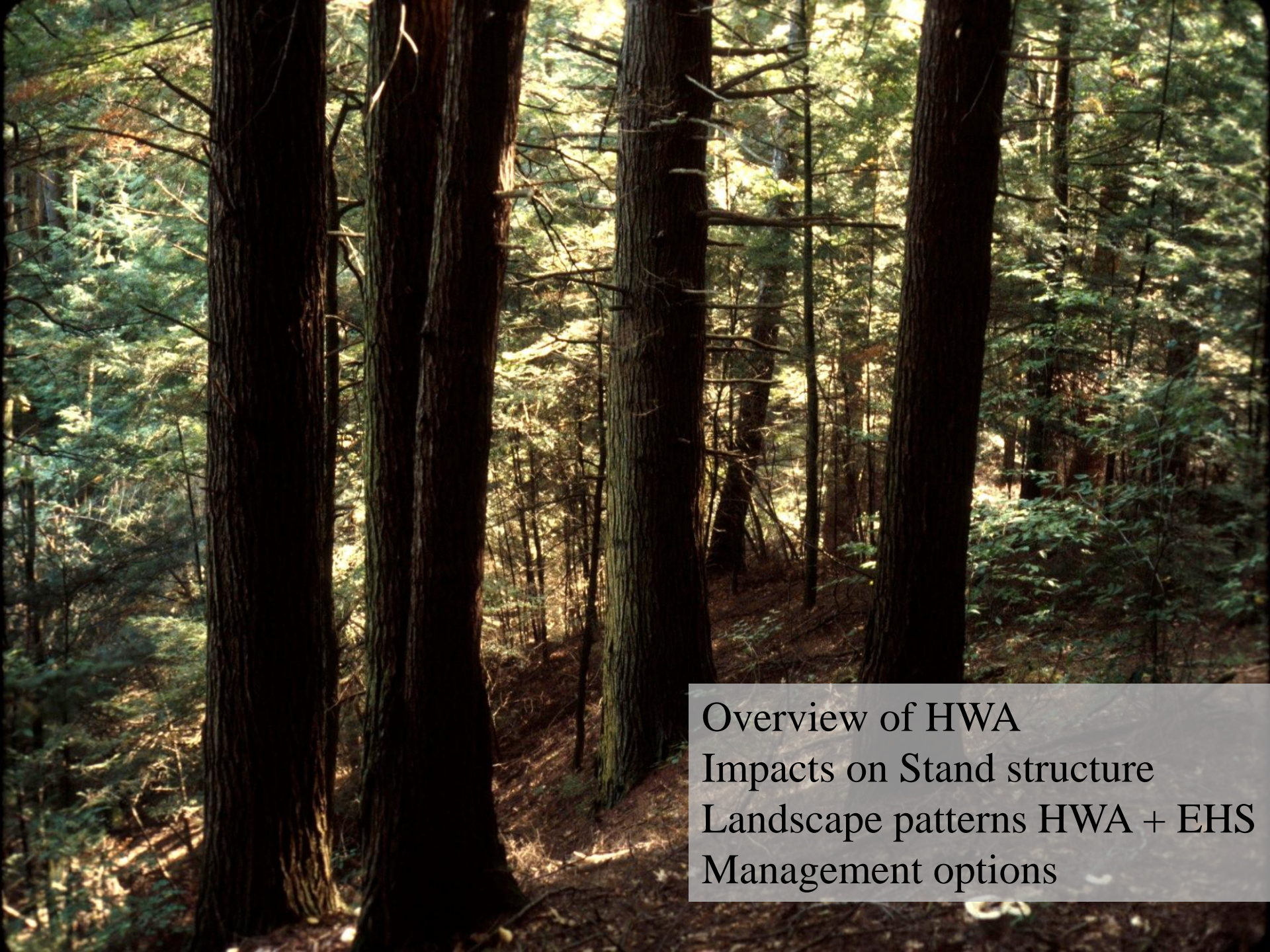


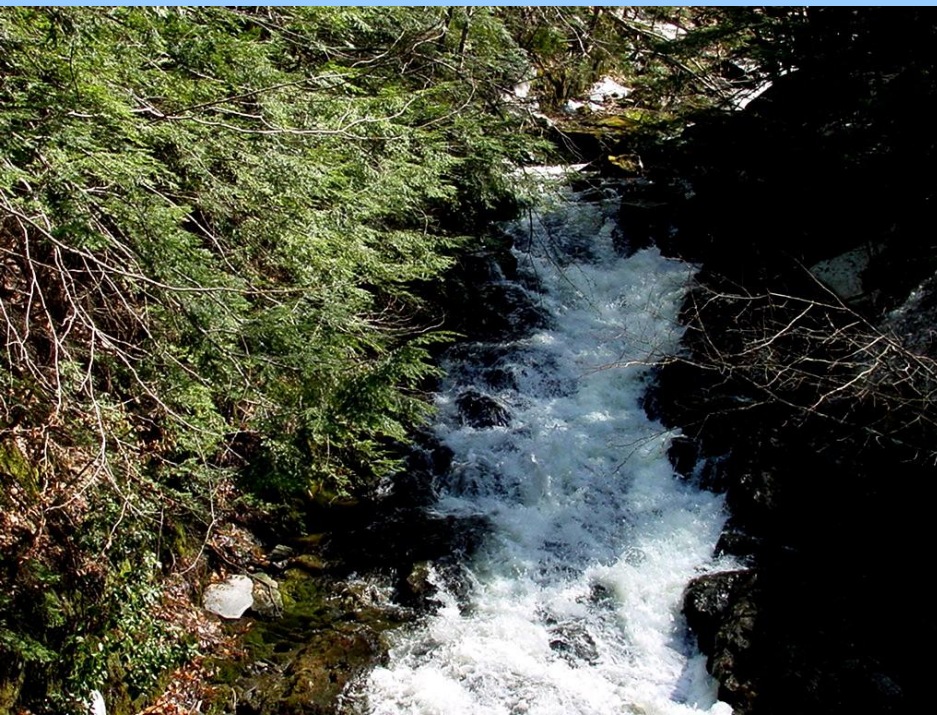


Hemlock Woolly Adelgid and its Impacts on Forest Ecosystems

David A. Orwig



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



Copyright © 1999 Arthur Morris / Birds As Art

Black-throated green warbler



Blackburnian warbler *

Photo by Mary Scott



Hemlock regeneration is limited by deer browsing.

