Goll-ly! Don't Take a Knapweed!

The Impact of Nonnative Plants and Animals on Deer Mice

Meet the Scientists

Dr. Ortega: ◂ I grew up in southern California in a big city. My first biology job took me all the way to the wilds of Alaska. That convinced me that I was on the right career path. On the first day of work, our boat was approaching a rugged shore in Princess Bay where we were to set up our bird banding station. We noticed a figure on the beach. As we got closer, we realized that it was a brown bear, standing on its back legs! It did not seem afraid of us or our boat and, in fact, was letting us know whose beach it was! We got the picture and turned around. But we returned to that beach in Princess Bay all summer long to band birds, never again seeing the bear, but always paying our respects to her by calling out, "Hey Princess!"

Dr. Pearson: ▸ My favorite science experience is when I can prove a scientific *hypothesis*. I work in a special scientific area called community *ecology*. Community ecology addresses the *relationships* of different kinds of communities within an *ecosystem*, such as plant communities and communities of animals. You have to examine many things at once, and these examinations make the research very complex. When you make a hypothesis about what is happening in a complex system and through careful experimentation are able to show that your hypothesis is correct, it is very satisfying. In this photograph, I am holding a Lynx kitten.

Dr. McKelvey: ◂ My favorite science experience was not in the outdoors, but while sitting at a computer. I had just finished building a map-based computer model of how spotted owls move across the land. The model could draw land areas of different sizes and shapes. I was surprised to see that large areas of irregularly shaped land behaved like networks of smaller areas. Shape was as important as size to providing good *habitat* for the spotted owl. As I pondered this finding, I realized that many scientists were dismissing the importance of the size and shape of land areas for wildlife habitat. This realization has shaped my career as a scientist. Here is a picture of me handling a 1-year-old wolverine. I was placing radio collars on wolverines to track them as they moved across the land.

Glossary:

hypothesis (hi **paw** thuh sis): An unproven idea that is accepted for the time being and is often tested during a scientific study. Plural is hypotheses (hi **paw** thuh ses).

ecology (e **kä** luh je): The study of the interactions of living things with one another and with their environment.

relationship (re **la** shun ship): When two or more things are connected in some fashion.

ecosystem (**e** ko sis tem): Community of plant and animal species interacting with one another and with the nonliving environment.

habitat (**hab** uh tat): Environment where a plant or animal naturally grows and lives.

invasive (in **va** siv): Tending to spread or infringe on.

species (**spe** sez): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

nonnative (nän **na** tiv): Not naturally occurring in an area.

larval (**lär** väl): Relating to the wormlike feeding form that hatches from the egg of many insects or animals that changes form when it becomes an adult.

native (**na** tiv): Naturally occurring in an area.

mammal (**ma** mul): Any warm-blooded animal with a backbone and glands to produce milk for feeding their young.

larva (**lär** vuh): Wormlike feeding form that hatches from the egg of many insects. Larvae (**lär** ve) is the plural.

arid (**air** id): Dry.

prey (pra): An animal hunted for food by another animal.

livestock (**liv** stawk): Animals kept or raised on farms or on rangelands.

population (päp yoo **la** shun): The whole number of individuals of the same type occupying an area.

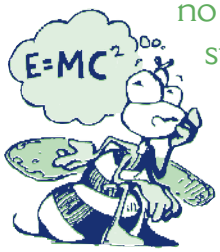
Pronunciation Guide

a	as in ape	o	as in go	ü	as in fur
ä	as in car	ô	as in for	oo	as in tool
e	as in me	u	as in use	*ng*	as in sing
i	as in ice				

Accented syllables are in **bold.**

Thinking About Science

In environmental science, scientists see no end to the problems they could study. Scientists often identify new problems to study from the findings of earlier research. When research is done, more questions always emerge at the end of a study. Scientists spend a lot of time reading and thinking about the results of previous research. They may also observe on their own what is happening. They then think about what information is missing.



Often, scientists compare what they know with what is missing to develop hypotheses or predictions. This method of comparison is one way that science progresses.

In this study, previous research had discovered information about the relationship between an *invasive* plant *species* and *nonnative* insects that might help to control it. Part of the insect's life cycle includes a *larval* stage. The scientists observed that a *native mammal* enjoyed eating these insect *larvae*. The scientists wondered if the substitution of the mammal's usual food with a nonnative food might affect the ecology of the whole area.

