



Citizen Scientists

Fifth graders work as researchers on the hunt for an invasive species.

By Katherine Bennett

When a colleague called me in 2004 to invite me to a four-day summer institute at a forest ecology research center, I jumped at the opportunity. I am an elementary math and science teacher with a limited science background but a passion for nature and the environment. These few days of training started a journey that developed into a profound teaching and learning experience for both my fifth-grade students and for me. We would become citizen scientists, participating in an important ecological study with distinguished scientists—on our school’s own nature trail!

The Harvard Forest Schoolyard Ecology Program provides teachers and students with the opportunity and materials to participate in regionally focused ecological studies under the guidance of a mentor scientist working on a similar study. The Harvard Forest is part of a national

network of ecological research sites known as the Long Term Ecological Research Network (LTER). The study protocols it offers are inquiry-based and incorporate science education best practices. I chose *Woolly Bully: The Invasive Pest, The Hemlock Woolly Adelgid*. My students and I would study the hemlock woolly adelgid (HWA), *Adelges tsugae*, and monitor the hemlock trees in our schoolyard for its presence. Our mentor scientist, Dr. David Orwig of the Harvard Forest, has been studying this invasive pest since 1995 and mapping the range of the insect as it appears in New England. He also has long-term experiments that mimic the disappearance of hemlock trees to study the forest response. The students were introduced to the insect and Dr. Orwig’s work by the scientist himself on a field trip to the Harvard Forest in September. Four times a year, my students monitored the hemlock trees on our nature trail for signs of the insect.

This study appealed to me because invasive species pose a threat to many native species and because we have magnificent hemlock trees (*Tsuga canadensis*) on our schoolyard nature trail. I knew the idea of their destruction by this dangerous insect would be just as upsetting to my students as it was to me. HWA has not yet been identified in our town, but when it arrives—Dr. Orwig says it is only a matter of time—students will be the first to see it. This study was a huge success with my students from the start. They became expert data collectors and their observational skills improved significantly. They took their jobs seriously, as they knew they were involved in a real research project that addresses important current environmental issues.

Data Collection

I set up my field site the day before school began with the help of the education director of the nearby Nashua River Watershed Association, a partner in the program. We selected 10 hemlock trees on the nature trail next to the school and labeled 10 branches—easily reachable by the students—on each tree.

I first scouted the area for any potential hazards such as in-ground bees nests (a common local hazard), broken branches, and hidden rocks or holes in the ground. Follow your school guidelines for field explorations, including sending home notes for parental permission and instructions for proper clothing for field work, such as closed-toe shoes.



I divided my two science classes into teams of four, each team responsible for monitoring 10 branches on one tree. During one science class we looked at pictures of infested branches and read about the life cycle of the HWA and how it feeds and eventually kills hemlocks. We discussed Dr. Orwig's study and examined his maps of the range of the HWA in Massachusetts and all over the East Coast. I knew measuring new tree growth would be difficult for some students, so for another class I brought hemlock branches indoors so that we could practice looking for the subtle color changes in the twigs and needles at the end of each branch that signify new growth and then measure that growth. Hemlocks produce new growth only in the spring, so these measurements are done only on the first visit to our trees. We then role-played how to inspect for HWA by looking for the cottony egg sacks on the underside of branches. A third class was spent reviewing the data collection sheet, on which students listed the 10 branch ID letters and recorded with a plus or minus sign if HWA was present or absent on each branch. If present, students were instructed to count the egg sacks on the 10-cm segment at the end of their branch.

On the next clear day, we ventured into the field, where the students were “introduced” to their tree. As

a team, the students checked the 10 branches of their tree and measured and recorded new growth on the branch. This is important because if HWA infestation does occur, new growth decreases significantly. I circulated among the teams answering their questions and checking their data sheets (Figure 1; see project website for a blank copy).