Hemlock provides valuable habitat
for a variety of wildlife species

Ward et al. 2004





USDA Forest Service

Hemlock woolly adelgid (*Adelges tsugae*)

2 generations /year

rapid dispersal

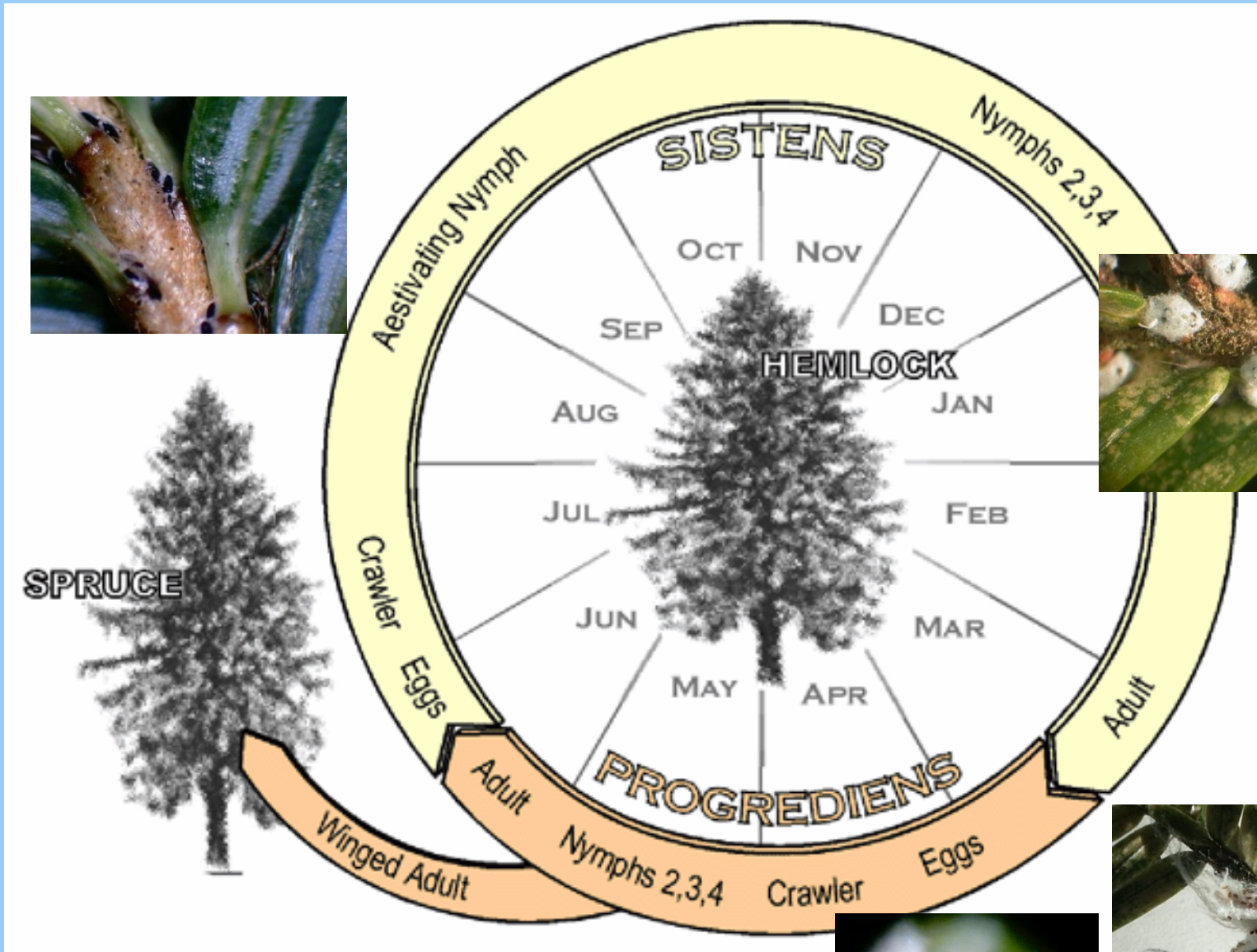
hemlock resistance?

Parthenogenetic

feed and kill all sizes and ages

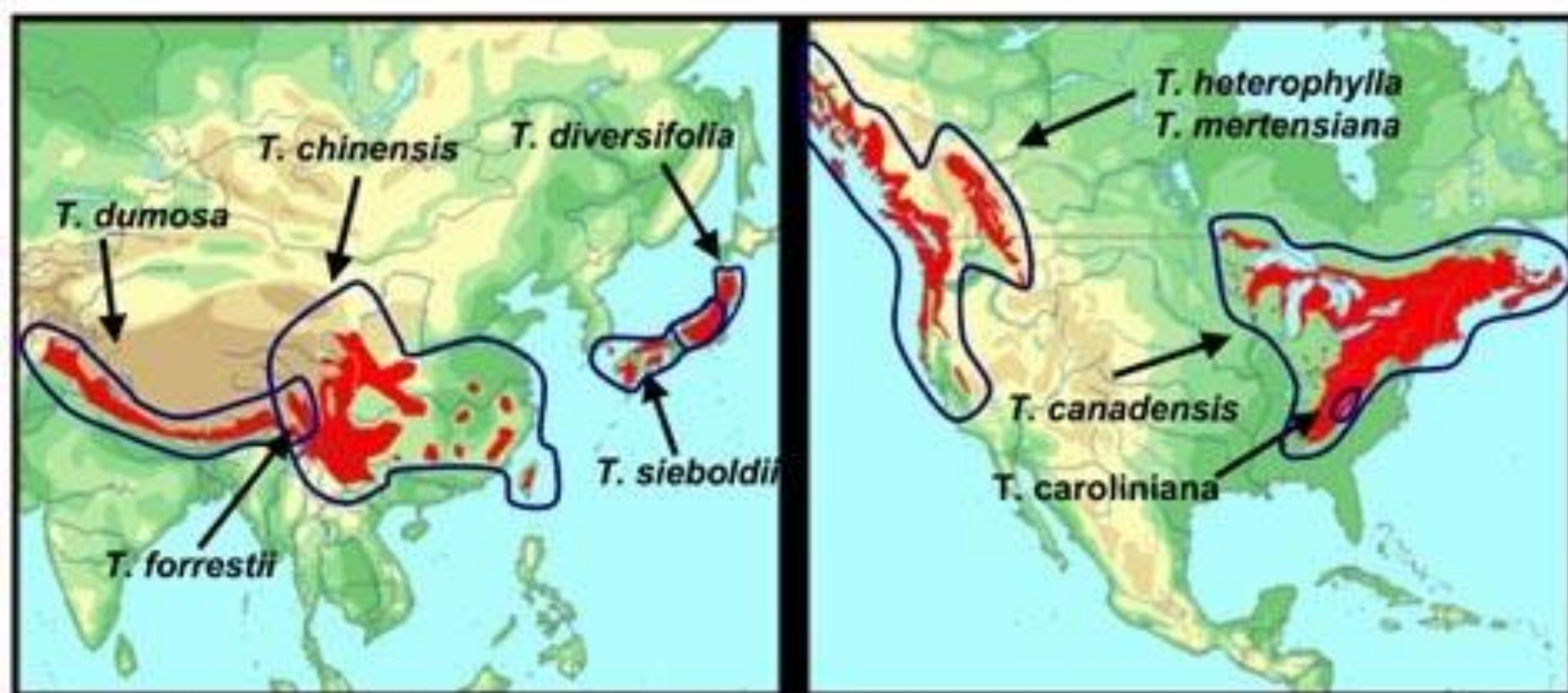
No effective native predators





HWA life cycle in E. North America (USDA)