Thinking About the Environment

An ecosystem is a community of plants and animals that interact with each other and with the nonliving environment. An ecosystem is not a specific size area. It can be any size one wishes to study. For the purposes of research, scientists often define an ecosystem by the plant or animal communities that live in a particular area. In this research, the scientists were interested in the ecosystem defined as an *arid* grassland (**figure 1**).

One animal living within this arid grassland ecosystem is the deer mouse (**figure 2**). In an arid grassland ecosystem, deer mice usually breed and raise their young in the summer when food is most easily found. Deer mice eat a lot of different foods, including fruits, small nuts, insects, and spiders. Deer mice are *prey* for a wide variety of other animals, including snakes and owls. During the day, deer mice hide under rocks, in burrows, and use the thick grasses for protection. Using the deer mouse as an example, you can see that in an ecosystem many different plants and animals interact with and depend on each other.

Figure 1. Arid grassland with bluebunch wheatgrass and balsamroot.

Figure 2. Deer mouse being measured during this study.

Introduction

One risk to a native ecosystem is an invasion of nonnative plants or animals. In the Western United States, spotted knapweed is one of the most widely found nonnative plants (**figures 3a and 3b**). Spotted knapweed was brought to the United States from Eastern Europe in the early 1900s. When spotted knapweed spreads into an area, it takes over and native plants cannot compete with it. This change reduces the amount of food available to animals that eat the native plants, such as *livestock* and other hoofed animals.

To control the spread of spotted knapweed, two types of gall flies have been released into

Figures 3a and 3b. Spotted knapweed.

areas with spotted knapweed (**figure 4**). Gall flies lay their eggs on the flowerhead of the spotted knapweed. When the eggs hatch and become larvae, the larvae burrow into the flowerhead to feed on the plant (**figure 5**). This feeding destroys the developing seeds and helps control the reproduction of spotted knapweed.

Unfortunately, these gall flies are not native to the arid grassland ecosystem. The scientists in this study observed that deer mice prefer eating gall fly larvae more than they prefer native foods. The scientists thought that this preference could cause a problem for the ecosystem overall.

Figure 4. Gall fly.

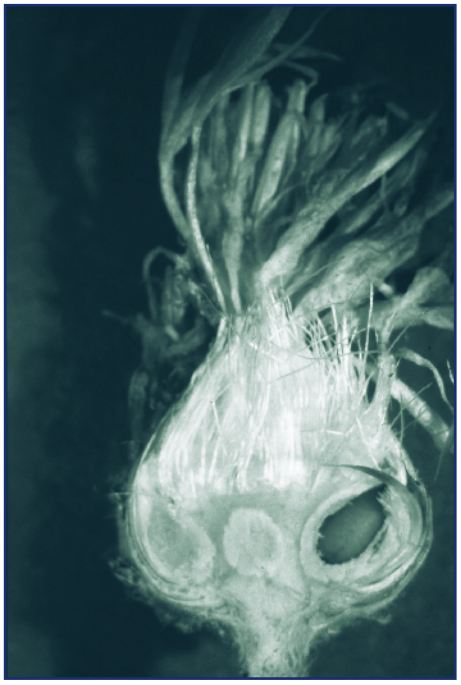


Figure 5. Cross-section of a spotted knapweed flowerhead showing a gall fly larva (on the right).

Gall fly larvae are available to deer mice from September through May of every year. They become unavailable in the summer when the adult gall flies emerge. This change means that deer mice, which usually do not reproduce in the winter when native food is scarce, might be reproducing into the winter months because gall fly larvae are available to eat. More importantly, the scientists thought that the availability of gall fly larvae in the winter might help more mice to survive the cold winters.

Usually, deer mice reproduce during the summer when native foods are available. Because knapweed overtakes native plants, native foods are less available to the deer mice. You can see that the presence of spotted knapweed and gall flies are changing the habits of deer mice. Because gall fly larvae are available to eat throughout the winter, the *population* of deer mice might be growing beyond its normal size.

The scientists wanted to study the effect of spotted knapweed and gall flies on the population of deer mice in arid grassland ecosystems. They predicted that they would find an overall increase in the population of deer mice within these ecosystems.

