

# Lesson: The Xylem isn't Flowing

**Grade Level:**  
5th - 8th grade

**Subject Areas:**  
Earth Science

**Prep time:** 10 minutes  
**Activity time:** 10 minutes

**Setting:** Indoors

**Skills:** Gathering information through observing; Analyzing information; Drawing conclusions.

**Vocabulary:**

- **Ecosystem:** all living organisms in a certain area as well as their physical environment.
- **Exotic:** species living in, but not native to, an area.
- **Invasive:** usually an exotic species that displaces native species and threatens the balance of an ecosystem.
- **Native species:** species naturally found living in an area.
- **Phloem:** part of the transport system for trees along with xylem. Phloem is always alive and doesn't die each year like xylem. Phloem transports nutrients through a series of cells
- **Xylem:** part of the transport system for trees along with phloem. Xylem dies after one year and creates a growth ring seen in a tree cross section. Xylem moves water through the tree with a system of vessels, similar to veins in humans.

**Objectives: Students will:**

- 1) explain what exotic pests are and how they might disrupt the balance of an ecosystem;
- 2) describe the feeding methods of the Hemlock Woolly Adelgid.

**National Standards:**

- Content Standard A: Science as Inquiry;
- Content Standard C: Life Science;
- Content Standard F: Science in Personal and Social Perspectives;

**Materials:**

- Small paper cups (one for each pair of students)
- Plastic straws (one for each pair of students)
- Push Pins (one for each pair of students)
- Diagram of adelgid feeding (page 3)
- Drinking water

**Background:**

Eastern hemlock trees are some of the largest and most common trees in Great Smoky Mountains. Unfortunately, they are under attack from a non-native insect called the hemlock woolly adelgid (*pronounced "A-dell-gid"*). Without successful intervention, the hemlock woolly adelgid is likely to kill most of the hemlock trees in the park.

Called the "redwood of the east," eastern hemlocks (*Tsuga canadensis*) can grow more than 150 feet tall on trunks measuring six feet in diameter. Some hemlocks in the park are over 500 years old.

Over 800 acres of old-growth hemlock trees grow in the Smok-

ies—more than in any other national park. Younger hemlock forests cover an additional 90,000 acres of land in the park. Originally discovered here in 2002, adelgid infestations have now spread throughout the park's hemlock forests. In some areas infested trees have already begun to die.

Since its arrival in the U.S. in the 1920s the hemlock woolly adelgid has rapidly colonized parts of New England and the Mid-Atlantic States, where it feeds on eastern hemlock. In the south, it also feeds on Carolina hemlock. The insect is easily dispersed by birds and wind but travels most rapidly as a hitchhiker on infested horticultural material.

The hemlock woolly adelgid has infested hemlocks on the Blue Ridge Parkway for about 10 years and in Shenandoah National Park since the late 1980s. In these areas as many as 80 percent of the hemlocks have died due to infestation.

Hemlocks play an important role by providing deep shade along creeks, maintaining cool microclimates critical to survival of trout and other cold water species. The impact of widespread loss of hemlock could trigger changes more significant as those that followed the demise of the American Chestnut in the 1930s and 40s.

**Introduction:**

Explain to the students that they will mimic the effect that the hemlock woolly adelgid has on the eastern hemlock tree.

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## Procedure:

1: Pair up students and give each pair one paper cup partially filled with water, one straw and one push pin.

2: Ask students what each material might represent (the straw is a hemlock limb, the water is the nutrients in the soil, the push pin is the adelgid)

3: One student is the "branch", one student is the "adelgid". Begin by asking the "branch" to take a small sip of water through the straw. Explain that this is a healthy tree that can grow and take up nutrients normally.

4: Ask the "adelgid" to poke one hole into the straw somewhere between the water line and the top of the straw, then remove the push pin. Next ask the "branch" to take another sip.

5: Repeat the procedure until there are 5 to 10 holes in the straw.

## Wrap Up:

Summarize how the action of a tiny insect can decimate an entire forest. In the Smokies, trees like the eastern hemlock and the Fraser fir both are being devastated by their own invasive adelgid. At this point, we don't know the exact impact from the loss of the eastern hemlock but we do know how the loss of the Fraser fir tree impacted the highest elevations in the Park. As Fraser fir trees died, the shade they provided disappeared. This caused the mossy ground cover to dry out which took away vital habitat for the now federally endangered

spruce-fir moss spider. We also have several rare high elevation species that are dependant on the mossy, damp shady areas provided by the Fraser firs. Most of these species are listed as either Federally Endangered or Species of Concern.