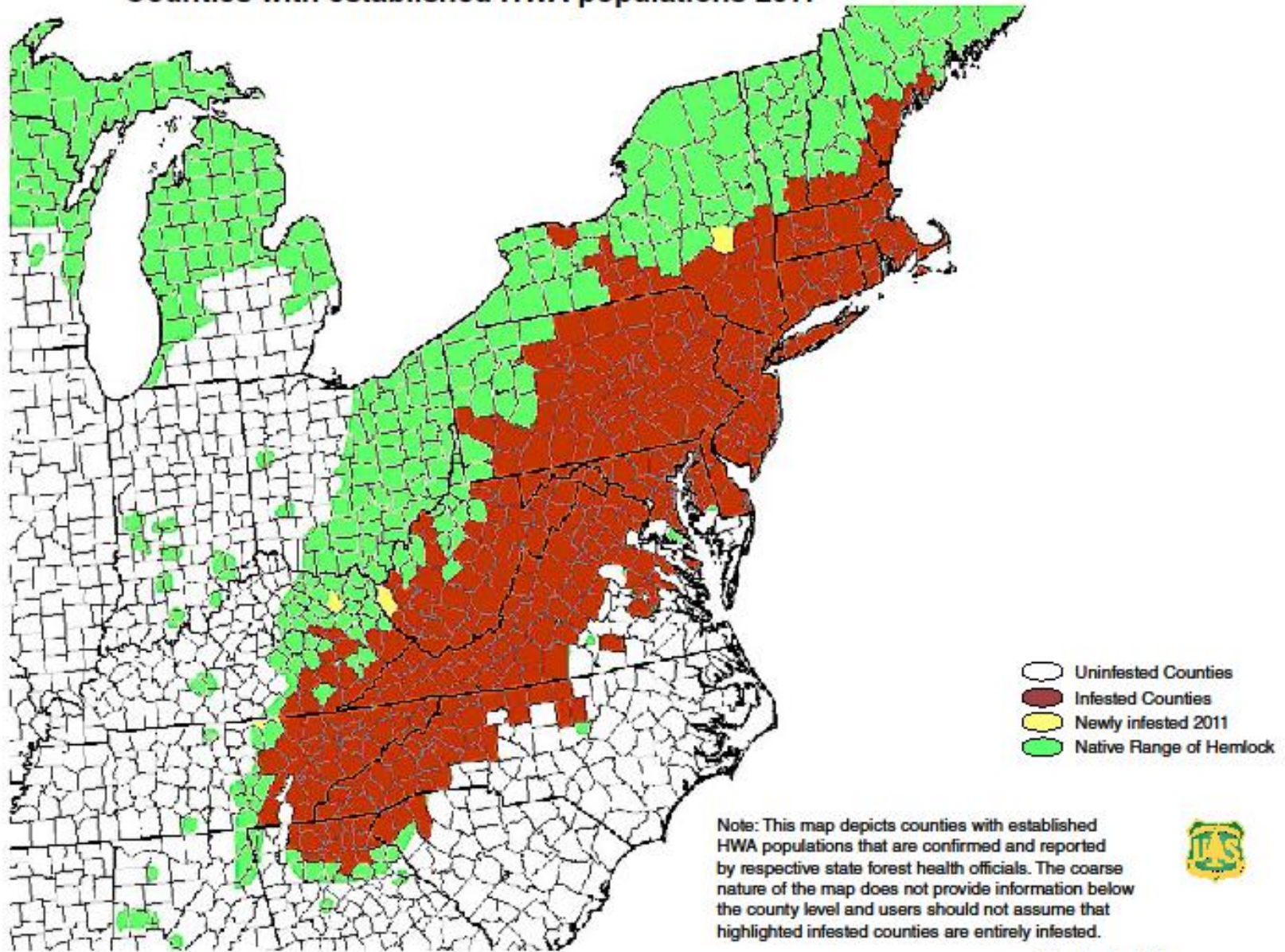
Hemlock (*Tsuga*) Distribution



Nathan Havill, Yale University

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 2011

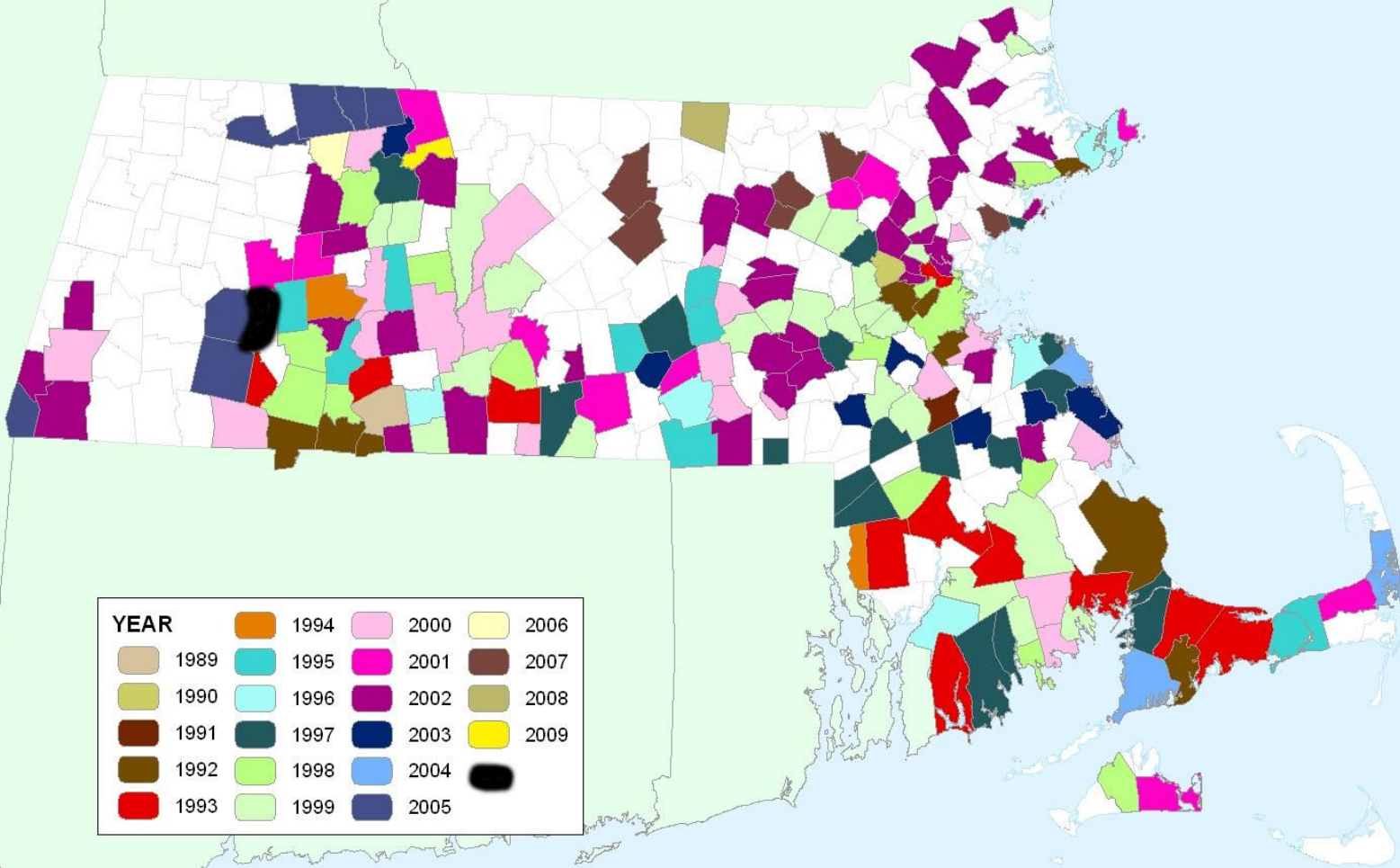


Note: This map depicts counties with established HWA populations that are confirmed and reported by respective state forest health officials. The coarse nature of the map does not provide