5.2 Let's Take a Dip (Expanded Version)

Virtual Macroinvertebrate Population Sampling

Overview

Students will virtually "dip" nets in four different aquatic habitats, collect data, and draw conclusions. This serves as preliminary research by familiarizing students with scientific sampling protocol and organisms they may encounter when they are conducting the Macroinvertebrate Field Study at Hard Bargain Farm Environmental Center or other location.

Lesson Planner

Use the table below for lesson planning purposes.

Time Required	Pre-Field Study: 45 minutes Post-Field Study: 45 minutes
Key Concepts/Terms	Diversity, Population, Frequency, Habitat, Classification
Prerequisites	Understanding of the Energy Cycle: Food Chains/Food Webs
Setting	Computer Lab/Classroom with Computer Access, Individual/Student pairs

Learning Objectives

After completing this activity, students will be able to…

- Explain how to sample the macroinvertebrate population of a body of water;
- Compare and describe typical species inhabiting creek, swamp, marsh, and river habitats;
- Describe the steps in the scientific method;
- Explain why a standardized procedure and repeated sampling in an experiment will generate more accurate data;

Materials Required

<u>For each student/pair</u>

- ***Habitat Populations Frequency Table***, pg. 5-10
- ***Student Worksheet-Let's Take A Dip***, pg. 5-11
- Access to a computer with Internet capability

<u>For the class</u>

- Enlarged poster/transparency of the ***Habitat Populations Frequency Table***

Background Information

- For more on classification, see ***Classified Information*** an online activity for students (available at www.fergusonfoundation.org).
- Refer to ***What Macroinvertebrates Can Tell You About Stream Health***, pg. 5-15; this may also be distributed to students.

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Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td rowspan="3">Engage</td><td>1</td><td>Explain to the students that in this exercise they will use an online activity to collect data on the number and kinds of organisms (living things) found in four different aquatic (watery) habitats—creek, swamp, marsh, and river. Some reasons scientists conduct this type of research are to:
• learn about the health of the environment (see What Macroinvertebrates Can Tell You About Stream Health)
• look for patterns to help understand relationships between different living organisms
• understand relationships between organisms and their surrounding environment.

"Today we are going to collect data on the number and types of organisms found in four different aquatic habitats. Scientists conduct this type of research to learn about the health of the environment and look for patterns of relationships in the habitat."</td></tr>
<tr><td>2</td><td>Give each student/pair a copy of the Habitat Populations Frequency Table, pg. 5-10, and Student Worksheet, pg. 5-11.

The table allows the students to keep track of the data they collect.</td></tr>
<tr><td>3</td><td>Discuss the meaning of the words habitat, population, and frequency.

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td>Habitat</td><td>A place that has the minimum required amounts of food, water, shelter and space for a particular species.</td></tr>
<tr><td>Population</td><td>The total number of individuals of one species occupying a particular area.</td></tr>
<tr><td>Frequency</td><td>The ratio of the number of times an event occurs in a series of trials to the total number of trials in the experiment. For example, a banded killifish was caught in four out of ten dips in the marsh.</td></tr>
</table>
</td></tr>
</table>

Phase	Step	Action
Engage	4	Review the classifications for organisms that may be encountered in the activity (amphibian, fish, mollusk, reptile, crustacean, insect, plant, etc.).
	5	Have students (either in pairs or as a class) generate questions that can be investigated in this activity. They should ask "what", "how", or "when" questions, not "why" and involve habitat(s), population size, and/or frequency of organisms. Ex: *How do the number and type of organisms differ between the creek, swamp, marsh, and river habitats?* Review questions and have students select one to investigate. Students record the question on ***Student Worksheet***.
	6	Help students formulate a hypothesis based upon the question selected. Ex: *We will find a greater diversity of organisms in the _____ habitat versus the _____ habitat.* Ex: *We will find more fish/amphibians/X in the ____habitat than in the _____habitat.* Have students record their hypothesis on ***Student Worksheet***.
	8	Discuss how to design an experiment to investigate their question and hypothesis by incorporating the discussion points in ***Experimental Design Discussion for Let's Take a Dip***, pg. 5-17.
	9	Model how students will collect data using your poster/transparency of ***Habitat Populations Frequency Table***. Each dip should be recorded as one tally mark, regardless of how many organisms are pictured on the screen. Note: Advise them to click carefully, one at a time, and to record their data as they go.