This first data collection takes one 45-minute class period, but the next three data collections take less time, so it is good to add another activity such as measuring snow depths, taking air and ground temperatures, or measuring the diameter at breast height (DBH) of your tree (see NSTA Connection). After the first visit in the fall and the last visit in the spring, students posted their data on the Harvard Forest website along with other participating schools (see Internet Resources). Students compared their data to the 16 other schools throughout the state that are collecting HWA data, looking for trends in the infestation and identifying possible factors such as latitude and elevation, similar to the studies Dr. Orwig does. Because we have luckily not found HWA on our hemlocks yet, we used some of Dr. Orwig's HWA data to make graphs at the computer lab using Excel and look for trends in HWA infestations.



Keyword: Invasive species
www.scilinks.org
Enter code: SC091002

Figure 1.

Hemlock Woolly Adelgid Student Data Sheet; HF-LTER Schoolyard

Name: _____
School: *John R. Briggs Elementary School*
Tree ID: *5*
Date: *9-5-08*

Tree Crown health (0-3): 1

0 - Healthy-all green
1 - Some bare branches
2 - Unhealthy- half or more bare branches
3 - Dead- no green needles

Field Notes & Comments: *Hot & Windy, some bare branches, still healthy, upon visit.*

Branch ID	White wool - present (1) absent (0)	Number of Egg Sacs per 10 cm	New Growth at Branch Tip (cm)
<i>A</i>	<i>0</i>	<i>0</i>	<i>8.2</i> CM
<i>B</i>	<i>0</i>	<i>0</i>	<i>7.1</i> CM
<i>C</i>	<i>0</i>	<i>0</i>	<i>4</i> CM
<i>D</i>	<i>0</i>	<i>0</i>	<i>3.8</i> CM
<i>E</i>	<i>0</i>	<i>0</i>	<i>6.1</i> CM
<i>F</i>	<i>0</i>	<i>0</i>	<i>4</i> CM
<i>G</i>	<i>0</i>	<i>0</i>	<i>11</i> CM
<i>H</i>	<i>0</i>	<i>0</i>	<i>4</i> CM
<i>I</i>	<i>0</i>	<i>0</i>	<i>15</i> CM
<i>J - Replaced</i>	<i>0</i>	<i>0</i>	<i>12</i> CM
Whole Tree	White wool - present (1) absent (0)	Average Number of Egg Sacs per cm	Average New Growth (cm)
		<i>7.7</i>	<i>7.7</i>

Handwritten calculations:

$$10 \times \frac{7.7}{10} = 7.7$$

$$8.2 + 12 = 20.2$$

$$\frac{20.2}{2.6} = 7.7$$

That “Woolly Bully”

The hemlock woolly adelgid (HWA) is an aphidlike insect that was first identified on the East Coast of the United States during the 1950s. It originally came from Japan, most likely on ornamental nursery stock. Since then it has devastated southeastern hemlock forests and traveled up the East Coast all the way to Maine. In the South, these insects can kill ancient hemlock trees in less than five years!

The tiny insect has a long feeding tube called a *stylet* that it inserts into the base of the hemlock needle to feed off the sap. The most dangerous



aspect of the insect is its rapid rate of reproduction and spread. It reproduces asexually and can produce two generations in a single year. The insects are tiny and can be spread by birds and other forest visitors, including people.

Being an invasive species, the insect has no effective native predators. Anyone can identify an HWA infestation by the cottony egg sacs they leave on the undersides of

hemlock branches. The insect has not yet been seen in our northern Massachusetts area. Scientists have hypothesized that our winters' low temperatures are a degree too cold for it to survive. With climate change, the threat of the insect's ability to survive in our area increases.

All Students Can Be Citizen Scientists

Some tips for getting your students involved in a research study:

- Introduce the concept (e.g., invasive plants and animals or another local environmental issue). In the Northeast we have examples such as the HWA, bittersweet, purple loosestrife, and the Asian longhorned beetle. Your town conservation commission, the state department of conservation, local watershed associations, botanical gardens, the Audubon Society, and other local environmental organizations can provide valuable information.
- Have your students do some research on the internet.
- Contact local environmental organizations that might be partners.
- Stress to students that they will be doing research similar to what real scientists do.
- Prepare an overhead of the data collection sheet and go over all the sections with the students.
- Help students practice outdoor skills while they are inside.
- For more citizen science projects, check out the following resources and Natural Resources on p. 80.

