to the present.
- **NHMO 14-1** Be keen observers of their natural environment.
- **NHMO 14-7** Be familiar with and respectful of places within their community.

KEY CONCEPTS

- To compare stream sites and understand the impact of different land uses, it is important to identify variables that need to be controlled when collecting data.
- Streams in forested areas tend to have better habitats for native stream life, including more fast-moving riffles, lower temperatures, higher dissolved oxygen, and less silt.

ACTIVITY AT A GLANCE

Students look at data, make predictions, and develop and test hypotheses about the connections between land use, stream characteristics, and the number and kinds of invertebrates at an urban and a forested stream site.

ASSESSMENT

Students:

- Identify variables in a scientific investigation and describe why the variables need to be controlled.
- Analyze data from comparing local streams and make predictions based on the trend revealed by the data.

TIME

3 class periods plus a field study

SKILLS

predict, measure, observe, analyze, formulate and testing hypotheses

Materials

Provided:

- ✓ Learning Log 3
- ✓ stream life data sheet (for all *hui* or teams)
- ✓ observation sheet (for each student)
- ✓ *hui* data sheets (one for each *hui*)
- ✓ stream life ID sheets
- ✓ PowerPoint presentation (provided on CD)
- ✓ chant *E Hō Mai* (provided on *Oli* CD)

Needed:

- ✓ clipboards and grease pencils (one per pair of students)
- ✓ goggles (a few pairs for water testing)
- ✓ *Flowing to the Sea* (6 books for students in groups to share or copies of chapters)

Student Checklist for Field Trip:

- ✓ hat
- ✓ sunscreen
- ✓ *tabi* or old shoes
- ✓ clothes that they don't mind getting dirty
- ✓ bottled water in backpack
- ✓ rain poncho or jacket (large garbage bags will work)

Note: The following items will be provided for your students at the stream study sites. If you want to borrow a dissolved oxygen test kit for students to try out before the trip, please see contact information in the Advance Preparation section below.

- ✓ turbidity measure
- ✓ 2 buckets
- ✓ dissolved oxygen test kit
- ✓ thermometers
- ✓ boundary markers
- ✓ stopwatch
- ✓ tape measure

Vocabulary

abundance – in this context, the total number of individual organisms in a given area

channelized – dredged and straightened stream channels

dissolved oxygen – oxygen dissolved in water

diversity – in this context, the total number of species in a given area

invertebrates – animals without backbones

ʻoʻopu – native stream fishes; gobies

ʻōpae kalaʻole – native shrimp that live in fast-moving riffles in streams

ʻōpae oehaʻa – native prawns

patterns – consistent characteristics

riffles – shallow area within a stream where the flow of water is constricted and forced over rocks and ledges

turbidity – the amount of suspended sediments in water; a measure of water clarity

variable – something that is likely to change

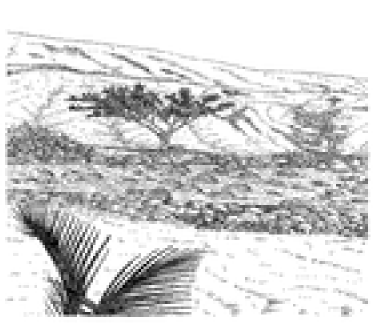
Advance Preparation

- ☐ For Oʻahu teachers: Visit the Pacific American Foundation Web site to reserve a date and set up your field trip: www.thepaf.org and click on *Aloha ʻĀina.*
- ☐ Send field trip permission slips home with students and request a few parent chaperones for the field trip.
- ☐ Copy Learning Log 3 and the observation sheet for each student.
- ☐ Make five copies of the *hui* data sheets, stream life data sheets and observation sheets on waterproof paper (or place them in sheet protectors) and place on clipboards.

- ☐ Copy a few sets of stream life ID sheets on waterproof paper (or laminate them) for students to use in the field.
- ☐ Review the water safety guidelines (provided in the Appendix).