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Phase	Step	Action
Explore	10	Write the website address on the board: www.fergusonfoundation.org Have students access the website using the school's Internet browser.
	11	When the HBF Webpage appears on the screen, students will go to the "***Kids' Zone***" tab, then to the "***Let's Take a Dip***" activity.
	12	Instruct students to read the information and directions on the screen, then to proceed at their own pace following instructions. **Reminders to students**: • start in the creek first, • click carefully, • record data after each dip (click), • dip and record 10 times in the creek, then repeat in the next habitat, • read the information about each critter caught, • write the classification for each creature in the column on the data sheet. ***Note:*** This provides an excellent opportunity to follow instructions and read to acquire information. Students should work independently as much as possible.
	13	If they did not catch a particular creature, they can go to the online "***Critter List,***" to read about it.
Explain	14	Have students think about what conclusions they can make using only their data, and complete the ***Data Analysis*** section of the ***Student Worksheet***, providing supporting evidence that helps justify their answers.
	15	Combine data from the class using a large poster version of the frequency table or a transparency and overhead projector.

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Phase	Step	Action
Explain	16	As a group, draw conclusions about the organisms and habitats studied. Use questions in the ***Data Analysis*** section of the ***Student Worksheet*** and ***Data Analysis Discussion Questions***, pg. 5-18, as a guide. **Do the group conclusions differ from their individual conclusions?** *They should be somewhat different. Encourage students to explain how.* **Are conclusions based on larger amounts of data more accurate than those based on less data?** *Yes, conclusions are more accurate when based on more data. A larger sample size will give you a more accurate representation of the entire population than just taking a small sample.* *Short of draining the entire habitat and counting every creature, we will never know exactly which organisms and how many of each are in the different habitats. Sampling gives us an estimate or approximation. This is how scientists conduct population studies.* **Does the data support your hypothesis?** Does the data answer the question asked at the beginning of the investigation? *Answers will vary.* **Are further studies necessary to answer your question?** Discuss examples of when further studies may be necessary to answer the question asked. *My Question: what habitat do crayfish prefer, river or marsh? I found an equal number of crayfish in both habitats. Repeating the study or changing the design of the study could provide the data needed to answer my question.*
Elaborate	17	• **Field Study at Hard Bargain Farm Environmental Center**—a staff-led exploration of various habitats within the Potomac River watershed, including a sampling activity (dip net or other technique) in at least one habitat, weather and water conditions permitting. (Information for the **Habitat Hike** and **Up A Creek** classes available at www.fergusonfoundation.org.) • Discussion of actual sampling results compared to virtual results from Web activity.
Evaluate	18	Use the ***Habitat Population Frequency Table*** and the ***Student Worksheet*** to evaluate student performance and understanding.

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Name: _____

Habitat Population Frequency Table

Tally and classify the organisms caught in each of the four habitats: creek, swamp, marsh, and river. Classify the organisms as AMPHIBIAN, CRUSTACEAN, FISH, INSECT, MOLLUSK, PLANT, or OTHER.

		HABITAT TYPE			
NAME OF ORGANISM	**CLASSIFICATION**	**CREEK**	**SWAMP**	**MARSH**	**RIVER**
American Toad					
Arrow Arum					
Backswimmer					
Blacknose Dace					
Bluegill					
Caddisfly Larva					
Cranefly Larva					
Crayfish					
Dragonfly Nymph					
Eastern Mudminnow					
Freshwater Mussel					
Green Frog					
Hydrilla					
Isopod					
Mosquitofish					
Mud					
Mummichog Minnow					
Pill Clam					
Scud					
Silverside Minnow					
Snail					
Southern Leopard Frog					
Tadpole					
Water Boatman					
Water Strider					
Whirligig Beetle					
OTHER.					

