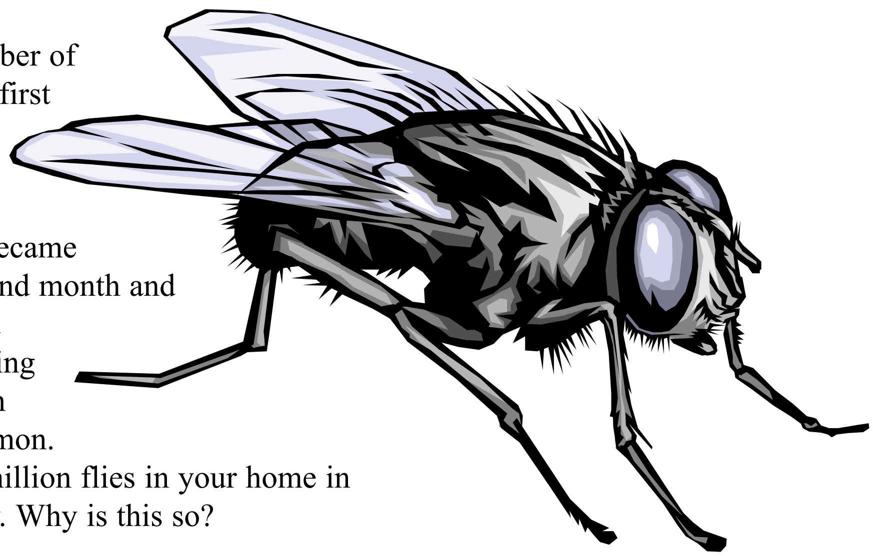
Senior 2

Appendix 1: Dynamics of Ecosystems

SLA
Student Learning Activity

Environmental Factors and Population Size

Imagine you notice a pair of houseflies in your warm house on a cold day in December. Assuming one of the flies is a female, and the other a male, you could expect them to reproduce. Houseflies lay up to 900 eggs at a time. If the house is warm (approximately 20°C), the eggs will hatch into larvae (a small worm-like stage of fly development) in about one day. The larvae go through several stages of development, and become mature houseflies in about a month. If the home remains warm, and the larvae find enough food to eat, there could be approximately 900 flies in the house by January (assuming that all the larvae survive until they become mature flies!). If all goes well, hundreds of pairs of these flies will lay hundreds of eggs each, producing approximately 400,000 new flies by late February. If this continues, you could have an additional 180,000,000 mature flies by the time you open your windows in late March (and maybe let some of the flies out).



As you can see, the number of flies increases slowly at first (in this example, 2 flies become 900 flies in the first month), then very rapidly (900 flies became 400,000 flies in the second month and 180,000,000 by the third month). Finding a breeding pair of flies in a house in December is not uncommon. Having a few hundred million flies in your home in March is highly unlikely. Why is this so?

What factors in the environment prevent a breeding pair of organisms from becoming a population numbering in the billions in a relatively short period of time? One reason is that resources are in limited supply. There may be enough food in a typical house for a few dozen flies, but there usually isn’t enough for thousands of them. Also, there may be other insects in the house that compete with the flies for the little bits of food that humans leave behind. Many of the flies and their larvae starve to death. Some flies are eaten by other insects in the home (predators), while others die of “natural causes” (such as disease). If the home’s heating system were to break down, and the temperature in the house were to drop to the freezing point, many flies and larvae would die due to lack of warmth. Although this doesn’t usually happen in your home, it does happen outdoors where many organisms live. All these environmental factors help limit the population size of a particular organism.

Many environmental factors affect the population size of a particular organism. This is true in a “closed” environment such as a home, but also in an “open” environment such as the outdoors. Limiting factors may be categorized as density-dependent or density-independent. Density-dependent factors operate when a population is large and crowded, and density-independent factors operate regardless of the population density. Some limiting factors are

- availability of food and water
- availability of living space
- heat or cold
- predators
- disease
- overcrowding and stress

Questions

1. How many flies were in the house in December?
2. How many new flies were added in January?
3. How many new flies were added in February?
4. How many new flies were added in March?
5. Why does the population grow slowly at first (in December and January), and much more rapidly later (in February and March)?
6. Suggest two other organisms that houseflies compete with for food in a home.
7. Which factor(s) changed when the window was opened in March?
8. From the list of limiting factors, identify those that are density-dependent.
9. From the list of limiting factors, identify those that are density-independent.
10. Would you consider drought to be a density-dependent or density-independent limiting factor? Explain your answer.
11. Would you consider competition for resources a density-dependent or density-independent limiting factor? Explain your answer.

