



INTRODUCTION

This activity engages students in science practices by guiding them through analysis of data from the citizen science project, WildCam Gorongosa (www.wildcamgorongosa.org). This activity is divided into five parts. In the first part of the activity, Planning Data Collection, students consider a scientific research question and identify the variables needed to make a claim about the question. In the second part, Data Analysis, students are provided with a sample data set along with instructions and guidance on how to calculate the species diversity for two additional small data sets. An Excel spreadsheet tutorial is available to assist students in making the calculations. In Part 3, Discussing Results, students propose a claim to the research question based on the experimental results and identify factors that may have influenced the study. In the next part, Verifying Results, students gather additional data to confirm the experimental results, building evidence for their claim. In the fifth and final part of the activity, Proposing and Answering a Research Question, students propose their own original research question and collate and analyze data from WildCam Lab (lab.wildcamgorongosa.org) in order to make a claim and provide an explanation based on scientific evidence.

Students will engage in meaningful work with the science practices by completing the first three parts of the activity. Parts 4 and 5 provide the opportunity for in-depth, independent practical work in science and are highly recommended; however, if time is limited, these sections could be used as an optional enrichment assignment. For IB students, these sections also provide Data Collection and Processing experience for their practical work.

KEY CONCEPTS

- Human activities influence the abundance and distribution of living organisms.
- Proposing a claim and developing an explanation for a scientific research question requires the systematic analysis of relevant data.
- Thorough scientific research requires the careful and thoughtful interpretation of experimental results and analysis of all variables.
- The elevation of a scientific finding to a theory or fact requires the corroboration of many investigations and confirmation of the original finding by many independent scientists.
- Data can sometimes be used to make claims about scientific questions that were not foreseen when the data was collected, or to identify new questions to investigate.

LEARNING OBJECTIVES

Students will be able to:

- Propose a claim and explanation about a scientific research question supported by scientific evidence.



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- Identify and distinguish between dependent, independent, and controlled variables in scientific research.
- Calculate the species diversity in a community.
- Determine if scientific results confirm or contradict a research question.
- Evaluate the methodology used to answer a scientific research question.
- Verify the results of scientific research through multiple studies.
- Propose a scientific research question that can be investigated using available data.

CURRICULUM CONNECTIONS

Curriculum	Standards
NGSS (2013)	Science Practice 1, 2, 3, 4, 5, 6, 7, 8 MS-LS2.A, MS-LS2.C MS-ESS3.C HS-LS2.A, LS2.C, LS4.C, LS4.D
Common Core (2010)	Mathematics MP.2 Mathematics HSN-Q.A.2, HSN-Q.A.3 ELA/Literacy RST.11-12.7, RST.11-12.8 ELA/Literacy WHST.9-12.7
AP Environmental Science (2013)	II.A, II.C, VII.C
IB Environmental Systems and Societies (1 st Assessment 2017)	2.4, 2.5, 3.1, 3.3, 3.4
AP Biology (2015)	2.D.1, 4.A.5, 4.C.4
IB Biology (1 st Assessment 2016)	C.3, C.4

KEY TERMS

Gorongosa National Park, species diversity, Shannon-Wiener diversity index, probability, independent variable, dependent variable, controlled variable, claim, evidence



TIME REQUIREMENTS

This activity allows for flexible implementation: only parts 1 through 3 could be completed, which would take approximately two 50-minute class periods, with the possibility of completing the last data set as homework. Parts 4 and 5 will each take at least one 50-minute class period to complete, with additional work required of the students as homework. If class time is limited, these sections could be assigned as homework or treated as optional.

SUGGESTED AUDIENCE

This activity is appropriate for high school biology and environmental science (all levels including AP and IB), and middle school life or earth science.

PRIOR KNOWLEDGE

Students should be familiar with the WildCam Gorongosa website (www.wildcamgorongosa.org) and should familiarize themselves with animal identification by spending a minimum of 15 to 30 minutes identifying animals at the site. Students should have basic computer skills and be familiar with the use of the Microsoft Excel spreadsheet program to organize data tables and perform basic calculations (or familiarity with a scientific calculator if only completing through Part 3). Students should understand the concepts of biodiversity and species abundance.

MATERIALS

The instructor will need:

- An internet-connected computer
- An overhead projector

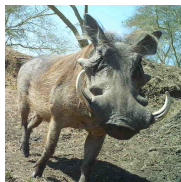
Each pair of students will need:

- A copy of the Student Worksheet
- A computer with Microsoft Excel and internet connectivity, or a calculator with the natural log function (ln) if only completing through Part 3
- The Data Table and Spreadsheet Tutorial Excel files

TEACHING TIPS

Prior to Lesson:

- Show the lecture The Science of Camera Traps from the 2015 Holiday Lectures on Science (<https://www.hhmi.org/biointeractive/science-camera-traps>) prior to the activity.
- In the days leading up to the activity, have students create an account and spend 15 to 30 minutes identifying animals on the WildCam Gorongosa website (www.wildcamgorongosa.org). This can be assigned as homework (provided all students



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have adequate internet access outside of school), or done during class with a laptop cart, on tablet computers, or in a computer lab.

