ACTIVITY 1

Using Models

CARD-BASED INVESTIGATION

Ecological models are used to investigate populations of species such as frogs.

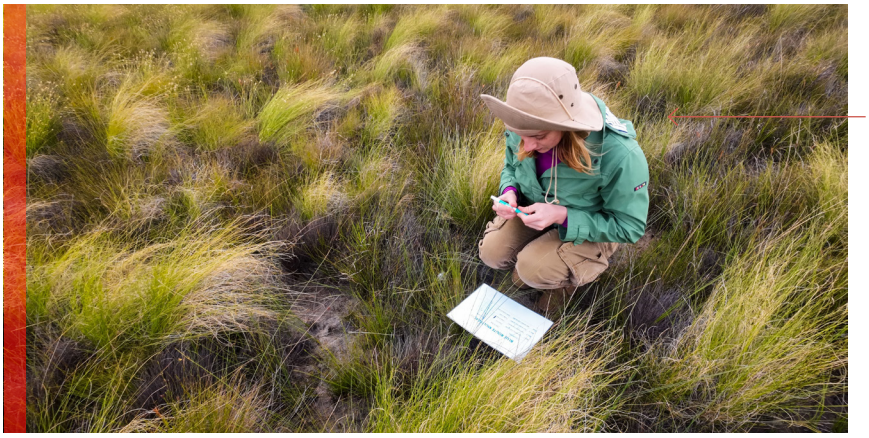
1 : USING MODELS

GUIDING QUESTION

How can models be used to inform a decision?

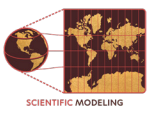
INTRODUCTION

Global environmental changes, such as invasive species, climate change, and habitat loss, are affecting organisms in new ways. Some species are expanding beyond their historic ranges, while others are contracting into smaller habitats. Understanding the effects of environmental change can help people make decisions about conservation, development, and resources. Scientists are creating models to predict the likely population size, distribution, and interactions of species in the future. A scientific model is a representation of an idea, object, process, or system. Scientific models can be used for different purposes, including to explain phenomena and make predictions. In this activity, you will use models to inform a decision about a frog population.



One way that scientists gather data to build models is by observation.

CONCEPTUAL TOOLS



If you need to review the concept of populations of organisms in ecosystems, you will find a Science Review at the end of this activity.

MATERIALS LIST

FOR EACH GROUP OF FOUR STUDENTS

- SET OF 2 FROG MODEL CARDS
- SET OF 2 FROG DATA CARDS

FOR EACH STUDENT

- STUDENT SHEET 1.1 "Daylighting Decision"

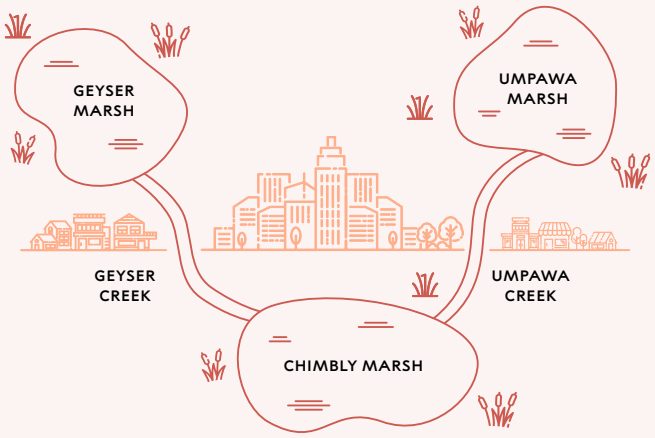
PROCEDURE

1 Read the following fictional scenario.

Anura menanda *is a species of frog found only within the county of Menanda. Changes in the regional climate over the past 50 years have resulted in a steady decline of its total population. Local residents have noticed an increase in the number of mosquitos over that same period. Because frogs eat mosquitoes, residents hope that increasing the frog populations will help address the mosquito problem.*

Historically, Anura menanda *frog populations have been found in 3 local marshes: Chimbly, Geyser, and Umpawa. As recently as 20 years ago, frogs were observed traveling along creeks between Chimbly Marsh and the other marshes. Since then, the creeks connecting the marshes have been paved over, and all 3 frog populations have declined.*

Uncovering a stream that was previously buried underground in drains and pipes and restoring its natural, above-ground flow is known as daylighting. *Local scientists agree that daylighting the creeks will allow the frogs to travel between marshes and likely increase the* Anura menanda *populations. But there is only funding to daylight one of the two creeks. While everyone agrees that it would be best to daylight a creek that connects to the better marsh habitat, they cannot agree on which creek to restore.*



2 As a group, your task is to decide which of the two creeks to daylight. To do this, you will look at models about two other fictional frog species. When there is limited data on a particular species, scientists sometimes use models based on data from similar species. Decide which half of your group will examine Frog Model 1 and which half will examine Frog Model 2.