Student Worksheet – Let's Take a Dip

Name: _____

Before Data Collection

1. State the question you will investigate:

2. State your hypothesis:

Data Analysis

After Data Collection

3. Where did you catch the **most animals**?

4. Where did you catch the **most different kinds** of animals?

5. Check the habitat where you caught the **most** of **each type** of animal:

Animal Type	**Habitat**			
	CREEK	**SWAMP**	**MARSH**	**RIVER**
Amphibians				
Crustaceans				
Mollusks				
Reptiles				
Plants				
Insects				
Fish				

6. Make bar graphs to display the data you collected for **two habitats**.

Habitat 1. _____

Number of Animals

Animal Name	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Species of Animal

Habitat 2. _____

Number of Animals

Animal Name	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Species of Animal

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7. How do your two graphs compare?

8. What are some reasons that might explain the differences you observed between the two habitats?

9. Compare your graphs with those of other students in your class. Do they look the same?

10. Review your hypothesis stated in question #2. Does the data support your hypothesis? If not, what does your data show?

11. Which method is best to find a true picture of the animals that live in each habitat?

a. ____ Use your data because you did a good job collecting animals.
b. ____ Use another student's data because she usually gets things right.
c. ____ Combine the data from all the students because the more samples you use, the greater the accuracy of your results.

12. You know that killifish are predators of amphipods. Make a prediction of what would happen if the killifish population suddenly doubled.

13. Imagine that the amphipods disappeared suddenly because of a flood or other environmental change. What would happen to the killifish?

Teacher Answer Key for

Student Worksheet – Let's Take a Dip: Data Analysis

8. What are some reasons that might explain the differences you observed between the two habitats?

Animals have favorite places to live: they are adapted to prefer certain habitats. Some animals cannot live in another habitat, or are present in much smaller numbers.

9. Compare your graphs with those of other students in your class. Do they look the same?

Graphs will vary because net dips are random, and will catch different assortments of animals.

11. Which method is best to find a true picture of the animals that live in each habitat?

    a. ____ Use your data because you did a good job collecting animals
    b. ____ Use another student's data because she usually gets things right
    c. _X_ Combine the data from all the students because the more samples you use, the greater the accuracy of your results.

12. You know that killifish are predators of amphipods. Make a prediction of what would happen if the killifish population suddenly doubled.

The killifish would eat a lot more amphipods and the population size of amphipods would decrease. Eventually they would eat so many that the killifish would no longer have enough amphipods to eat. Then they would either eat some other animal, or die of starvation. With an increase in the population of killifish, organisms that eat killifish would have more food available to eat which could lead to an increase in organisms that eat killifish.

13. Imagine that the amphipods suddenly disappeared because of a flood or other environmental change. What would happen to the killifish?

The killifish would lose their food supply, which could lead to a decrease in their population size. The killifish would have to migrate to another area, find another kind of food, or die of starvation. A change in the population size or availability of killifish would also affect other organisms that eat killifish.

What Macroinvertebrates Can Tell You about Stream Health

Think About It

Have you ever sat by a pond watching dragonflies flitting about?

Or wondered why there always seem to be more mosquitoes near water?

Or watched spider-shaped insects dancing on the surface of water?

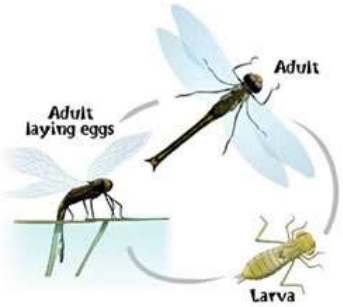
MACROINVERTEBRATES are insects and other creatures that are:

- big enough to see without a microscope (MACRO), and
- do not have a backbone (INVERTEBRATE).

We are interested in aquatic macroinvertebrates (ones that live in the water). Examples of these are dragonfly larvae, crayfish, and clams.

How Insects get from Water to Land

Many insects lay their eggs in water. When they hatch, the young live and grow under water.



When they are ready to become adults, they go through a great body change called **METAMORPHOSIS**.

