EXPLORATIONS

Activity 16

Probing an Aquatic Ecosystem

Objectives

- To understand the meaning of pH
- To understand the effect of changes in pH and temperature on ecosystems

Materials

- TI-73
- Unit-to-unit cable
- CBL 2™
- pH sensor (with DIN adapter if necessary)
- Temperature sensor
- Three aquariums
- Strainer
- Gravel
- Tape measure
- Tap water
- Plants for two aquariums
- Aquatic animals for aquarium
- Data Collection and Analysis pages (p. 148 - 153)

In this activity you will

- Set up three aquariums: one with water only; one with water and plants; and one with water, plants, and animals. You will observe them for several weeks.
- Use the CBL 2™ with a pH sensor and temperature sensor to collect data on the three aquariums.
- Compare the results from the three aquariums to determine how plants and animals affect the water quality.

Problem

How will plants and aquatic animals affect the pH value of an aquarium?

Introduction

By setting up aquariums containing different organisms you can observe the interactions of living and nonliving parts of a fresh water ecosystem. You begin with three tanks containing only tap water and gravel and allow them to sit for three days. Then you add one new organism to two of the tanks each day for four to six weeks.

The three tanks are set up as follows.

Tank 1: Control (contains only water)

Tank 2: Producers (contains plants)

Tank 3: Producers and Consumers (contains plants and animals)

As you add plants and aquatic animals to the aquariums, you use the CBL 2™ with a pH sensor and temperature sensor to track the pH and temperature of the water in the aquariums. The pH value tells you whether the water is an acid, a neutral, or a base. A scale of 0 to 14 is used, with 7 being neutral.

After you have added all of the organisms, you will determine what impact, if any, plants and aquatic animals have on the acidity and temperature of water.

Hypothesis

Before testing, complete the **Hypothesis** section on the **Data Collection and Analysis** page to predict the effects of plants and animals on the pH value of an aquarium. Then complete the **Experimental Design** section on the **Data Collection and Analysis** page.

Procedure: Collecting the Data

You will repeat this procedure each day for four to six weeks.

1. Add the plants and/or animals to two of the tanks as directed by your teacher.
2. Plug the pH sensor into Channel 1 (**CH 1**) on the CBL 2 using the DIN adapter, if necessary. Plug the temperature sensor into Channel 2 (**CH 2**) on the CBL 2.
3. Start the DATAMATE program.
4. The Main Screen is displayed. If **CH 1:PH** and **CH 2:TEMP(C)** are displayed at the top of the screen, go to step 9. If **CH 1:PH** and **CH 2:TEMP(C)** are not displayed, go to step 5.
5. Select **1:SETUP**.
6. Select **CH1**. Select **2:PH**.
7. Select **CH2**. Select **1:TEMPERATURE**.
8. If you are using the TI stainless steel temperature sensor, select **4:STAINLESS TEMP(C)**. If you are using a different temperature sensor, select the appropriate item from the menu. Select **1:OK** to return to the Main Screen.
9. If **MODE:SINGLE POINT** is displayed, go to step 12. If not, go to step 10.
10. Select **MODE**. Select **4:SINGLE POINT**.
11. Select **1:OK** to return to the Main Screen.
12. When the temperature reading at the top of the screen is steady, record the room temperature on the **Data Collection and Analysis** page.

13. Before measuring the pH and temperature of your first tank and each time you get ready to measure a new tank, rinse the pH sensor and temperature sensor as demonstrated by your teacher.
14. Place the pH sensor and temperature sensor in the tank.
15. When you are ready to begin, select **2:START**. The screen displays **COLLECTING DATA FOR 10 SECONDS**.
16. After 10 seconds, the pH and temperature readings are displayed. Record them on the **Data Collection and Analysis** page.
17. Press ENTER to return to the Main Screen.
18. Repeat steps 13 through 17 for each tank.
19. To exit from the DATAMATE program, select **6:QUIT** and then press ENTER.

Procedure: Graphing the Data

xyLine Graph

After you have finished adding plants and/or animals to the aquariums, use an xyLine graph to plot time versus pH for the two tanks containing organisms.

