



ACTIVITY 10

Applying Models to Decisions

CARD-BASED INVESTIGATION



Models can
represent different
scales of systems.





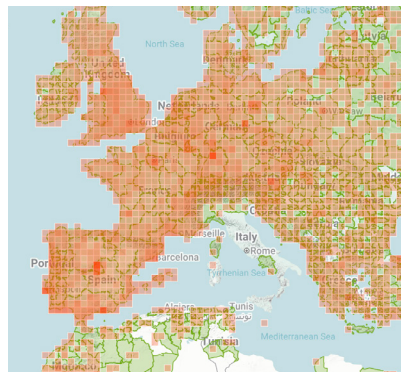
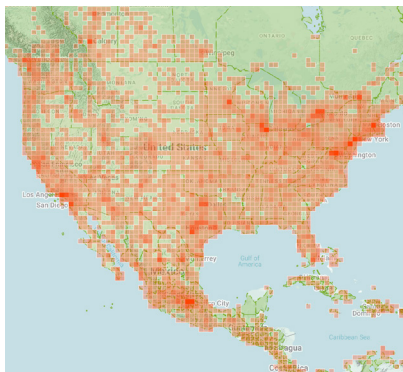
10: APPLYING MODELS TO DECISIONS

GUIDING QUESTION

What role can models play in making a conservation decision?

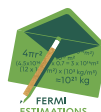
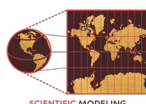
INTRODUCTION

In 2008, biologist Ken-ichi Ueda turned his graduate project into a website called *iNaturalist* where people could post pictures to identify species. Today, *iNaturalist* is an app with over 7 million users who have recorded over 150 million observations of 430,000 species. In the fall of 2020, large numbers of migratory birds, such as geese and sparrows, were found dead in people's backyards in parts of the United States. *iNaturalist* set up a project to gather more data. Researchers compared the community-provided data to datasets about wildfire, air quality, extreme weather, and land cover. They found a strong correlation between the dead birds and wildfires. Scientists are now working to better understand how wildfires affect birds by developing models of how wildfire smoke moves over landscapes and how the resulting smoke affects birds. People use models to explain, predict, and inform. In this activity, you will apply your knowledge of models to understand the role that models play in decision-making.



The house sparrow is native to most of Europe, Asia, and North Africa. These images show reported observations on the *iNaturalist* app of house sparrows in the United States (left) and in parts of Europe (right).

CONCEPTUAL TOOLS



MATERIALS LIST

FOR EACH GROUP
OF FOUR STUDENTS

— SET OF 4 MENANDA
SITE CARDS

FOR EACH STUDENT

— STUDENT SHEET 10.1
"Evaluating Sites"

— STUDENT SHEET 10.2
"My Site Model"

— STUDENT SHEET 10.3
"Estimating Factor
Impact on Population
in 50 Years"

PROCEDURE

PART A: SETTING UP YOUR MODEL

- 1 Read the following fictional scenario.

The county of Menanda continues to be concerned about its shrinking frog population. The successful effort to daylight a creek, which now connects two marshes, has improved the frog habitat and appears to be having a positive effect on the frog population. But some residents are still worried about the mosquito population, which may carry infectious diseases. They would like to do more to address this issue.

Scientists studying the Menanda frogs have identified 5 factors that appear to have the greatest impact on local frog populations: food availability, predation, yearly rainfall, average annual temperature, and traffic. Moderate to high rainfall can boost populations by providing breeding sites and mating, while extreme rainfall or drought can cause declines. Warmer temperatures can increase the potential range of populations, while increased average temperatures can disrupt reproduction and survival. Traffic negatively affects frog populations through death from cars, barriers to movement, and indirect effects such as stress from noise.

Currently, frogs can be found in 25 sites around the community, and the county has, at present, set aside funds to protect and improve the frog habitat at 1 site. Community residents at 4 sites have requested funding. You will role-play scientists investigating the frog population at each of the 4 sites.



- 2 Your group will receive a set of 4 Menanda Site cards. Each group member will read and analyze one card.
- 3 Use the information on the Menanda Site card to rate the factors affecting the frog population at your site by considering orders of understanding, with 1 having the greatest impact and 3 having the least impact.

NOTE: You may choose to use the same rating for factors that appear to have similar impacts (for example, labeling two factors as 3) or not use some rating numbers.

