

An online exploration
of the biotic
communities of
Arizona with an
emphasis on
Mathematics and
Technology

Exploring Biomes

Lesson 3: Endangered Biomes

LESSON OVERVIEW

In recent years, controversy has developed over how best to preserve the diversity of plants and animals on the Earth. In this lesson, students will have the opportunity to compare data from two proposed strategies and come to their own conclusions.

SUGGESTED GRADE LEVELS

- 6 – 10

ENDURING UNDERSTANDINGS

- The expansion of human populations can negatively affect the diversity of plants and animals.
- Conservation solutions are complex and people may not agree.

OBJECTIVES

Students will:

- Calculate ratios.
- Identify the similarities and differences between world biomes.
- Use data to analyze two solutions to a problem.

ARIZONA DEPARTMENT OF EDUCATION STANDARDS

Grade	Science	Mathematics	Technology
6	S1-C3-02; S1-C3-03; S1-C3-04; S1-C4-03; S1-C4-05; S2-C2-01; S2-C2-02; S3-C2-02	S1-C1-01; S1-C1-04; S1-C2-03; S2-C1-04; S2-C1-06; S2-C1-07	None
7	S1-C3-02; S1-C3-05; S1-C4-03; S1-C4-05; S2-C2-01; S2-C2-02; S3-C1-01; S3-C1-03; S3-C2-02; S4-C3-04	S1-C2-06; S1-C2-07; S2-C1-05; S2-C1-07; S2-C1-08	
8	S1-C3-02; S1-C3-05; S1-C4-03; S1-C4-05; S2-C2-02; S3-C2-02	S1-C2-06; S2-C1-08	
High School	S1-C3-03; S1-C3-06; S1-C4-03; S1-C4-04; S3-C1-01; S3-C1-05; S3-C2-05	S1-C2-03; S2-C1-09; S2-C1-11	None

Note: The full text of these standards can be found in Appendix A.



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TIME FRAME

- 1 day (45 minutes)

MATERIALS

- *Endangered Biomes* worksheet (one per student)
- Calculators

TEACHER PREPARATION

- Make a copy of the *Endangered Biomes* worksheet for each student.
- Gather enough calculators for students to use.
- Students need to have a basic understanding of the climates that characterize various biomes. If students have not completed Lesson 2 – Biome Research, allow them to research information on the Internet before or during this activity.
- Students should understand how to calculate and interpret ratios.

TEACHER BACKGROUND

Human population growth is taking its toll on the environment. Deforestation, grazing, and pollution are just some of the ways that critical habitats are being destroyed. As a result, thousands of plants and animals are becoming endangered or, even worse, approaching extinction. Scientists are trying to develop strategies to protect these species, but funding is in short supply.

For years, the leading strategy for conservation biologists has been to focus on biodiversity hotspots. These are areas that have extremely high concentrations of unique species but have lost more than 70% of their original vegetation. So far, 34 hotspots have been identified. Combined, these locations account for more than 50% of the world's plant species and 42% of its terrestrial vertebrate species. They cover only 2.3% of the world's total land area. Proponents of this idea believe that by focusing on these areas, a relatively small amount of money and effort can be used to save a large number of species.

For many people this solution is not adequate because the significant majority of biodiversity hotspots are found in tropical rainforests. These people believe that an intense effort to save such a small amount of land will ultimately destroy the Earth's diversity. Instead, they say, we should focus our efforts and resources on preserving a representative sample of all biomes, starting with the ones that are most threatened, such as chaparral and grasslands. This strategy will allow us to preserve larger areas of land, which could also ensure the survival of large carnivores such as wolves and lions.

For additional information about either of these strategies, check out the resources below:

“Biodiversity Hotspots.” *Conservation International*.

<http://www.biodiversityhotspots.org>.

Hoekstra, J.M., Boucher, T.M., Ricketts, T.H. and Roberts, C. (2005) Confronting a biome crisis: Global disparities of habitat loss and protection. *Ecology Letters*, 8, 23-29.



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SUGGESTED PROCEDURES

1. Ask students to name the biomes with which they are familiar. Which of these is most important? Why? Which of these is in greatest need of being protected? Point out that not everyone in the class agrees to the answers to these questions, and the same is true of scientists. The students will now have the opportunity to explore this idea in more detail.
2. Hand out the *Endangered Biomes* worksheet to each student.
3. As a class, read the first page. Briefly discuss the Biodiversity Hotspot and the Endangered Biome strategies to be sure that students understand the basic differences between them.
4. Students now have the opportunity to compare the two conservation strategies to see how they can result in differing ideas about which lands are important to conserve. Students complete the worksheet independently.
5. Allow students time in or out of class to finish.
6. When all of the students have completed the worksheet, invite them to share their views about which strategy is “better” along with their reasons. Discuss any similar or opposing opinions with the class.
7. Collect the *Endangered Biomes* worksheet.