Teacher Background Information

In this activity, students discover how scientists control variables to study streams. The student reading provides some basic information from a 2004 study (Brasher et al., 2004) of nine streams on Oʻahu that represented different stream habitats found in forests, mixed land-use (agriculture and residential), and urban areas. The purpose of the study was to determine the associations among land use, habitat characteristics, and the presence and abundance of different invertebrates in the streams. The authors of the study focused on the invertebrates, such as insects, snails, shrimp, and prawns, to determine if the number and kinds of invertebrates found at the different sites could be used as an indicator of stream quality. With the ultimate goal of effectively managing Hawaiian watersheds to provide habitats for more native stream species, the researchers wanted to find out how the species responded to human-induced changes (i.e., urban and mixed land-use). They found that there was a greater abundance of invertebrates and more native species at the forested stream sites than at the urban or mixed land-use sites. Conversely, they discovered that there was a greater diversity (higher number of species) of invertebrates at the urban and mixed land-use sites.



The results of the study indicated that urban and mixed land-use sites, most of which were channelized streams, had less vegetation, higher water temperatures, smaller substrate, and higher levels of silt than forested stream sites (Brasher et al., 2004). Many streams on Oʻahu have been channelized to protect residential and business areas from flooding. The cement channels contain the flow of the stream during heavy rainfall, but these stream channels lack the pools, riffles, runs and large boulders that provide good habitat for native stream animals. The channelized streams also tend to have fewer trees and vegetation along the banks, resulting in less shade and higher water temperatures.

Water temperatures also increase with runoff of silt and other organic matter from human activities. Many urban and mixed land-use streams have high turbidity--high levels of suspended particles such as clay, silt or organic matter, which make the water cloudy or dirty. These particles absorb sunlight, resulting in increased water temperature. Warm water holds less dissolved oxygen, which native stream animals need to survive. Many non-native invertebrate species, such as Asiatic freshwater clams (*Corbicula fluminea*) are adapted to the degraded conditions found in channelized streams (Yamamoto and Tagawa, 2000).

Brasher and fellow researchers found that the most common freshwater molluscs are non-native, and that these were indicator species for degraded habitat conditions. Regarding the crustaceans, the native *ʻōpaekalaʻole* (Atyid shrimp) was only found at sites with greater than 95 percent forested land use. The maximum water temperature in the urban section of the Kāneʻohe Stream exceeded the upper lethal limit (34°C) for *ʻōpaekalaʻole* (Brasher et al., 2004).

Controlling Variables

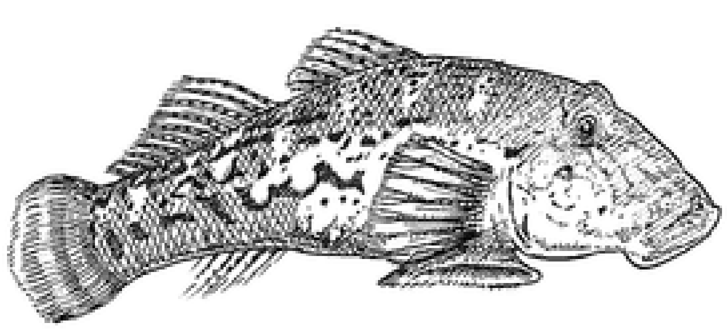
When conducting experiments it is important to control variables so that you isolate the influence causing the effect. When studying streams in the field, there are many variables to be considered, such as stream velocity or the size of the sample. To compare the sites and control for variables, Brasher et al., (2004) did the following:

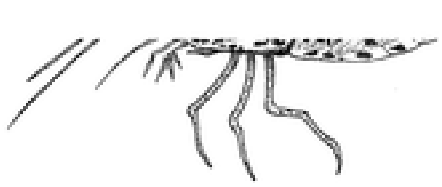
- They collected all of their data during base-flow conditions in the streams.
- They collected five quantitative samples at each site using the same size net.
- All surface material within a one-quarter square meter area in front of the net was gently dislodged and scrubbed to remove all of the organisms. All of the organisms collected from each sample area were then sorted into various taxonomic groups and counted.

They also collected qualitative samples from each available habitat at the sites using the same size net at each site. They analyzed these samples using a timed visual-sort method. (This method entails collecting all samples within a set time, e.g., duration of one hour. Each sample site is then visually sorted and only the presence or absence of species is recorded for each sample.) The habitat characteristics were studied on the same day that the invertebrates were collected. Streamflow, temperature and other measures were recorded at 11 equally spaced transects (lines perpendicular to the flow of the stream) at each site.

