

of tree frogs in a lake was due to the lake's characteristics or whether it was due to the presence and number of nonnative trout.

- **After reading the “Findings” section above, would you conclude that the presence of nonnative trout had an effect on the number of tree frogs in a lake?**

**Why or why not?** Yes. The evidence shows that after considering the characteristics of the lakes, the presence and number of nonnative trout had the strongest relationship with a lower number of tree frogs.

## Discussion

- **Garter snakes are a source of food for skunks found in the Sierra Nevada mountains. Basing your thoughts on what you know about food webs and the results of this research, do you think it is likely or unlikely that continued stocking of nonnative trout could affect the population of skunks in the Sierra Nevada mountains? Why?** It seems likely that a reduction in an animal population's food source would affect its numbers. If fewer tree frogs are available as food and the population of garter snakes is therefore reduced, it seems likely that the population of skunks could be affected as well. Your students might have different explanations, such as the skunks finding a new food source. Above all, the students should be able to support their answers.

*Shoot! Foiled Again!*

## Introduction

- **Explain in your own words how verbenone protects the beetle population but not the pine trees.** The verbenone is emitted from individual beetles as they reproduce, eat, and grow. When a large number of beetles is on a tree, the combined amount of verbenone tells other beetles that many beetles are already present. This

message discourages more beetles from attacking the tree and, therefore, encourages them to find new trees. The number of beetles present at this point is already high enough to damage or kill the tree.

- **In your own words, ask one question the scientists wanted to answer.** (1) Can verbenone be used to discourage pine shoot beetles from attacking pine trees? (2) Can other volatiles, such as those from broadleaf trees, be used to discourage pine shoot beetles from attacking pine trees? Your students may state these questions a little differently.

## Method

- **Explain in your own words what the scientists might learn from each of the four sets of traps (from figure 6).** The first set of traps is a control. With no chemicals, it provided a way to equally compare each of the other traps. The second set contained the chemical that attracts pine shoot beetles to Scots pine. This set of traps told the scientists how many beetles would be attracted in the absence of any repelling chemical. The third set of traps contained the attractant and the broadleaf chemicals that might discourage beetles. This set of traps, when compared with the second set, told the scientists how many beetles might be discouraged from Scots pine trees when using chemicals from broadleaf trees. The fourth set of traps contained the attractant, the broadleaf chemicals for discouraging beetles, and the verbenone, which should also discourage beetles. This set of traps, when compared with the third set, told the scientists how many more beetles might be discouraged from Scots pine trees with the addition of verbenone to the broadleaf chemicals.
- **Why do you think the scientists repeated the experiment 10 times on each plantation?** The more traps that could be set and compared, the more confidence the

scientists could have in their results. If the traps set in different areas of the plantation showed different results, then the scientists might suspect that something more than the chemicals was affecting the behavior of the beetles. If the results were similar across all experiments, then the scientists could assume that the beetles' behavior was the result of the different chemicals in the traps.

## Findings

- **Look at table 1. Would you say the Scots pine volatiles attracted pine shoot beetles to the traps? Why or why not?** Yes. The average number of beetles caught was much higher than in the control, which contained no attractant.
- **If you were one of the scientists, what would you tell people who manage holiday tree plantations about the use of chemicals to discourage pine shoot beetle damage?** I would tell them they can discourage the pine shoot beetle by using broadleaf volatiles or a combination of broadleaf volatiles and verbenones.

## Discussion

- **Why do you think the broadleaf volatiles discourage the pine shoot beetle from attack?** Because the broadleaf volatiles smell like a broadleaf tree to the beetle. Broadleaf trees are not the preferred habitat of the beetle. The beetle is fooled into thinking the tree is a broadleaf, not a pine.
- **Do you think these findings are important to people who grow holiday pine trees for sale during the winter holiday season? Why or why not?** Yes. If the pine shoot beetle damages or kills too many holiday trees, the trees will not be available for sale. If the people who grow these trees cannot sell them, they will lose money.

## Tag, You're It!

## Introduction

- **State in your own words the question the scientist wanted to answer through this research.** About how far do Asian long-horned beetles fly in a day's time?
- **If the Asian long-horned beetle were found again in the United States, how would forest managers use the scientist's information to help them destroy the insects?** They could determine approximately how far and how fast the insects would disperse. This information would help them determine how large an area they would need from which to remove and burn the trees.
- **If a different insect pest were found in the United States, should forest managers use this information about the Asian long-horned beetle to tell them how far the insect might fly? Explain.** If the insect pest were similar to the Asian long-horned beetle, the information learned in this study could be used as a guide, if no other information were available. Different insect species behave differently, however, and it could be disastrous to use information learned about one insect and apply it to the behavior of another.

## Method

- **Do you think the scientist should have done this study in the United States? Why or why not?** No. The Asian long-horned beetle is an insect pest in the United States. It might be disastrous to do this study in the United States. Beetles would likely escape from the study area and destroy trees.
- **What would have happened if the scientist had forgotten to paint a number on each beetle?** The scientist would have no idea how far each beetle had dispersed, because he would have no way of knowing which beetle was which.