



ACTIVITY 4

Modeling Factors Affecting a Population

COMPUTER SIMULATION

Scientists have modeled the range of the painted lady butterfly and learned that it has one of the largest ranges of any butterfly. They are found across every continent except Antarctica and Australia.





4 : MODELING FACTORS AFFECTING A POPULATION

GUIDING QUESTION

What factors should be included in a scientific model?

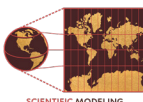
INTRODUCTION

Monitoring the distribution of a species over time can help evaluate the health of its population and predict its future geographic range. It can also provide insight into the factors that will most impact its future population. In this activity, you will use two computer models to investigate the factors that most impact changes in the distribution of two fictional butterfly species.



Scientists use computer models to analyze large amounts of data, understand complex systems, and forecast future events.

CONCEPTUAL
TOOLS



MATERIALS LIST

FOR EACH PAIR
OF STUDENTS

COMPUTER WITH
INTERNET ACCESS

FOR EACH STUDENT

STUDENT SHEET 4.1
"Butterfly Bluff
Simulation:
Model 1 Data"

STUDENT SHEET 4.2
"Butterfly Bluff
Simulation:
Model 2 Data"

STUDENT SHEET 4.3
"Butterfly Bluff
Simulation: 2050"

PROCEDURE

PART A: BUTTERFLY BLUFF SIMULATION: MODEL 1

- 1 With your partner, read the following fictional scenario.

OBSERVATIONS OF CHANGE IN BUTTERFLY BLUFF PARK

Butterfly Bluff Park is located in a rural area and has many species of butterflies. Two notable butterfly species are the Crystal Alpine and the Indigo Longwing. The Crystal Alpine's habitat is in the mountains, while the Indigo Longwing is found in low-lying areas. Over time, regular park visitors have observed these species in areas where they haven't been seen before.

Ecologists at a nearby college have decided to construct a map model to describe how the distribution of the two butterfly species has changed over time. The team is recording data on the butterflies' distribution. The study uses historical data to determine which factors are impacting the species. The goal is to predict where the butterflies might be found in the future.

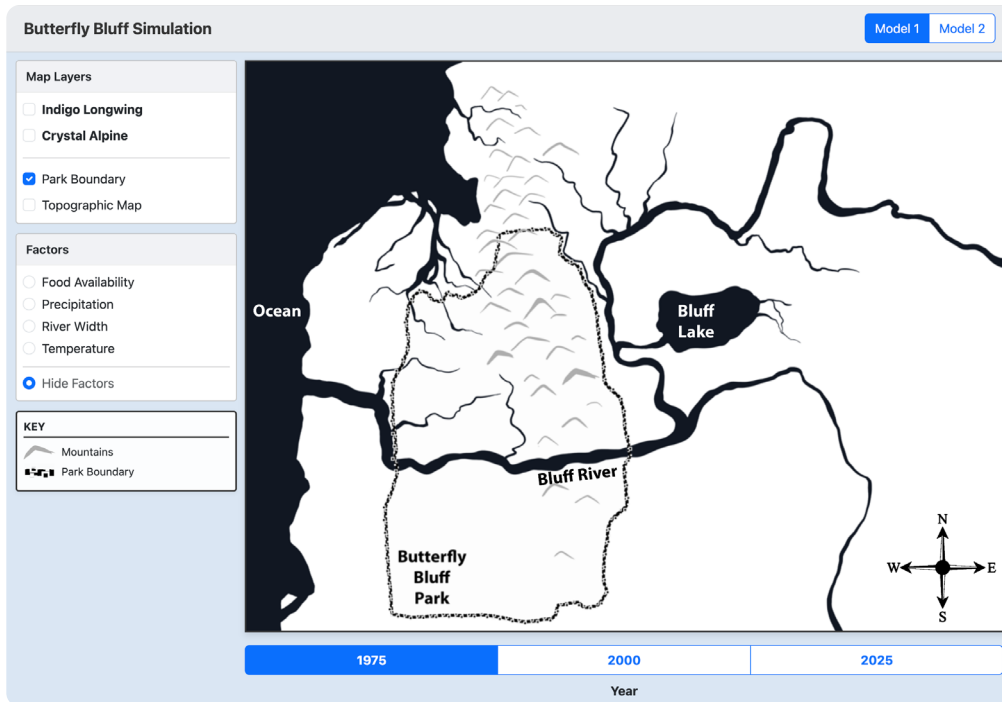
Another group of scientists used the historical data from the map model to create an additional model to identify the factors that impact the populations the most. This information can help predict how the butterflies will be distributed in the park in the future.

- 2 As a class, brainstorm reasons why the distribution of butterflies might be changing and record these ideas in your science notebook.

- 3 Your teacher will assign you and a partner to one of two butterfly species. Follow your teacher's instructions for accessing the Butterfly Bluff Simulation. To begin, use the button on the top right of the screen and select Model 1 (as shown in Figure 4.1).