- 4 On Student Sheet 10.1, “Evaluating Sites,” record the orders of understanding for the factors at your site in the appropriate column in Table 1: Orders of Understanding for Each Site.
- 5 Share the orders of understanding for the factors at your site with your group and use the group information to complete Table 1. Remember to listen to and discuss the ideas of other group members. If you disagree with other group members, explain why you disagree.
- 6 In Table 1 on the student sheet, circle your site number and the two factors that have the greatest impact on your frog population. (You will complete Table 2 in Part B.)
- 7 On Student Sheet 10.2, “My Model Site,” construct a model (like the one shown in Figure 10.1) to explore the future of the frog population at your site. Arrows show relationships between related factors: a “+” indicates a positive effect or an increase, and a “—” indicates a negative effect or a decrease.
 - Center the factor (population size) you are investigating.
 - Add the two factors that you identified in Procedure Step 6.
 - Draw arrows to show relationships between related factors.
 - Add + or — signs along each arrow to indicate predicted changes in your species.
 - Write 2–3 sentences describing the relationships shown in your model.

You will complete Student Sheet 10.2 for Build Understanding item 1.

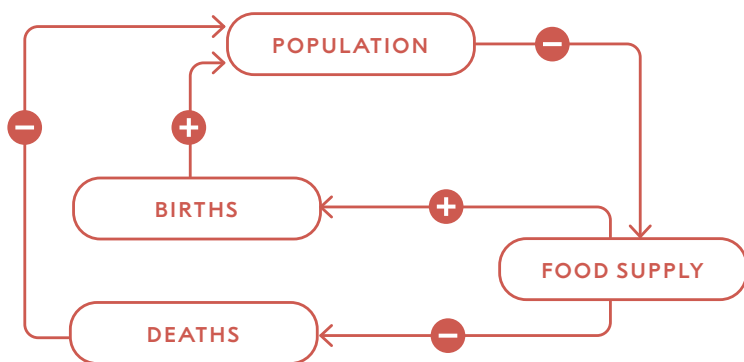


FIGURE 10.1
Example of a Population Model

- 8 Explain your model to the rest of your group. Respond to any questions, comments, or suggestions they have and modify your model as needed.

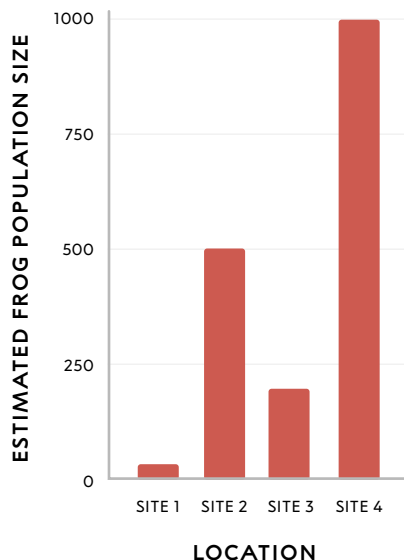
PART B: ESTIMATING FUTURE POPULATIONS

- 9 Examine Figure 10.2, which provides the current estimated frog population at each site. Go back to Student Sheet 10.1 and record this information in the first column of Table 2: Present and Future Frog Populations for Each Site.
- 10 When there is limited data on a particular species, scientists sometimes use models based on data from similar species. The frog population of a nearby species has doubled every 25 years. Use this information to predict the future frog population for each site and record it in the second column of Table 2 on Student Sheet 10.1. Discuss with your partner the assumptions that you are making, how they affect your predictions, and how reasonable you think your predictions are.
- 11 Discuss with your partner how each factor in your model would likely be affected by future conditions and, in turn, affect the future size of the Menanda frog population.
- 12 On Student Sheet 10.3, “Estimating Factor Impact on Population in 50 Years,” make a Fermi estimate of the **impact of the factors** at your site on the size of the frog population **50 years in the future**. Circle your site number at the top of the student sheet. Be sure to identify any assumptions that you make and show your calculations. Record your population prediction in the last column of Table 2 on Student Sheet 10.1.
- 13 Share your model, prediction, and Fermi estimate with your group. As other group members share, record population data for the other sites in Table 2 on Student Sheet 10.1. Discuss:
 - the factors you took into account.
 - how those factors may change over time.
 - sources of uncertainty in your prediction.

Respond to any questions, comments, or suggestions, and modify your estimate as needed.