Adapted from *Locally Developed Grade 10 Science—Catholic* (Toronto, ON: Ministry of Education and Training, 2000), Appendix 2.5.9.

SLA Student Learning Activity

Creating a Closed Ecosystem

Purpose

To create and use a closed ecosystem to study the concepts of the cycling of matter and the flow of energy.

Introduction

A closed ecosystem is a good way to study the interactions between the abiotic and biotic components of the environment. In this system, the material parts of the environment will be contained within a jar. The energy for the system, in the form of light, will come from outside the system. This model is similar to our own planet where the Sun provides energy for the Earth and the Earth provides the materials.

Living things will be imported into the ecosystem. Micro-organisms such as bacteria and algae are important to an aquatic ecosystem. One way to introduce them into a closed ecosystem is to add water or a small amount of gravel from an established pond or aquarium. First, plants will be added to the ecosystem; then, animals will be added. After that, the ecosystem will be sealed to study the interactions.

Materials

For each day, groups will require the following:

Day 1

- clear glass jar with a lid (5–10 L) or a suitable alternative
- gravel
- tap water
- light source (a lamp or grow light)

Day 2

- 50 mL of water and/or a small handful of water from an established aquarium or pond

Day 3

- several sprigs of Elodea (or a suitable alternative)

Day 7 – 14

- two snails

The timing of this stage will vary in different environments. The snails should only be added after a green coating of algae is visible on the sides of the container.

Procedure

1. Rinse the jar, gravel, and lid with clean water. Do not use soap.
2. Place the clean gravel in the bottom of the jar. Add tap water to within 10 cm from the top of the jar. Do not put the lid on the jar.
3. Let the jar sit overnight to allow the gravel to settle, and any chlorine to escape from the tap water.
4. Add 50 mL of water and/or a handful of gravel from an established aquarium or pond. Seal the jar with the lid and place the jar under a light source. The light must be kept on at all times to maintain a constant environment.
5. On Day 3, add several sprigs of Elodea (or suitable alternative) to the jar. Reseal the jar and place it back under the light.
6. Once algae have formed on the sides of the jar, introduce the two snails. Reseal the jar, and place it under the light again.
7. Observe the system daily.

Observations

1. Maintain a daily log of observations. Date each entry, and list the materials, procedures, and/or observations made that day.
2. Make observations carefully. Be sure to note any changes, as well as anything that appears to remain the same.

Analysis

1. What role do the bacteria play in your ecosystem?
2. What role does the aquatic plant play in your ecosystem?
3. What role do the snails play in your ecosystem?
4. Why were you instructed to wait until the algae had formed on the sides of the jar before you added the snails?
5. Why does your ecosystem require a source of light?
6. Draw a diagram of your ecosystem and include the carbon and oxygen cycles present. Indicate where oxygen and carbon dioxide are made and consumed.
7. Suggest two ways in which the cycling of carbon and oxygen could be disturbed in your ecosystem. Predict the effects of each disturbance on the organisms present.

Adapted from *Locally Developed Grade 10 Science—Catholic* (Toronto, ON: Ministry of Education and Training, 2000), Appendix 2.5.9.