- Reserve a computer lab or a laptop cart with Microsoft Excel installed for the days students will work on parts 2, 4, and 5 of the activity. If computer time is unavailable, ensure that all students have a calculator with the natural log function (ln) to complete Part 2 of the activity. Parts 4 and 5 can only be completed with a computer. Internet access is only required to download data for Part 4 of the activity. If internet access is not available, you may download a data set and provide it to your students on their computers.
- If you plan to have your students complete the assignment using computers, review the Data Table (for Part 2) and Spreadsheet Tutorial (for Part 4) files available as downloads. Ensure that you are comfortable providing instructions and answering questions about the use of the spreadsheets.
- If your students will complete Part 4 of the activity, you should set up an account and a classroom on the WildCam Lab website (lab.wildcamgorongosa.org). This will generate a link you can provide your students to join your classroom, where they can access the WildCam data. You should familiarize yourself with how to filter and download data prior to class to ensure you are comfortable guiding students through this process.

Implementing the Lesson:

- Part 1 can be assigned to students as homework before coming to class, where they will complete Part 2. Part 3 can be assigned as homework the night after completing Part 2 in class.
- Prior to your students starting Part 4, you should demonstrate how to view, filter, and download data on WildCam Lab on the overhead projector. In Part 3, they learned about controlled variables. Urge them to filter by habitat and season to control for those variables.

SAMPLE STUDENT RESPONSES

Part 1: Planning Data Collection

1. Identify the independent variable(s) in the research question. Justify your selection.

The independent variable is the distance of the camera from human structures. This is the variable that can be manipulated by the researcher.

2. Identify the dependent variable(s) in the research question. Justify your selection.

The dependent variable is the species diversity of animals captured by the camera. This is the variable that cannot be manipulated by the researcher.

3. Based on your answers above, identify the data that is needed to answer the research question. For every variable you identify, explain its role in answering our research question.



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The required data is:

- *The distance from each camera to the nearest human structure, which is the independent variable in the research question.*
- *The abundance of every species captured by the trail cameras, which is the data required for determining the Shannon-Wiener diversity index.*

Part 2: Data Analysis

5. Data set #2: Fill in the data table below using a scientific calculator or the “data table” spreadsheet provided. This data set is filtered by a new “distance to humans” value. Remember that column 5 is the Shannon-Wiener diversity index.

Species	Number of Individual s	p_i	$\ln p_i$	$p_i \ln p_i$	Distance to Humans (m)	Distance to Water (m)	Vegetation Type
Baboon	10	0.2439	-1.4110	-0.3441	8.2	1,029.20	Savanna / Woodland
Bushbuck	3	0.0732	-2.6150	-0.1913	8.2	1,029.20	Savanna / Woodland
Civet	8	0.1951	-1.6341	-0.3189	8.2	1,029.20	Savanna / Woodland
Honey Badger	1	0.0244	-3.7136	-0.0906	8.2	1,029.20	Savanna / Woodland
Mongoose	1	0.0244	-3.7136	-0.0906	8.2	1,029.20	Savanna / Woodland
Nyala	9	0.2195	-1.5163	-0.3329	8.2	1,029.20	Savanna / Woodland
Oribi	2	0.0488	-3.0204	-0.1473	8.2	1,029.20	Savanna / Woodland
Porcupine	2	0.0488	-3.0204	-0.1473	8.2	1,029.20	Savanna / Woodland
Sable Antelope	1	0.0244	-3.7136	-0.0906	8.2	1,029.20	Savanna / Woodland
Vervet Monkey	3	0.0732	-2.6150	-0.1913	8.2	1,029.20	Savanna / Woodland



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Educator Guide

Warthog	1	0.0244	-3.7136	-0.0906	8.2	1,029.20	Savanna / Woodland
Totals				-2.04			
				H' = 2.04			

6. Data set #3: As you did above, fill in the data table below using a scientific calculator or the “data table” spreadsheet provided.

