Hemlock Woolly Adelgid and its Impacts on Forest Ecosystems

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Overview of HWA
Impacts on Stand structure
Landscape patterns HWA + EHS
Management options
Hemlock is important for:

Old-growth forests

CWD to upland and streams

Moderation of stream temps

important for trout
Hemlock provides valuable habitat for a variety of wildlife species.

Black-throated green warbler

Blackburnian warbler

Hemlock regeneration is limited by deer browsing.  
Ward et al. 2004
Hemlock woolly adelgid (*Adelges tsugae*)

- 2 generations/year
- Parthenogenetic
- Rapid dispersal
- Feed and kill all sizes and ages
- Hemlock resistance?
- No effective native predators
HWA life cycle in E. North America (USDA)
Recent work shows egg laying as early as Dec/Jan!!
**Adelges tsugae** documented on all 9 hemlocks worldwide

Recent genetics: from So. and low elevations in Japan

Serious pest only in Eastern U.S.
Counties with established HWA populations 2012

Uninfested Counties
Infested Counties
Newly Infested in 2012
Native Range of Hemlock

Note: This map depicts counties with established HWA populations that are confirmed and reported by respective state forest health officials. The coarse nature of the map does not provide information below the county level and users should not assume that highlighted infested counties are entirely infested.

Map Produced by:
USDA Forest Service 5/21/13
Harvard Forest HWA studies include:

1) Stand and community analyses

2) Landscape investigations of hemlock structure and HWA infestation patterns

3) Ecosystem analyses of HWA infestations including n cycling, decomp, throughfall chemistry

4) Comparisons of HWA vs. Hemlock Logging

5) Wildlife studies

6) Hydrological Investigations

7) HWA dispersal

Figure 1. HWA space-for-time study area, representing 7500 km². Hemlock represents >86,000 ha or 21% of the mapped area in MA (up to 36% in northern MA), and 16,500 ha or ~5% of the mapped area of CT.
Overstory mortality trends, high in many, but not all stands
Crowns continue to deteriorate, with no sign of recovery
However, at some sites, decline is slower (cold temps.?)
Variability in winter temps important (esp. cold following warm)
Rapid birch establishment
Occurs with canopy thinning
Invasives and ferns can also increase tremendously
Trees remain standing for 5-8 years; branches, then tops fall off; then boles.
Birch forms the new forest
What will replace hemlock in Massachusetts?

Secondary Species # of Occurrences in 123 Hemlock Stands

<table>
<thead>
<tr>
<th>Species</th>
<th>Trees</th>
<th>Saplings</th>
<th>Seedlings</th>
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<td>White Pine</td>
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- **White Pine**
- **Black Birch**
- **Red Maple**
- **Red Oak**
LANDSCAPE PATTERNS

CT: 114 stands
MA: 123 stands

HWA found within a few km of Vermont (2004)!
[now 1/3 way up VT & NH]

Latitudinal pattern present
But damage not as rapid

Only 2 stands > 50%
Overstory mortality in MA
HWA change in abundance over time
Northern Massachusetts Sites with major infestation - 2013

Along Swift River, Petersham MA

Bernardston, MA
Harvard Forest 2016
Overstory and understory thinning

7 years after initial infestation

First ha; > 400 dead trees found
So, what can be done?

Imidacloprid (Merit) pesticide of choice:
- Tree I.V.
- Kioritz soil injection
- Soil drench
- Stem injection—important near streams
- CoreTect time-release tablet
  often provides 2 to 4+ years protection
Soil application widely used

There is also a time-release tablet

*Safari* (Dinotefuran) Fast-acting systemic, spring applications
Effective, not persistent, often used first, then Merit
**Biological Controls**

From Japan, over 1.5 million have been released in over 100 sites in 15 Eastern sites including MA

Native to British Columbia, over 7000 adults have been released at 19 sites in 8 eastern states—recovery 2 years later

Others being evaluated:  
*Scymnus sinuanodulus*  
*Tetraphleps galchanoides*  
Pathogenic fungi  
Uncertain success, impact
So, how can we incorporate the study of invasive species into a school curriculum?

what can students do to add to this body of work?
Student research can provide:

- year by year assessments of HWA densities
- year to year branch growth, related to HWA
- important data at the northern extent of HWA range
- new discoveries of HWA at their homes, schools, towns
Katherine Bennett’s 5th Grade class

Measuring snow depth
A co-occurring pest on the rise! Students can also contribute here

Elongate Hemlock Scale (EHS; *Fiorinia externa*)

Also from Japan, introduced in NYC in 1908

Now located in 14 eastern states, range overlaps with HWA

Often co-occur with HWA on same tree: uncertain consequences
EHS trends over time

Interactions between invasive herbivores and their long-term impact

Facilitation by HWA??

Gomez et al. 2015
Woolly Bully Protocol revolves around 2 measurements:

1) Measurement of new branch growth in early Autumn
Core measurements:

Spring counts of HWA egg sacs along outer 10 cm

HF provides data sheets, protocols