information below the county level and users should not assume that highlighted infested counties are entirely infested.



Map Produced by:
USDA Forest Service 1/6/12

Hemlock Woolly Adelgid



YEAR			
1989	1994	2000	2006
1990	1995	2001	2007
1991	1996	2002	2008
1992	1997	2003	2009
1993	1998	2004	
	1999	2005	

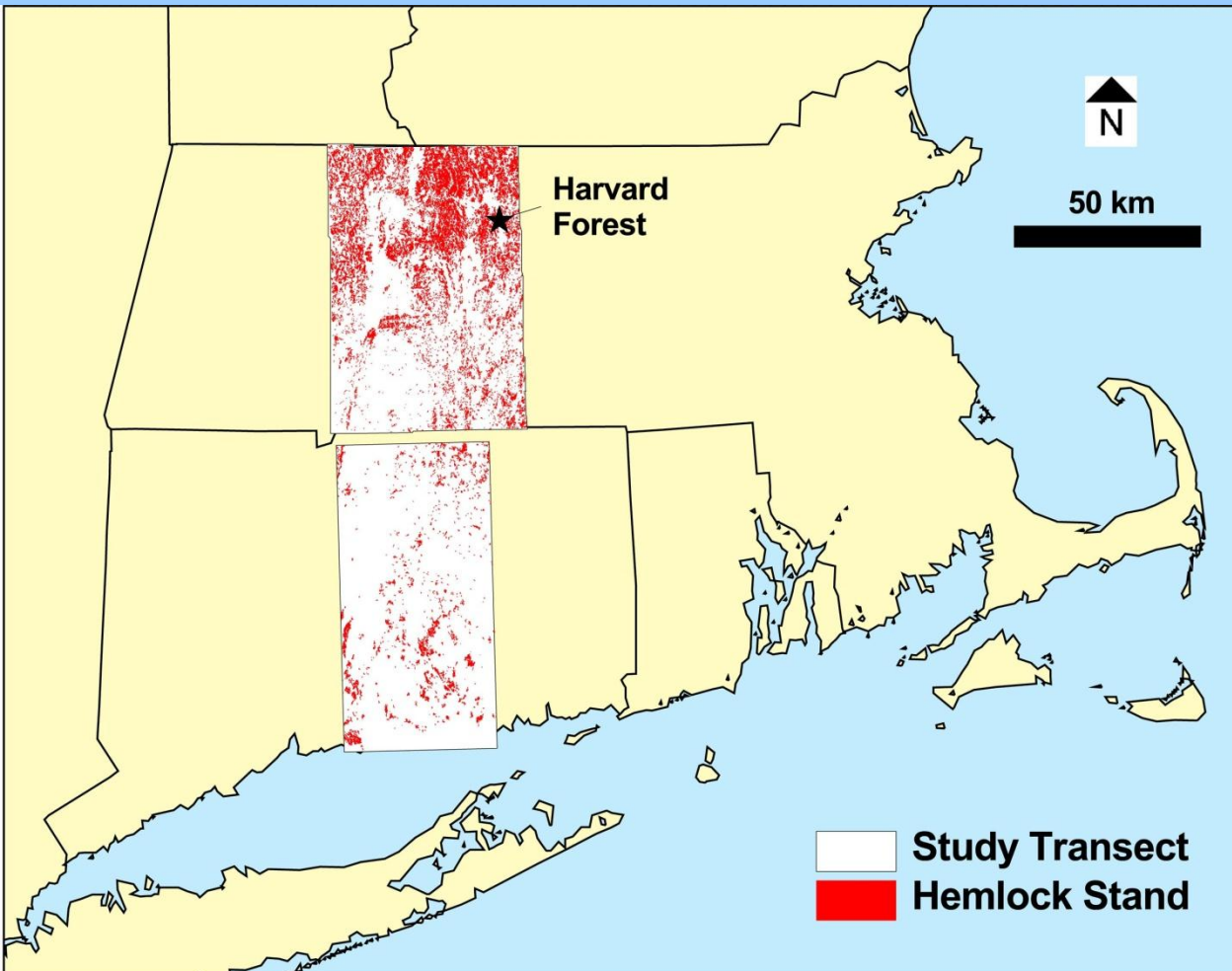
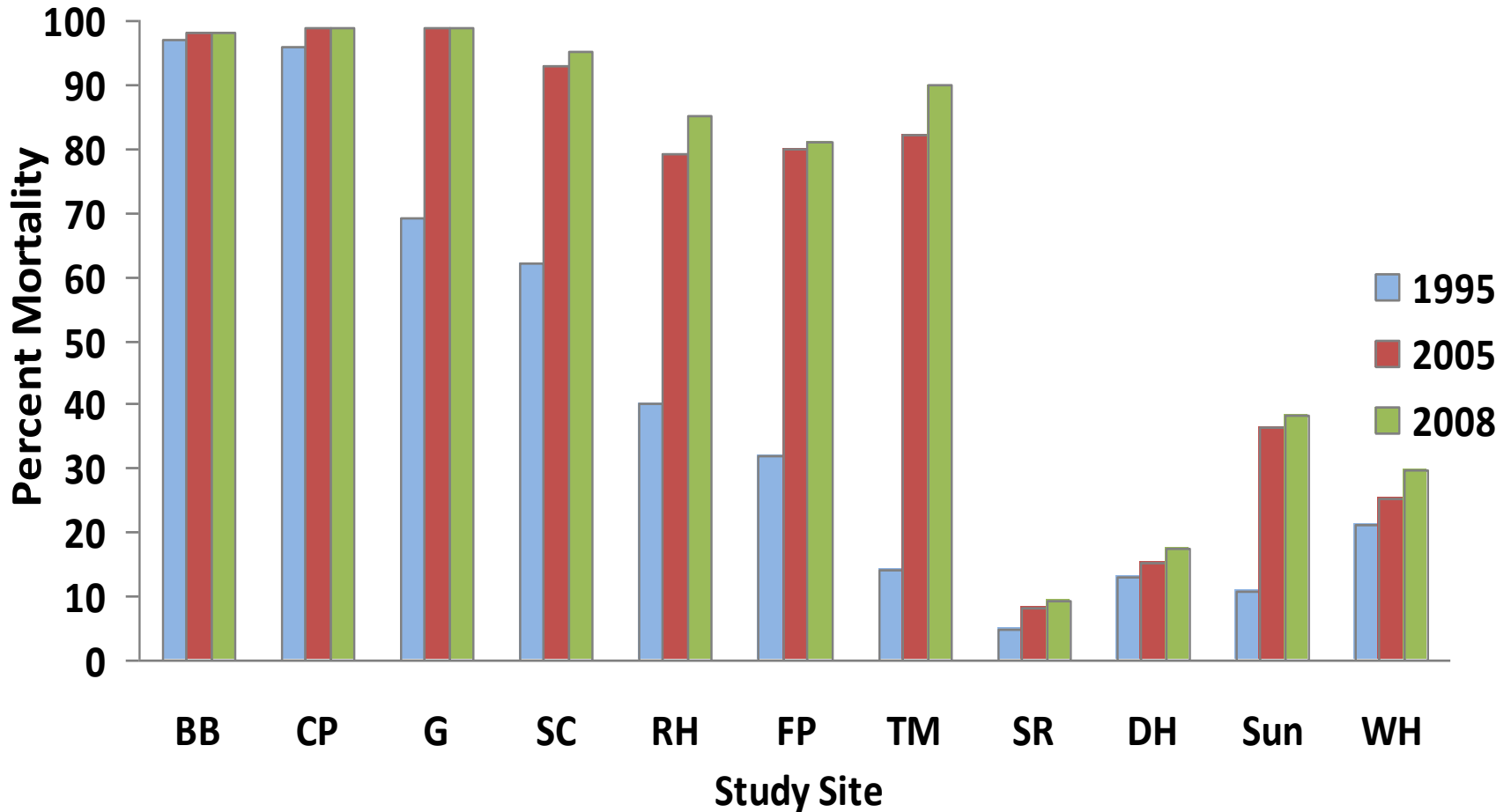


