Harvard LTER Schoolyard Program

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Teacher Developed Lessons and Documents that integrate Harvard Forest Schoolyard Ecology Themes into curriculum.

- **Presentation Title:** Enhancing ‘The Woolly Bully’ Schoolyard Project
- **Teacher/Author:** Shirley Griffin
- **School:** Oakmont High School
- **Level:** 12th Grade- Environmental Planning-Environmental Science-Global Ecology
- **Date:** April 13, 2011
Enhancing “The Woolly Bully” School yard Project

S.L.Griffin 4-2011
Oakmont Regional High School
Ashburnham, MA
Overview

Introduction:
Schoolyard Project – Harvard Forest
“Woolly Bully”

Hemlock Woolly Adelgid
Project Goals: If the HWA infests Oakmont – What changes can we expect?

Oakmont Team Study Sites (Red)

Overlook M.S.

Oakmont H.S.

Wetland

State Lands
Project Goals: If the HWA infests FWL abutting lands – What changes could we expect?

Total Acres:
Almost 3,000 acres – hemlocks are in clusters in mixed forest
Teacher Goals:

1. To expand student ecological knowledge about Transitional Forests,

2. To incorporate Harvard Forest Scientists’ research findings about HWA in classroom activities,
Teacher Goals:

3. To Involve students in local scientific surveys of HWA infestation at Oakmont, on FWL lands, and on their home property/communities.

4. To stimulate student critical thinking through spatial data analysis (GIS Tools)
Implementing

Teacher Goal #1:
To expand student ecological knowledge about Transitional Forests and Invasive Insects in order to understand the impact of Woolly Adelgid on Hemlocks.
#1 - Building Ecological Content

Types of Forests
(Coniferous, Mixed, Deciduous)
Observation - Oakmont Forests are in clusters, not dominant in the canopy layer (Field walks, Ortho Images)
#2 - Invasive Species Vs. Pest Species

**Activity #1:** What is a Life Cycle?

Made and Compared Diagrams/Charts
Activity #1: Students arranged “life cycle cards” in a circular pattern on tables
Activity #2: Native, Invasive, Pest or both?

- Fall Webworm
- Asian Longhorn beetle
- Hemlock Woolly Adelgid
- Eastern Tent Caterpillar
- Japanese Beetle
- Gypsy Moth
Implementing

Teacher Goal #2:
To incorporate Harvard Forest Scientists’ research findings about HWA in classroom activities, to facilitate “student research” at Oakmont and beyond.
#3 – Exploring Forest Habitat

**Power Point: What is Edge and Core Habitat?**

- Explored the importance of Hemlock in supporting “Core Habitat”
- Began a discussion of types of wildlife that need edge/core habitat
- **Walked Grounds**
Activity #3: “Eastern Hemlock – Irreplaceable Habitat” (Dr. David Orwig)

Read the article - Make a list of information in a bullet format that provides possible answers to the general question (Why are Hemlock forests important and irreplaceable habitats?)
After reading, students agreed on the following major bullet facts:

**Hemlocks create unique types of habitat:**

- Provide shade, cool temperatures
- Ground is spongy/wet/thick needle layer
- Soil organisms are plentiful
- Favored habitat for HWA/Elongate hemlock Scale
- Many birds spend “life cycle” here (neotropical)
- Influence streams and create fish habitat
“Eastern Hemlock – Irreplaceable Habitat” – for who?
Specific Questions by students (some):

- Kinds of animals in older “Hemlock Clusters”?
- Are Green Throated Warblers in the upper layers of the Hemlocks?
- Are wetlands near the Oakmont “Hemlock Clusters”?
- Is there evidence of Porcupines?
- Are there Red-backed salamanders in the ground cover?
- Do hemlocks provide cover for White-tailed deer?
- Why do only some birds live in the “hemlock clusters”?
- Does the temperature vary under hemlocks?
Wildlife Habitat Associations in Eastern Hemlock – Birds, Smaller Mammals, and Forest Carnivores

