WORLD OF DIFFERENCE

People and the Planet
Lessons for a Sustainable Future

INTRODUCTION

It is estimated that there may be as many as 30 million plant and animal species worldwide, although only 1.4 million have been named. Over half of all species make their homes in the **tropical rainforests** of Asia, Africa and Latin America.

This variety of life not only adds to the beauty and richness of our planet, it is also critical to human health and survival for many reasons. People depend on other species for food, medicines, industrial products, and such "ecological services" as water purification, nutrient cycling, and pollination. The rate of **deforestation**, and therefore habitat loss, is now greatest in the tropical rainforests where people cut down almost 38 million acres (an area larger than Florida) each year.

As human populations grow, we require more space for homes, roads, farmland, etc. There is also an increasing demand for timber for everything from chopsticks and paper to housing and furniture. And in developing countries, where population growth rates are highest, wood is the major source of energy. To meet these human demands for space, resources, and energy, we often clear land that has been home to other species of plants and animals. This can alter the delicate web of life whereby each species depends on other species to survive.

MATERIALS

For each group:
- Student Worksheet
- Counting Grid (provided)
- Die
- Sealable baggie labeled "Temperate Forest"
- Sealable baggie labeled "Tropical Forest"
- Variety of beans, seeds and dry noodles
- Graph paper

CONCEPT
Biodiversity is vital for maintaining the health and beauty of the Earth. Tropical forests are some of the most biodiverse places on the planet but many are located in areas experiencing high population growth rates, resulting in rapid habitat loss.

OBJECTIVES
Students will be able to:
- Define biodiversity.
- Calculate probabilities to compare and contrast the biodiversity of a temperate forest with a tropical forest.
- Assess how human population growth impacts temperate and tropical forests differently.

SUBJECTS
Science (life, Earth and environmental), social studies (geography), math

SKILLS
Analyzing data, modeling natural systems, critical thinking, calculating probabilities, identifying trends and patterns

METHOD
Through a small group simulation using probability, students explore how different population growth rates are impacting biodiversity levels.

PROCEDURE

1. Before class, prepare a Temperate Forest and Tropical Forest for each group. Make substitutions as necessary.

Temperate Forest baggie
20 dry black beans = White-tailed deer
40 dry red beans = Oak trees

Tropical Forest baggie
20 popcorn seeds = Mutuba trees
20 dry red beans = Fluted milkwood trees
8 dry black beans = Goliath beetles
5 raw sunflower seeds = Forest green snakes
4 dry black eyed peas = African green broadbill
2 dry lima beans = Cream-banded swallowtail butterfly
1 dry macaroni noodle = Gorilla

2. If students do not have any background knowledge on the importance of **biodiversity**, they can watch all or a portion of the TED-Ed video "Why is biodiversity so important?"

   You might also have students consider the roots of the word biodiversity and what they mean. Bio = life; Diversity = variety. So biodiversity is the variety of life.

3. Divide the class into groups of two or three, and provide each group with one die, a bag of beans for each forest, a Counting Grid, and a Student Worksheet for each student. If students do not have a flat surface to work on, egg cartons may be used in place of the Counting Grids.

4. Students distribute the beans on their Counting Grid as listed on their Student Worksheet and complete Part 1, comparing the biodiversity of a temperate forest to that of a tropical forest.

5. Students move on to Part 2 of the Student Worksheet, comparing how population growth in the United States and Uganda impact the biodiversity of those areas.

6. Go over the Discussion Questions as a class.

Answers to Student Worksheet
1. *Answers will vary.*
2. *For the temperate forest, there are many of each kind of bean. Every acre has at least one of each bean. In the tropical forest, each acre is very different in bean composition — no two acres are alike.*

3. a.

