



Harvard Forest Schoolyard Ecology
Hemlock Trees and the Pesky Pest, The Woolly Adelgid

Project Overview

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I. Schoolyard Study Questions:

A. Big Ideas- Questions for Long Term Study:

*Will the Hemlock Woolly Adelgid (HWA) destroy our hemlock trees forever?
How will our forest change if the hemlock disappears?*

B. Concrete Concepts-Questions for Here and Now:

*Is the Hemlock Woolly Adelgid currently present in our local field site?
If so, is the population of HWA increasing or decreasing this year?
If so, how is the HWA affecting our hemlock trees and/or surrounding forest
now?*

II. Related Research:

A. Harvard Forest: Forest ecologist, **Dr. David Orwig**, is studying the forest response to the exotic pest, the hemlock woolly adelgid. Perhaps this study will help us learn to limit its spread, or at least how best to adapt to the inevitable changes it will bring to our forests ([see Hemlock Woolly Adelgid Studies](#)).

III. Field Time:

A. Minimum number of data collection field visits: 2 field sessions total.
1. Autumn: Begin in early September to introduce field study and field site and measure new growth.

2. Winter or Spring: From late November through Spring, new woolly egg sacs are potentially visible if HWA is present.

IV. Project Objectives:

A. Students learn how to do field research by participating in a program associated with the Harvard Forest Long Term Ecological Research Site.

B. Teacher and students collect field data seasonally.

C. Data is given to HF to share with citizen scientists as well as HF scientists.

D. The autumn and spring protocols should be combined in order to **monitor the status of Hemlock Woolly Adelgid presence** at your schoolyard. When you do this project annually, and compare with other long term studies on a larger scale, you can begin to see the patterns of HWA spreading regionally and within individual trees and its impact on forest species distribution, habitat, etc.

V. Materials:

Flagging and/or metal tags
Data sheets
clipboards/pencils
Tree and Plant Field guides

Centimeter ruler
Permanent marker
Pictures of HWA to aid ID

Optional Materials:

Thermometer
10X hand lenses or seeing wool and egg sacs

VI. Choosing a Schoolyard Study Site: Project coaches will support teachers in choosing and flagging research sites based at a location in walking distance to school.

Sites with a variety of native hemlock trees with multiple branches in easy reach of students, located in an easily monitored area, are best for this project.

A. Guidelines for Choosing Study Trees:

1. **Trees in reach:** Ideally each tree in your study site will have two or more branches that allow students to reach branch tips to check for HWA.

2. **Trees that will last the duration:** These are the same trees you will study in the autumn and the spring, as well as in future years.
3. **Number of branches and trees to include:** Use enough trees to provide at least 1 branch per student research team (2-4 students). Based on the number of classes, class size, team size, and number of branches studied per team, you can determine the amount of trees to include in your study. Determine the appropriate team size for your students and whether you have time for your teams to study one or two branches each. Be sure to use at least 2 branches per tree for replication. An example of how this may work for "the average class" of 20 students would be to divide into 10 teams of 2. In that case, you would mark 2 branches on each of 5 trees included in study site, to allow for a total of 10 study branches. Each team of 2 would focus on one branch in the study.

VII. Site preparation:

A. Labeling branches: Teachers choose, flag, and identify Individual trees. At least two branches on opposite sides of each tree will be flagged and labeled. Assign numbers to each tree 1 through x, x being the total # of trees, and assign letters to each branch on each tree. For example a branch may be labeled 1A. 1 being the number of the tree, and A being the branch you are studying. Another tree will have a branch marked 5B, which shows it is tree 5, branch B.

B. If a branch or tree is removed/destroyed: Sometimes the inevitable hand of change strikes your study site, and that means you may find a branch or even a tree has died, been cut down, or struck by lightning... In these cases, you need to identify a substitute branch or tree to include in your study.

1. To substitute branches, follow these steps:

- a. Locate a different branch on same tree in reach of students and label it the same tree number and the same letter as previous branch, but add an asterisk. For example if 4A broke off, label the new branch 4A*. And then if another branch needs replacement 4A**
- b. If there is no other branch in reach on that tree, try to find an additional branch on another hemlock tree in reach of students and label it a different tree number and proceed as above in A., recording that it is a new tree

c. To substitute trees, try to find a tree of the same species and relative size if possible and assign it a new number. If you previously had 5 trees in study, label this one 6, and so on.

C. Optional site preparation activities: We recommend that you take the time to map and describe your field site either with or without students. The following sheets can be found in the activity section of your teacher notebook.