1. Enter the data from the table on the **Data Collection and Analysis** page in the List editor. Enter the time (the day number) in **L1**, the pH value of Tank 2 (Producers) in **L2**, and the pH value of Tank 3 (Producers and Consumers) in **L3**.
2. Press 2nd [PLOT] **4:PlotsOff** ENTER to turn off all stat plots.
3. Press 2nd [PLOT] ENTER to select **Plot1**.
4. Press ENTER to select **On** (to turn on **Plot1**).
5. Select ⌊⩘ (the xyLine icon) for **Type**.
6. Plot **L1** (time) as the **Xlist** and **L2** (pH for Tank 2) as the **Ylist**.
7. Press 2nd [PLOT] ▼ ENTER to select **Plot2**.
8. Press ENTER to select **On** (to turn on **Plot2**).
9. Define **Plot2** as ⌊⩘ (an xyLine graph) with **L1** (time) as the **Xlist** and **L3** (pH for Tank 3) as the **Ylist**.
10. Press ZOOM **7:ZoomStat** to set the window and display the graph.
11. Press TRACE to display the times with the corresponding pH values on both lines. Sketch the graphs on the **Data Collection and Analysis** page.

Box Plot

After you finish collecting the data, set up a box plot to compare the pH values of Tank 1 (Producers) to the pH values of Tank 2 (Producers and Consumers).

1. Use the same lists you entered for the xyLine graph.
2. Press 2nd [PLOT] **4:PlotsOff** ENTER to turn off all stat plots.
3. Press 2nd [PLOT] ENTER to select **Plot1**.
4. Press ENTER to select **On** to turn on **Plot1**.
5. Select ⊢□⊢ (the box plot) for **Type**.
6. Plot **L2** (pH values for Tank 2) as the **Xlist**.
7. Press 2nd [PLOT] ▼ ENTER to select **Plot2**.
8. Press ENTER to select **On** to turn on **Plot2**.
9. Define **Plot2** as ⊢□⊢ (a box plot) with **L3** (pH values for Tank 3) as the **Xlist**.
10. Press ZOOM **7:ZoomStat** to set the window and display the graph.
11. Press TRACE to find the minimum data point, maximum data point, median, and quartiles. Sketch the graphs on the **Data Collection and Analysis** page.

Data Analysis

After you collect and plot all of the data, answer the questions on the **Data Collection and Analysis** page.

Application

1. Find trends in the data for each tank over time by graphing air temperature and water temperature as a line graph. Record the results on the **Data Collection and Analysis** page.
2. Answer the questions on the **Data Collection and Analysis** page to discuss whether these aquariums provide a healthy environment for the plants and animals.
3. Compare your pH values from the aquariums to various water sources in your area. Record your findings on the **Data Collection and Analysis** page.

Extensions

- Does sunset (darkness) have any effect on the pH of the plant tank? Try short-term data collection using the time graph mode setting on the CBL 2™. Track the pH of the plant tank from afternoon through late evening (about 3 – 10 PM). Leave the tank in natural light only. Take readings every 20 – 30 minutes.

- Are there patterns in the pH of the water over a 24-hour period? Use the time graph mode setting of the CBL 2 to track the pH of the plant tank over 24 hours. Plug the light sensor and temperature sensor into the other two CBL 2 channels at the same time. Take readings every 30 minutes. Compare any pH changes to the light and temperature changes.
- Would different plants and/or animals affect your pH results? Design a lab to see how adding other plants, fish, or animals to the tank will affect the water's pH. Test for only one type of organism at a time. Hold everything else constant. After data collection, compare your hypothesis to actual results.
- Compare the water quality of various tanks (water only, plants only, and plants and animals) using three tests: pH, ammonia, and nitrite. Record your data in a table for several weeks, and then graph your results over time. Explain trends in your data in order to compare the water qualities of the tanks.
- Design a lab to test the effect of temperature on the reproduction of plants or animals. Vary only the temperature in different tanks. Record your observations of plant growth and reproduction and/or numbers of brine shrimp over time. Do growth and reproduction increase, decrease, or have no relation to temperature?

Data Collection and Analysis

Name _____

Date _____

Activity 16: Probing An Aquatic Ecosystem

Problem

How will plants and aquatic animals affect the pH value of an aquarium?

Hypothesis

- Tank 1: Control (water only)
- Tank 2: Producers (Plants):

  If _____ _____ plants are added to an aquarium, the pH over
  number type
  _____ days will _____ compared to a water-only tank.