TSM Teacher Support Material

Creating a Closed Ecosystem

1. Remind students of electrical safety precautions when working with electricity near water.

2. Use a light source that promotes the growth of plants. Ensure jars are not placed too close to the light.

3. Remind students to wash their hands with soap and water after handling any live organisms.

4. A large pickle jar can be used as a container for the ecosystem.

5. Substitute a floating aquatic plant, such as hornwort or parrot feather, in place of Elodea.

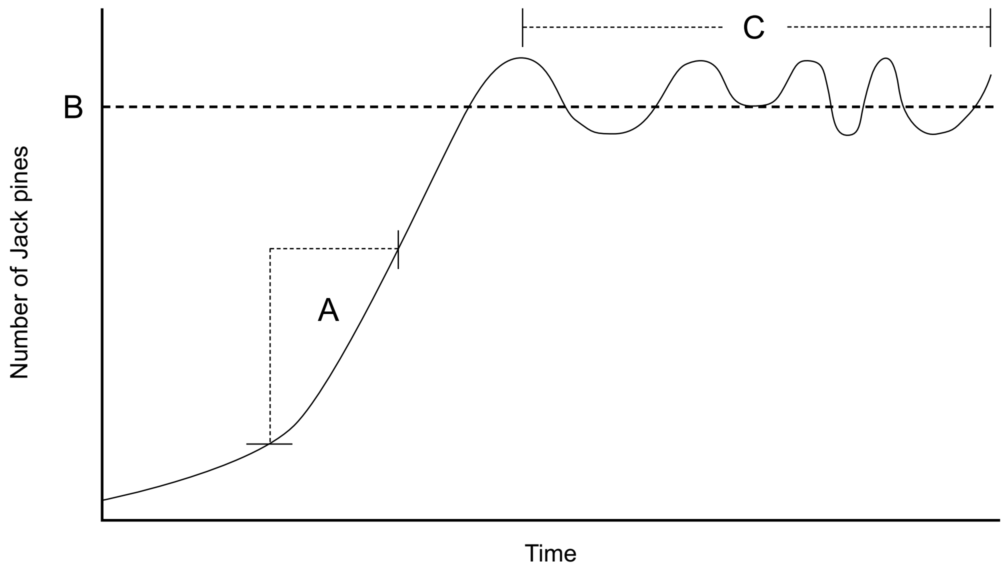
6. An algae-eating fish can be added to larger (10 L) ecosystems.

7. When disposing of the ecosystems, pour the water down the drain first. Place plants, gravel, and snails in sealed plastic bags before disposal. If jars are to be reused, they must be cleaned with soap and rinsed several times.

SLA
Student Learning Activity

Carrying Capacity

Many years ago, a fire swept through the boreal forest in an area of northern Manitoba. The trees, shrubs, and other plants perished in the fire. A team of wildlife biologists decided to study the regrowth of the forest over time. They chose to focus on the Jack pine population as these trees are some of the first to grow back after a fire. A graph of the results of their study is shown below.



Questions

1. Why is the number of Jack pines increasing so rapidly in area A of the graph?
2. How do you account for the fluctuations in area C of the graph?
3. What does B represent?
4. What is your estimate of the average growth rate in area C?
5. Describe, in your own words, what is happening to the Jack pine population in the graph.
6. Predict how the graph would change if another forest fire swept through the region.
7. Predict how the graph would change if a forestry company began to log the area.

SLA
Student Learning Activity

Limiting Factors

1. Explain the difference between density-dependent and density-independent limiting factors.

2. Each of the statements below involves a situation that will affect the growth of a population. Classify each of the statements as DD (density-dependent) or DI (density-independent) and give a reason for your choice.

   a. A lion and a cheetah attempt to occupy the same niche. The more aggressive lion survives; the cheetah does not.

   b. Coyotes cross the winter pack ice and enter Newfoundland. The moose population starts to decline.

   c. A severe frost wipes out 50 percent of the coffee crop in Brazil.

   d. A forest fire destroys much of the wildlife in an area of northern Manitoba.

   e. Due to severe overcrowding in an Asian village, many children do not survive to reach adulthood.

f. Since lynx prey on hares, an increase in the hare population causes an increase in the lynx population.

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g. A severe flood in the Red River valley causes a decline in the deer population.

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h. Due to stress, large numbers of female lemmings miscarry their young and fail to reproduce.

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i. Travelers who visit a crowded African village become infected with a disease caused by parasites.

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j. Many fish die due to a change in the winds and the appearance of the El Niño ocean current off the coast of Peru and Chile.

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k. Because rabbits in Australia have no natural enemies, their population increases rapidly.

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l. Fish on a coral reef stake out their territory and chase away any younger fish that try to live there.

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m. An extensive drought on the Serengeti Plain threatens wildebeest, giraffe, zebra, and springbok populations.

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SLA
Student Learning Activity

Predator-Prey Interactions

In the 1980s, people became concerned about the wolf and deer populations in a Manitoba provincial park. A wildlife biologist was hired to monitor the populations over 10 years. The results of the study are found below.

Year	Wolf Population	Deer Population
1991	20	4000
1992	24	4600
1993	33	5000
1994	44	4800
1995	56	4500
1996	48	4200
1997	42	3900
1998	36	3850
1999	38	3900
2000	38	3950

Questions

1. On a piece of graph paper, plot the fluctuations in the deer and wolf populations for the study period. Place the year along the horizontal axis. Create two vertical axes. Number the left vertical axis to accommodate the number of deer. Number the right vertical axis using a different scale for the size of the wolf population.

2. Examine the completed graph. What factors could account for the large increase in the deer population between 1991 and 1992?