FIGURE 4.1

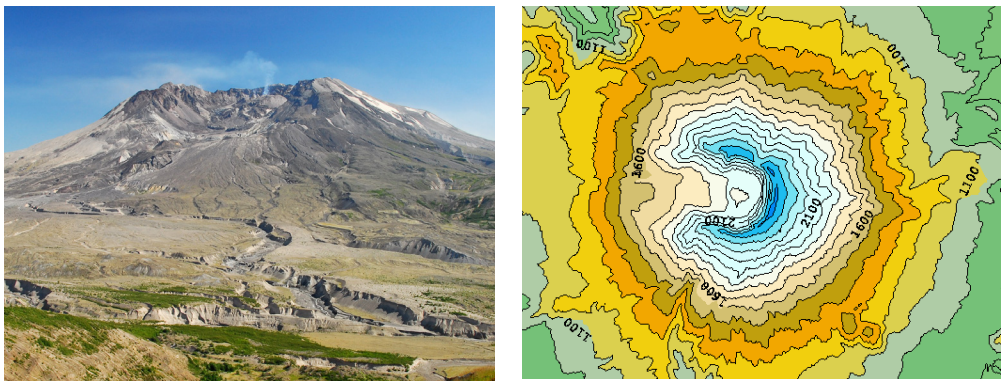
Image of the Butterfly Bluff Simulation



- 4 Explore differences in land elevation by using the key to identify the location of mountains and by selecting the Topographic Map button. As a class, discuss what information is provided by a topographic map, as shown in Figure 4.2.

FIGURE 4.2

Understanding Topographic Maps



Mount St. Helens is a volcano in the U.S. state of Washington. It erupted on May 18, 1980 and lost 122 meters (1,314 feet) in elevation, changing its topography. A *topographic map* is a flat, 2-dimensional map that is a model of the actual 3-dimensional shape of a land surface.

- 5 Select your assigned butterfly species and then use the time period buttons below the map to investigate how the distribution of your species has changed over time. Be sure to observe its distribution relative to the park's boundary. In Table 1 on Student Sheet 4.1, "Butterfly Bluff Simulation: Model 1 Data," record how your species changed or stayed the same from 1975 to 2000 to 2025.
- 6 Before looking at how each factor affects the butterfly populations, observe how each factor changes over time. Do this by deselecting the butterfly species, selecting a single factor, and observing it over the time. Record your findings for each factor over time in the "Trend Over Time" column in Table 2 on Student Sheet 4.1.
- 7 Select your assigned butterfly species. Observe if there appears to be a correlation between each factor and the species' distribution over time and record your ideas in the last column on Student Sheet 4.1. With your partner, discuss possible reasons why each factor could cause the size and range of butterfly populations to change.
- 8 Share your results with a pair of students who were assigned the other butterfly species. Compare the similarities and differences between what happened to the species distribution over time. Record these in your science notebook.

PART B: BUTTERFLY BLUFF SIMULATION: MODEL 2

- 9 Go back to the Butterfly Bluff Simulation. Select Model 2 and the species you are investigating. The initial population size of each species is 1,000 butterflies.
- 10 Review the six factors listed on the left. Slide one factor at a time to see how it affects the population size. Record the data on Student Sheet 4.2, "Butterfly Bluff Simulation: Model 2 Data." Leave the "Relative Impact on Population" column blank at this time.
- 11 Work with your partner to rate the factors affecting the population in the model, with 1 having the greatest impact and 3 having the least impact. Record your ratings in the "Relative Impact on Population" column on Student Sheet 4.2.

NOTE: You may choose to use the same rating number for factors that appear to have similar impacts. For example, you can label two factors as a 3. You may not end up using every rating number.

- 12 Your ratings from Step 11 are a way to identify the **orders of understanding**, which are the factors included in a model based on which factors have a greater impact on the system than others. On Student Sheet 4.2, circle the factors that are a part of the highest orders of understanding (greatest impact) for each butterfly population. Cross out the factors that are a part of lower orders of understanding (least impact or no effect).

- 13 With your partner, share your results with a pair of students who were assigned the other butterfly species. Discuss which factors appeared to have the greatest effect on the size of the two butterfly populations and which have the least effect.
- 14 Based on both models, predict the distribution of the two butterfly species in 2050. Draw your predictions on Student Sheet 4.3, “Butterfly Bluff Park: 2050,” and explain your reasoning, making sure to explain how each model informed your prediction.
- 15 With your class, compare your predictions from Step 14. Discuss how each model affected your prediction.

BUILD UNDERSTANDING

- ① When constructing a model, it is important to know which aspects of the real world to include and which to leave out. Imagine you were asked to construct a model to investigate a previously unstudied butterfly population in Butterfly Bluff Park. The model should answer the scientific question *Why is the population of this species increasing at lower altitudes?* What factors would you include in the model and why?
- ② Butterfly enthusiasts who visit Butterfly Bluff Park are concerned about the changes in the populations of Indigo Longwing and Crystal Alpine butterflies. They are discussing the following four options with local park rangers.
 - A Expand the boundary of Butterfly Bluff Park to the east and north so Bluff Lake and the surrounding areas are maintained as a protected food source for the Indigo Longwing.
 - B Actively plant the host plant at the top of Butterfly Bluff, which is the primary food for the Crystal Alpine.
 - C Increase the treatment of disease for both butterfly species.
 - D Do nothing.

Which option(s) would you recommend as the highest priority? Support your answer with evidence from the models and identify the trade-offs of your decision.



Many teens use social media apps on their cell phones.

CONNECTIONS TO EVERYDAY LIFE

- ③ You may spend a lot of time on social media apps. The apps' feeds seem to know what videos you want to watch next. What are three factors you think are incorporated into the apps' models to predict what videos you may like? List these factors according to their impact, considering orders of understanding, and explain your reasoning.
- ④ Think about how your actions affect your grade in your favorite class. Construct a model to represent the factors that you control that most affect your grade and whether each factor has a positive or negative effect. Be sure to include arrows showing any relationships between factors.

KEY SCIENTIFIC TERM

orders of understanding