

A World Of Difference

Introduction:

As human populations grow, we require more human habitat for homes, roads, farmland, etc. To create more human habitat, we use 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.

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. Within four square miles of rainforest, there may be over 750 species of trees, over 1,500 different kinds of flowering plants, 125 different mammals, 400 kinds of birds, 100 reptiles, 60 amphibians and countless insects — including 150 types of butterflies! This variety 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. One-quarter of all drugs that doctors prescribe in the United States contain a natural compound, often from the rainforest.

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. That’s 73 acres per minute! Forests have been cut down so that the land can be used for agriculture as there are more and more people to be fed. Even so, this land is not well-suited to farming as the nutrient-rich topsoil in the rainforests soon blows away when there are no more tree roots to hold the soil in place, leading to desertification. Population growth has also created an increasing demand for timber, for everything from chopsticks and paper to housing and furniture. Wood is the major source of energy in developing countries where population growth rates are highest.

Materials for each group:

Student Worksheet (one set per student)

Student Counting Grid (or egg carton)

1 die

1 plastic bag labeled “Temperate Forest,” containing:

20 dry black beans = Deer

40 dry red beans = Oak trees

1 plastic bag labeled “Tropical Rainforest,” containing:

20 dry pinto beans = Kapok trees

20 dry red beans = Mahogany trees

8 dry black beans = Leaf cutter ant colonies

5 dry sunflower seeds = Poison arrow frogs

4 dry black eyed peas = Rosy periwinkle plants

2 dry lima beans = Hummingbirds

1 dry unshelled peanut = Jaguar

(Substitute beans as necessary)

Graph paper

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People, Resources
and the
Environment

Concepts:

Biodiversity is important both for maintaining the health and beauty of our planet's ecosystems and for ensuring the survival of all species, including humans. Countries with tropical rainforests are areas of high biodiversity, and, coincidentally, of high human population growth. Consequently, tropical rainforests have some of the highest rates of habitat loss.

Objectives:

Students will be able to:

- ◆ Define biodiversity.
- ◆ Compare and contrast the biodiversity of a temperate forest with a tropical rainforest.
- ◆ Use probability to demonstrate the impact of human population growth on these two ecosystems.
- ◆ Hypothesize how people and ecosystems are affected by deforestation, and propose ways to address those issues.

Subjects:

Science, Social Studies, Art, Geography, History, Math

Skills:

Observing, counting, analyzing data, critical thinking, probabilities

Method:

Through a simulation, probability exercises and discussion, students learn what is meant by “biodiversity,” why it is important and the impact human population growth can have on biodiversity.

Part 1: Spilling the Beans on Biodiversity

Procedure:

1. Divide the class into groups of two or three, and provide each group with one die, one bag of beans for each forest, a Counting Grid, and Student Worksheets for each student. Egg cartons may also be used in place of Counting grids. Students should work on a flat surface.
2. Have students distribute the beans on their Counting Grid and complete the activity, following the directions on pages 1 and 2 of the Student Worksheets.
3. Go over the discussion questions as a class.

Answers to Student Worksheets, pages 1-2

1-2. *Answers will vary.*

3. *For the U.S. forest, there are many of each kind of bean. Every acre has at least one of each bean. In the tropical rainforest, each acre is very different in bean composition — no two acres are alike.*

4. a. $P = 6/6$ or 1. *All outcomes will impact deer because they are in every acre.*
b. $P = 6/6$ or 1. *All outcomes will impact the oak trees.*

5. See table:

Species	Probability
Pinto beans = Kapok trees	$(6/6 = 1)$
Red beans = Mahogany trees	$(6/6 = 1)$
Black beans = Leaf cutter ants	$(4/6 = 2/3)$
Sunflower seeds = Poison arrow frogs	$(4/6 = 2/3)$
Black eye peas = Rosy periwinkle	$(4/6 = 2/3)$
Lima beans = Hummingbirds	$(1/6)$
Peanut = Jaguar	$(1/6)$

6. a. $P = 0/6$ or 0. *No species is unique to one acre.*
b. $2/6$ or $1/3$. *Clearing an acre with the jaguar or the hummingbirds will cause an extinction, because each species is unique to those acres. (If students have placed the jaguar and hummingbirds in the same acre, then $P = 1/6$.)*



7. a. $P = 5/6$
b. $P = 5/6$
c. *The probabilities stayed the same because each roll is an independent event.*

8-9. *Answers will vary.*

Discussion Questions:

1. What basic observations can be made from the U.S. temperate forest biodiversity data and the tropical rainforest data?