Mariko Yamasaki, Richard M. DeGraaf, and John W. Lanier

Abstract
Ninety-six bird and forty-seven mammal species are associated with the hemlock type in the northeastern United States. Of these species, eight bird and ten mammal species are strongly associated with the hemlock type, although none of these species are limited to it. Hemlock species richness appears to be lower than in other conifer or hardwood types. Avian habitat considerations include the distribution and variety of structural habitat features throughout managed and unmanaged stands in sustainable patterns. Sawtimber hemlock stands support significantly smaller numbers of species and generally lower densities of larger tree communities than smaller stands. Smaller mammal habitat considerations include dense patches of coniferous regeneration, hard mast-producing inclusions, cavity trees, coarse woody debris, and wetland seeps and inclusions. Forest carnivore habitat considerations include the availability and distribution of predictable prey and suitable cover opportunities (cavity trees, coarse woody debris, wetland seeps and inclusions, and rocky ledge and well-drained den sites). Differences of ten or more inches of annual precipitation distinguish most northern New England landscapes from the majority of landscapes in the western Great Lakes region. Northern New England landscape elements habitat elements include lower slope positions and imperfectly drained, excessively drained, or shallow bedrock sites.

Introduction
Although eastern hemlock (Tsuga canadensis) is a well-documented habitat element in winter deer range management throughout the northeastern United States and eastern Canada (Matthews 1984; Hoot et al. 1984; Blouch 1984; Crawford 1984; Reay et al. 1990), limited research has been conducted specifically on bird and mammal communities in hemlock stands. Roughly 56 avian and 47 mammalian species have been documented using the hemlock type in New England (DeGraaf and Rudis 1986; DeGraaf et al. 1992). Appendix 1 lists eight bird and 10 mammal species strongly associated with the hemlock type.

We reviewed some of the more important landscape and habitat considerations regarding the hemlock type and provide some examples of avian and mammalian habitat associations in the northeastern United States and eastern Canada for birds, small mammals, and forest carnivores.

Landscape Level Habitat Elements
Eastern hemlock occurs from the Maritime Provinces in eastern Canada to northern Georgia and west into northeastern Minnesota (Godman and Lancaster 1990). Average annual precipitation in New England ranges from 30–50 inches compared to 21–36 inches in the upper Lakes States (McKibben and Avers 1994). Average annual snowfall in New England ranges from 40 to 160 inches compared to 40 to 70 inches and in some sections upward of 250 to 400 inches along the Lake Superior shoreline (McKibben and Avers 1994). This tends to generally produce abundant hemlock regeneration on coniferous sites in New England in contrast to the difficulties faced by forest managers in the upper Lakes States to regenerate hemlock in the face of significant dense layers (Anderson and Loucks 1979; Alverson et al. 1988; Godman and Lancaster 1990; Midlenoff and Stearns 1993).

Hemlock grows on both imperfectly drained and shallow to bedrock sites as well as excessively drained sites as described by Leak (1982). Secondary successional processes on the Bartlett Experimental Forest in the White Mountains of New Hampshire continue to increase the percentage of hemlock basal area on both managed and unmanaged stands. Distinctive as well as coniferous land types occurring on lower slope positions (Figure 1) (Leak and Smith 1990). Extrapolating this information across northern New England land types means there are more opportunities to manage hemlock in distinct stands, mixedwood stands, and coniferous inclusions than in the western Great Lakes region.

Hemlock volume in the northeastern United States is considerably greater in New England than the western Great Lakes region (Table 1) (Powell et al. 1993). New Hampshire timberland acreage in hemlock has increased slightly over the last 25 years from 156,783 acres (Cullen, personal communication). Current size-class distribution of hemlock timberland acreage is concentrated in the sawtimber size-class (120.1 acres) and pole size-class (45.6 acres), with almost no discernible seedling-sapling size-class acreage. New Hampshire sawtimber volume has increased over the last 25 years from 156,783 to 252,411 MMBF, as has growing stock volume from 596.7 to 832.9 MMBF. These numbers suggest that the hemlock resource is distributed across the New England landscape in much different patterns compared to the patterns seen in the western Great Lakes region.