- Tank 3: Producers and Consumers (plants and animals):

  If _____ _____ fish, _____ snails, and _____ crayfish are
  number type number number
  added (in addition to the plants as in Tank 2) to an aquarium, the pH over

  _____ days will _____ compared to a water-only tank.

Experimental Design

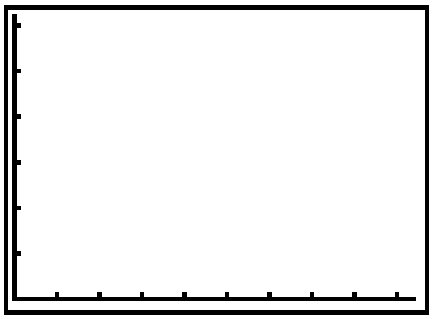
1. Independent Variable: _____
2. Dependent Variable: _____
3. Number of Trials: _____
4. Constants: _____

Data Collection

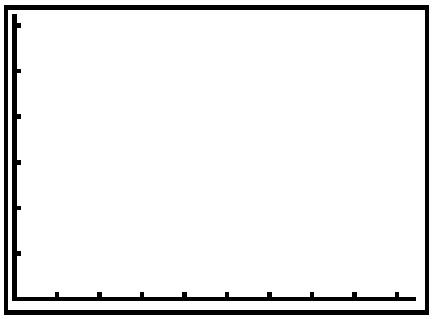
1. Record the temperature and pH value taken during each class period in the table below. Cross out any days when measurements are not taken.

			Tank 1: Water		Tank 2: Plant		Tank 3: Animal	
Day	**Date**	**Room Temp °C**	**pH Value**	**Water Temp**	**pH Value**	**Water Temp °C**	**pH Value**	**Water Temp °C**
1								
2								
3								
4								
5								
1								
2								
3								
4								
5								
1								
2								
3								
4								
5								
1								
2								
3								
4								
5								
1								
2								
3								
4								
5								
	Average							

2. Sketch and label the xyLine graph or print it on the computer and attach it to this page.



3. Sketch and label the box plot or print it on the computer and attach it to this page.



Data Analysis

Using the data from the chart, TI-73 lists, and graphs, answer the following questions.

1. What is the range in pH values for each tank?

   Tank 1:_____

   Tank 2:_____

   Tank 3:_____

   In which tank did the pH vary the most? _____

   Give possible reasons for this.

   _____

   _____

   _____

   _____

2. Find the mean, median, and mode pH values for each tank.

Tank	Mean	Median	Mode
1			
2			
3			

3. Was the average pH of each tank an acid, a neutral, or a base? Give possible reasons for the acidity levels. Give situations where pH values may decrease in a tank due to the addition of plants or animals.

_____

_____

_____

_____

_____

4. Referring to the box plot, where are most of the data values clustered? Is there much variance in the data?

_____

_____

_____

_____

_____

5. Write a summary that compares the effect of plants and fish on the pH of a closed fresh water ecosystem. Include statistics from your charts and graphs.

_____

_____

_____

_____

_____

6. What general trend do you see over time for each tank? Do plants and fish have different effects on their habitat?

_____

_____

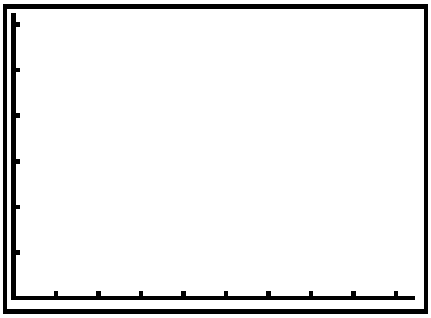
_____

_____

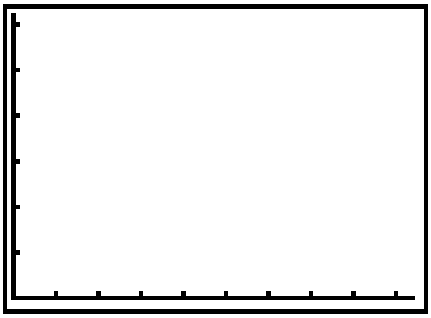
Application

1. Sketch and label the xyLine graph showing air and water temperatures for each tank or print them on the computer and attach them to this page.

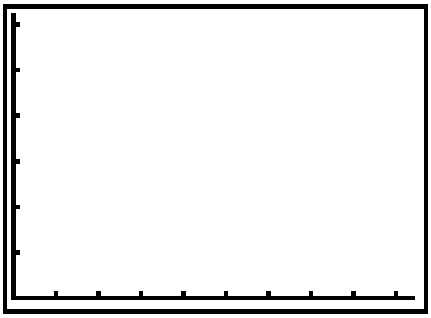
Tank 1



Tank 2



Tank 3



What general pattern do you notice? Explain any peaks and valleys in your graph.