For the U.S. forest, there are lots of each kind of bean. Almost every acre has at least one of each bean. In the tropical rainforest, each acre is very different in bean composition — no two acres are exactly (even closely) alike.

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

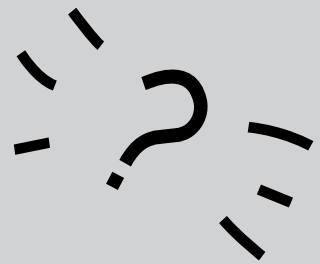
Biodiversity is much higher in tropical rainforests. In fact, a 2:7 bean ratio does not even reflect the overwhelming percentage of rainforest species. Even though rainforests occupy less than 7% of the Earth's surface, over half of all species are found there. Take trees for example: A tropical rainforest contains an average of 20-86 tree species per acre compared to about four tree species per acre in a temperate zone forest in North America. The reason that tropical rainforests have a higher biodiversity is that they are believed to be the oldest land-based ecosystem on Earth. They have probably been around for about 60 million years, which is plenty of time for so many species to evolve to fit every available niche. Also, the warm climate and humidity keeps plants and animals from expending their resources on harsh winter survival. Costa Rica, though only the size of West Virginia, has more species of trees and birds than are found in all of North America!

3. How is biodiversity affected by human activity in the U.S. forest? In the tropical rainforest?

In the U.S. forest, there was a decline in the number of individuals of both species, but they still exist in the other acres that were not destroyed. In the tropical rainforest, there was significant loss of biodiversity. Some species were rare to begin with and their numbers have been further reduced. Some species may have only existed in the acres that were cut. Many 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 the rainforest without cutting it 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.



Part 2: What If?

Procedure:

Divide students into groups of four or five and give each group one of the discussion questions on the Student Worksheet. Allow the groups 10 or 15 minutes to discuss these “What If?” questions that help them explore the importance of biodiversity. Ask each group to jot down the three most important points in their discussion. When you bring the class back together, have each group present their question and the highlights from their discussion.

Follow-up Activity:

Biodiversity: The Treasure Chest of Life

Now that your students have begun to understand the importance of maintaining the planet’s biodiversity, they can have a hand in educating others. Ask students to think of biodiversity as the “treasure chest of life” where each and every living thing glitters like a precious genetic gem. You can now put this thought into a 3-D display.

1. Borrow a trunk, like the kind you or one of your students might have in an attic, or have students decorate a big box to look like an old trunk.
2. Have each student research an obscure plant or animal found in a remote tropical rainforest, like the rosy periwinkle found in Madagascar. Lots of websites have information on rainforests, and books and magazines with rainforest information are available for background reading in libraries. Back issues of *National Geographic*, *Ranger Rick* and other wildlife magazines are good sources.
3. Take empty food boxes (cereal, detergent, etc.) of all different sizes and shapes and wrap them in recycled paper that has been artistically decorated with colorful illustrations of the rare plant or animal. Students could collage, paint, draw or stick colored clay onto the box to decorate it. They could also glue leaves, twigs or grasses onto the box.
4. Wrap the box with leftover holiday ribbons and bows. Have students choose the most exciting “gift” their plant or animal offers the world and write it on a gift tag. How is it unique? Why is it truly precious? It’s O.K. for a life form to exist just because it does, not just for the benefits to other species.
5. Put all “gifts” of biodiversity into the trunk. Place it in the school lobby and let people touch and read the gifts. You’ll be sharing the gift of knowledge about biodiversity!



Parts 1 and 2 and the Follow-up Activity adapted with permission from Sheila Jones, Wake Soil and Water Conservation District, Raleigh, NC, as printed in *The Conservation Catalyst Newsletter*, Winter 1993-94. Part 3 adapted from “Biodiversity What Ifs?”, from *Community Connections*, Oakland Museum of California, 1992.

Name: _____ Date: _____

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Student Worksheet – Page 1 of 3

1. 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 Rainforest:

Kapok tree (20 pinto beans): Place at least 3 in each acre, but no more than 4 in any acre.