FIGURE 10.2

Current Estimated Frog Population at Each Menanda Site



PART C: MAKING A DECISION

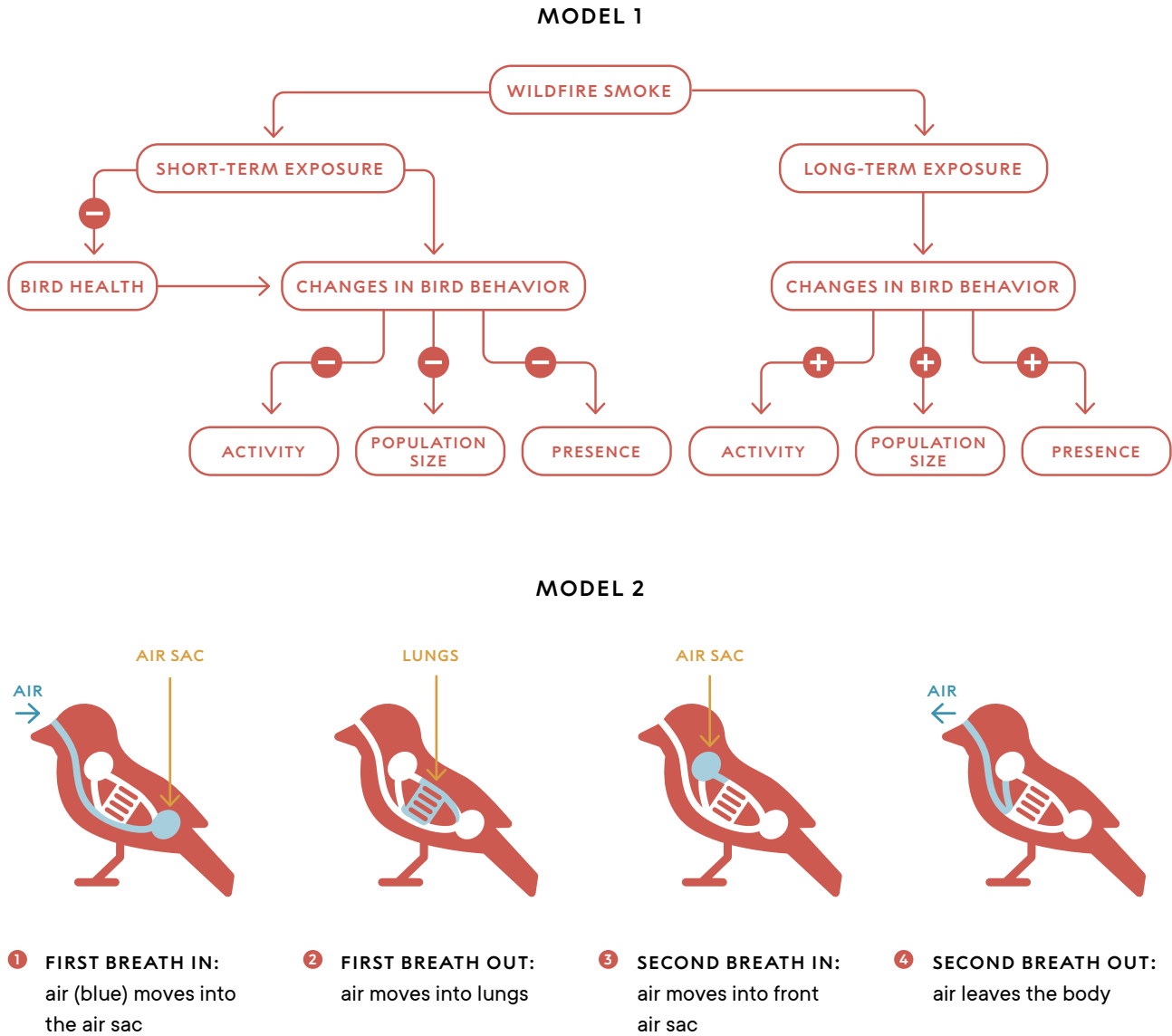
- 14 Consider the factors, models, estimated population, and predicted population for each site. Use this information to decide which site you would recommend funding to protect and improve frog habitats.
- 15 Share your recommendation with your group. Work with your group to:
 - describe other future events that might cause you to change your decision.
 - brainstorm additional information you would like to have to support your decision-making.
- 16 Share your recommendation and the evidence supporting your decision with the class.

BUILD UNDERSTANDING

- ① In Procedure Step 7, you constructed a model and described it. Complete Student Sheet 10.2 by:
 - a identifying the two most high-impact factors affecting the population at this site.
 - b explaining what your model predicts about the effect of the two factors on the frog population at your site.
 - c describing at least one source of uncertainty in your model.
- ② Which site do you recommend for funding to protect and improve Menanda frog habitats? Support your answer with evidence from the activity and identify the trade-offs of your decision.
- ③ A researcher creates a model to predict the local deer population over the next 5 years. At the end of the first year, the model's prediction for the population size was 40 deer, but the actual count was 25. Should the researcher revise the model? Explain what you think the researcher should do and why.
- ④ In the Introduction, you learned that scientists are constructing models to explore the effects of wildfire smoke on house sparrows. Explain how each of the two models in Figure 10.3 might be used to begin to investigate this question.

FIGURE 10.3

Two House Sparrow Models: Wildfire Effects (Model 1) and Respiration (Model 2)



CONNECTIONS TO EVERYDAY LIFE

- 5 This activity explored *population dynamics*—the study of how and why the size, structure, and distribution of a population change over time. Consider the ways in which people rely on and interact with different populations of organisms such as for food, recreation, conservation, and so on.
 - a Create a question about population dynamics that investigates a relationship between humans and an organism's population.
 - b List the factors that would be most relevant to creating a model to investigate this question.