Teaching Activity: Global Warming Projections

Introduction: The relationship between biological diversity and climate change in natural systems needs further analysis. Natural ecological systems and the diversity of living things that they support is a legacy that obviously must be preserved. There are several factors that are relevant to the growth and distribution of plants within these systems: temperature, precipitation, carbon dioxide concentration, light, nutrient availability, chemical environment, disturbances (disease, hurricanes, wildfires, or human land use) or any combination of these factors. Trees have "moved" thousands of miles over the course of Earth history in response to global temperature changes on the order of 5 degrees C occurring over many thousands of years. At the rate of climate change of a degree or so per thousand years, forest species were able to move and "keep up" with the changing climate. However, as discovered in extensive studies done of fossil pollen in lakes around North America, it was seen that intact forest and animal ecosystems do not simply move north. The species moved, but they changed their relative abundances and thus the habitats as a whole changed. It is this transition over time and space that is of most concern to ecologists.

Objectives:

- To trace the effects of a gradual climatic change on a model ecosystem which is simplified from a real situation;
- To explain ways in which environmental factors interact to set limits on geographic ranges;

Materials: ***Lab Investigation Sheet, Climate Change Information Sheet,*** paper / pencil, butcher paper, markers;

Important Terms: Biological diversity, species abundance, fossil pollen, ecosystem, food web, adaptation;

Procedure:

1. Organize students into pairs.
2. Have students read ***Information Sheet: Part 1.***
3. Instruct students to diagram the food web in the ecosystem described in Part 1 on the butcher paper;
4. Instruct each pair to create a chart similar to the example below.
   - Continue labeling in the "Round" column to 50 rounds.
   - Label the "Years" column counting by 200.

Round	Years	Average Annual Precipitation	Average Annual Temperature	Changes in Organisms
1	200			
2	400			

5. Have students read ***Information Sheet: Part 2.***
6. Instruct students in how to fill out the chart they created using the information from the second reading selection.
7. After filling out the chart, instruct students to diagram a food web on butcher paper for the same ecosystem at the end of 10,000 years.
8. Instruct students to prepare a written summary of the climatic changes they saw occur in the ecosystem under study over the 10,000 year period.
9. Discuss the questions in the ***Analysis and Conclusions*** section with the class.
10. Have students prepare written answers to each of the questions independently.

Analysis and Conclusions:

1) When did the first changes in the ecosystem occur?
2) What were the changes that took place?
3) What subsequent changes occurred, and in which years?
4) What similarities or differences are there between the initial and the final food webs?
5) What is a barrier to dispersal for the Merriam pocket mouse?
6) What limited the red wolves population size?
7) What climatic factor was responsible for the other changes?
8) Why could the use of annual average values for temperature and precipitation make this model artificial?

Answers:

1. After 6600 years the precipitation falls to 51 cm; oaks are gone, duckweed disappearing;
2. After 9200 years precipitation falls to 38 cm; Duckweed, ducks and wolves gone; grass disappearing; After 10, 000 years, precipitation falls to 34 cm; Grass replaced by mesquite; mice and snakes move in; Grasshoppers and jack rabbits are the only organisms common to both the initial and the final food webs;
3. Lack of mesquite;
4. Number of ducks;
5. A decrease in precipitation was solely responsible for the other changes'
6. Maximum and minimum levels would be more realistic.

Options:

Use this activity with upper middle school or high school students as you see fit. If necessary to modify for ability level, guide the students in the completion of the chart section of the activity.

Extensions:

- Have students with sufficient skill on computers create a program top find out when the critical points are reached and what the outcomes are;

Student Activity Sheet:

Background: The relationship between biological diversity and climate change in natural systems needs further analysis. Natural ecological systems and the diversity of living things that they support is a legacy that must be preserved. There are several factors that are relevant to the growth and distribution of plants within these systems: temperature, precipitation, carbon dioxide concentration, light, nutrient availability, chemical environment, disturbances (disease, hurricanes, wildfires, or human land use) or any combination of these factors. Trees have "moved" thousands of miles over the course of Earth history in response to global temperature changes on the order of 5 degrees C occurring over many thousands of years. At the rate of change of a degree or so per thousand years, forest species were able to move and "keep up" with the changing climate. However, as discovered in extensive studies done on fossil pollen in lakes around North America, it was seen that intact forest and animal ecosystems do not simply move north. The species moved, but they changed their relative abundances and thus the habitats as a whole changed. It is this transition over time and space that is of most concern to ecologists.

Task:

- To trace the effects of a gradual climatic change on a model ecosystem which is simplified from a real situation;
- To explain ways in which environmental factors interact to set limits on geographic ranges;

Materials: Lab Investigation Sheet, Climate Change Information Sheet, paper/pencil, butcher paper, markers;

Procedure:

1. Read the ***Information Sheet: Part I.***
2. With your partner, diagram the food web in the ecosystem described in Part I on the butcher paper.
    - You may either draw your own organisms or cut out the drawings provided in the packet.
3. Create a chart similar to the sample shown below.

