

LEVEL: Grades 7-12

SUBJECTS: Mathematics,
Science (Biology, Life Science),
Social Studies.

PROCESS: Through a physically-active process of role playing "herds" of animals seeking food, students are introduced to the concept of carrying capacity.

OBJECTIVES: The student will:

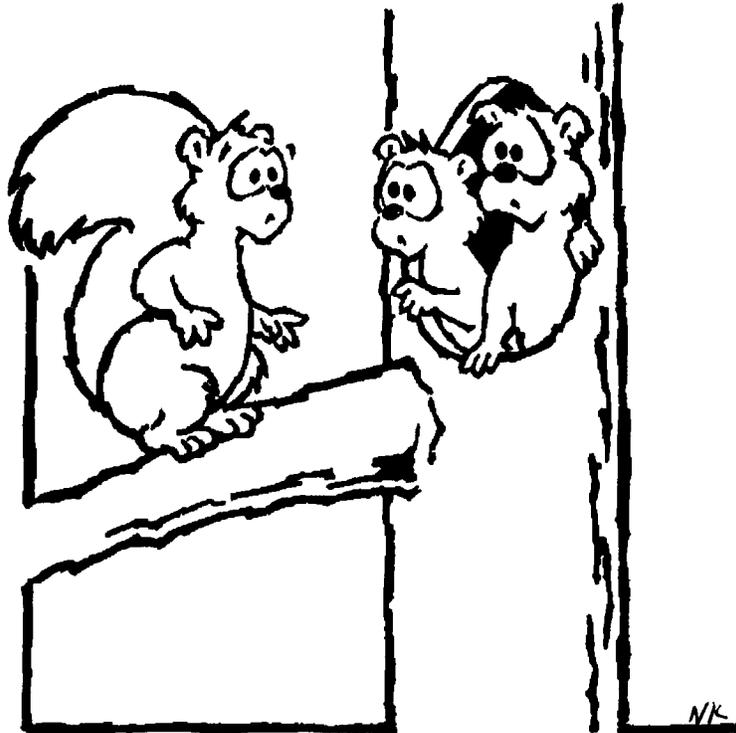
1. Formulate and test hypotheses related to wildlife populations and carrying capacity.
2. Describe the significance of carrying capacity.

TIMEFRAME: 45 minutes or longer.

SKILLS: Analyzing, comparing similarities and differences, describing, evaluating, generalizing, hypothesizing, listing, observing.

MATERIALS: One bag of dried beans, kitchen timer.

VOCABULARY: Carrying capacity, habitat, limiting factor, management, population.



CARRYING CAPACITY

OVERVIEW: Carrying capacity affects all living things, including humans. The term is usually thought to mean the number of animals of a given type that can be supported in a given area.

Carrying capacity is also interpreted more broadly as the number of living things - plants as well as animals - an area of land or water can support at any one time. Different life forms have different carrying capacities within the same area. Different ecosystems have plants and wildlife with different carrying capacities.

Carrying capacity is usually limited by some aspect of a species' habitat requirements. These requirements include the quantity and quality of available food, water, shelter, space, and the suitability of their arrangement. Different factors are important in each case. Natural and human causes both affect carrying capacity. Effects may be short or long

term. Ecosystem managers have to balance the different factors, called *limiting factors*.

Carrying capacity for many species is in a constant state of change, both seasonally and from year to year. For example, it is typically most limited for terrestrial animals in the winter season when food supplies are reduced. Year-to-year variations may result from factors such as natural disasters, changes in rainfall and temperature patterns, or human interventions. Factors affecting plant growth affect animals since they either directly (as herbivores or omnivores) or indirectly (as carnivores) depend on plants.

Populations of living things tend to fluctuate naturally around some levels. Carrying capacity is that level. A population may be below carrying capacity in the spring following a hard winter, or temporarily above it after a good summer. When the population is

too high, there is inevitably a decline due to a variety of natural limiting factors, e.g., mortality, disease, emigration, and lowered reproduction rate. The carrying capacity of any area is affected and adjusted by such natural factors as well as by human intervention.

