

Modeling Diversity and Disease

Migration refers to the seasonal movement of animals from one habitat to another. Many organisms that migrate annually, such as birds and butterflies, stop to rest and feed in habitats along their migration routes. If these habitats are fragmented or destroyed, migrating populations may not make it from their winter homes back to their nesting grounds safely.

Human activities can have an enormous impact on the diversity of habitats. Humans have greatly reduced plant diversity by growing a limited number of crops on commercial farms. Dedicating land use to a single plant is known as monoculture. Unfortunately, monocultures are more easily damaged by disease and insects because they are composed of a single species. Monocultures are easily invaded by aggressive plants—weeds—which are unwanted by the farmer and which compete for water and soil nutrients, leaving fewer resources for the crop plants. When humans attempt to maintain the monoculture, they need to use more and more insecticides and herbicides.

In the first part of this activity, you will play a board game to investigate how migrating animals are affected by threats to ecosystem diversity. In the second part of this activity, you will explore how a particular disease may spread rapidly in a monoculture forest, but not in a forest with many different species of trees.

OBJECTIVES

Generalize the results from each game round.

Compare the effects of a disease in forest communities.

Evaluate methods of planting.

MATERIALS

- construction paper
- envelope
- game chip or other marker
- photocopies of habitat cards, forest ecosystem diagram, and game board
- scissors

Procedure

PART I—ECO-DIVERSITY

1. To prepare to play the game, photocopy the game board at the end of this lab. Make enlarged copies of the 16 **habitat cards** on heavy paper and cut them apart. Create 12 small **number cards**, numbered from 1 to 12, and place them in an envelope.
2. The object of the game is to get the population of migrating birds from their winter home to their summer nesting grounds. At the summer nesting grounds, food and favorable conditions will enable the population of the birds to double. Then the birds must safely fly back to their winter home.

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3. As the birds progress, they may encounter habitats that have been damaged or destroyed. On the game board, a damaged habitat will be covered with a piece of construction paper. If the birds are forced to skip over a damaged habitat, some birds will die.
4. Work in teams of two students. Player #1 will be the Bird Population, represented by a game piece. Player #2 will be the Ranger, who manages the resources and habitats. The habitat cards tell players whether a habitat will be lost or added. The number cards tell players which habitat will be lost or added.
5. Rules for scoring: The bird population starts at 1,000. If the birds have to skip one unusable habitat, 100 birds die. If two consecutive lost habitats must be skipped, 200 birds die. If three consecutive lost habitats are skipped, 400 birds will die. If four consecutive lost habitats must be skipped, 800 birds will die. If the entire Bird Population dies, the game is over.
6. Play begins when the Ranger chooses the first habitat card from the pile, reads it, and then chooses a number card. If the first habitat card says “add one habitat,” the Ranger must keep choosing habitat cards until a “lose one habitat” card is chosen. The Ranger then covers the lost habitat with a piece of construction paper.
7. The birds will now fly to the first habitat. If habitat #1 has been covered with construction paper, the birds must instead continue on to habitat #2. Record the bird population.
8. Habitats can be added (recovered) only when the Ranger chooses a habitat card that says “add one habitat” *together with* a number card corresponding to an already damaged habitat. If the Ranger chooses a “lose one habitat” card and a number card corresponding to the birds’ current habitat, the birds must immediately fly to the next available habitat. The remaining bird population changes only if the birds are forced to fly past damaged habitats.
9. Be sure to double the bird population when the birds reach their summer nesting grounds. Continue playing and scoring until the birds have either safely reached their winter home or the entire bird population has perished. At the end of the game, the two players will trade places, so that player #1 has a chance to be the Ranger and player #2 has a chance to be the Bird Population.

PART II—DISEASE AND DIVERSITY

10. Using the **habitat cards** from the bird migration game in Part I, examine all the scenarios that resulted in habitat destruction. Find the two **habitat cards** that relate to disease in a forest habitat. How are the two cards different? Write your ideas below.

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- 11.** Look at the Forest Ecosystems Diagram in this lab. Notice there are two vertical columns. The right-hand column represents an old growth forest, which contains a variety of trees. This represents biodiversity. The monoculture represented in the left-hand column is a new (or secondary) growth forest composed of one species of tree. When trees are planted for harvesting purposes, usually only one species is planted. Compare the two forests.

- 12.** Imagine that oak wilt disease strikes these two forest communities. Oak wilt is caused by a fungus and spreads when trees touch each other, either above-ground when branches touch or underground when roots touch. The disease can also be transmitted rapidly by insects. While other species of oaks are susceptible, red oaks are especially vulnerable. This disease kills the trees quickly, usually within a few months. Oak wilt will not affect other kinds of trees, which are resistant to this disease.

- 13.** Imagine that the first tree in the top of left-hand column (the monoculture forest) has oak wilt disease. Cross out all the trees in the left-hand column that are likely to contract the disease. What has happened? How many trees have been crossed out and have died?

- 14.** Now imagine the first tree in the top of the right-hand column (the old growth forest) has oak wilt. Cross out all the trees that are likely to die. Again, what has happened?

Analysis

- 1. Describing Events** What happened to the bird population in the game? How many birds safely reached their winter home again? If the birds all died, how far were they able to migrate?

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2. Explaining Events What types of events caused the loss of habitats?

3. Applying Conclusions What happens if a disease attacks one species of tree in a biodiverse forest? What happens to the forest? What happens to the birds?

Conclusions

4. Making Predictions Biodiversity resists the spread of diseases in an area, which can be particularly important if a species of birds migrates through that area. If a forest is a monoculture with only one type of tree, and if that species dies, what happens to the birds?

5. Drawing Conclusions How can biodiversity in the landscaping of your own yard, schoolyard, or other community land reduce the use of insecticides and herbicides?

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HABITAT CARDS		FOREST ECOSYSTEMS DIAGRAM	
		Monoculture	Old Growth Forest
Wildlife refuge created	Drought cuts water supply	Red Oak Red Oak	Red Oak Beech
Add 1 Habitat	Lose 1 Habitat		
Disease strikes in monoculture forest habitat	Drought cuts water supply	Red Oak Red Oak	Chestnut White Pine
Lose 1 Habitat	Lose 1 Habitat		
Botanic gardens built with lagoons	Prairie habitat restored	Red Oak Red Oak	Ash Cherry
Add 1 Habitat	Add 1 Habitat		
Chemicals dumped in wetland habitat	Oil spill cleaned up	Red Oak Red Oak	Birch Maple
Lose 1 Habitat	Add 1 Habitat		
Trees harvested by selective cutting	Shopping mall built	Red Oak Red Oak	Red Oak Cedar
No Change	Lose 1 Habitat		
Airport built	Disease strikes in old growth forest	Red Oak Red Oak	Ash Spruce
Lose 1 Habitat	No Change		
Polluted wetland restored	Floods cause soil erosion and runoff	Red Oak Red Oak	Maple White Pine
Add 1 Habitat	Lose 1 Habitat		
Dam constructed; blocks stream	Trees replanted after harvesting	Red Oak Red Oak	Cherry Beech
Lose 1 Habitat	Add 1 Habitat		

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WINTER HOME		
	Habitat #1	
	Habitat #2	
	Habitat #3	
Habitat #4	Habitat #5	
	Habitat #6	
	Habitat #7	
	Habitat #8	
Habitat #9	Habitat #10	
	Habitat #11	
	Habitat #12	
SUMMER NESTING GROUNDS		