3 Examine your model card, which shows the relationship between a frog population and factors affecting it. A factor is something that actively contributes to the production of a result. In scientific modeling, a factor is a variable that has an effect on another variable within the model. For example, one factor affecting the gold frog population is predators.

4 With your partner, use Student Sheet 1.1, "Daylighting Decision," to analyze your selected model. For now, complete only the first three rows of *either* Table 1 or Table 2.

5 Your table includes two rows of additional data about Geyser Marsh and Umpawa Marsh. Examine this data. Based on the model you examined, circle the value in each row that most likely indicates better conditions for the *Anura menanda* frogs.

6 Discuss the following questions with your partner and record your responses in your table:

- Based on the model you examined, which marsh do you predict will be a better habitat for the *Anura menanda* frogs: Geyser Marsh or Umpawa Marsh? Why?
- Which creek would you recommend for daylighting: Geyser Creek or Umpawa Creek?

7 Have each pair in your group explain their model to the group. Use this information to complete Tables 1 and 2 on Student Sheet 1.1.

8 As a group, discuss whether the two models resulted in the same recommendation about which creek to daylight and why or why not.

In 2005, the city of Seoul, Korea, daylighted an 11-kilometer (7-mile) stream by removing an elevated highway.

9 Over the last decade, scientists have collected data on *Anura menanda* populations. Your teacher will give 2 Frog Data cards to each group. With your group, examine the data and discuss how each of the following factors appears to be affecting the *Anura menanda* frog population:

- average temperature
- insect population
- pesticide
- Bd fungus

Record your ideas in Table 3 on Student Sheet 1.1.

10 Work with your group to identify which one of the four factors appears to have the greatest effect on the *Anura menanda* frog population. Circle that factor in Table 3.

11 Based on the data, discuss with your group which marsh—Geyser Marsh or Umpawa Marsh—you predict will be a better habitat for *Anura menanda* and why. Record your prediction in the table.

12 Based on the data, discuss with your group which creek—Geyser Creek or Umpawa Creek—you would recommend for daylighting and why. Record your recommendation in the table.

13 Share your recommendation with your class.

BUILD UNDERSTANDING

1. In this activity, you used models to investigate an ecosystem.
   - **a** Which creek do you recommend for daylighting: Geyser or Umpawa?
   - **b** Explain which model—Model 1 or Model 2—was the most useful for deciding which creek to daylight and why.
   - **c** Provide at least two reasons why the model you chose supports your recommendation.
   - **d** Make a prediction for what will happen to the *Anura menanda* frog population if your recommendation is followed.

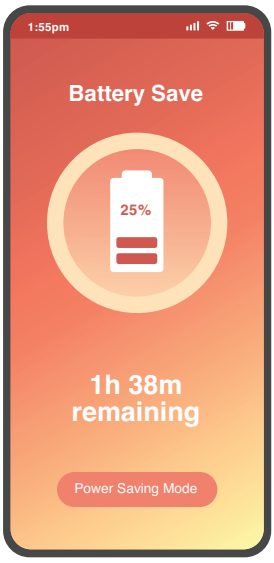
2. Simple diagrams modeled the interactions between frogs and the factors affecting its population. Identify at least two additional factors that could affect the size of a frog population.
   - **a** Using the following symbols, draw a model to show how these factors will likely affect a frog population.
     - → a relationship between factors
     - ⊕ a positive effect, such as an increase in population size
     - ⊖ a negative effect, such as a decrease in population size
   - **b** What data could you collect to test the accuracy of your model?