Mahogany tree (20 red beans): Place at least 1 in each acre, but no more than 8 in any acre.

Leaf cutter ant colony (8 black beans): Place at least 1, but no more than 3, in any 4 acres. DO NOT place ant colonies in 2 acres.

Poison arrow frog (5 sunflower seeds): Place at least 1, but no more than 2, in any 4 acres. DO NOT place frogs in 2 acres.

Rosy periwinkle (4 black eyed peas): Place 1 in each of four acres. DO NOT place periwinkles in 2 acres.

Hummingbird (2 lima beans): Place 2 in the same acre.

Jaguar (1 peanut): Place 1 in any acre.

2. Once you have placed the beans, 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.

3. How would you contrast the temperate forest biodiversity and the tropical rainforest biodiversity?

Temperate Forest Table						
Species	Acre A	Acre B	Acre C	Acre D	Acre E	Acre F
Deer						
Oak tree						
Total species per acre						

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

a. What is the probability that the deer population will change if you clear one acre in the temperate forest?

_____.

b. What is the probability that the oak tree population will change if you clear one acre in the temperate forest?

_____.

Tropical Rainforest Table						
Species	Acre A	Acre B	Acre C	Acre D	Acre E	Acre F
Kapok tree						
Mahogany tree						
Leaf cutter ant colony						
Poison arrow frog						
Rosy periwinkle						
Hummingbird						
Jaguar						
Total species per acre						

Name: _____ Date: _____

A WORLD OF DIFFERENCE Student Worksheet – Page 2 of 3

5. What is the probability that the population of each species in the tropical rainforest will change if you clear an acre there? Fill in the table at right.

Species	Probability
Pinto beans = Kapok trees	
Red beans = Mahogany trees	
Black beans = Leaf cutter ants	
Sunflower seeds = Poison arrow frogs	
Black eyed peas = Rosy periwinkle	
Lima beans = Hummingbirds	
Peanut = Jaguar	

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

b. What is the probability that any species will become **extinct** if you clear one acre in the tropical rainforest? _____.

The United States, which contains temperate forests, has a population growth rate of 0.6% annually. In central Africa, the Democratic Republic of Congo has tropical rainforests and a growth rate of 3.1 %, approximately five times that of the U.S. When you roll the die, a roll of 1 will represent 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, 5, or 6 will represent population growth in the Congo and therefore one acre of tropical rainforest should be cleared.

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

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

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

8. *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.*

a. Which forest was eliminated first? _____.

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

9. 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.

Roll Number	Forest (Circle One)		Area 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			

Name: _____ Date: _____

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Student Worksheet – Page 3 of 3

Discussion Questions:

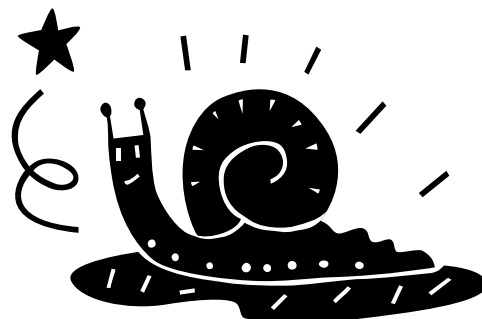
1. What would the world be like if no organism existed that decomposed (broke down into small pieces) dead things?

2. How would you feel if all the lions, tigers and bears in the world went extinct? If all the slugs, snails and worms went extinct? Which do you think would have a greater effect on your life? On the health of other animals and plants? Do these animals have dollar values that we can calculate and compare? What values do they have that we cannot put a price tag on?

3. Name as many objects in your home as you can think of that come from a plant or an animal. Name 10 jobs that depend on plants. Can you think of any jobs that do not depend on any plant material?

4. 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. What would be your arguments for or against plowing the fields? Would your arguments be different if, instead of a golf course, the land were being developed for housing for low-income families, or for a factory that would give 200 people jobs, or for a retirement home for senior citizens?

5. Even within the human species, there is a great deal of diversity. What if this racial and cultural diversity did not exist? What would our world be like if all people looked and acted alike and shared the same views? Can you think of ways that diversity among people is essential for human survival, just as biodiversity is essential for ecological survival?



A World of Difference Counting Grid

Temperate Forest		
A	B	C
D	E	F

Tropical Rainforest		
A	B	C
D	E	F