Figure 1. HWA space-for-time study area, representing 7500 km². Hemlock represents >86,000 ha or 21% of the mapped area in MA (up to 36% in northern MA), and 16,500 ha or ~5% of the mapped area of CT.

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

Hemlock Overstory Mortality



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.?)



**Rapid birch establishment
Occurs with canopy thinning**

Invasives and ferns can also increase tremendously

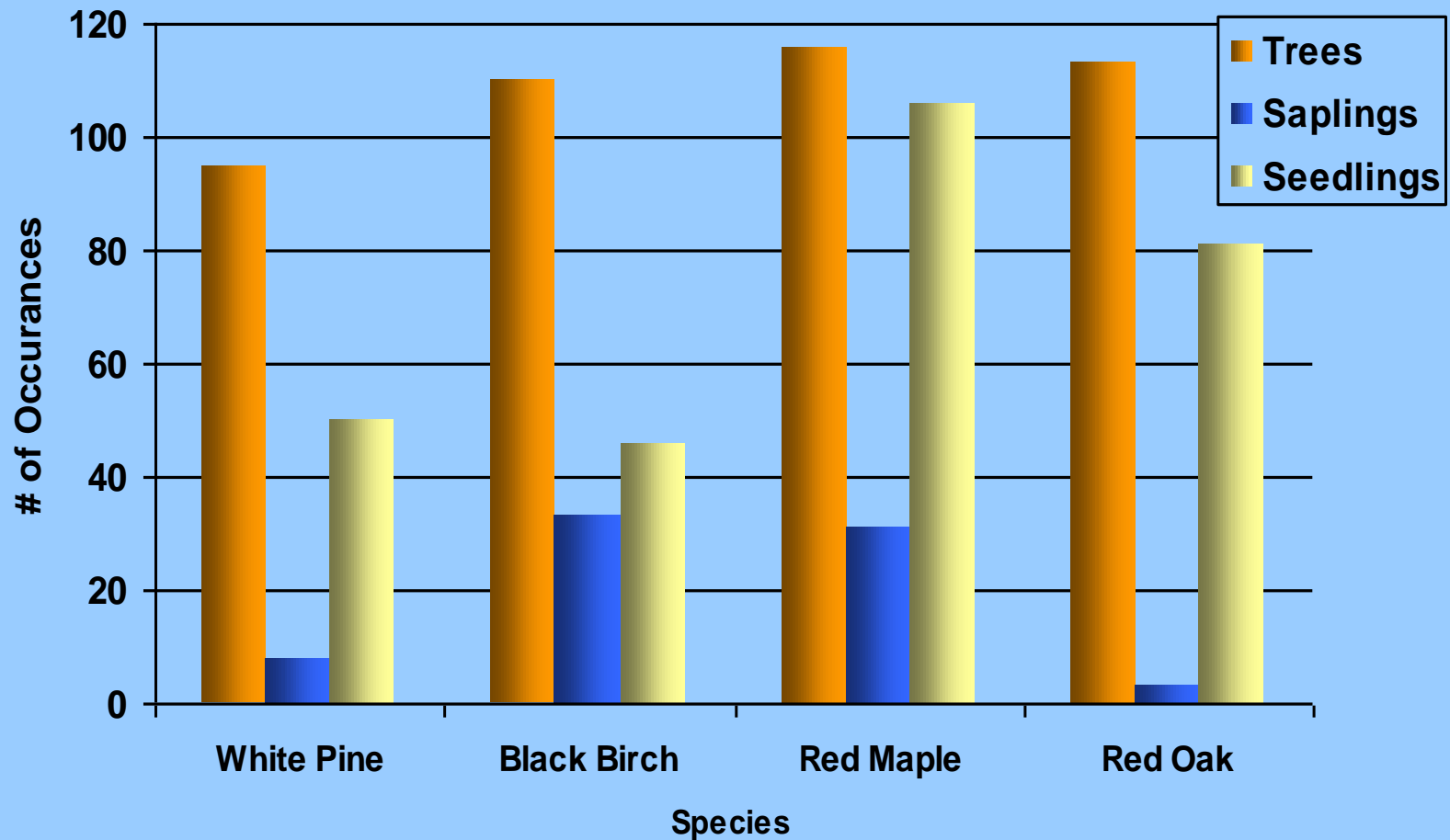




Dead trees remain standing for 8 to 12 years

What will replace hemlock in Massachusetts?