Reflection Section

- In your own words, state how spotted knapweed and gall flies have changed some things for deer mice living in the arid grassland in this study.
- What question did the scientists want to answer?

Method

The scientists selected two large areas to study in the Lolo National Forest in Montana (**figure 6**). The large areas were similar in many ways, except that one had mostly native plants and the other had been invaded by spotted knapweed. In the area with knapweed, gall flies had been released and were living throughout the area. Within the two large areas, the scientists selected four smaller areas. Then within each of those four areas, they identified four even smaller sites to study.

Number Crunches

- How many total sites did the scientists study?
- How many total areas with spotted knapweed did they study?

The scientists trapped deer mice using live traps at each of the 32 study areas (**figure 7**). Live traps enable scientists to trap animals unharmed and then release them back into the environment. They baited the traps with peanut butter and oats. The scientists checked each trap two times every morning for 4 days.

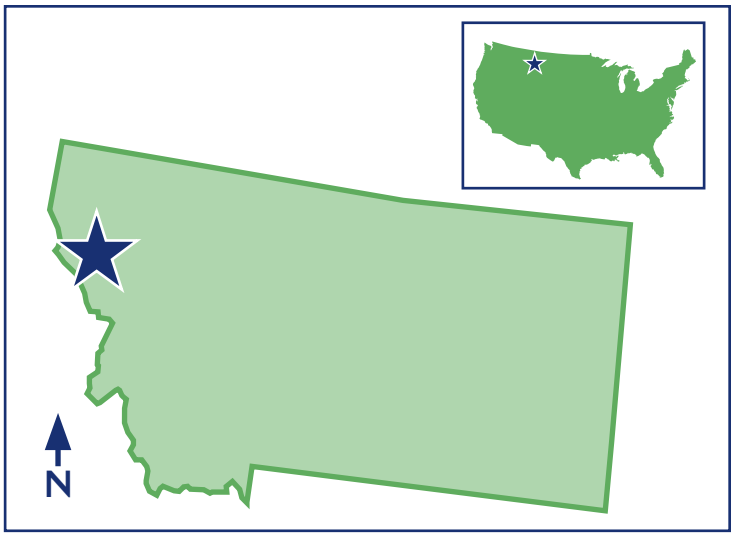


Figure 6. The location of the Lolo National Forest in Montana.

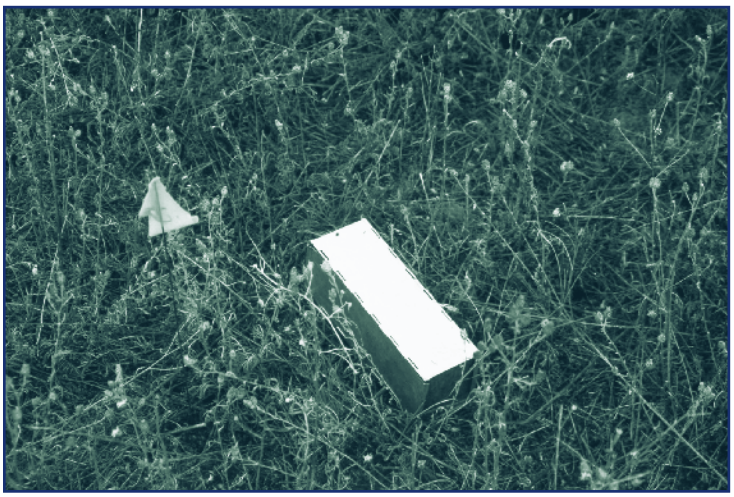


Figure 7. A live trap in the knapweed.

When a mouse was trapped, the scientists weighed it and recorded its sex. They gave each mouse a different number and placed an ear tag on it. The scientists then released the mouse back into the environment.

The scientists repeated the trapping and recording of mice for 3 years. They trapped mice for 4 days each in May (spring), July (summer), and September (fall) of each year.

The scientists then counted the number of different individual mice trapped at each site in each of the seasons. They compared the number of mice trapped in the spring with the number trapped the previous fall. The difference between the two numbers would give them an estimate of the number of mice that had lived throughout the winter.