Potential impacts of an expanding hemlock woolly adelgid (Adelges tsugae) population concern forest and wildlife managers over the possible loss of significant sources of winter thermal cover in a variety of site types and slope positions (Evans et al. 1996).


#4 – Taking the Challenge - Real Research: Homework “Hemlock as Critical Forest Wildlife”
Activity #4: Pulling out the Key Information for understanding

- Students Read the Article, answered “study guide” questions (homework)
- Generated a list of wildlife “strongly associated” with Hemlock forests

<table>
<thead>
<tr>
<th>BIRDS</th>
<th>MAMMALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Great Horned Owl</td>
<td>• Snowshoe Hare</td>
</tr>
<tr>
<td>• Long-eared Owl</td>
<td>• Red Squirrel</td>
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<tr>
<td>• Northern Saw-whet Owl</td>
<td>• Deer Mouse</td>
</tr>
<tr>
<td>• Blue Headed Vireo</td>
<td>• Southern Red-backed Vole</td>
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<tr>
<td>• Red-breasted Nuthatch</td>
<td>• Porcupine</td>
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<tr>
<td>• Hermit Thrush</td>
<td>• Red Fox</td>
</tr>
<tr>
<td>• Black-throated Green Warbler</td>
<td>• Black Bear</td>
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<td></td>
<td>• Marten</td>
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<td></td>
<td>• Bobcat</td>
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<tr>
<td></td>
<td>• White-tailed Deer</td>
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</tbody>
</table>
Activity #5: Adopting a Species – Who is Your Animal?

- Students used “info” sheets from New England Wildlife (DeGraaf, Yamaski)
- Filling in a chart, they simplified the facts
- Using Google Images and Power Point produced an image view, and a factual sheet.
## MATRIX: HABITAT PREFERENCE “PREFERRED”

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>Seasonal use</th>
<th>Aspen</th>
<th>Paper birch</th>
<th>Northern hardwoods</th>
<th>Red maple</th>
<th>Northern red oak</th>
<th>Red maple</th>
<th>White pine</th>
<th>Balsam fir</th>
<th>Eastern white pine</th>
<th>Red spruce - Balsam fir</th>
<th>Red spruce</th>
<th>Eastern hemlock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snowshoe Hare <em>Lepus americanus</em></td>
<td>B</td>
<td>BF</td>
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<tr>
<td>European Hare <em>Lepus capensis</em></td>
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<tr>
<td>Eastern Chipmunk <em>Tamias striatus</em></td>
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<tr>
<td>Woodchuck <em>Marmota monax</em></td>
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<tr>
<td>Gray Squirrel <em>Sciurus carolinensis</em></td>
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<tr>
<td>Red Squirrel <em>Tamiasciurus hudsonicus</em></td>
<td>B</td>
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<tr>
<td>Southern Flying Squirrel <em>Glaucomys volans</em></td>
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<tr>
<td>Northern Flying Squirrel <em>Glaucomys sabrinus</em></td>
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<tr>
<td>Beaver <em>Caster canadensis</em></td>
<td>B</td>
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<tr>
<td>Deer Mouse <em>Peromyscus maniculatus</em></td>
<td>B</td>
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<td>BF</td>
</tr>
<tr>
<td>White-footed Mouse <em>Peromyscus leucopus</em></td>
<td>B</td>
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</tbody>
</table>
American Marten

(*Martes americana*)
Habitat
• Coniferous forests of fir, spruce, cedar and hemlock
• Swampy areas, dense mixed hardwood-conifer forests

Special Habitat
• Den sites - Lrg. Hallow or logs and subterranean dens
• Summer resting sites in tree canopies ex. Balsams

Reproduction
• Females: 2-3 years
• Males 1 yr.
• Breeding period: late June early Sept. Born mid march to late April
• Litter size 1-5

Home Range
• Summer/Fall ranges, harvested in Maine 5.2km males
• 2.8 km Females

Samples Densities
• Algonquin park – Adult densities 0.6 - 1.2
• Maine ranged from 0.1-1.2

