Let's FIND Out!

What? How? When? Why?

If you like to ask questions, you could become a great scientist. Scientists spend a lot of their time asking questions. They also spend a lot of time trying to answer them.

There are many ways to answer questions. You can guess. You can ask other people what the answer is. You can answer the question based on information you have or learn.

Scientists ask and answer questions in a process known as the *scientific method,* or scientific inquiry. This process has several steps that may occur in different orders, but however they happen, they help scientists figure out how the world works. The answers scientists find can then be used to solve a problem, make the world a better place to live, help us understand things, or help us think of more questions to ask!

By Mary Hoff

Illustrations by Stan Fellows

SCIENTIFIC Inquiry

Observe

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Ask a question

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Gather background information

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Write down hypotheses about what might happen

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Design an experiment to answer the question

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Do the experiment and record your results

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Analyze your results and draw a conclusion

↓

Communicate your results

Count COMMON Loons

DNR wildlife biologist Richard Baker was worried. He observed that the numbers of bird species such as common terns and piping plovers were decreasing in Minnesota. He wondered: Was our state bird, the common loon, in trouble too? If loon populations were decreasing, he wanted to know, so he could help. So he designed a study to answer his question.

For his study, Baker found 600 lakes around the state that would provide a snapshot of what's happening with all loons on all Minnesota lakes. He found volunteers who were willing to count loons on those lakes between 8 a.m. and noon one day during a 10-day period in July each year.

Every year the counters took boats onto their lakes and counted all of the loons they saw. They sent their results to Baker.

Using all of the count data, Baker calculated the average number of loons per 100 acres of lake. He made graphs and analyzed the results (see graph).

What conclusion would you draw from Baker's results?

Baker concluded that Minnesota loons are doing OK! What other questions could he ask about loons? How could he answer them? What might be some explanations for why loon populations are doing better than some other bird species?

Check out the results of the Minnesota Loon Monitoring Program at www.mndnr.gov/eco/nongame/projects/mlmp_results.html.

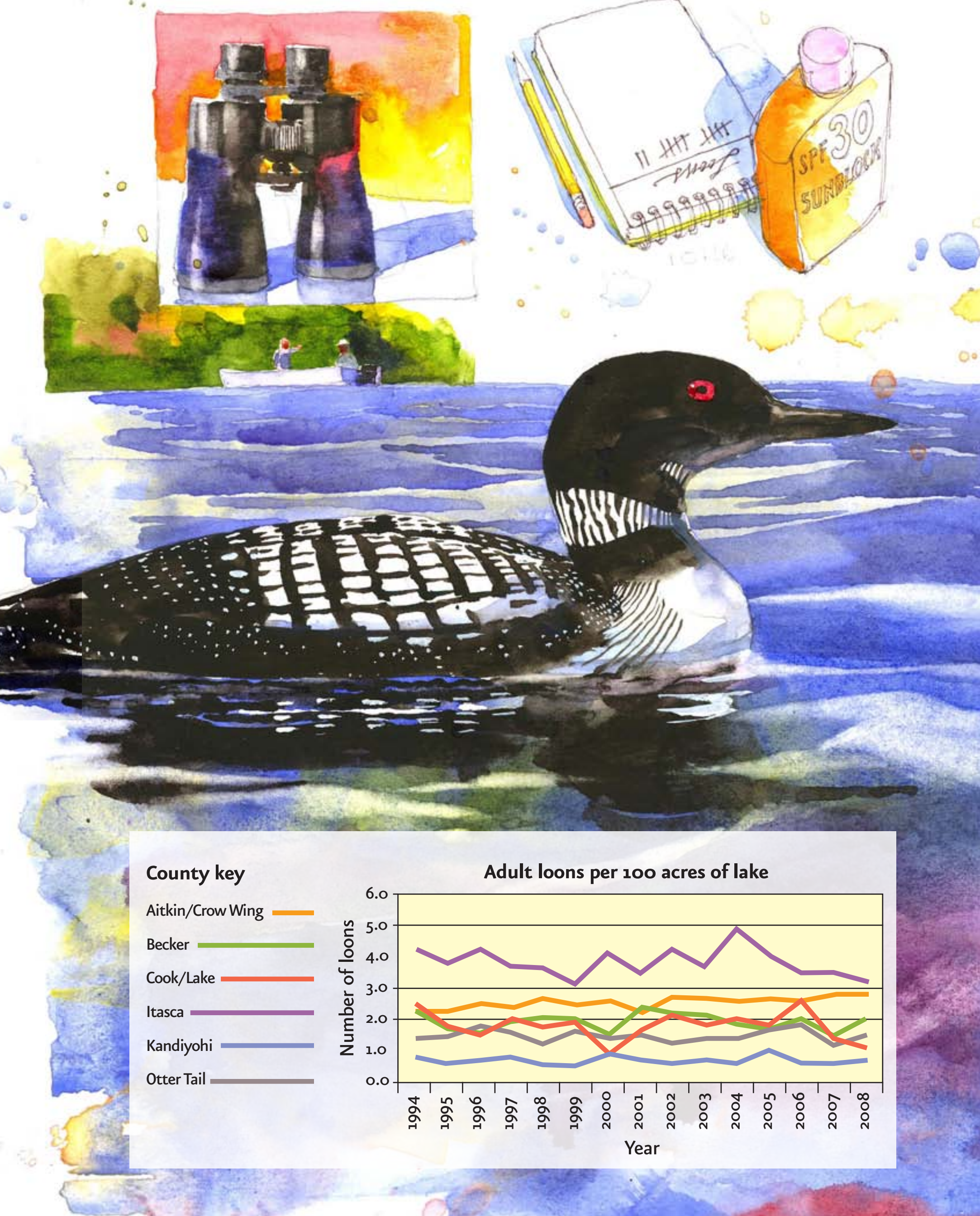
Science Sleuths. Scientists doing research are a lot like sleuths trying to solve a crime:

First, they observe the world around them and ask a question about it.

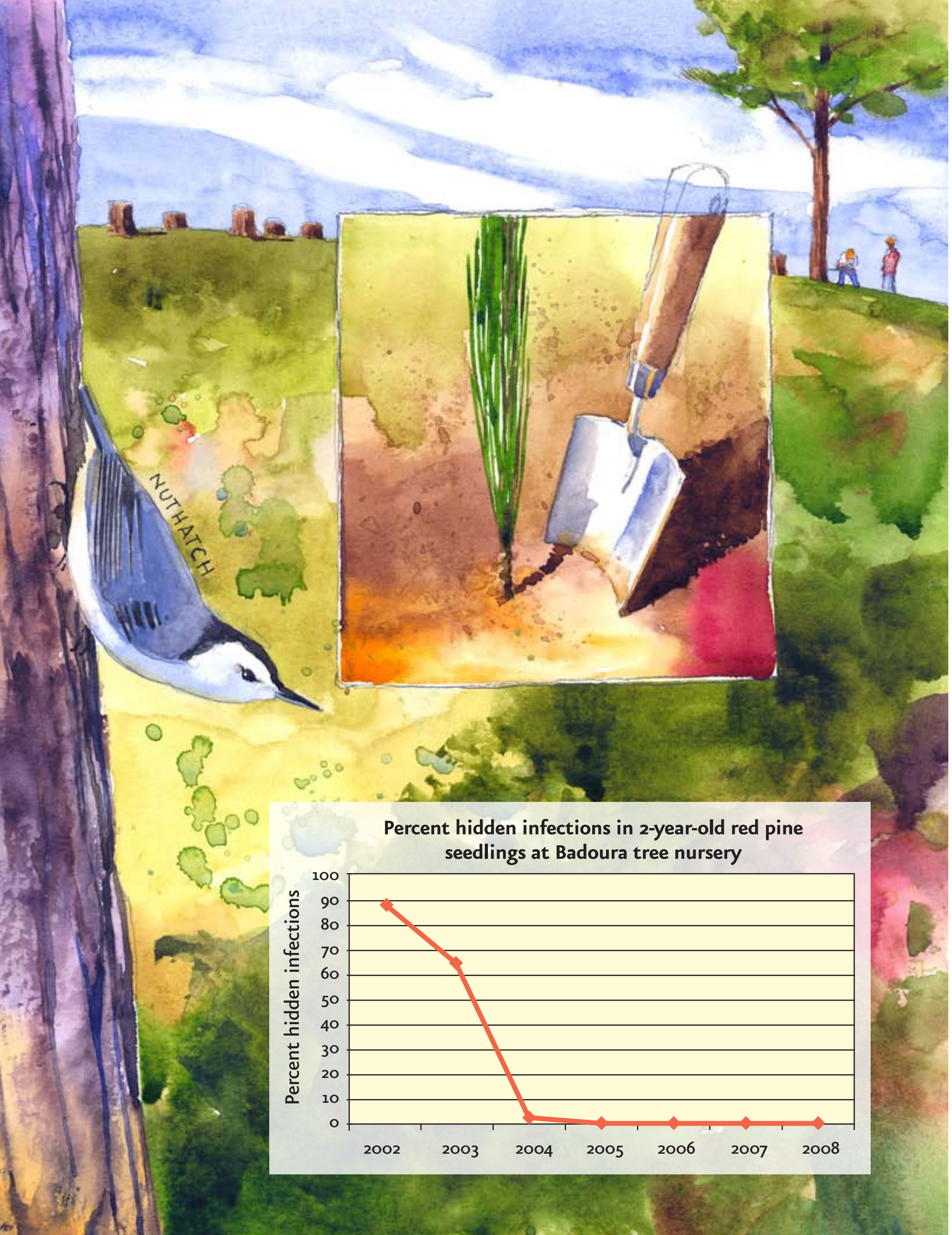
Then they gather background information that will help them figure out the best way to try to answer their question. This research might help them imagine a possible explanation (*hypothesis*).