Reflection Section

- Why did the scientists select two large areas to study—one ecosystem with nonnative knapweed and the other a native ecosystem without knapweed?
- Why was each deer mouse given a different number?
- Why did the scientists collect information over 3 years?

Findings

Throughout the 3 years, the scientists checked the traps 21,760 times. They trapped 583 individual deer mice. If they counted the deer mice they trapped more than once, in total they trapped deer mice 913 times.

Number Crunches

- What percentage of deer mice were trapped more than once? (Hint: Divide 583 by 913 then subtract that number from 100.)
- What percentage of the time did the scientists trap deer mice? (Hint: Divide 913 by 21,760.)

In all 3 years, the scientists trapped more deer mice in the knapweed sites than in the native grassland sites (**figure 8**).

In 1999 and 2000, the number of deer mice was larger in every season, except for the summer of 2000 (**figure 9**). Look closely at figure 9. Do you see a difference between 1999, 2000, and 2001? The 2001 numbers show a large decline in the number of mice found at knapweed sites. This decline probably happened because of the drought

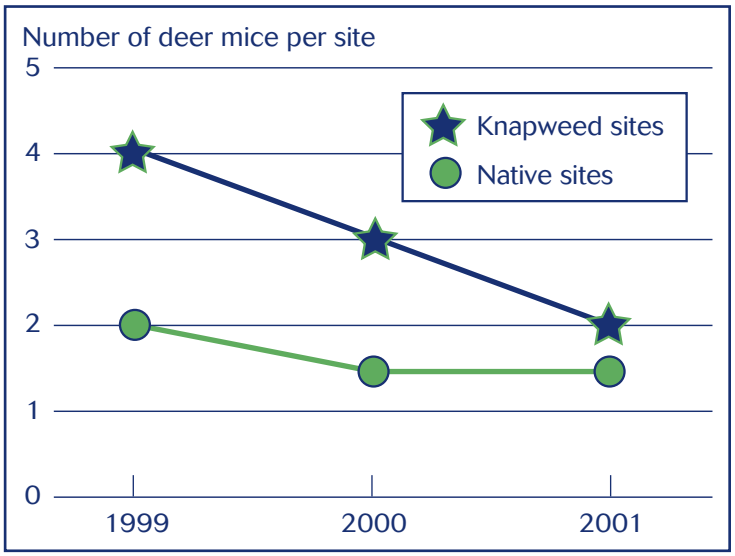


Figure 8. The average number of deer mice trapped per site.