Food
• Masked shrew
• Snowshoe hare
• Passerine birds and ruffed grouse
• Vegetation (fruits, berries, nuts)

Comments
• Commonly called the pine marten - easily trapped
• Pop. is susceptible to over harvesting

Source of Information
New England Wildlife( Habitat Natural History, and Distribution)
Northern Saw-Whet Owl

*Aegolius acadicus*
• **Habitat:**
  - Moist mature woods
  - Dense forested wetlands
  - Common at forest edges

• **Special habitat:**
  - Large trees with large woodpecker holes or natural cavities

• **Reproduction:**
  - Egg dates – April 1 to May 31
  - Incubation period – 21 to 28 days

• **Home range:**
  - Breeds from s. Alaska, central British Columbia and central Alberta to s. Quebec and n. new Brunswick to s. California, central Mexico, extreme w. Texas, central Missouri, s. Wisconsin, central Ohio, w. Virginia and new York.

• **Sample densities**
  - 1 bird per 1.86 miles

• **Food:**
  - Mostly small mammals, also insects and small birds

• **Comments:**
  - Smallest owl, males weigh as much as the American robin. Females 25% more. Hunt and roost close to the ground

**Source of Information:**
New England Wildlife (Habitat, Natural history, and distribution)

Courtney Blood
Block C
Ecology 1/14/11
Red Breasted Nuthatch

Sitta canadensis
HABITAT
• Breeding: coniferous forest, mixed woodlands
• Coniferous forest wetlands
• Winter: coniferous forest
• Mixed woodland with cone-bearing trees

SPECIAL HABITAT
• Decaying trees or live trees with natural cavities

REPRODUCTION
• Egg dates: May-June
• Nesting period: 18-21
• Broods per year: 1 year

HOME RANGE
• S. New Jersey and S. New York
• Winters breeding areas except at the higher latitudes and elevations

SAMPLE DENSITIES
• 0.4 territorial males per 100 acres.

FOOD
• Seeds from spruce, fir, and pine
• Spiders some insects, and spruce budworms
• Summer-seen eating moths

COMMENTS
Red breasted nuthatches are far more common in coniferous forests that in mixed forests.

Source of Information:
New England Wildlife (Habitat, Natural History, and Distribution)

Danielle Smith
Block C
Ecology 1-14-2011
#4 – Taking the Challenge - Real Research

Activity #6: Building a Hemlock Forest Food Web

Task – Collecting the food data:

1. Students given “animal cards image/food”

2. Ask to list the animals in a chart, and the foods they consume.

3. Draw a food web using the “Producers” below:
   - Eastern Hemlock
   - Northern Red Oak
   - Sugar Maple
   - Teaberry
   - Princess Pine
   - Partridge Berry
**White Footed Mouse**
- Seeds
- Acorns
- Nuts
- Fruits
- Tender Green Plants
- Insects
- Carrion

**Porcupine**
- Herbaceous Plants
- Woody Vegetation
- Grasses
- Leaves
- Twigs
- Mast (nuts)
- Bark
- Hemlock (Winter)

**Fisher Cat**
- Mammals
- Shrews
- Mice
- Birds
- Squirrels
- Insects
- Toads
- Berries
- Nuts
- Carrion
- Porcupine

**Southern Red Backed Vole**
- Green Vegetation
- Seeds
- Nuts
- Fungi
- Bark
- Insects
- Carrion

**Black-Capped Chickadee**
- Insects
- Spiders
- Seeds
- Fruit

**Ruffed Grouse**
- Seeds
- Insects
- Fruits
- Leaves
- Buds of Birch, Aspen, Cherry, Hazel, Hop hornbeam
Activity #7: How Crowded is your Species? Will It Survive?