ASSESSMENT

- Class discussion
- *Endangered Biomes* worksheet

EXTENSIONS

- Students can map the locations of the thirty-four biodiversity hotspots found on <http://www.biodiversityhotspots.org>, compare the map to biome maps, and try to determine how many are found in each of the biomes.
- Students can use the Internet to research both arguments in more depth and write a persuasive essay.



Appendix A: Arizona Department of Education Standards – Full Text

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Science Standards

Grade	Strand	Concept	Performance Objective	
6	1	3 – Analysis and Conclusions	2 – Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events) 3 – Evaluate the observations and data reported by others 4 – Interpret simple tables and graphs produced by others	
		4 – Communication	3 – Communicate the results of an investigation with appropriate use of qualitative and quantitative information 5 – Communicate the results and conclusion of the investigation	
	2	2 – Nature of Scientific Knowledge	1 – Describe how science is an ongoing process that changes in response to new information and discoveries 2 – Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories	
	3	2 – Science and Technology in Society	2 – Compare possible solutions to best address an identified need or problem	
	7	1	3 – Analysis and Conclusions	2 – Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events) 5 – Formulate a conclusion based on data analysis
			4 – Communication	3 – Communicate the results of an investigation with appropriate use of qualitative and quantitative information 5 – Communicate the results and conclusion of the investigation
2		2 – Nature or Scientific Knowledge	1 – Describe how science is an ongoing process that changes in response to new information and discoveries 2 – Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories	



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Science Standards Continued

Grade	Strand	Concept	Performance Objective
7	3	1 – Changes in Environments	1 – Analyze environmental risks (e.g., pollution, destruction of habitat) caused by human interaction with biological or geological systems 3 – Propose possible solutions to address the environmental risks in biological or geological systems
		2 – Science and Technology in Society	2 – Compare possible solutions to best address an identified need or problem
	4	3 – Populations of Organisms in an Ecosystem	4 – Evaluate data related to problems associated with population growth (e.g., overgrazing, forest management, invasion of non-native species) and the possible solutions
8	1	3 – Analysis and Conclusions	2 – Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events) 5 – Explain how evidence supports the validity and reliability of a conclusion
		4 – Communication	3 – Present analyses and conclusions in clear, concise formats 5 – Communicate the results and conclusion of the investigation
	2	2 – Nature or Scientific Knowledge	2 – Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories
	3	2 – Science and Technology in Society	2 – Compare solutions to best address an identified need or problem
High School	1	3 – Analysis and Conclusions	3 – Critique reports of scientific studies (e.g., published papers, student paper) 6 – Use descriptive statistics to analyze data, including: <ul style="list-style-type: none"> • mean • frequency • range
		4 – Communication	3 – Communicate results clearly and logically 4 – Support conclusions with logical scientific arguments

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Science Standards Continued

Grade	Strand	Concept	Performance Objective
High School	3	1 – Changes in Environments	1 – Evaluate how the processes of natural ecosystems affect, and are affected by, humans 5 – Evaluate the effectiveness of conservation practices and preservation techniques on environmental quality and biodiversity
		2 – Science and Technology in Society	5 – Evaluate methods used to manage natural resources (e.g., reintroduction of wildlife, fire ecology)

Mathematics Standards

Grade	Strand	Concept	Performance Objective
6	1	1 – Number Sense	1 – Express fractions as ratios, comparing two whole numbers (e.g., $\frac{3}{4}$ is equivalent to 3:4 and 3 to 4) 4 – Determine the equivalency between and among fractions, decimals, and percents in contextual situations
		2 – Numerical Operations	3 – Apply grade-level appropriate properties to assist in computation
	2	1 – Data Analysis (Statistics)	4 – Answer questions based on simple displays of data including double bar graphs, tally charts, frequency tables, circle graphs, and line graphs 6 – Identify a trend (variable, increasing, decreasing, remaining constant) from displayed data 7 – Compare trends in data related to the same investigation
7	1	2 – Numerical Operations	6 – Divide integers 7 – Apply grade-level appropriate properties to assist in computation
	2	1 – Data Analysis (Statistics)	5 – Answer questions based on data displays including histograms, stem-and-leaf plots, circle graphs, and double line graphs 7 – Interpret trends from displayed data 8 – Compare trends in data related to the same investigation
8	1	2 – Numerical Operations	6 – Apply grade-level appropriate properties to assist in computation
	2	1 – Data Analysis (Statistics)	8 – Compare trends in data related to the same investigation



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Mathematics Standards Continued