## Assessment:

Ask students to describe other small animals that can have large effects in the forest when there is a large population of them. Are these exotics? Do they have predators? How does that make them different or similar from the exotic adelgid?

## Extensions:

Invite a speaker from your agricultural extension office to present on other forest pests and how to prevent them.

## Resources:

Batten, Mary. Aliens from Earth: When Animals and Plants Invade Other Ecosystems. Peach Tree Publishers, 2008.

**National Park Service Invasives Curriculum for Middle School**  
<https://www.nps.gov/teachers/classrooms/invasive-species-curriculum.htm>

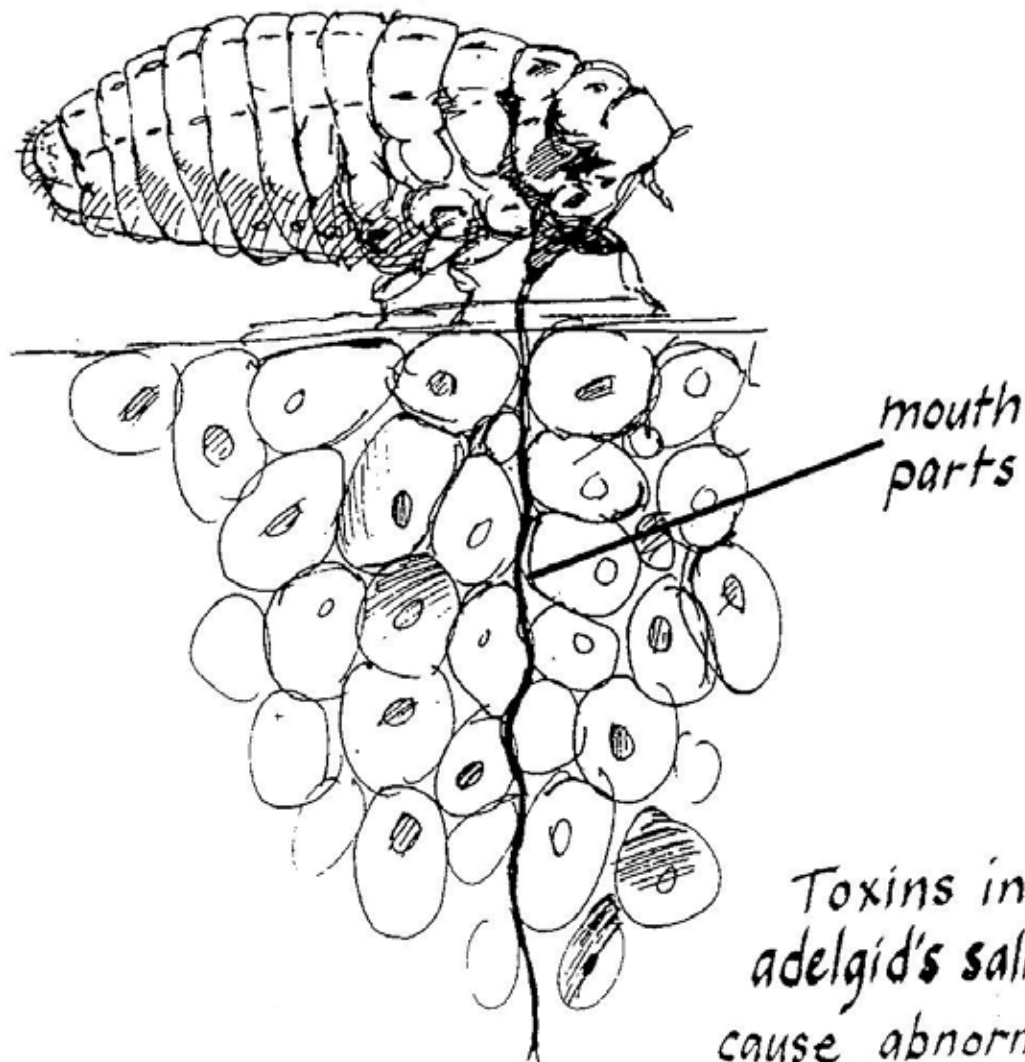
## **Bureau of Land Management Invasives Curriculum**

<https://www.blm.gov/documents/national-office/public-room/educational-material/native-plants-classroom-investigation>

## **Natural Inquirer, Issue 10 on Invasives from USFS**

<http://www.naturalinquirer.org/Invasive-Species-Edition-i-10.html>

The adelgids attach themselves to the tree with their long, sucking mouthparts. The wax they exude protects them from weather and predators.



Toxins in the adelgid's saliva cause abnormal cell growth in the tree. The tree's normal nutrient flow is disrupted, and the tree weakens and dies.