3. What might have caused the decline in the deer population between 1993 and 1997?

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4. Why was the wolf population so high in 1995?

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5. How would you describe the relationship between the wolf population and the deer population?

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6. Make a prediction for the size of each of the populations for the year 2005.

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7. Should there be a concern about the changes in the wolf and deer populations in the area studied? Explain your answer.

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8. Predict the effect on the deer population if…
   a. a forest fire occurs ____
   b. the wolf population suffers from mange ________________________________
   c. prolonged harsh winter weather conditions occur ________________________
   d. deer hunting quotas are increased ____________________________________
   e. wolf trapping quotas are increased ___________________________________

9. How can understanding the natural fluctuations of these populations aid conservation officers in setting trapping and hunting limits?

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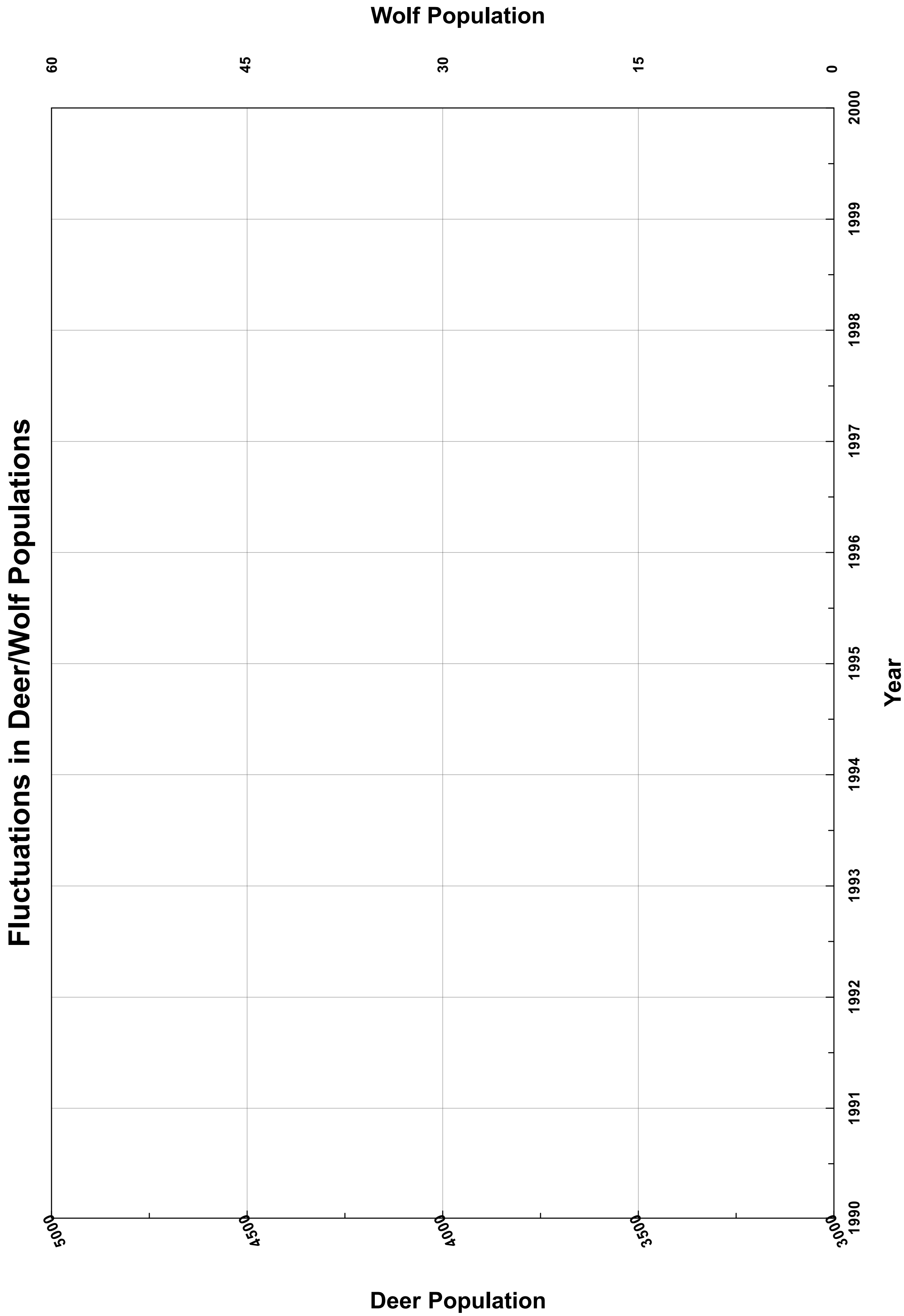
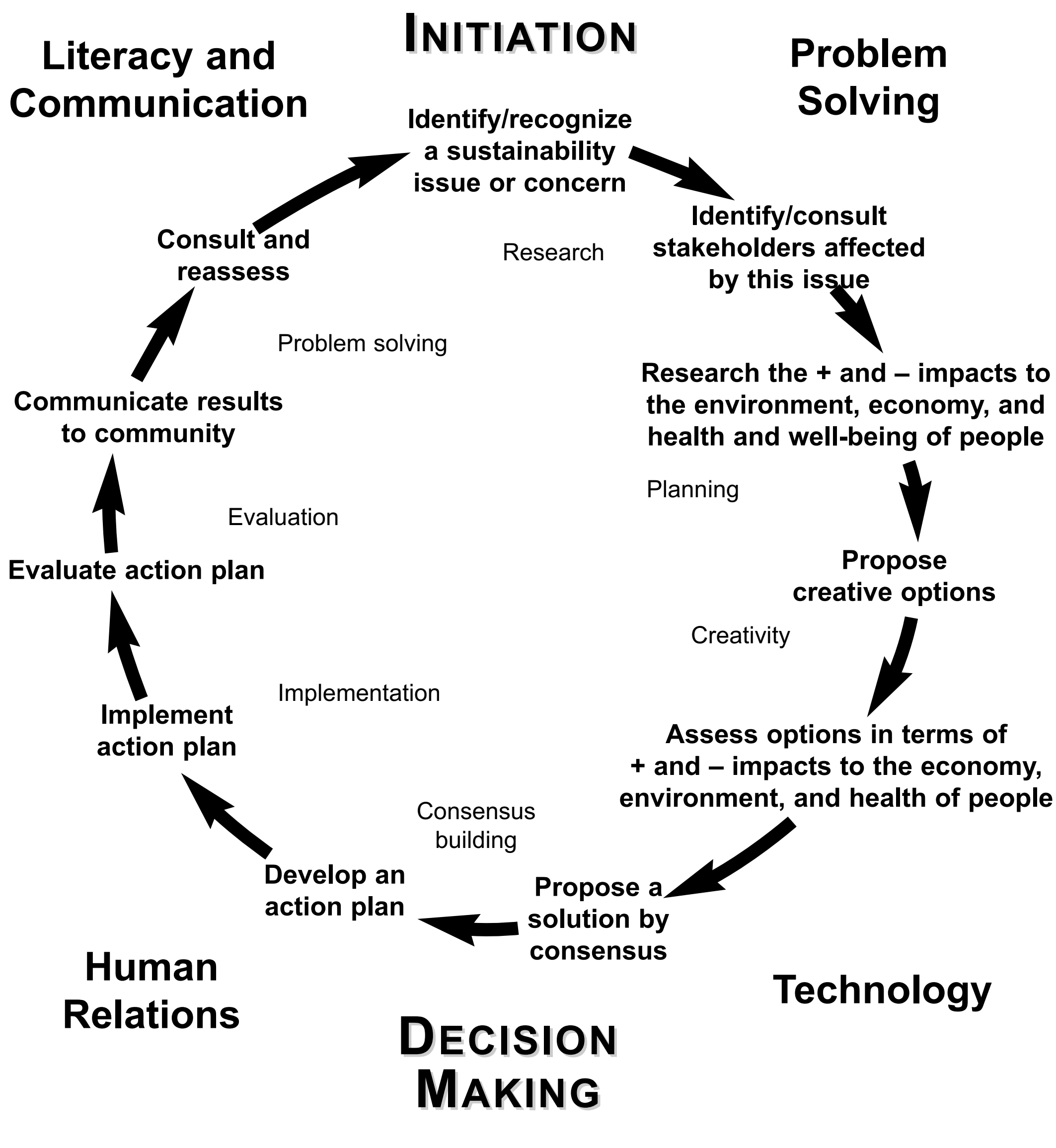

Fluctuations in Deer/Wolf Populations
Wolf Population
60
45
30
15
0
Deer Population
5000
4500
4000
3500
3000
Year
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000

TSM
Teacher Support Material

Educating for Sustainability: Decision-Making Skills



Reproduced from *Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators* (Winnipeg, MB: Manitoba Education and Training, 2000) 16.