Secondary Species # of Occurances in 123 Hemlock Stands



LANDSCAPE PATTERNS

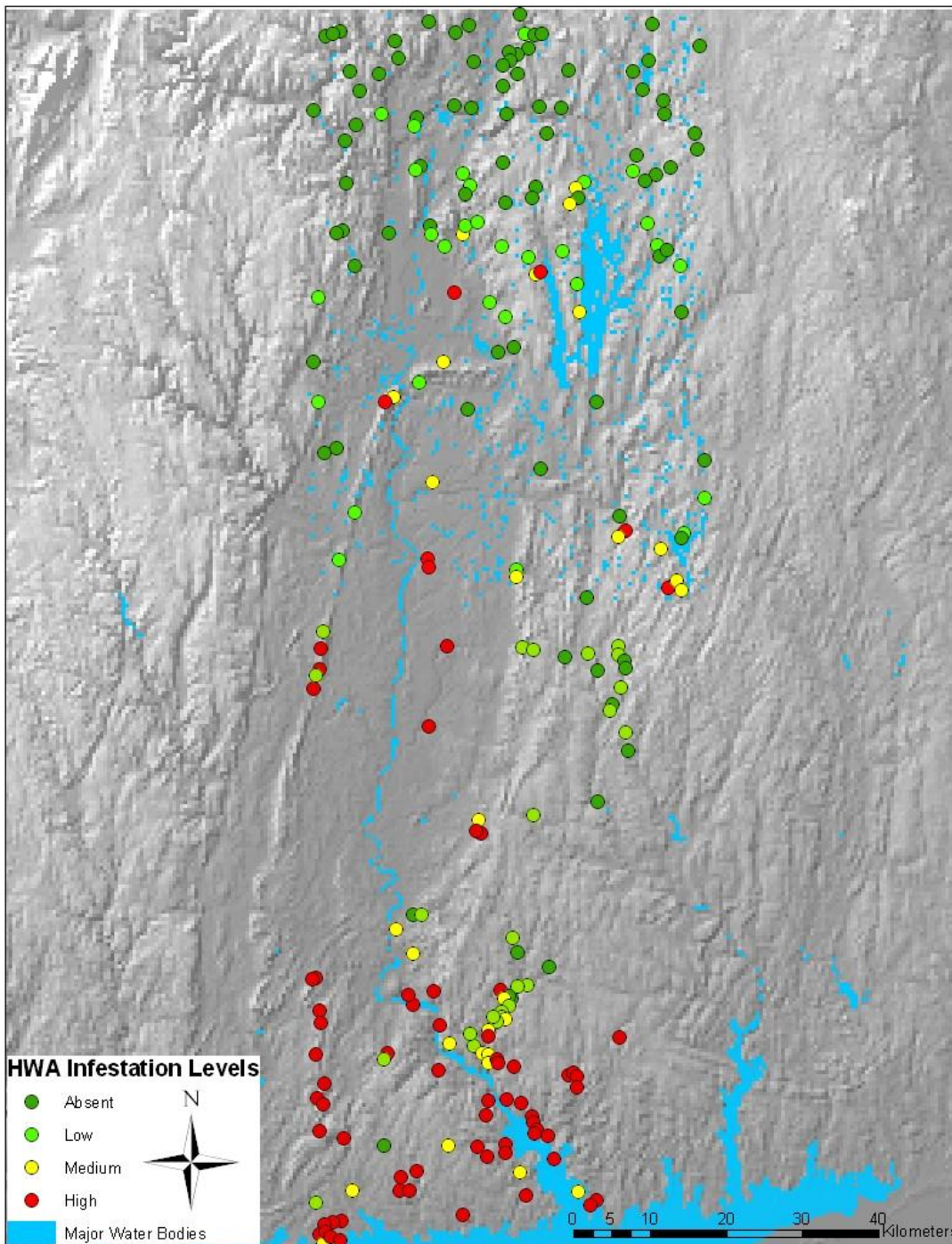
CT: 114 stands

MA: 123 stands

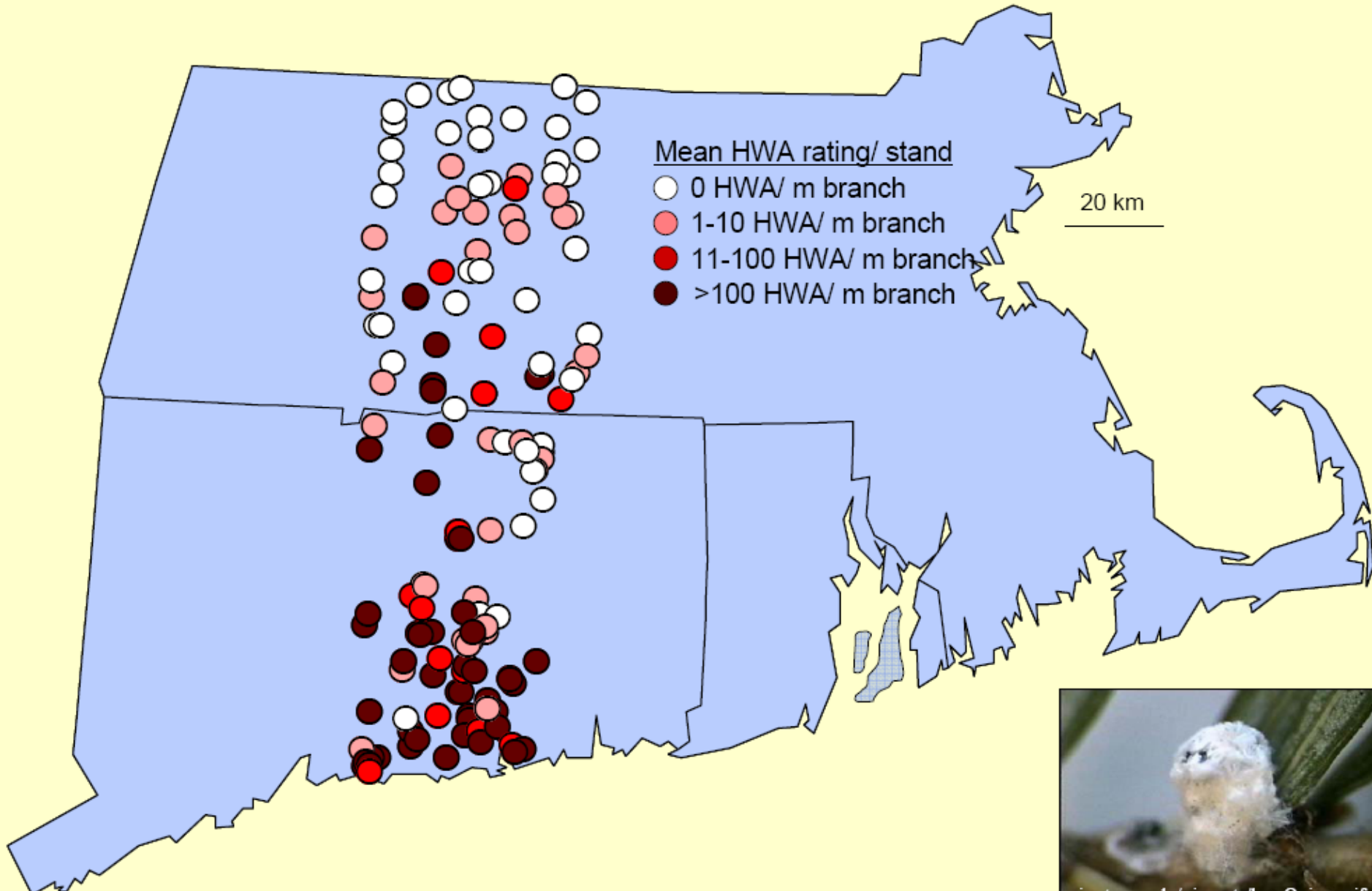