Some of the data collected by Brasher et al., (2004) are displayed in the bar graphs on the following page. The student activity sheet also includes a bar graph that summarizes the abundance of invertebrates at the different sites. By looking at that graph, students might predict that **both** abundance and diversity will be greater at the forested stream site than at the urban site. Don't persuade them to think differently since it will get their attention to see how scientific studies can help us to question our assumptions and gain new understandings. By gathering and analyzing data in their own investigations of streams, your students will learn about the process of scientific investigations while gaining a deeper understanding of the connections between our land uses and the quality of streams.

Note: Channelization can involve the cementing of stream bottoms and sides to prevent erosion. This also acts to force as much water as possible away from an area in a short period of time. Traditionally this was done to prevent flooding (Problems Facing Urban Streams, 2007)





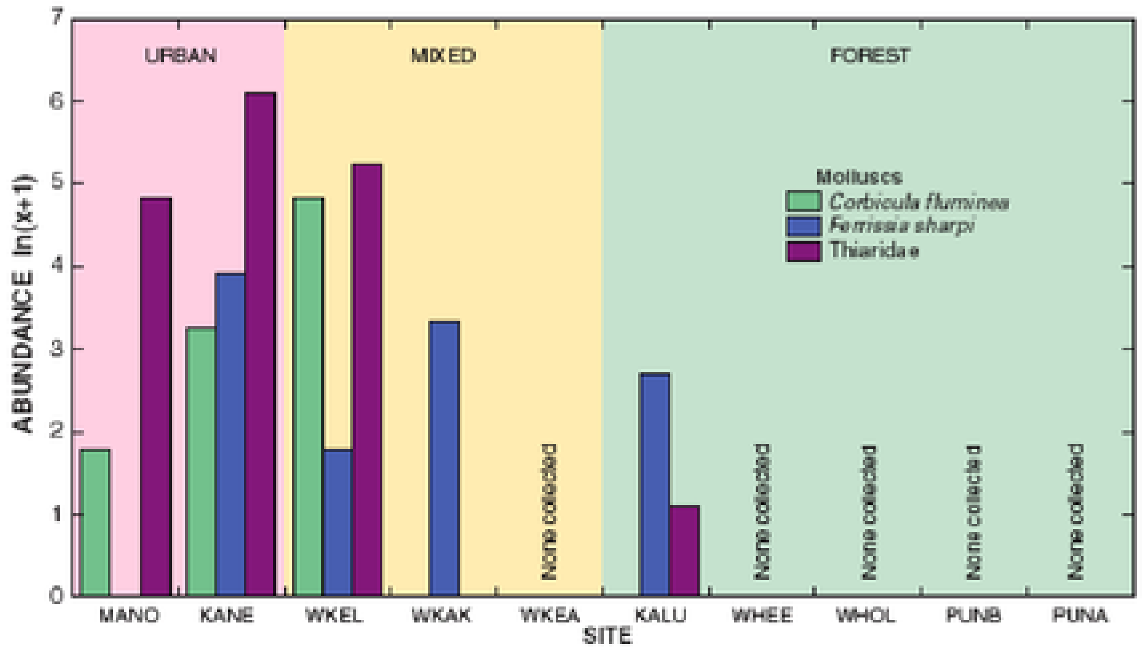


Figure 23. Relative abundance of molluscs at sampling sites.