Temperate Species	Probability
Black beans = White-tailed deer	6/6, or 1. All outcomes will impact deer because they are in every acre.
Red beans = Oak trees	6/6, or 1

b.	Tropical Species	Probability
	Popcorn seeds = Mutuba trees	6/6, or 1
	Red beans = Fluted milkwood trees	6/6, or 1
	Black beans = Goliath beetles	4/6, or 2/3
	Sunflower seeds = Forest green snakes	4/6, or 2/3
	Black eyed peas = African green broadbills	4/6, or 2/3
	Lima beans = Cream-banded swallowtail butterflies	1/6
	Macaroni noodle = Gorilla	1/6

4. a. P = 0/6 or 0. No species is unique to one acre.
   b. 2/6 or 1/3. Clearing an acre with the gorilla or the butterflies will cause an extinction, because each species is unique to those acres. (If students have placed the gorilla and butterflies in the same acre, then P = 1/6.)
5. a. P = 4/6
   b. P = 4/6
   c. The probabilities stayed the same because each roll is an independent event.
6. Answers will vary but most likely, the tropical forest was cleared first.

DISCUSSION QUESTIONS

1. What basic observations can be made about the temperate forest biodiversity and the tropical forest biodiversity?

   In the temperate forest, there were not many types of beans, but there were many individuals of each type. Almost every acre had at least one of each bean. In the tropical forest, there were more types of beans but less individuals of each. Every acre was very different in bean composition — no two acres were alike.

2. Why do you think a greater variety of beans were used in the tropical forest?

   Biodiversity is much higher in tropical forests. In fact, a 2:7 bean ratio (2 beans/species in the temperate forest versus 7 beans/species in the tropical forest) does not even come close to reflecting the overwhelming number of species that make tropical forests their home.

3. How was biodiversity affected by human activity in the temperate forest? In the tropical rainforest?

   In the temperate forest, there was a decline in the number of individuals of both species, but they still existed in the other acres that were not destroyed. In the tropical forest, there was significant loss of biodiversity. Some species were rare to begin with and their numbers were further reduced. Some species may have only existed in the acres that were cut.

Many tropical rainforest species are vulnerable to extinction because they depend on other species in extremely specific ways. Whenever this kind of partnership exists, the extinction of one species often leads to the extinction of other species.

4. Can you think of ways that people could benefit from the richness of tropical forests without cutting them down? (Hint: What are some things we value that are grown in the rainforest?)

   Biodiversity is immensely valuable, but this value is often not recognized. For example, a healthy rainforest provides many goods that are valuable— the fruits, nuts, resins, oils, medicinal plants and tree bark, and subsistence food — to the people who live there. These goods are often ignored in economic assessment of forest use, but studies show their value may far exceed that of timber or crops that will only grow for a few seasons in the poor rainforest soil. People who live near rainforests can also profit from ecotourism (visitors coming to see a specific ecosystem), which depends on preserving the rainforest.

ASSESSMENT

Students complete the following sentences:

Define: Biodiversity is _____.

Explain: Biodiversity is important to humans and the environment because _____

_____.

Compare/Contrast: A _____ forest and a _____ forest are similar in that they

both _____.

However, differences between the two include _____

_____.

FOLLOW-UP ACTIVITIES

1. Pose the following scenario to your students: There is a native plant that grows only in the area around your community. A particular butterfly will only lay eggs on this plant. Its roots are an important food for a species of native gopher, which in turn is a major food source for local hawks and coyotes. A group of your neighbors wants to plow the fields that contain the last of the plant to build a golf course.

   Ask students to create a persuasive argument either for or against plowing the fields. They might consider if the argument would change if, instead of a golf course, the land were being developed for housing for low-income families, a factory that would give 200 people jobs, or a retirement home for senior citizens.

2. Each student should research an obscure plant or animal found in a tropical rainforest. Have students research the species and create a poster displaying what they learned. This might include a map of where the species is found, a photo or drawing of the species, characteristics such as what it eats and/or who eats it, the climate it requires, etc.

Data source: United Nations Population Division via the World Bank.

Adapted with permission from Sheila Jones, Wake Soil and Water Conservation District, Raleigh, NC, as printed in *The Conservation Catalyst Newsletter*, Winter 1993-94.

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STUDENT WORKSHEET

Name: _____ Date: _____

Place beans on your Counting Grid according to the instructions below. Each type of bean represents a species, and each bean is an individual of that species.

Temperate Forest:
Deer (20 black beans): Place at least 1 in each acre, but no more than 5 in any acre.
Oak tree (40 red beans): Place at least 3 in each acre, but no more than 10 in any acre.