Next, they design and do an experiment that will help them answer the question or test the hypothesis.

Finally, scientists analyze their results, draw conclusions, communicate their results, think about them—and often ask another question.



Between 1994 and 2002, nearly 1,000 citizen volunteers recorded observations of loons on a sampling of Minnesota's lakes. Data gathered by these citizen scientists helped DNR wildlife biologists draw conclusions about the populations of Minnesota's state bird.



DNR foresters discovered a fungus called *Diplodia* was infecting red pine seedlings at Badoura tree nursery. They also found the infection in large red pines surrounding the seedlings. The graph shows what happened to the seedlings after they cut down the large pines.

Red PINE Puzzler

The red pine seedlings grown at Badoura State Forest nursery were having big troubles. The little red pines seemed to be healthy when they were dug up and shipped around the state for transplanting. But after transplanting, they died. What was wrong?

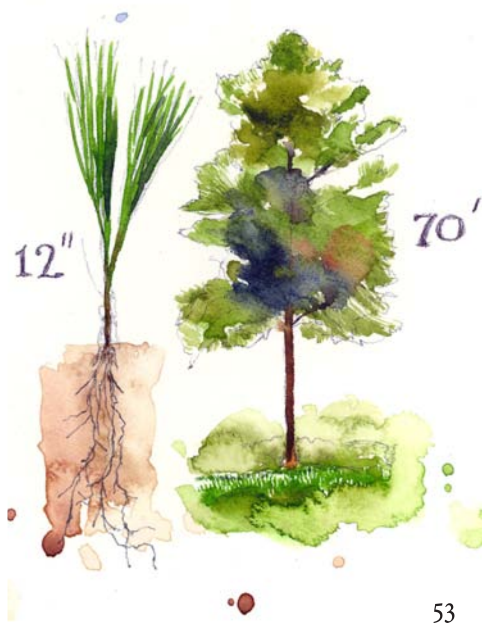
DNR forest health specialist Jana Albers was stumped. Then she read about an experiment another tree scientist had done. He had tested red pine seedlings and found that some were infected with a fungus known as *Diplodia*. The fungus could hide inside healthy-looking seedlings, then emerge and kill them when they underwent a stressful event such as transplanting.

Did Badoura's red pine seedlings have hidden *Diplodia* infections? Albers thought that they might. To test her hypothesis that the seedlings had infections, she sent samples of dead seedlings to a laboratory that could test for the hidden fungus. The lab found many infections. Albers concluded that the seedlings were dying from *Diplodia*.

Now what? Albers knew from reading about other people's research that the main source of *Diplodia* in nurseries is big pines that surround fields of pine seedlings. If the big pines around Badoura's fields were the source of the fungus problem, removing them should solve it, saving millions of baby trees.

The big trees had been planted long ago to slow the wind as it blew across the open fields. No one wanted to cut them down. But it was the only hope for saving the little trees that would grow into more tall pines in other places.

To see how much removing the big pines helped, researchers gathered and tested samples of seedlings for *Diplodia* for the next few years. The graph shows what happened to seedlings with hidden *Diplodia* infections. What does the graph tell you?



What's UP at the lake?