HWA found within a few
km of Vermont (2004)!

Latitudinal pattern present
But damage not as rapid

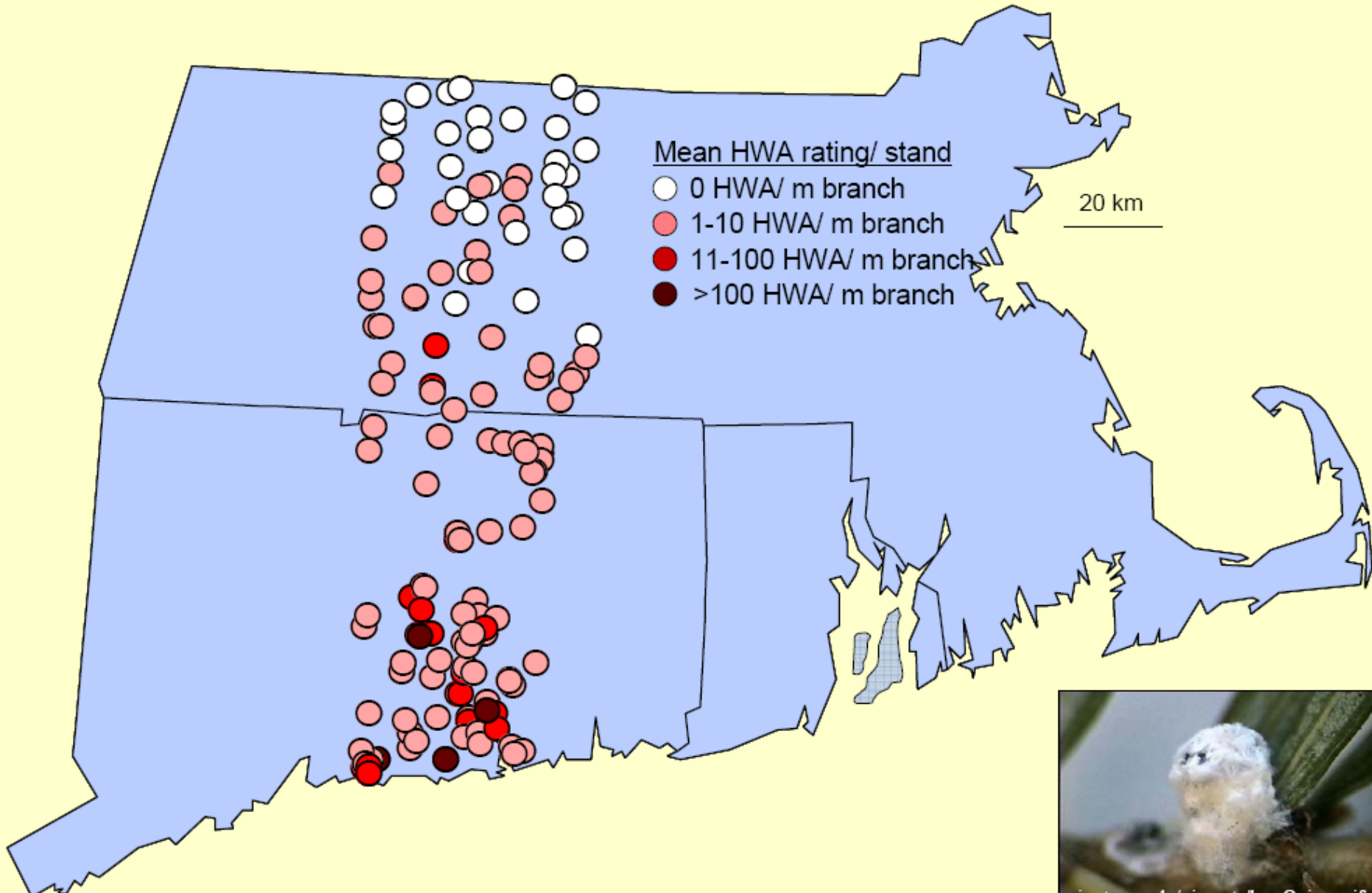
Only 2 stands > 50%
Overstory mortality in MA