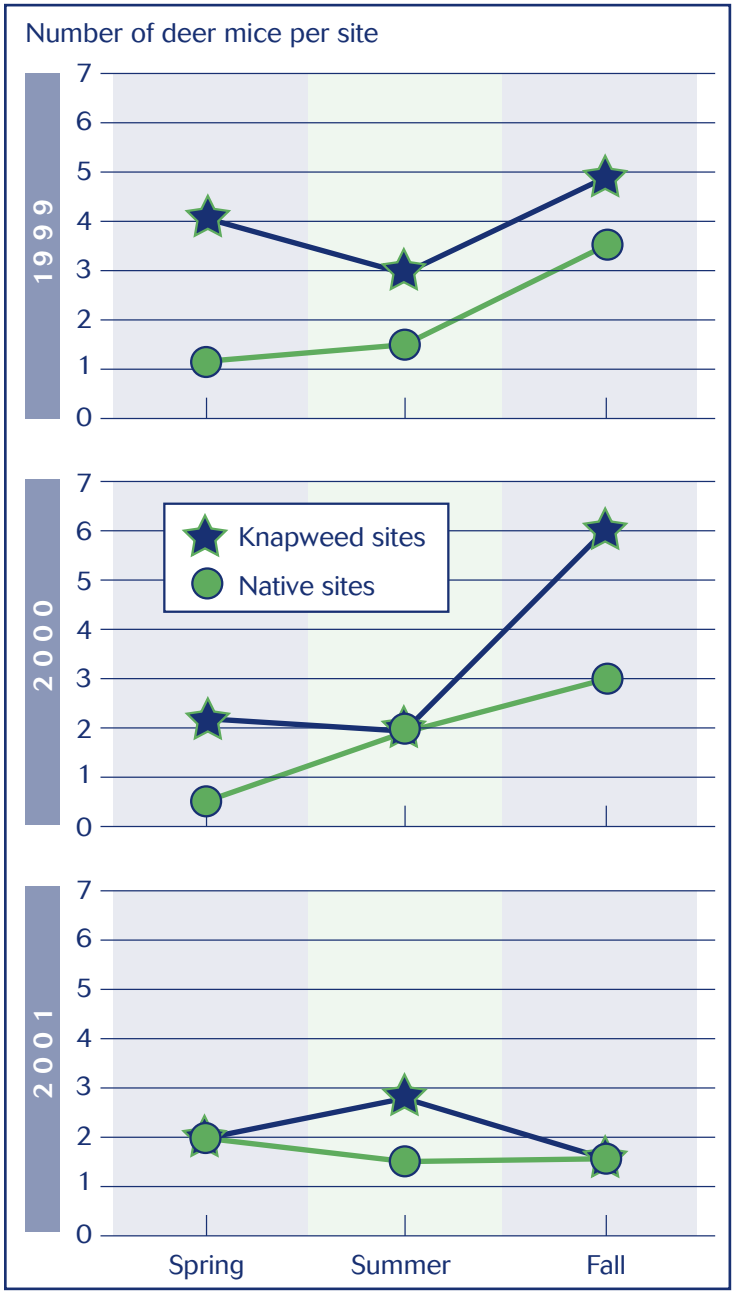


Figure 9. The average number of deer mice trapped per site by season of the year.

that occurred over the spring and summer of that year. Because the number of knapweed plants decreased, the scientists expect that the number of gall flies was reduced as well.

The scientists found that in the sites with knapweed plants, 80 percent of the spring population of deer mice trapped were adults. This finding told the scientists that the winter availability of gall fly larvae helped to keep deer mouse adults alive over the winter months.

Reflection Section

- Reread the last paragraph in the "Introduction" section. Was the scientists' prediction correct? What is the evidence?
- During the summer when gall fly larvae are not available, the population of deer mice living in areas with spotted knapweed eats more native seeds and insects than it normally would eat simply because the total number of individuals is higher. How might an overall increase in the number of deer mice affect the native seeds and insects?
- Do you think the introduction of invasive species can upset the ecology of any area? Using this study as an example, explain your answer.

Discussion

In this study, the invasive plant species knapweed was supposed to be controlled by the nonnative gall fly. Unfortunately, the knapweed population is still getting larger. In addition to not solving the knapweed problem, the introduction of gall flies has affected the population of other animals in the ecosystem. ■

Reflection Section

- Basing your response on the findings and implications of this study, what would you conclude about using nonnative species to control invasive ones?
- Purple loostrife is an invasive plant. Scientists recently found that Galerucella beetles, native to Europe and Asia, help control purple loostrife by eating its leaves. How does this information change your answer to the question above?

From: Ortega, Y.K.; Pearson, D.E.; McKelvey, K.S. 2004. Effects of biological control agents and exotic plant invasion on deer mouse populations. *Ecological Applications.* 14(1): 241–253.

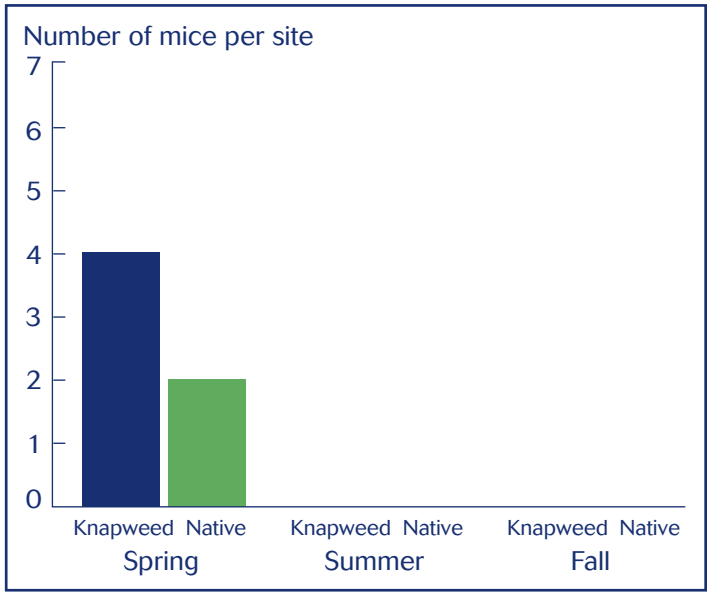
FACTivity

In this FACTivity, you will compare different ways of displaying research findings. You will answer the following questions in this FACTivity:

1. Which of two methods of displaying results is easier for you to understand?
2. Can the use of pie charts, rather than tables, help you better understand the results of an experiment?