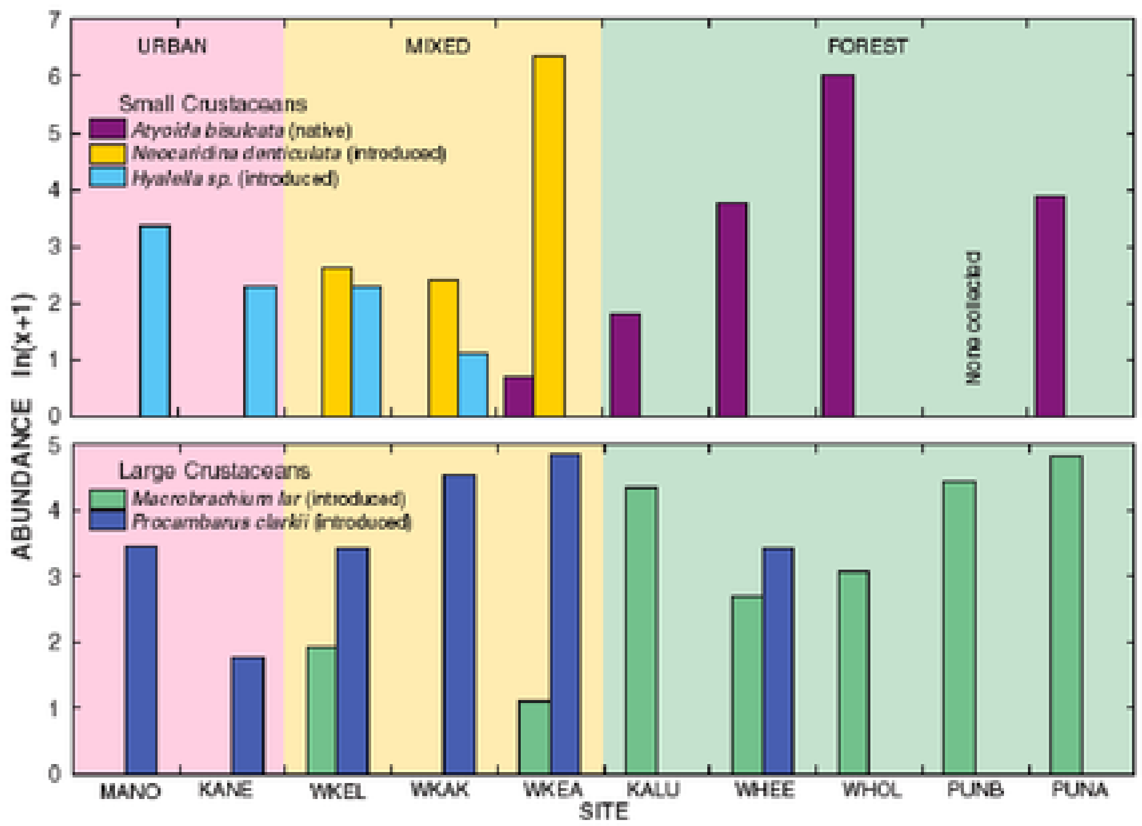


Figure 24. Relative abundance of crustaceans at sampling sites during benthic surveys and electrofishing.

Molluscs (all non-native)
Corbicula fluminea – Asiatic freshwater clam
Ferrissia sharpi – limpet
Thiaridae – snail

Small Crustaceans
Atyoida bisulcata – ʻōpaekalaʻole
Neocaridina denticulata – grass shrimp
Hyalella sp. - amphipod

Large Crustaceans
Macrobrachium lar – Tahitian prawn
Procambarus clarkii - crayfish

(*Source: Brasher et al., 2004*) Note: the abundance scale (x+1) in the graphs above represent a mathematical transformation of data to normalize differences in variation between samples. For the purposes of this lesson, have students look at the bars in the graphs to compare relative abundance of species under different conditions.

The abbreviated sampling sites represent the following streams:

Mānoa (MANO)	Kaluanui (KALU)
Kāneʻohe (KANE)	Waiheʻe (WHEE)
Waikele (WKEL)	Waiāhole (WHOL)
Waikakalaua (WKAK)	Punaluʻu (PUNB = site below the diversion;
Waiakeakua (WKEA)	PUNA = site above the diversion)

Measuring Turbidity

In the field, students will be measuring turbidity (the amount of suspended particles in the water) by collecting water samples from the stream and pouring the water into a turbidity tube. The bottom of the tube has a black and white disc. Students pour the water sample into the tube until the point when they can no longer clearly see the black and white markings at the bottom. They record the height of the water in the tube and then use the conversion chart provided to get the turbidity reading. Scientists measure turbidity in NTUs (Nephelometric Turbidity Units). NTU is a measure of the amount of light scattered by suspended particles in the water. The amount of time that the water is turbid is a key factor in how the turbidity affects stream life (University of Wisconsin, 2006).

Teaching Suggestions

Before the field trip:

1. **Introduce the standard benchmarks and essential question for this lesson.**

2. **Distribute Learning Log 3 and review vocabulary.**
- Ask students to read the text and study the bar graph.
- Challenge them to use this information to make predictions about the characteristics of the different stream sites and the invertebrates that might be found in each site.

3. **Show the PowerPoint presentation provided with this unit.**
- Make a chart of students' predictions about habitat characteristics and stream life.
- Ask them to explain the reasoning behind their predictions.