- Students used maps of FWL lands plus Oakmont – Acres = 2,720
- Students used “range” and “habitat” size from data sources
- Students calculated approximate possible density

**Porcupine (Erethizon dorsatum)**

**Bobcat (Felis rarus)**

**Home Range:** Winter ranges averaged 6 acres (2.4 ha) in New Hampshire (Faulkner and Dodge 1962) and 13.3 acres (5.4 ha) in the Adirondacks of New York (Shapiro 1949). Spring and summer ranges ranged from 32 to 36 acres (13.0 to 14.6 ha) in conifer-hardwood forest in Minnesota (Marshall et al. 1962). Varies with climate and habitat (Dodge 1982).
Implementing Teacher Goal #3:
To Involve students in local scientific surveys of HWA infestation at Oakmont, on FWL lands, and on their home property/communities.
#5 – Looking Ahead - Using Spatial Tools: (GIS) to Assess HWA Impact

Activity #8 – Are You Infested? - Surveying Your Home

• Students locate homes (GPS) Google

• Aerial Map generated for each student using GIS

• Students survey home for hemlocks and infestation - use map and GPS
Using Google Maps for Location – Spatial Data
Implementing

Teacher Goal #4:
To stimulate student critical thinking through spatial data analysis (GIS Tools)
#5 – Looking Ahead - Using Spatial Tools: (GIS) to Assess HWA Impact

**Activity #9** – Infested Neighbors, but How? *(The Abstract)*

- Students read an article about how HWA is spread
- Students answer questions about abstract, discuss and make class list of various hypotheses

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**Role of Wind, Birds, Deer, and Humans in the Dispersal of Hemlock Woolly Adelgid (Homoptera: Adelgidae)**

**Author:** McClure, Mark S.

**Source:** *Environmental Entomology*, Volume 19, Number 1, February 1990, pp. 36-43(8)

**Publisher:** Entomological Society of America

**Abstract:**
Activity #9 – Infested Neighbors, but How? (Potential Hypotheses)

- Students given pre-made “GIS Maps” representing reported data
- Students use the spatial representation of survey data to prove or disprove a hypothesis.

Studies in Connecticut revealed the following may disperse Hemlock Wooly Adelgid:

- Wind (sticky tape)
- Birds (?)
- Deer (browsing)
- Humans (logging)
Activity #9 – Infested Neighbors, but How? (Examining “Simulated Data” – Is your team’s hypotheses true or false?)
Dr. Griffin_Sample

Sampled Hemlocks 1-10
<table>
<thead>
<tr>
<th>Code</th>
<th>Branch 1</th>
<th>Branch 2</th>
<th>Branch 3</th>
<th>Branch 4</th>
<th>Branch 5</th>
<th>Average Per Tree</th>
<th>Percent of Area Infestation</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>G1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1.4</td>
<td>14%</td>
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<tr>
<td>G2</td>
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<td>1</td>
<td>2</td>
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<td>1</td>
<td>0.8</td>
<td>8%</td>
<td>Infestation on middle branches, not near ground or top</td>
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<td>0</td>
<td>0</td>
<td>0.2</td>
<td>2%</td>
<td>Infestation on middle branches, not near ground or top</td>
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<td>0.8</td>
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<td>22%</td>
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<td>1</td>
<td>2</td>
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<td>18%</td>
<td>Heavy infestation, mostly on branches touching ground</td>
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<td>18%</td>
<td>Heavy infestation, mostly on branches touching ground</td>
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</table>
Hemlock Clusters – greatest infestation HWA
Evidence of Deer Droppings

Wetland

Deer Run

Bird Feeders

Streams

Land-uses on Site

Dr. Griffin_Sample
Through our participation in the “Schoolyard Project...” Our Students:

- participated in real field-based ecological research at Oakmont, Fish and Wildlife lands and their homes;

- had access to Harvard ecologists for assistance;

- were involved in current environmental issues (Insect invasion/infestation in New England)
Our students...leaving high school with spatial analysis and research skills...Harvard Schoolyard Project 2011

S. L. Griffin, Ed. D.
Oakmont Regional High School
Ashburnham, MA
Environmental Planning Class 10-11
Hemlock Woolly Adelgid Survey
Spring Team