Grade	Strand	Concept	Performance Objective
High School	1	2 – Numerical Operations	3 – Simplify numerical expressions including signed numbers and absolute values
	2	1 – Data Analysis (Statistics)	9 – Draw inferences from charts, tables, graphs, plots, or data sets 11 – Evaluate the reasonableness of conclusions drawn from data analysis



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Appendix B: Worksheets and Overheads

The pages that follow contain the worksheets listed below:

- A. *Endangered Biomes Worksheet* – A worksheet that allows students to compare two differing ideas about habitat conservation (2 pages)
- B. *Endangered Biomes Worksheet: Teacher Version* – The answers to the student worksheet (2 pages)



Endangered Biomes

The debate is on! With so many ecosystems threatened by expanding human populations and relatively limited funds to save them, conservation biologists are trying to determine the best way to maintain the world's biodiversity.

For years, the leading strategy has been to focus on saving *biodiversity hotspots*. Basically, these are areas of the world that have lost at least 70% of their original vegetation, but have high concentrations of species found nowhere else in the world. Thirty-four hotspots have been identified. Most of them are found in the tropical rainforests. These locations make up only 2.3% of the Earth's total land area, but account for more than 50% of its plant species and 42% of its terrestrial vertebrate species.¹

For many scientists, this is not an adequate solution. They believe that such an intense effort to save such a small amount of land, most of which is limited to a single biome, threatens the rest of the Earth's ecosystems that are so valuable to other species (like the large carnivores that need vast areas to roam) as well as to humans.

As a result, these scientists have suggested we focus our resources (i.e., time, money, and energy) on conserving endangered biomes instead of individual hotspots. They believe that this strategy will save a larger representation of the Earth's species and will be of greater benefit to biodiversity in the long run.

To determine how endangered a biome is, scientists compare the percent of habitat that humans have converted within a biome to the percent of habitat that has been protected. These percentages are represented in the table below. Use them to answer the questions that follow.

Table 1: Biome land converted and protected²

Biome	Habitat Converted	Habitat Protected	Conversion:Protection Ratio
Tropical Rainforest	32.2	16	
Tropical Savanna	23.6	11.9	
Desert	6.8	9.9	
Chaparral	41.4	5	
Grassland	45.8	4.6	
Temperate Deciduous Forest	46.6	9.8	
Temperate Boreal Forest	2.4	8.9	
Tundra	0.4	16	
Total	2	1	

¹ "Biodiversity Hotspots." Conservation International.
<http://www.biodiversityhotspots.org>.

² Hoekstra, J.M., Boucher, T.M., Ricketts, T.H. and Roberts, C. (2005). Confronting a biome crisis: Global disparities of habitat loss and protection. *Ecology Letters*, 8, 23-29.



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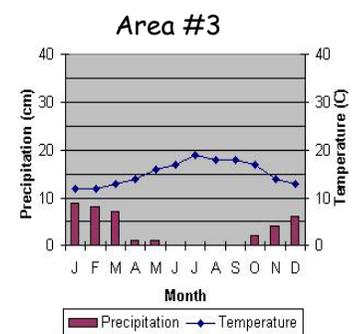
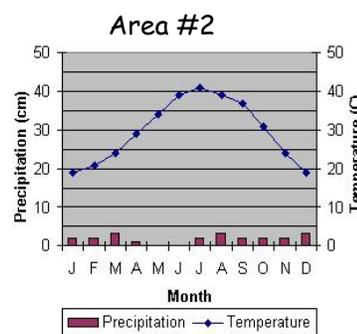
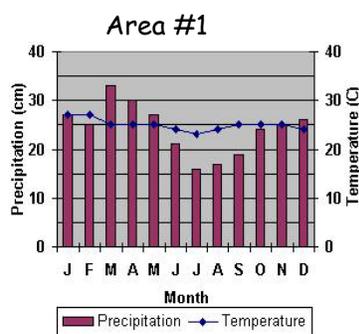
1. In the empty column in Table 1, express the percentages as a ratio of habitat converted to habitat protected.
2. According to proponents of the endangered biome conservation strategy, the larger the ratio between habitat converted to habitat protected, the more endangered that biome is. List the biomes in order from most endangered to least endangered, along with their ratios, in the table below.

Table 2: Rankings of endangered biomes according to Conversion:Protection ratio

Rank	Biome	C:P Ratio
1		
2		
3		
4		
5		
6		
7		
8		

3. According to the Biodiversity Hotspot idea described in the reading, in which biome should we be focusing our efforts?
4. Why do you believe these two conservation strategies do not agree?
5. Based on the information presented here, which strategy do you think is best? Why?

Below are the climographs for three areas that are being considered for immediate conservation. Use your knowledge of biomes to answer questions #6 - 8.