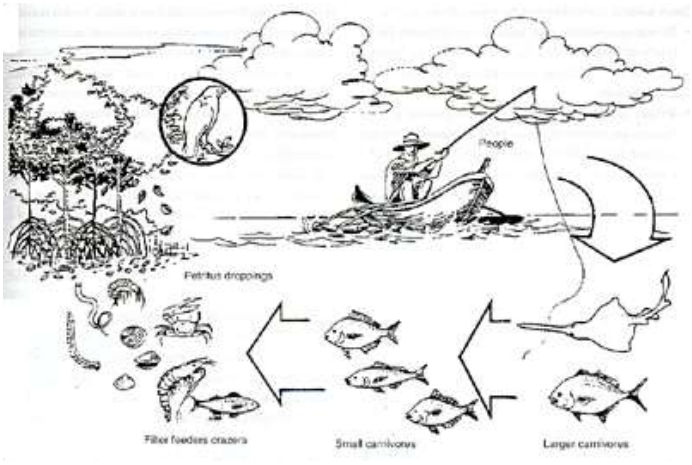
When they become adults, they don't live in the water anymore. They may still stay near water to eat and mate.

Examples of these kinds of insects include dragonflies, stoneflies, and mosquitoes.

Why Should We Care?

Insects are an important part of **FOOD WEBS.**

Many other animals eat them, so they are needed in our water.



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What Macros Tell Us about the Water They Live In

You cannot always see pollution, so you have to find other ways to find out if the water is clean or dirty. The animals living there give you information.

- Some animals need very clean water to live. If you find a lot of these, you have clean water.
- Some can handle a little bit of pollution. If you find these, and not many of the ones that need clean water, then you have fair water.
- Some animals can live in very dirty water. If you only find these, then you have dirty water.

Rating Streams

We rate streams according to the categories listed below:

Excellent: In a very healthy stream, there are many different KINDS of organisms (high biodiversity). If you find these, then you have good to excellent water. Examples of organisms that require good-excellent water are mayflies, stoneflies and case-making caddisflies. You will probably also find animals from the other categories (fair and poor). These can live in any water.

Fair: A medium healthy site will have animals that can handle a little more pollution. These include crayfish, dragonflies, crane flies, and snails. There will not be as many KINDS of different species. You will not find many mayflies, stoneflies, and caddisflies.

Poor: There will not be many KINDS of organisms (low biodiversity) in poor water. In poor water, you will find mostly organisms that can handle a lot of pollution. Examples are black fly larvae, worms, midge larvae and possibly leeches. If you find mostly these, you have poor quality water.

Experimental Design Discussion for Let's Take a Dip

Steps in the Scientific Method

- Ask a Question - what, how, when (not why)
- Formulate Question & Hypothesis
- Design an Experiment - Fair test of hypothesis
- Collect Data
- Data Analysis – Compare, evaluate, and explain findings

Design an Experiment - Fair Test

The experiment should attempt to answer the student's question and prove or disprove their hypothesis. In ***Let's Take a Dip***, students will collect data in an online activity using a virtual dip net to collect (sample) macroinvertebrates in four habitats—swamp, creek, river, and marsh. Students will sample ten times in each habitat and record data on the ***Habitat Populations Frequency Table***.

Important discussion points about experimental design include:

- **Equipment**: To collect (sample) organisms in the four habitats what kind of equipment is needed? How will we catch organisms in an aquatic habitat? *Dip nets* How will we know what type of organism we catch? *Identification guides* (provided in activity) How will data be recorded? *Data sheets:* ***Habitat Populations Frequency Table***

- **Standardized procedure/methods**: Is it ok to dip 40 times in location A, 5 times in location B, and conclude that location A has more organisms? *No, the experiment would be unfair. We might catch more organisms* ***only because*** *we are dipping (sampling) more times in location A. Our results would be biased because our experimental design did not follow a standard procedure for all locations and therefore we would not be able to compare the two locations. Having an unequal number of samples at each location would not accurately test our hypothesis.* How do we make the study more fair? *Same size nets, same number of dips, same method of dipping every time, same day, etc*.