1. Mapping site- See sample map attached [under construction]
2. Site description sheet
3. Site history sheet

VIII. Data Coordination:

A. Information from each data sheet should be transferred to the Harvard Forest HWA Excel Template on the computer by either students or teachers.

The HWA project Excel template is available online at:

<http://harvardforest.fas.harvard.edu/museum/data/sy002/hwa.xls>

B. Teachers must email completed autumn templates to the Harvard Forest Schoolyard Coordinator within 2 weeks of the November seminar, and spring templates by June 1st. This allows us to share your data with scientists, other students, and citizens who are interested in finding out about how the length of the growing season is related to climate. Data submittal is required of all participants of the Forest Ecology in the Schoolyard Summer Institute for Teachers.

C. We recommend teachers save the original data sheets (on a storage space-available basis). All teachers should send copies of the data sheets to Harvard Forest at the end of the school year.

D. An optional activity we encourage is to have coaches, teachers, and/or students complete a one-page summary of the study after each season.

IX. Data Analysis:

Teachers may choose to analyze data in a number of ways.

- A. No matter which activities are used, the main thing is to ask students:
- i. What can we learn from the data?
 - ii. Do you think we have enough data to answer our *Big Idea* study questions:

Will the Hemlock Woolly Adelgid destroy our hemlock trees forever?

How will our forest change if the hemlock disappears?

- iii. Do you think we have enough data to answer our Concrete Concepts study questions:

Is the Hemlock Woolly Adelgid currently present in our local field site?

If so, is the population of HWA increasing or decreasing this year?

If so, how is the HWA affecting our hemlock trees and/or surrounding forest now?

- iv. What predictions can we make about the spread of the hemlock woolly Adelgid and/or the future of our hemlock forests?
- v. How do this year's data compare with previous years' data?
- vi. Do you think you have enough data to contribute to the overall study?

- B. A sample data analysis lesson plan based on Harvard Forest's Hemlock Woolly Adelgid studies is available on the HF website at:

<http://harvardforest.fas.harvard.edu/museum/data/sy002/HWA%20JRB%20Bennett%202007.pdf>

- C. Sample of data analysis lesson plans related to different Schoolyard Ecology topics are available on the HF website at:

<http://harvardforest.fas.harvard.edu/museum/data/k12/lesson-plans.html#hwa>

- D. LTER Teacher's Manual Activity #1 introduces students to real data on global warming from a Wisconsin LTER site and teaches them ways to look at ecological data. This activity was designed for middle school and high school students, so it would need to be modified for elementary. A copy of the LTER Manual is available online at:
<http://www.dnr.cornell.edu/ext/LTER/lter.asp>
- E. Students can graph their own data to see if they can find patterns in the data (it would be difficult to find patterns in one year of study-but this could be a lesson in the need for long term study).
- F. As schools gather years' worth of data, graphing can identify patterns over time.
- G. Students can graph data from HF scientist, Dr. David Orwig – data is available online from HF website:
<http://harvardforest.fas.harvard.edu/data/hem.html>

X. Optional Supplemental Activities:

Teachers may choose to supplement this field research study with a number of related activities depending on their time available and curriculum needs. Below are some suggestions:

- A. Field trip to Harvard Forest:** Students could see what an ecological research forest/institution looks like. Indoor slide show and dioramas tell story of HF and the changing forests of our region. Outdoors, students could tour our regular nature trail or choose to visit a large native Hemlock stand, as well as an HWA infected tree.
- B. Plot Inventory Activity:** In order to teach students about the unique ecological niche that is currently filled by the Hemlock in our forests, we highly recommend that you provide an opportunity to compare understory plant growth in Hemlock and Hardwoods stands [plot inventory lesson is in revision]
- C. Tree ID practice:** Using trees in schoolyard or on field trip, students could practice learning to use keys and/or guidebooks to identify common trees including the varieties included in their schoolyard study. This could be done on its own or as preparation for the plot inventory activity. General questions could

help students think about what makes each species unique. Questions that you may choose to ask students include: Do other trees look like this tree? How do they resemble it? How are they different? What is the leaf shape of this tree? The bark type? The flower? The fruit?

D. Tree Measurement: Students could learn to measure tree height, diameter, etc. Diameter measurements could be taken once a year as part of data collection in order to look at tree growth in relation to environmental factors including HWA invasion, climate, or other factors. See lesson 67 in Project Learning Tree: How Big is Your Tree. See below for resource info.