_____

_____

_____

_____

2. If the pH range should be between 6.5 and 8.0 for fish and plant survival, describe how healthy these tanks would be for a long-term habitat for fish and plants. What steps would you take to keep these tanks healthy for these organisms?

_____

_____

_____

_____

3. Compare tank pH levels to local fresh water readings collected with the CBL 2™ or from research. Cite any local issues related to water acidity levels.

_____

_____

_____

_____

Teacher Notes

Activity 16

Probing an Aquatic Ecosystem

Objectives

- To understand the meaning of pH
- To understand the effect of changes in pH and temperature on ecosystems

NSES Standards

- Life Science: Populations and ecosystems
- Life Science: Diversity and adaptations of organisms

Overview

This water quality activity can take place within a unit exploring populations and ecosystems. Observing an aquatic ecosystem over time and recording its changes takes four to six weeks. Students can use a log or a journal to record quantitative data such as temperature and pH values as well as more qualitative observations such as color changes, growth, reproduction, death, and amounts of matter in the water.

Preparation

- This activity focuses on how organisms affect water quality. Small aquariums can be set up at each lab station, or a larger set can be observed by the whole class. Set up a control tank containing water only, one tank for plants, and one tank for plants and aquatic animals. pH can be tracked over time by the CBL 2™ along with manual ammonia and nitrite tests (optional). You can also use the CBL 2 to log room and air temperatures.
- To set up the tanks:
  - **a.** Rinse the gravel in a strainer and put it in each of the aquariums to a depth of about one inch.
  - **b.** Fill the aquarium with tap water. Mark the depth with tape so that you can measure changes in water level due to evaporation.
  - **c.** Label the aquarium contents on the tank: **1. WATER**, **2. PLANTS**, and **3. PLANTS AND ANIMALS**.
  - **d.** Let the tanks sit for three days so that the chlorine can dissipate. Then begin collecting data. Record observations from microscopes and magnifying glasses as well as CBL 2 measurements each class period.

e. Add the producers to tanks 2 and 3. Add the same amount and type of plants to each tank each day for two weeks. Leave the control tank as water only.

Sample Introduction of Producers: 35 ml of algae solution, about 50 fronds of duckweed, three sprigs of elodea, and two bottom-rooted plants.

f. After two weeks of plants only, add the consumers to the plants and animals tank each day for another two or more weeks. Sample Consumer Additions: three fish (guppies or small goldfish work well — try to mix the sexes), two pond snails, one crayfish, and about 10 brine shrimp or daphnia (use dropper).

g. Continue taking measurements until the activity ends. Graph pH values and temperature readings to analyze the data for trends. Compare changes on the graph to the tank changes noted in journals during observations.

h. Use the CBL 2™ with two sensors — pH and light — to collect data for 24 hours. Place elodea in a flask containing tank water. Fit the flask with a stopper that has a hole. Place the flask near a window. Put the pH sensor in the flask and rest the CBL 2 with the light sensor on the sill. Collect data every 20 or 30 minutes for 24 hours using the time graph mode settings.

Management

- If there is one set of class tanks, have students from each lab station take pH readings from sample cups of tank water. Readings can be taken directly if each station has individual tanks. Temperature readings should be taken from the same tank location daily and compared to air temperature.
- Data from each lab station may be entered into a class computer spreadsheet by sending one student from each station to key in data during the period. Rotate this job with the jobs of measurement of temperature, pH, and tank care.
- Students can print line graphs using TI-GRAPH LINK™ or TI™ Connect and label them with tank changes as on a time line. They can also paste the graphs into a word processing document and write water quality summaries.

Application

- Students may form conclusions about the impact of plants and animals on water quality based on their data.
- Students may design a lab to investigate the effect on the ecosystem of the introduction of a man-made variable such as fertilizer from run-off.
- Give students pH data from an unhealthy tank or from a different source. Pet stores are great for getting interesting tank water samples. Ask students to compare and contrast the data to their tanks.

- Track temperature and pH data from a local aquatic ecosystem such as a pond or small creek for the same length of time as the indoor aquariums. Compare and contrast the measurements using data from graphs to justify.

Selected Answers

Experimental Design

1. Independent Variable: *addition of life (plants and animals) to aquarium water*.
2. Dependent Variable: *pH*
3. Number of Trials: ——
4. Constants: *water source, amount of water, tank equipment, tank location (temperature and light), measurement equipment (CBL 2 and sensors)*.