Is there a connection between the number of cabins and other buildings on a lake and the amount of fish and wildlife habitat? DNR research scientist Paul Radomski saw fewer wild plants along shore as people built cabins and made changes along the lakefront. He decided to do some research to find out if there was a link between the decrease in a lake's health and more development.

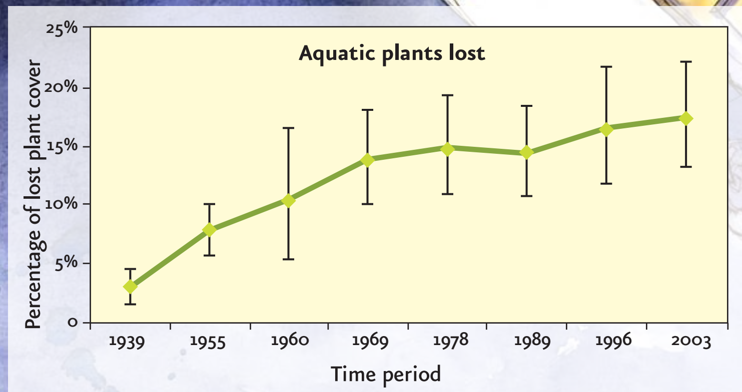
Radomski divided Minnesota lakes into three groups: lakes with few cabins or houses, lakes with some cabins, and lakes with lots of cabins. He chose about 30 lakes in each group, from lakes around the state.

For each lake, Radomski looked at photos of the lake taken from the air. He counted the number of docks along the shore of each lake. He also used computer software to estimate how much of each lake included water lilies and other aquatic plants that fish and other animals could use as habitat.

Radomski looked at data from all of the lakes. He found that as development increased, the amount of habitat decreased. In a survey of lakehome owners, other scientists had found that many homeowners said they had removed plants, fallen trees, and other natural things that fish and wildlife use for food and shelter.

Radomski concluded that as people built and made other changes along shore, the amount of fish and wildlife habitat went down. He shared his results with people in the Department of Natural Resources and others who help take care of lakes.

The graph shows what happened on some lakes as the shoreline changed. What does it tell you?



Over more than 60 years, many Minnesota lakes saw more development—more cabins, more docks, more changes to the shoreline. This graph shows that more aquatic plants were lost during the time that this development occurred.

Look at the world around you. What do you wonder?

Try the PROCESS of Science.

Get a notebook. Follow the steps below. As you do, make notes about what you do and what you think.

1. Observe the world around you. What do you see? What do you wonder about?

2. Ask a question. What time of day are squirrels most active? Does moss really grow mainly on the north side of trees? Do maple seeds sprout faster in the sun or the shade?

3. Gather information. Who might have asked a similar question, and what have they already learned? Check a book or search the Internet. Ask experts what they know.

4. Write down some possible answers to your question. These are hypotheses about what might happen. For example: "Maple seeds sprout as fast in the shade as they do in the sun."

5. Design an experiment to figure out which hypothesis is correct. Be sure to clearly identify the *independent variable* (the thing that is varying because of the way you designed the experiment, such as growing in the sun or growing in the shade) and the *dependent variable* (the thing you are watching for, such as the appearance of a sprout).

Decide how you will measure things such as sprouting speed. Think of what other variables there might be, and figure out how you can keep them from varying during your experiment. For example, if you're trying to test whether maple seeds sprout faster in sun or shade, you'll want to use equally healthy seeds from the same tree, soil from the same source, similar pots, and the same amount of water in each pot.

6. Do the experiment and record your results as you obtain them.

7. Analyze your results. What do they tell you? Putting your results (such as the time it takes a seed to sprout) into a chart or graph can help you see a pattern. Make a conclusion. But don't say you proved anything! Your research only supports—or doesn't support—a hypothesis. Be very careful about using the word *cause*. Things can happen more or less together without having one cause the other. Leaves turn color when you go back to school in the fall. But going back to school doesn't cause leaves to turn color!

8. Communicate your results. Let others know what you found out!

Think about your results. What do you wonder now? Go back to step 2 and start all over again! The scientific method helps answer questions. But every answer brings more questions. The fun of doing science never ends.

A Note to Teachers

Find links to teachers guides to this and other stories online at *www.mndnr.gov/young_naturalists*.

Other Young Naturalists stories about DNR wildlife research include "Counting Critters," Jan.–Feb. 2008, and "Wired Life," Nov.–Dec. 2003.