6. According to the Biodiversity Hotspot idea, which area should be conserved? Explain.
7. According to the Endangered Biomes idea, which area should be conserved? Explain.
8. According to the Endangered Biomes idea, which area is least in need of conservation? Explain.



Endangered Biomes - Teacher Version

The debate is on! With so many ecosystems threatened by human population and relatively limited funds to save them, conservation biologists are trying to determine the best way to maintain the world's biodiversity.

For years, the leading strategy has been to focus on saving *biodiversity hotspots*. Basically, these are areas of the world that have lost at least 70% of their original vegetation but have high concentrations of species found nowhere else in the world. Thirty-four hotspots have been identified, most of which are found in the tropical rainforests. These locations make up only 2.3% of the Earth's total land area, but account for more than 50% of its plant species and 42% of its terrestrial vertebrate species.¹

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As a result, these scientists have suggested we focus our resources (i.e., time, money, and energy) on conserving endangered biomes instead of individual hotspots. They believe that this will save a larger representation of the Earth's species and will be of greater benefit to biodiversity in the long run.

To determine how endangered a biome is, scientists compare the percent of habitat that humans have converted within a biome to the percent of habitat that has been protected. These percentages are represented in the table below. Use them to answer the questions that follow.

Table 1: Biome land converted and preserved²

Biome	Habitat	Habitat Protected	Conversion:Protection Ratio
Tropical Rainforest	32.2	16	2:1
Savanna	23.6	11.9	2:1
Desert	6.8	9.9	2:3
Chaparral	41.4	5	8:1
Grassland	45.8	4.6	10:1
Temperate Deciduous Forest	46.6	9.8	5:1
Boreal Forest	2.4	8.9	1:4
Tundra	0.4	16	1:40
Total	2	1	2:1

¹ "Biodiversity Hotspots." Conservation International.

<http://www.biodiversityhotspots.org>.

² Hoekstra, J.M., Boucher, T.M., Ricketts, T.H. and Roberts, C. (2005). Confronting a biome crisis: Global disparities of habitat loss and protection. *Ecology Letters*, 8, 23-29.



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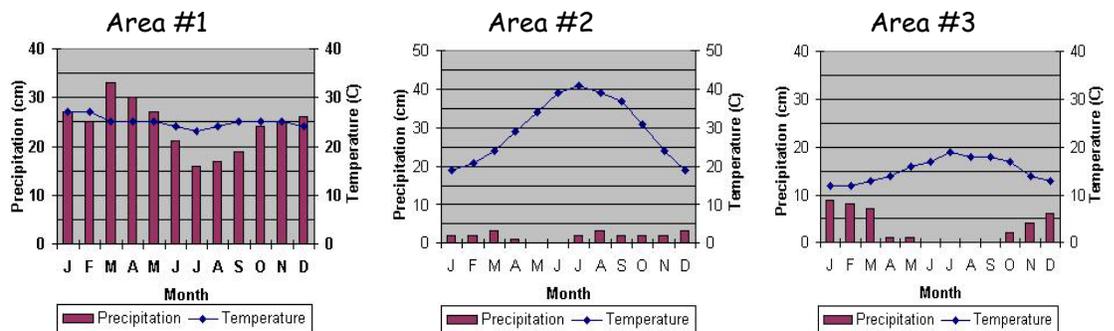
- In the empty column in Table 1, express the percentages as a ratio of habitat converted to habitat protected.
- According to proponents of the endangered biome conservation strategy, the larger the ratio between habitat converted to habitat protected, the more endangered that biome is. List the biomes in order from most endangered to least endangered, along with their ratios, in the table below.

Table 2: Rankings of endangered biomes according to Conversion:Protection ratio

Rank	Biome	C:P Ratio
1	Grassland	10:1
2	Chaparral	8:1
3	Temperate Deciduous Forest	5:1
4	Tropical Rainforest	2:1
5	Savanna	2:1
6	Desert	2:3
7	Boreal Forest	1:4
8	Tundra	1:40

- According to the Biodiversity Hotspot idea described in the reading, in which biome should we be focusing our efforts? *Rainforests*
- Why do you believe these two conservation strategies do not agree?
Answers will vary.
- Based on the information presented here, which strategy do you think is best? Why?
Answers will vary.

Below are the climographs for three areas that are being considered for immediate conservation. Use your knowledge of biomes to answer questions #6 - 8.



- According to the Biodiversity Hotspot idea, which area should be conserved? Explain.
Area 1. Climograph clearly shows a rainforest.
- According to the Endangered Biomes idea, which area should be conserved? Explain.
Area 3. Climograph clearly shows a chaparral.
- According to the Endangered Biomes idea, which area is least in need of conservation? Explain.
Area 2. Climograph shows a desert, which is the lowest of the three.