A population tends to fluctuate naturally with carrying capacity, with or without human intervention. Humans may not always be willing to accept the consequences of natural events like starvation. Examples of intentional human intervention are reintroducing predators, winter feeding, constructing nesting boxes, planting additional vegetation suitable for food, relocating animals, and hunting. Human intervention can reduce a population or prevent its expansion to meet an expected natural reduction in carrying capacity. Such an intervention may result in a higher survival rate.

Altering of habitat quality or quantity may increase or decrease carrying capacity. Environmental degradation may reduce it for affected species. Activities such as development or pollution are not aimed at intentionally reducing carrying capacity, but often have this impact.

Intentional intervention may be based on a particular management philosophy or practice. Ecosystem Management of an area of land or water in relation to its carrying capacity for certain species can be open to question and controversy. Whether and/or how is appropriate for humans to intervene in natural systems is sometimes a part of such questions and controversy. Management may be defined as intentional choice based on human goals and objectives. Such goals and objectives are always open to question by other groups and individuals.

The major purpose of this activity is to provide students with a general introduction to the concept of carrying capacity.

PROCEDURE:

PRE-ACTIVITY:

Count out enough beans so there are five per student. Spread the beans on a table outdoors or in a cleared area of the classroom. This arrangement of the beans represents a food supply that has been fixed by the end of a

growing season.

ACTIVITY:

1. Divide the class into "herds" of five students each, and have them all gather on the periphery of the cleared area.

2. Act as a timekeeper and set the timer to ring at intervals of one minute or less. (The time interval you use per round depends on the size of the physical area you use for the activity as well as the size of your group. For the purposes of this activity, all students should not get enough food to survive.)

3. One member at a time, each "herd" comes up to the table during each interval ("feeding time"). Each student in each herd attempts to take one piece of food per turn, simulating the animal's need to eat reasonably regularly. When you start, all the first people from each herd will move at once to get food. Then (relay-fashion) they each tag the next person in their herd who moves to get food, who then tags the next person, and so on. This continues long enough so some students don't get to the food supply before the timer rings and the round ends. Any member of a herd going for three rounds without getting any food dies.

4. The food will run out before the next growing season begins and a significant percentage of the animals will die, depending upon the size of the "herd." Define carrying capacity and limiting factors with the students what could be done or might happen to allow more of the population to live through the "winter" on the food available. Management options may include reducing the population in various ways to match the carrying capacity - for example, by redistributing some of the population to another area, or introducing or increasing natural predators. Options to increase the carrying capacity could include bringing in or planting more "food" for the "herds." Another option is no action in the form of human intervention. Each of these options involves costs as well as benefits, and each may be controversial.

5. Repeat the activity two more times, incorporating two different options the students have discussed. What happens to the number of survivors that live to reproduce the next year?

6. Repeat the activity one more time, incorporating one of the options used above, and also include five or six young animals born the previous spring. This can be done by designating one student in each "herd" to take food for themselves and an offspring. How does this annual increase affect the population? What must now happen to re-establish the herd size within carrying capacity?

7. Record the number of "survivors" that result from the various manipulations of carrying capacity on the chalkboard. What can be learned from this numerical representation? Which manipulation was the most successful? What criteria did you use for success? What are examples of both cultural and natural influences on carrying capacity?

8. Ask for a summary of some of the most important things the students feel they have learned about the concept of carrying capacity.

ASSESSMENT: It is the early 1900s, and you are a scientist. You have just learned of the following situation: All the natural predators of deer in the Kiabab Plateau in Arizona were removed from the area. Within a few years, the deer population had increased tremendously and within another few years, the population had collapsed to a very small number. Formulate a hypothesis that might explain the increase and decrease of the deer population related to carrying capacity. Explain how you would test this hypothesis.

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