3. Time has passed. A group of residents has been working on habitat restoration of Menanda marshes. Their work has improved water quality and reduced pollution levels, including pesticides, to levels that cannot be measured. While some residents would like to daylight the other creek, it is currently buried under a pedestrian bridge. Other people do not want to daylight it because it would cost a significant amount to move the crossing.

   Would you recommend daylighting the other creek? Support your answer with evidence from Student Sheet 1.1 and identify the trade-offs of your decision. A trade-off is a desirable outcome given up to gain another desirable outcome.

The Build Understanding and Connections to Everyday Life items are intended to guide your understanding. Some of these items may be discussed with a partner, be part of a class discussion, or require an individual written response. Your teacher will guide you as to how these items will be used in your class.

CONNECTIONS TO EVERYDAY LIFE



④ Your smartphone uses a model to show you the estimated minutes or hours remaining on your phone's battery.

- **a** What are some of the factors this model must incorporate to calculate an accurate time estimate?
- **b** How could you test your ideas about the factors included in this model?

KEY SCIENTIFIC TERMS

factor
scientific model
trade-off

SCIENCE REVIEW: POPULATIONS OF ORGANISMS IN ECOSYSTEMS

Organisms

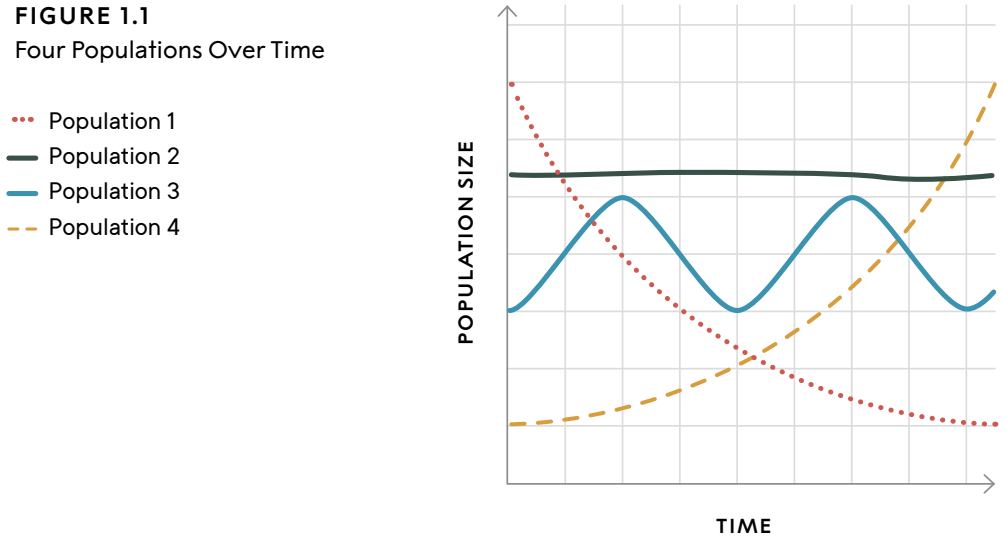
An individual animal, plant, or other living life-form is called an *organism*. Organisms live in an *ecosystem*—the living and nonliving parts of a physical environment that interact with each other in a specific area. An ecosystem can be as small as a puddle or as large as planet Earth. The particular ecosystem where a given organism lives and which provides it with necessary resources such as food and water is known as its *habitat*.

Population

There may be many populations of various species in an ecosystem. A *population* is a group of individuals of the same species that live in the same general area and are able to reproduce with one another. For example, in a pond ecosystem, there can be populations of frogs, dragonflies, and aquatic plants. A group of individuals that can interbreed in nature is a *species*. The common green darner and the clubtail are both species of dragonflies that can be found in pond ecosystems, but they cannot interbreed to produce offspring.

The following graph shows different ways in which the size of a population might change over time. Think about which line is likely to represent a species heading toward extinction and which line is likely to represent a species that has been successfully introduced into a new ecosystem.

FIGURE 1.1
Four Populations Over Time



Range

Some species are found across large regions, such as the brown rat, which was originally native to Asia but is now found on every continent except Antarctica. Other species are located in a much smaller area, such as Devils Hole pupfish. The species is found in a single location: the upper 24 meters (80 feet) of Devil's Hole Pool, a limestone cave in California's Death Valley National Park. In ecology, a *range* is the total geographic area where a species lives and is found during its lifetime—including where it migrates or hibernates.