Species	Number of Individual s	p_i	$\ln p_i$	$p_i \ln p_i$	Distance to Humans (m)	Distance to Water (m)	Vegetation Type
Baboon	13	0.2281	-1.4781	-0.3371	0.01	3,077.70	Savanna / Woodland
Bird (other)	4	0.0702	-2.6568	-0.1864	0.01	3,077.70	Savanna / Woodland
Bushbuck	1	0.0175	-4.0431	-0.0709	0.01	3,077.70	Savanna / Woodland
Bushpig	1	0.0175	-4.0431	-0.0709	0.01	3,077.70	Savanna / Woodland
Civet	4	0.0702	-2.6568	-0.1864	0.01	3,077.70	Savanna / Woodland
Genet	2	0.0351	-3.3499	-0.1175	0.01	3,077.70	Savanna / Woodland
Ground Hornbill	1	0.0175	-4.0431	-0.0709	0.01	3,077.70	Savanna / Woodland
Honey Badger	1	0.0175	-4.0431	-0.0709	0.01	3,077.70	Savanna / Woodland
Impala	6	0.1053	-2.2513	-0.2370	0.01	3,077.70	Savanna / Woodland
Nyala	3	0.0526	-2.9444	-0.1550	0.01	3,077.70	Savanna / Woodland
Oribi	1	0.0175	-4.0431	-0.0709	0.01	3,077.70	Savanna / Woodland
Porcupine	2	0.0351	-3.3499	-0.1175	0.01	3,077.70	Savanna / Woodland



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Reedbuck	3	0.0526	-2.9444	-0.1550	0.01	3,077.70	Savanna / Woodland
Sable Antelope	3	0.0526	-2.9444	-0.1550	0.01	3,077.70	Savanna / Woodland
Vervet Monkey	1	0.0175	-4.0431	-0.0709	0.01	3,077.70	Savanna / Woodland
Warthog	4	0.0702	-2.6568	-0.1864	0.01	3,077.70	Savanna / Woodland
Waterbuck	7	0.1228	-2.0971	-0.2575	0.01	3,077.70	Savanna / Woodland
Totals				-2.52			

H' = 2.52

Part 3: Discussing Results

7. Which is the controlled variable in all three data sets?

The controlled variable is the vegetation type, which is the same in all three sets of data.

8. In the data analysis you performed, other than the dependent variable, identify the variable that was not a controlled variable. Justify your selection.

The distance to water was not a controlled variable. This value was different for all three data sets.

9. Based on your calculations in Part 2 and your analysis of the data, propose a claim about the research question: "Does the species diversity of the animals captured by a trail camera decrease when the camera is placed closer to locations where people are present?" Justify your response:

The species diversity of animals captured by the cameras at first decreases, then increases as the distance of a camera from human structures decreases. This finding contradicts the original research question.

10. Explain how the other variables in the data table like the distance to water and the type of vegetation in the vicinity of the trail camera could have influenced the results and introduced uncertainty into the answer to the research question.

The distance of the camera to water does not appear to correlate with species diversity. The vegetation type is the same in all three sets of data. Data collected in the vicinity of other types of vegetation is needed to draw conclusions about the influence of vegetation type on species diversity.



11. Identify three other limitations and/or biases due to using trail cameras to collect data on species/biodiversity. For each limitation and/or bias you identify, discuss how it could have influenced the results.

Answers will vary. A few possibilities include: cameras may only selectively photograph animals based on their size (small animals will not be photographed if their movement is not detected by the camera). Cameras placed in dense vegetation may not take as many photos of animals because the field of view is small. Species diversity may be different for different types of human structures. For example, many animals may use dirt roads to travel, or may be attracted to farms, whereas animals may avoid large villages or paved roads.

Part 4: Verifying Results

12. Open the “Shannon-Wiener Diversity Index” tab in the spreadsheet tutorial and complete the calculations by following the instructions. Attach a copy of your data tables containing all calculations and the values of the Shannon-Wiener diversity index.

Answers will vary. Several data tables should be attached.

13. Explain whether these additional results confirm or contradict your claim about the research question you proposed in Part 3.

Answers will vary. The use of data to support the confirmation or contradiction of the original research question should be evident.

14. Identify the controlled variable(s) in the data you processed, and justify your selection(s).

Answers will vary. Students should identify one or more variables that are held constant throughout the data analysis.

15. Identify other variables in the data you processed, other than the independent variable, that were not controlled variables. Justify your selection.

Answers will vary. Students should be able to identify several variables that were not held constant throughout their data analysis.

Part 5: Proposing and Answering a Research Question

16. Propose your new and unique, original research question.

Answers will vary. Ensure that the research question includes an independent and dependent variable that is included in the WildCam Gorongosa spreadsheet download.



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17. Download the data necessary to answer your research question from the WildCam Lab. Analyze the data you downloaded. Attach a copy of your data tables containing all calculations.

Answers will vary. Several data tables should be attached.

18. Identify the independent, dependent, and controlled variables in the data you processed.

Answers will vary.

19. List some variables that you couldn't control for that may have influenced your results.

Answers will vary.

20. Propose a claim about the original research question that is supported by the data and provide an explanation using evidence from your data and background research.

Answers will vary. Students should state whether their original research question was confirmed or contradicted. Students should also state any shortcomings in their experimental design.

21. Suggest other data that, if available, could be used to corroborate your results.

Answers will vary. Students should propose additional data related to their research question that will confirm their results.

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