4. **Introduce the field trip and distribute and review *hui* (group) data sheets.**
- Explain that students will be taking a field trip to an urban and a forested stream site to investigate how different habitat characteristics affect the abundance of native stream animals.
- Divide the class into five *hui* (groups) and give each group a different *hui* data sheet to review.
- Explain that each *hui* will be responsible for collecting data about one habitat characteristic at the stream site. If you have a small class, plan to combine the tasks for *hui* 2 and 3 into one group.
  - *Hui* 1 Percent shade cover
  - *Hui* 2 Water temperature
  - *Hui* 3 Dissolved oxygen
  - *Hui* 4 Velocity of stream flow
  - *Hui* 5 Turbidity

5. **Discuss what makes a hypothesis testable and use the template provided in the PowerPoint presentation to help guide students to develop hypotheses.**

- Present characteristics of testable hypotheses to answer questions about the abundance of native stream species in an urban versus a forested stream site.

  Characteristics of a testable hypothesis:
  - It is clearly stated.
  - The hypothesized relationship between the variable (in this case, habitat characteristic) and the predicted result is based on general knowledge, observations or research.
  - It can be tested with the materials and conditions available.
- Review students' hypotheses and discuss how they could test them in the field.
- Then have them record their hypotheses on their *hui* data sheets.

6. Discuss the method that the researchers used (see Background above) and the need to control variables to make useful comparisons.

- Ask students to record (on their *hui* data sheets) the variables they will be controlling.
- Ask them to share the variables they will be controlling and explain why.

7. Distribute the stream life data sheet (one copy to each *hui*) and the observation sheet (one copy to each student). Discuss how students will use these sheets in the field. (Note: each *hui* should have two sheets (a *hui* data sheet and a stream life data sheet. Each student should have an observation sheet and a pencil.) Have students within each *hui* review the data collection that they will conduct in the field and decide who will be responsible for the following tasks:
   - leader
   - data recorder
   - equipment organizer
   - reporter
   - stream life data recorder

8. Practice using the water quality tests with students before going on the field trip and discuss safety guidelines.

- Have students who will be conducting the dissolved oxygen test practice the procedure by following the directions provided with the kit.
- Ask students in each *hui* to read Chapter 8 from *Flowing to the Sea*. Discuss safety and review the concepts covered in the chapter including, Leptospirosis, flash floods, and tips for observing stream life.
- Explain that students with any open cuts will not be able to go into the stream due to the threat of Leptospirosis.

9. Introduce the term "*hōʻihi*" (respect) and discuss what students need to do to respect the sites they are visiting.

- Have a *kupuna* teach them an *oli* (chant) that will focus their attention when they arrive at the field sites. See *oli* provided on CD and in the Appendix.

10. Review what students need to bring and what to wear on the field trip.

- Bring: sunscreen, mosquito repellent, hat, drinking water, and backpack with lunch.
- Wear: old, comfortable clothes and closed-toed shoes or *tabi*.

During the Field Trip:

11. Establish the tone and set boundaries at the beginning of the field trip.

- Ask students to gather at the site and chant *E Hō Mai*. This will help to focus their energy and attention and set the proper tone for the experience.
- Set **boundaries** at each site and ask students to stay with their *hui* in the area assigned to them. The exception will be the team measuring percent shade. Allow them to work at each boundary marker and in the middle of the site.
- Remind them of **safety** precautions when moving near the edge of the stream. Rocks can be slippery!

12. Have students observe quietly for the first few minutes and record what they see on their observation sheet.

- Ask for volunteers to share some of their observations.
- Before students disturb the site with their water tests, the field trip leaders will show students how to sample for life in the stream and carefully collect organisms to observe in buckets.

13. Using the stream life data sheet

- Have students gather around the buckets to observe stream life.
- Students can use the stream life cards or stream life ID sheets to try and identify stream plants and animals.
- Ask the stream life data recorder to record what students observe on the stream life data sheet.

14. Collecting data and recording it on *hui* data sheets

- Set a time limit for each *hui* to collect the data outlined on their data sheet. Review safety guidelines and distribute equipment.
- Remind students that their data will be shared in class after the trip.

After the Field Trip:

Lesson 4 guides students through the process of analyzing their data and drawing conclusions to share with others during the culminating *hōʻike* experience.

Adaptation / Extension

If time allows during the visit to the forested stream site, ask students to sit quietly and draw what they see. They could also write poetry or stream reflections to add to their learning logs.

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