Round	Years	Average Annual Precipitation	Average Annual Temperature	Changes in Organisms
1	200			
2	400			

4. Read ***Information Sheet: Part II.***
5. Following your teacher's instructions, fill out the chart you created with the information from the second reading selection.
6. After reading Part II, diagram a food web on butcher paper for the same ecosystem at the end of 10,000 years.
7. Prepare a written summary of the climatic changes that you observed in the ecosystem over the 10,000 year period.
8. Read over the questions in the Analysis and Conclusions section on your own.
    - Be prepared to discuss them with the class.
9. Answer the questions in the Analysis and Conclusions section in written form independent of your partner.

Analysis and Conclusions:

- When did the first changes in the ecosystem occur?
- What were the changes that took place?
- What subsequent changes took place and in which years?
- What similarities or differences are there between the in initial and the final food webs?
- What is a barrier to the dispersal of the Merriam pocket mouse?
- What limited the red wolves population size?
- What climatic change was responsible for the other changes?
- Why could use of annual average values for temperature and precipitation make this model artificial?

Climate Change Information Sheet

Part I

An oak grows next to a shallow stream in a grassy area. There are no shrubs here. Grasshoppers and blacktail jack rabbits feed on little bluestem grass. Duckweed grows in the water, providing food for wood ducks. These birds also feed on grasshoppers, acorns and grass. The ducks are a major food source for red wolves.

Part II

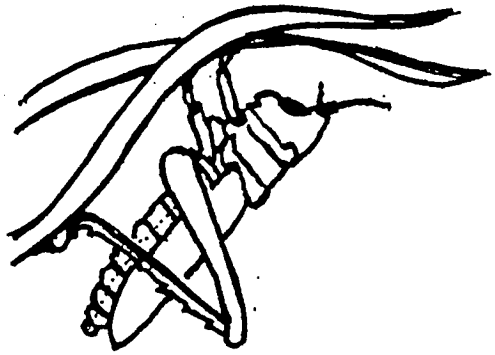
To the west of the grassy area is a desert. There glossy snakes eat Merriam pocket mice. These mice can burrow under shrubs or cacti to hide from the snakes; the mice cannot live in a grassy area. In the desert they burrow under mesquite shrubs and eat seeds. Grasshoppers and blacktail jack rabbits eat the mesquite leaves.

The climate is changing in the grassy area. For the next 10,000 years (50 rounds on your chart), the average annual precipitation will decrease by 1.25 cm every 200 years, and the average annual temperature will increase by 0.3 degrees C every 200 years.

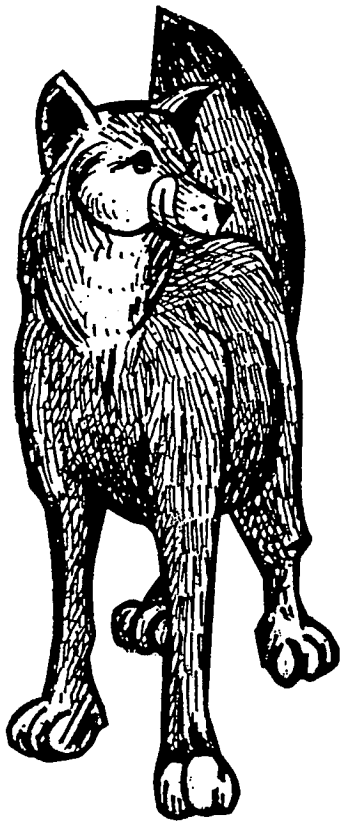
An average annual temperature of more than 22 degrees C or an average annual precipitation of less than 51 cm will cause the stream to start drying up and the oak trees to die.

If the average annual temperature reaches 31 degrees C or the average annual precipitation is less than 34 cm, the water table will be too low for the grass.

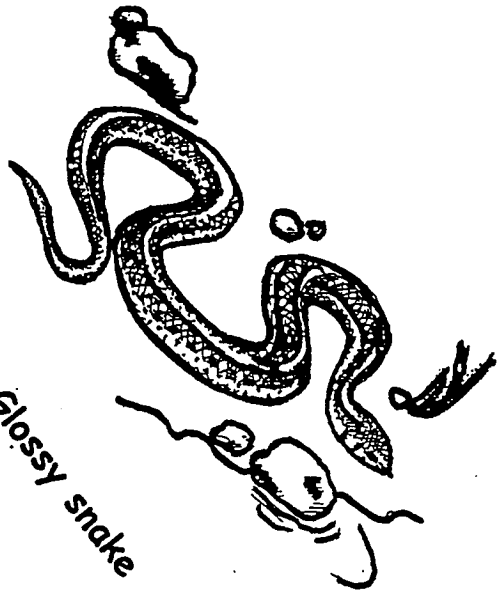
*****In filling out the chart, assume that organisms in the desert area are trying to disperse to the grassy area at all times, and that they will invade it whenever conditions allow it.*