Why is it important to follow the same procedure for each trial and that everyone uses the same type of equipment in our experiment? *To decrease the number of variables in our experiment so we can more accurately test our hypothesis and answer our question. It also allows students to compare results with each other and combine data to have a greater sample size (and/or experiment repetitions).*
The design of an experiment is critically important for collecting data that accurately represents a habitat population and conducting a fair test of the hypothesis. A poorly designed experiment could result in data that is inaccurate, not useful to scientists, and conclusions about the organisms being studied.

- **Repeated trials/samples**: Why is it important to have multiple trials (or samples) in an experiment? Would one dip at location A and one dip at location B be enough? *A greater sample size (and/or more repetitions) helps to make an experiment more robust and more likely that the data collected is accurate.*

- Discuss and identify **independent and dependent variables**. Attempt to eliminate as many variables as possible that may skew the data and give inaccurate results.

- **Hypothesis**: Is the experiment set up in a way that it will answer the question and either prove or disprove the hypothesis? This is the whole reason for the experiment so make sure it will actually investigate your question and hypothesis.

Data Analysis Discussion Questions

1. Why is it important to dip your net many times when collecting information about the organisms living in any of the habitats? How can combining your data with data collected by others affect the accuracy of your information?
   The more times you dip your net (assuming that the organisms are stored in a bucket), the more likely you are to catch all the organisms. Therefore, more dips will more accurately represent the actual composition of organisms in your habitat. However, one dip might scare the organisms away and you would not collect any other organisms. If you used that information for your graph, it would not accurately depict the actual number of organisms present in the habitat. Combining data is like taking more samples. Therefore, it is a more accurate representation of the habitat's populations.

2. Select two habitats you visited to collect information. What similarities and differences did you observe between the populations of the two habitats? What are some reasons that might explain the differences you observed?
   A Venn diagram or a bar graph would be a great way to see the similarities and differences for a selected habitat. Let's say you compared the number of killifish in a swamp versus a river. Reasons for similarities might be that similar food is available in both places, predators might be equally common in both habitats, or hiding places (shelter) might be similar in both habitats. Some reasons for differences might be different water currents, a larger area for organisms to get away, or predator populations may be different for each habitat. Think how the fish get their food, where they hide from predators, and the numbers of fish. Too many fish might mean less food for all or not enough hiding places. Also, consider water depth, water temperature, or water clarity as possible explanations for data differences.

3. According to the data from the Sample Habitat Populations Table (in the Teacher Resources Section), there are usually about three killifish for every four amphipods caught in the swamp at Hard Bargain Farm. You know killifish are predators of amphipods.

   a. Make a prediction about the changes that would occur in the distribution of organisms living in the swamp if the killifish population suddenly doubled. Use your knowledge of the swamp and the organisms living there to explain your prediction.
   The amphipods are food for the fish. If you suddenly have more fish competing for the same amount of food, this larger population will either drastically deplete the number of amphipods or totally wipe them out. Either way, this means less food for each fish, which could affect their long-term health. Overcrowding often leads to the easier spread of diseases, which in turn, leads to a population decline. Keep in mind that killifish are also food for other swamp residents. An increase in the fish numbers might make them an easier target for larger predators. The food chain is clearly complicated.

   b. If you were to use a net with much smaller holes, would your data and predictions have been different?
   If we used nets with smaller holes, we might have caught more amphipods. If the holes were already small enough to capture any size amphipod or baby fish, then it is unlikely that our data would be affected. If either amphipods or baby fish slipped through our net holes, then the population numbers we recorded would have been different.

4. Mosquito larvae live in the swamp water. They are 3-15mm in length.
   a. Why do you suppose you did not catch any in your dip net?
   Perhaps the net holes were not small enough to catch the tiny larvae. Maybe you sampled in the wrong season, when larvae were not present. Maybe a predator ate most of them.

   b. If you had used a net with smaller holes, would your data have been different? Explain your answer.
   A net with holes smaller than the tiniest larvae would very likely catch any larvae present in the water. If the holes are larger, the larvae simply slip through the holes back into the water before you actually see them.