You will use the following method to answer these questions:

1. Look at figures 8 and 9 in the article. You will be using these figures to create bar charts (also called histograms).
2. Create four bar charts using the information from figures 8 and 9. See the example below, taken from figure 8.
3. Compare your bar charts with the figures shown in this article. Hold a class discussion about the different forms. Are the bar charts easier to read? More difficult? Discuss how the same information can be shown in different forms. Can you think of any other ways to display this same information? Answer the first question of this FACTivity.



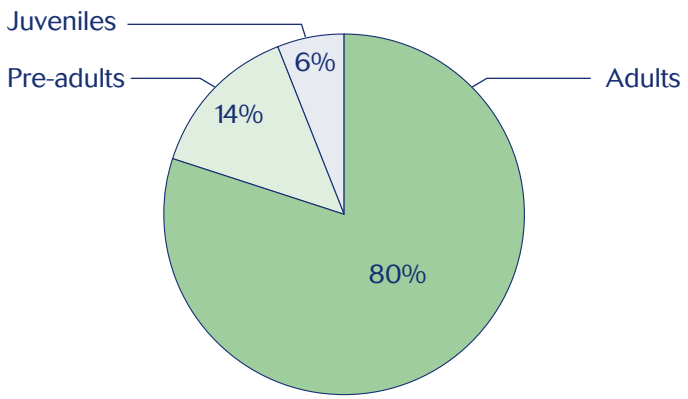
4. Examine the table on page 67.
5. After looking at the table, can you determine any patterns in the number of deer mice trapped by age class and season? If so, what are the patterns?
6. Complete the table by adding up the numbers in each of the two columns marked “Knapweed” and “Native” for each season. Total knapweed trappings in the spring is done as an example.
7. Using the total number as the denominator, determine the percentage of each age class for each season. For example, in the spring for knapweed trappings, the total of 106, 19, and 8 is 133. This number has been placed in the table for you. The denominator, therefore, is 133, and the numerators are 106, 19, and 8. To calculate the percentage represented by 106, divide 106 by 133. The answer is .796, or .80. You can see that .80 has been placed in the column next to 106. The other percentages have also been calculated for spring knapweed trappings. Fill in the shaded areas of the table with your calculations, like the example for knapweed trappings in the spring.
8. Create six pie charts based on the calculated percentages. Label each of your pie charts. See the example on page 67. This pie chart shows the information for spring knapweed trappings. To create the pie charts, you can use a computer program, such as Excel, or you can use a protractor.

Season and age class	Knapweed	Percentage	Native	Percentage
Spring				
Adult	106	.80	51	
Pre-adult	19	.14	7	
Juvenile	8	.06	3	
Total	133	1.00		
Summer				
Adult	83		45	
Pre-adult	26		19	
Juvenile	12		15	
Total				
Fall				
Adult	81		44	
Pre-adult	40		39	
Juvenile	25		19	
Total				

Number of deer mice trapped in knapweed and native grasslands by age class and season, 1999–2001.

9. After you complete and label your pie charts, revisit the question asked in #5, above. This time, use the pie charts rather than the table to describe the patterns.

Deer Mice Trapping During Spring, Knapweed, 1999-2001



10. Hold a class discussion about whether the pie charts helped you understand the findings of this research. What are the advantages of using charts and graphs over tables? What are the disadvantages? Reread the first paragraph of this FACTivity. What is the answer to question #2?

If you are a Project Learning Tree-trained educator, you may use PLT Forest Ecology Secondary Module #4, "Home Sweet Home," Pre K–8th Activity Guide #45, "Web of Life," and Activity Guide #43, "Seeds Will Travel," as additional activity resources. These activities introduce how nonnative insect control affects the web of life and how seed dispersal varies.