

Classroom Resource
**Gorongosa: Scientific Inquiry & Data
Analysis**

INTRODUCTION

Gorongosa National Park is a 1,570-square-mile protected area in Mozambique. Lion researcher Paola Bouley and her team use motion-detecting trail cameras to learn more about Gorongosa's lions. But lions are not the only animal captured by these cameras. The photos provide valuable information on a variety of different animals, including their numbers, behaviors, and interactions with other animals. The photos are available on a citizen science website called WildCam Gorongosa (www.wildcamgorongosa.org), where anyone can help identify the animals and contribute to the ongoing research.

The process of science is iterative and adaptable. The first step in scientific inquiry typically consists of **making observations** about the natural world. Observations can inspire questions about how something in nature works. For scientists to answer a question, it must be testable, meaning that designing an experiment and/or collecting data can answer it. After identifying a **testable question**, the scientist may form a **hypothesis**, which is an explanation for the observed phenomenon, based on observations and/or prior scientific knowledge. Before collecting data, the scientist may also make a **prediction** of the expected results of the investigation if the hypothesis is supported. The scientist can **test the hypothesis** through experimentation or further observation, followed by an analysis of the data collected.

In this activity, you will learn firsthand what it is like to be an ecologist studying Gorongosa's wildlife. You will use actual trail camera data to generate a testable question, form a hypothesis and prediction, and analyze new data to answer your question. The results of your investigation will contribute to the conservation effort in Gorongosa National Park.

PROCEDURES AND QUESTIONS

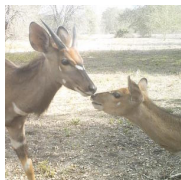
To familiarize yourself with the ecology of Gorongosa, read the background information in Appendix 1.

Part 1: Testable Questions

Many different questions can be asked about the natural world. In this scenario, you have been given a set of data generated from trail-camera images. Open the spreadsheet provided and examine the data. The rows in the spreadsheet each represent a different trail camera image, and each of the columns represents a variable and contains data that was collected for each photo. The second tab on the spreadsheet explains what each of the variables represents.

You will formulate a testable question to investigate using the spreadsheet data. How do you know if a question is testable?

For each of the three example questions below, assess whether the question is testable using the data provided in the spreadsheet. Write your responses in the spaces provided.



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1. *Which lions in Gorongosa are genetically related to one another?*

Is this question testable using the data in the spreadsheet? If so, which variables would you include in your analysis? If not, what additional data would you need to test this question?

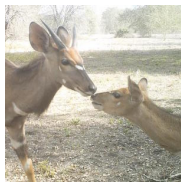
2. *Which vegetation type in Gorongosa supports the highest abundance of animals?*

Is this question testable using the data in the spreadsheet? If so, which variables would you include in your analysis? If not, what additional data would you need to test this question?

3. *Why are baboons often found in groups?*

Is this question testable using the data in the spreadsheet? If so, which variables would you include in your analysis? If not, what additional data would you need to test this question?

4. Now it's your turn to come up with your testable research question. If you completed the "Making Observations" activity, choose one of the questions that you formulated for that activity and that can be tested using the data in the spreadsheet provided. If you did not



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perform the observation activity, examine the variables in the spreadsheet and use the information in Appendix 1 to formulate a testable question.

What is your question and which variables from the spreadsheet would you use to test this question?

Part 2: Making Hypotheses and Predictions

Before you explore your question further, we will walk you through the process of making a hypothesis and a prediction using the following example question:

Which vegetation type in Gorongosa supports the highest abundance of animals?

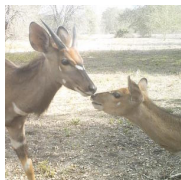
You may be able to generate some possible answers to this question just by reading the current scientific literature about Gorongosa and ecology in general. For example, you might discover through your background reading that the savanna/woodland vegetation type provides a diversity of habitats and many different types of food, which may lead to a higher abundance of animals. A possible hypothesis would be:

Hypothesis: *In Gorongosa, animals are most abundant in the savanna/woodland vegetation type because the high diversity of habitats and food sources can support larger numbers of animals than any other vegetation type.*

Before analyzing data, scientists will typically make a prediction of the expected results or observations that would be generated if the hypothesis were supported. In our example, a prediction might be:

Prediction: *I will find more animals in photos captured by trail cameras located in the savanna/woodland vegetation type than in the grassland or limestone gorge vegetation types.*

- Now it's your turn to try. Using your testable question from #4 above, formulate a hypothesis and a prediction.



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Hypothesis:

Prediction:

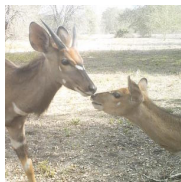
Part 3: Data Analysis

Scientists test their predictions by analyzing data that they collect through investigations, such as experiments or field observations. They perform statistical tests or produce graphs to reveal the relationships between the variables that they want to compare.

6. Using the spreadsheet tutorial provided, go through the steps to produce a graph that tests the following prediction: *I will find more animals in photos captured by trail cameras located in the savanna/woodland vegetation type than in the grassland or limestone gorge vegetation types.* Print your graph and attach it to this worksheet.

7. Which two variables did you compare?

8. Describe the trends that you see in your graph.



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9. Based on this graph, is the data consistent with your prediction? Is the hypothesis (i.e., *In Gorongosa, animals are most abundant in the savanna/woodland vegetation type because the high diversity of habitats and food sources can support larger numbers of animals than any other vegetation type*) supported by the data? Explain your answer using evidence from the graph.

10. Using the techniques that you learned in the spreadsheet tutorial, create a graph that will test the prediction that you formulated in question #5.