Grasshopper

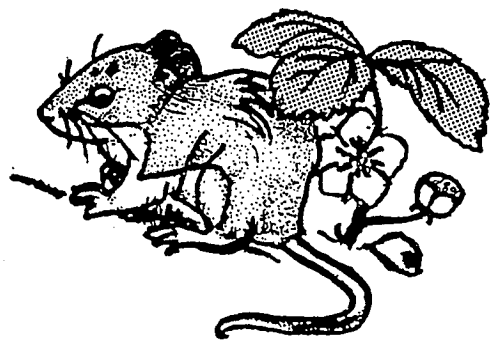


Red wolf

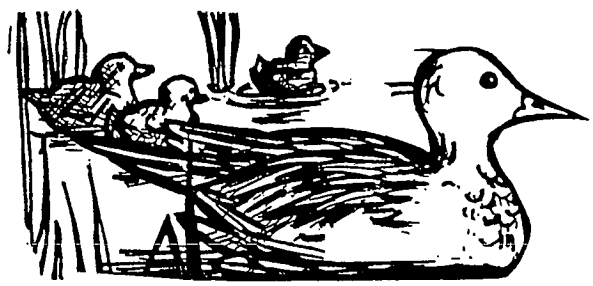


Glossy snake

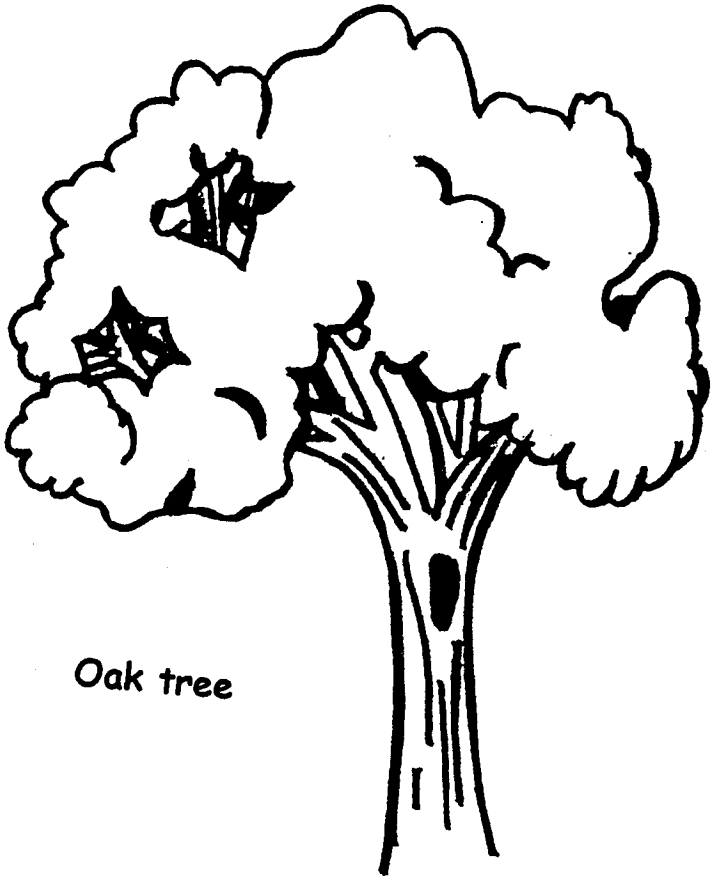
Black-tailed Jackrabbit



Merriam pocket mouse



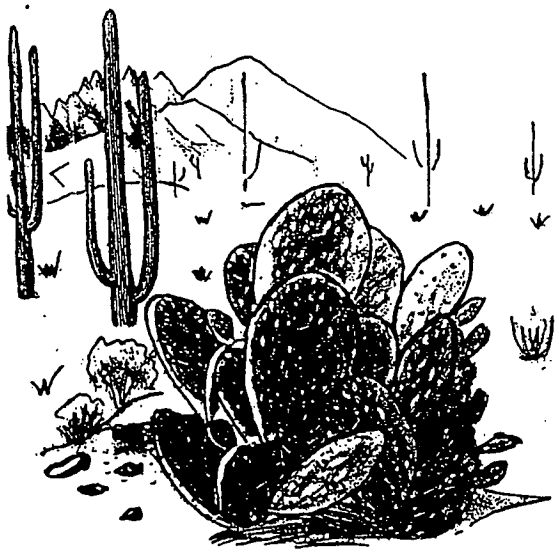
Wood Duck



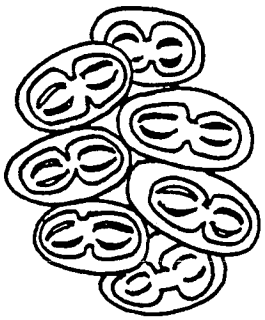
Oak tree

Bluestem grass

Mesquite bush



Cactus



Duckweed