Biodiversity Day

www.maccweb.org/biodiversity_days.html

Cornell Ornithology

www.birds.cornell.edu/netcommunity/Page.aspx?pid=1478

Journey North

www.learner.org/jnorth

LTER networks

<http://schoolyard.lternet.edu>

Project Budburst

www.budburst.ucar.edu

More Than Fieldwork

Throughout the year, and in the five years of doing this study, I have added lessons about basic tree physiology. Students also research the HWA and other invasive species online. A group of enthusiastic students spent their recesses this year working on an HWA informational video that will soon be aired on our local cable access network and can be viewed at our school website (see Internet Resources).

Every year I discover more ways to meet our state curriculum frameworks with lessons related to ecology and our HWA study. Teacher-generated lessons (including some of my own) based on the study protocol can be found on the Harvard Forest website (see Internet Resources), and some are featured on NSTA's website (see NSTA Connection).

The HWA study has expanded into a cohesive, inquiry-based forest ecology unit that helps students recognize the unique habitat the hemlock trees create in our forests. The students begin the unit by creating an ecosystem bulletin board to stimulate prior knowledge and activate observational skills. We inventory, graph, and compare the plants and arthropods in a one-square meter plot under our hemlock tree and in a similar plot under a nearby hardwood tree. This lesson can be used for any ecosystem in your area.

Long-term Learning

Assessment is authentic; rubrics are used to assess data sheets, and each student's level of understanding and critical-thinking skills are assessed as they answer open-ended questions such as, “What changes will we see in our forest if the hemlock trees disappear?” and “Ecology is the study of the relations and interactions between organisms and their environment. Why is our HWA study an ecology study?” I continue to be amazed and impressed at my student's insight into the ecological processes taking place in our small plots.

Every year our research study has led to great discussions about invasive species, climate change, and how scientists conduct research. When Dr. Orwig visits to discuss the research with the students and check out



In addition to monitoring trees with Dr. Orwig, students participate in activities throughout the year, such as measuring snowfall.



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their site, they bombard him with questions that show they are thinking critically, making connections, and drawing conclusions. And they always have plenty of ideas about how to destroy this killer insect—“If the cold kills the adelgid, why can’t we freeze them somehow?” “Could we import the natural predators they have in Japan?” These questions led to a great discussion about what might happen if another invasive insect was introduced. Students ask Dr. Orwig about his own research, learning that our town is in the northern range of the HWA, and with climate change, it is only a matter of time before the HWA appears on our own hemlock trees. Dr. Orwig also explains some of his other studies on how the forest dynamics change when all the hemlock trees die.

Reach Out

As the result of this partnership, I am a much more skilled and confident science teacher. The support of the Harvard Forest staff has been invaluable to me and my students, who have received a glimpse into how real scientific research is conducted. All areas of the United States are plagued by invasive species; a similar study could be conducted with students anywhere. Students could even design their own invasive species research project with the help of local environmental associations and national organizations (see Internet Resources). Begin your search by seeing if there is an LTER site near you (see “All Students Can Be Citizen Scientists”). Many university programs and environmental organizations are eager to partner with local schools to promote excellence in science education. Find one in your area. I guarantee the benefit to you and your students will be immeasurable! ■

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Internet Resources

Center for Invasive Species and Ecosystem Health
www.invasive.org

Harvard Forest Schoolyard Ecology Program
<http://harvardforest.fas.harvard.edu/museum/schoolyard.html>

John R. Briggs Elementary School
www.awrsd.org/JRB

National Invasive Species Information Center
www.invasivespeciesinfo.gov

Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Grades 5–8

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Standard C: Life Science

- Regulation and Behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Standard G: History and Nature of Science

- Science as a human endeavor
- Nature of science

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academies Press.

NSTA Connection

Download project worksheets and assessment materials at www.nsta.org/SC1009.