11. Which two variables did you compare?

12. Describe the trends that you see in your graph.

13. Based on this graph, are your hypothesis and prediction supported? Explain your answer using evidence from the graph.



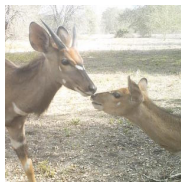
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Part 4: Analyzing Data Discussion

Answer the following questions about your experience asking questions, forming hypotheses and predictions, and analyzing data.

14. How is a prediction different than a hypothesis? Why do you think making a prediction prior to analyzing data is important?

15. What are the potential limitations of trail camera data? Identify at least two potential biases of trail camera data or with the way the trail camera survey was designed.



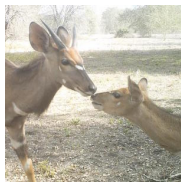
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16. In this activity, the scientific process followed a linear sequence: observation, question, hypothesis, prediction, and results. However, the process is typically iterative. Explain how new information might lead a researcher to go back and repeat certain steps in the scientific process, including asking different questions. At what stages in your process could you have obtained additional information from the scientific literature or other sources to inform or revise your process?

17. Based on the results of this investigation, what are some additional research questions that you could ask?



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APPENDIX 1: GORONGOSA ECOLOGY

As you read, explore the Gorongosa Interactive map to learn more about the hydrology, vegetation, and human influences in and around Gorongosa National Park:

<http://www.hhmi.org/biointeractive/gorongosa-national-park-interactive-map>

Gorongosa National Park in Mozambique is a 1,570-square-mile protected area at the southern end of the African Rift Valley. The valley runs through the center of the park with plateaus to the east and west. Water flows from Mount Gorongosa, down the Cheringoma Plateau, into Lake Urema in the center of the valley. During the wet season, from January to March, Lake Urema expands to over 10 times its size, covering the grassland in the center of the park. During the dry season, from July to September, the lake contracts. The grassy plain provides rich, nutritious grass for many of the park's herbivores. As the dry season progresses, the grass throughout the park slowly turns brown and dies. This dry grass fuels large wildfires that burn sections of the park in the late dry season until the rains come again.

Four broad vegetation types make up the Gorongosa ecosystem. Grasslands cover almost 20% of the park, primarily in the center. The grasslands are maintained by the seasonal flooding of Lake Urema and its rivers, by natural fires in the dry season, and by grazing herbivores. Elephants also play their part by knocking down trees along the edges of the floodplain. Grasslands are an extremely productive ecosystem, providing food to support a vast diversity of species. Gorongosa's large grazers, including hippos, buffalo, wildebeest, zebra, and waterbuck, eat a staggering amount of grass each day and help "mow" tall grasses, creating patches of short grass. Smaller antelope, like impala, reedbuck, and oribi, feed on the lush, green grass shoots that grow in these short patches. These herbivores attract large predators, like lions.

The mixed savanna and woodland vegetation type is found in the rift valley. It includes distinct forest patches—with bright yellow fever trees, tropical palm trees, and miombo woodland—which provide habitats for many different wildlife species, from insects to elephants. The tree canopy of the savanna patches is open, allowing enough light to reach the ground for grasses and herbs to blanket the ground. This vegetation type also provides different habitats at different vertical layers, from grass, flowers, and leaf litter on the forest floor, to short shrubs and tree trunks, to tall trees of different heights. The combination of forest and savanna patches across the landscape and the diversity in vertical habitats allows nearly all of Gorongosa's species to live in this vegetation type.

The most common type of forest in Gorongosa is the miombo woodland. Miombo is the Swahili name for the most prevalent type of tree from the genus *Brachystegia*. The small-leaved *Brachystegia* trees can grow in poor soils and are commonly found in the rocky plateaus to the east and west of the rift valley. Miombo woodlands are home to many of Gorongosa's antelopes that feed on leaves (browsers), including impala, bushbuck, nyala, kudu, eland, and sable antelope. Some of these antelopes are mixed feeders that also eat grass. Primates, like baboons, vervet monkeys, and bushbabies, are commonly found in woodland habitat, foraging on the ground or high in the trees. Birds, reptiles, amphibians, and insects, also found in miombo woodlands, are an important food source for small carnivores,



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like mongooses, genets, and civets. Because this forest is dominated by a single type of tree, there is typically less diversity of animals here than in the patchy woodland/savanna habitat.

The limestone gorges of Gorongosa National Park were formed over many millions of years as erosion from rivers and rain carved out deep gorges in the side of the Cheringoma Plateau in the eastern side of the park. Many of these gorges still contain small rivers surrounded by lush, riparian forest. The gorge stays cool and moist, even in the dry season, and provides nutritious green vegetation for a variety of animals year-round, including antelopes, baboons, birds, and carnivores. Sunlight only reaches the floor of the gorge for a limited period of time each day, so very little grass covers the ground. Primates, like baboons, and birds are especially common in these gorges, as are small antelopes that prefer dense forest. Massive animals, like elephants and hippos, and herbivores that eat only grass are much less common.

Humans are also a part of the Gorongosa ecosystem. Tourists stay in the Chitengo camp inside the park and drive on dirt roads to view animals during the day. Some animals are very used to these vehicles, while others, like elephants, tend to avoid them when they can. Local people live in villages around the park, and some live very close to the park borders. Many of these people grow crops on small farms next to the park, and animals, including elephants, hippos, and baboons, visit these farms to feed on crops. Crop raiding by animals can wipe out a family's food source in the course of a single night, so villagers use various techniques, like loud noises and the scent of chili peppers, to repel animals.