Tropical Forest:
Mutuba tree (20 popcorn seeds): Place at least 3 in each acre, but no more than 4 in any acre.
Fluted milkwood tree (20 red beans): Place at least 1 in each acre, but no more than 8 in any acre.
Goliath beetle (8 black beans): Place at least 1, but no more than 3, in any 4 acres. DO NOT place Goliath beetles in 2 acres.
Forest green snake (5 sunflower seeds): Place at least 1, but no more than 2, in any 4 acres. DO NOT place snakes in 2 acres.
African green broadbill (4 black eyed peas): Place 1 in each of four acres. DO NOT place African green broadbills in 2 acres.
Cream-banded swallowtail butterfly (2 lima beans): Place 2 in the same acre.
Gorilla (1 macaroni noodle): Place 1 in any acre.

Part 1

1. Fill in the tables below to show the distribution of species in each forest. If at least one individual of a species lives in an acre, place an "X" in that space on the table. To find total species per acre, count the squares with an X in the column for that acre.

Temperate Forest

Species	Acre A	Acre B	Acre C	Acre D	Acre E	Acre F
Black beans = White-tailed deer						
Red beans = Oak trees						
Total species per acre						

Tropical Forest

Species	Acre A	Acre B	Acre C	Acre D	Acre E	Acre F
Popcorn seeds = Mutuba trees						
Red beans = Fluted milkwood trees						
Black beans = Goliath beetles						
Sunflower seeds = Forest green snakes						
Black eyed peas = African green broadbill						
Lima beans = Cream-banded swallowtail butterfly						
Macaroni noodle = Gorilla						
Total species per acre						

2. How does the biodiversity of the temperate forest compare to that of the tropical forest?

_____

3. Look at your forests to find out what happens when an acre of forest is cleared:

a. What is the probability that the population of each species in the temperate forest will change if you clear an acre there? Fill in the table.

Species	Probability
Black beans = White-tailed deer	
Red beans = Oak trees	

b. What is the probability that the population of each species in the tropical forest will change if you clear an acre there? Fill in the table.

Species	Probability
Popcorn seeds = Mutuba trees	
Red beans = Fluted milkwood trees	
Black beans = Goliath beetles	
Sunflower seeds = Forest green snakes	
Black eyed peas = African green broadbill	
Lima beans = Cream-banded swallowtail butterfly	
Macaroni noodle = Gorilla	

4. What is the probability that any species will become **extinct** if you clear one acre in the temperate forest?

_____

What is the probability that any species will become **extinct** if you clear one acre in the tropical forest?

_____

Part 2

The United States, which contains temperate forests, has a population growth rate of 0.8 percent annually. In central Africa, Uganda has tropical forests and a population growth rate of 3.3 percent, approximately 4 times that of the U.S. When you roll the die, a roll of 1 represents population growth in the U.S., and you should clear one acre of temperate forest to meet the needs of society. Rolls of 2, 3, 4, or 5 represents population growth in Uganda and therefore one acre of tropical forest should be cleared. If you roll a 6, do not clear any acres or count it as a roll, and re-roll the die.

5. a. What is the probability that you will clear an acre of tropical forest on your first roll? _____

b. What is the probability that you will clear an acre of tropical forest on your second roll? _____

c. Does the probability change from one roll to the next? Why or why not? _____

_____

_____

Now roll the die and take out all the beans in Acre A of the forest indicated by your roll. Record your data in the table below. Continue rolling and clearing acres until one of your forests is gone. Record your data after each roll.

6. Which forest was eliminated first? _____

7. How many rolls did it take to eliminate that forest? _____

Roll Number	Forest (Circle One)		Acre Cleared (A-F)	Number of Temperate Species Remaining	Number of Tropical Species Remaining
1	Temperate	Tropical			
2	Temperate	Tropical			
3	Temperate	Tropical			
4	Temperate	Tropical			
5	Temperate	Tropical			
6	Temperate	Tropical			
7	Temperate	Tropical			
8	Temperate	Tropical			
9	Temperate	Tropical			
10	Temperate	Tropical			
11	Temperate	Tropical			
12	Temperate	Tropical			

Bonus

Draw a pair of line graphs on the same axes to show the fates of the forests. Die rolls can go on the x-axis, number of species remaining goes on the y-axis.

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COUNTING GRID

Each square represents one acre.

Temperate Forest

A	B	C
D	E	F

Tropical Forest

A	B	C
D	E	F