E. Project Learning Tree Activity Guide-Pre K-8: Great resource for teaching about trees. Project WILD is a similar reference to incorporate learning about wildlife. Online information at: <http://www.plt.org/> find out how to sign up for a workshop that will give you access to this activity guide. Locally, Mass. Dept. of Recreation Management, DCR, offers workshops.

F. Inquiry-based research project: Students can be given an opportunity to create their own ecological study. They can develop their own research question that can be studied at the schoolyard, using an inquiry approach to learning. LTER teacher's manual lessons 4 and 6 are helpful resources for this. You can also use the Cornell site at <http://ei.cornell.edu/teacher/IEform.asp> listed above to browse for ideas.

Contact Pamela Snow, Schoolyard Coordinator, at psnow@fas.harvard.edu or (978) 724-3302 x246 to begin your schoolyard research project.

Appendix: Connections to Curriculum Frameworks-

A. Grades 3-5: Prepared by *Ann Marie Pilch 11/04(revised6/07 with input from Kate Bennett)*

- **Science Frameworks**

- 1. Life Science**

- a. Characteristics of Plants and Animals**

1. Classify plants and animals according to the physical characteristics that they share

- Sort different types of leaves
- Use leaves and other characteristics of trees being studied to learn how to identify trees
- Learn how to use dichotomous keys

- b. Plant Structures and Functions**

2. Identify the structures in plants (leaves, roots, flowers, stem, bark, wood) that are responsible for food production, support, water transport, reproduction, growth, and protection.

- Use field time outside with trees to observe and explore the functions of the various parts of the tree
- Tie in lessons on photosynthesis with the purpose of the scientific study (growing season is tied to season when the trees have leaves because leaves make the tree's food, and allow tree to grow)

3. Recognize that plants and animals go through predictable life cycles that include birth, growth, development, reproduction and death.

- Observe trees in forest of varying ages, including seedlings
- Observe that some trees are dead or dying
- Look for different types of seeds produced, and sprouting tree seeds, e.g. acorns

5. Differentiate between observed characteristics of plants and animals that are fully inherited and those affected by the climate or environment.

- Observe similarities in leaves, bark, etc. of trees of the same species
- Observe differences in leaf shape and size on same tree – what could cause differences? (amount of sunlight, distance from roots, etc.)

- Observe galls and other abnormalities caused by insects, fungus, etc.

c. Adaptations of Living Things

6. Give examples of how inherited characteristics may change over time as adaptations to changes in environment that enable organisms to survive

7. Give examples of how changes in the environment have caused some plants and animals to die or move to new locations

9. Recognize plant behaviors, such as the way seedlings' stems grow toward light and their roots grow downward in response to gravity. Recognize that many plants and animals can survive harsh environments because of seasonal behaviors, e.g., in winter, some trees shed leaves, some animal hibernate, and others migrate.

- Discuss why some trees lose their leaves to cope with winter dryness
- Observe and discuss adaptations of evergreens – e.g., long thin needles offer less surface area for dehydration; waxy coatings also prevent dehydration; leaves always present allow photosynthesis earlier in spring.
- Note how tree characteristics differ in the middle of the forest vs. edges or lone trees

d. Energy and Living Things

11. Describe how energy derived from the sun is used by plants to produce sugars (photosynthesis) and is transferred within a food chain from producers to consumers to decomposers.

- Once again, a chance to tie in photosynthesis, plants as producers of food
- Observe food chains in action (nibbled leaves, other field observations)
- Observe the forest floor and leaf litter for evidence of decomposition and decomposers

3. INQUIRY SKILLS

- Ask questions and make predictions that can be tested.
- Select and use appropriate tools and technology (e.g., calculators, computers, balances, scales, meter sticks, graduated cylinders) in order to extend observations.
- Keep accurate records while conducting simple investigations or experiments.
- Conduct multiple trials to test a prediction. Compare the result of an investigation or experiment with the prediction.

- Recognize simple patterns in data and use data to create a reasonable explanation for the results of an investigation or experiment.
- Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.

❖ **Mathematics Frameworks:**

5.D.2 Construct and interpret bar graphs

B. Massachusetts Curriculum standards for High School Biology:

5.3 Describe how the taxonomic system classifies living things into categories

6.2 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels.

6.3 Identify the factors in an ecosystem that influence fluctuations in population size.

6.4 Analyze changes in an ecosystem resulting from natural causes, changes in climate, human activity, or introduction of non-native species.

6.5 Explain how symbiotic behavior produces interactions within ecosystems.