Initial surveys - adelgid



2005 survey - adelgid



2007 survey – adelgid

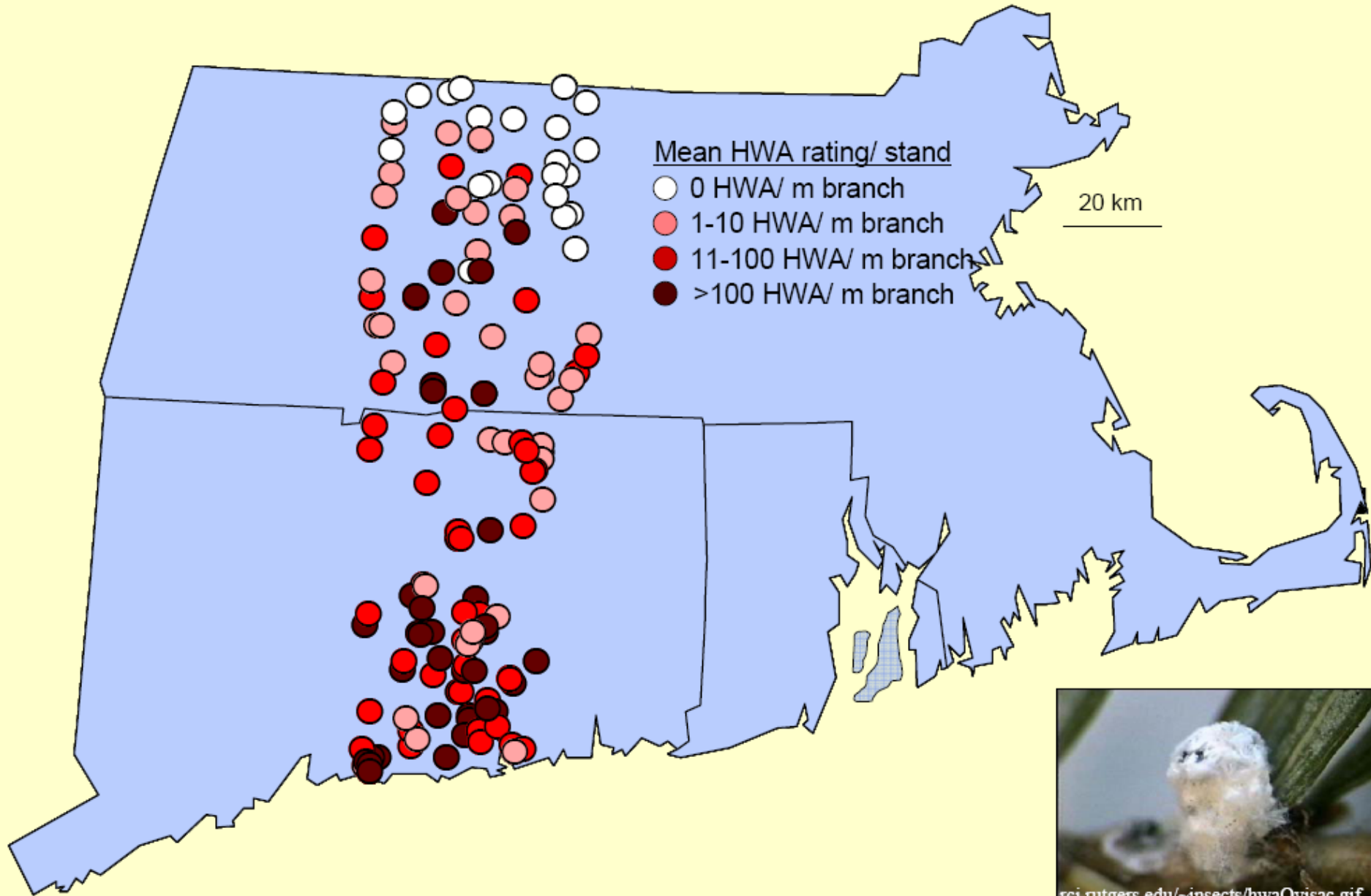




Photo: David Foster

**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



Biological Controls

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



Carol Cheah

Sasajiscymnus tsugae

Native to British Columbia, over 7000 Adults have been released at 19 sites In 8 eastern states-recovery 2 years later



USDA

Laricobius nigrinus

Others being evaluated:
Scymnus sinuanodulus
Tetrachleps galchanoides
Pathogenic fungi
Uncertain success, impact

So what can students do to add to this body of work?

Can provide year by year assessments of HWA densities

Can evaluate year to year branch growth, related to HWA

Can provide important data at the northern extent of HWA range

Can discover HWA at their homes, schools, towns

Katherine Bennett's 5th Grade class



Measuring snow depth at Hemlock field site

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

**Elongate Hemlock Scale
(EHS; *Fiorinia externa*)**

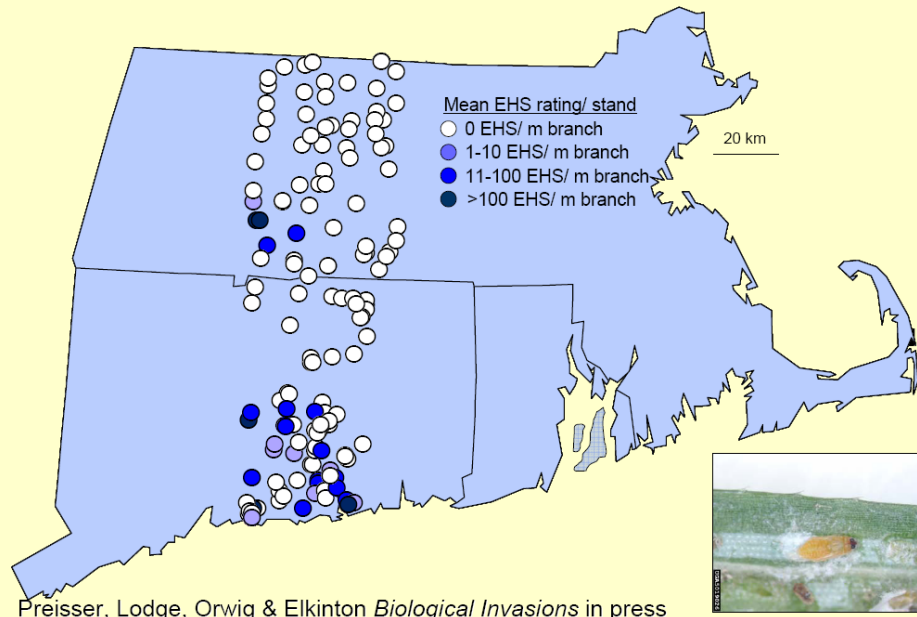
**Also from Japan, introduced in
NYC in 1908**

**Now located in 14 eastern states,
range overlaps with HWA**

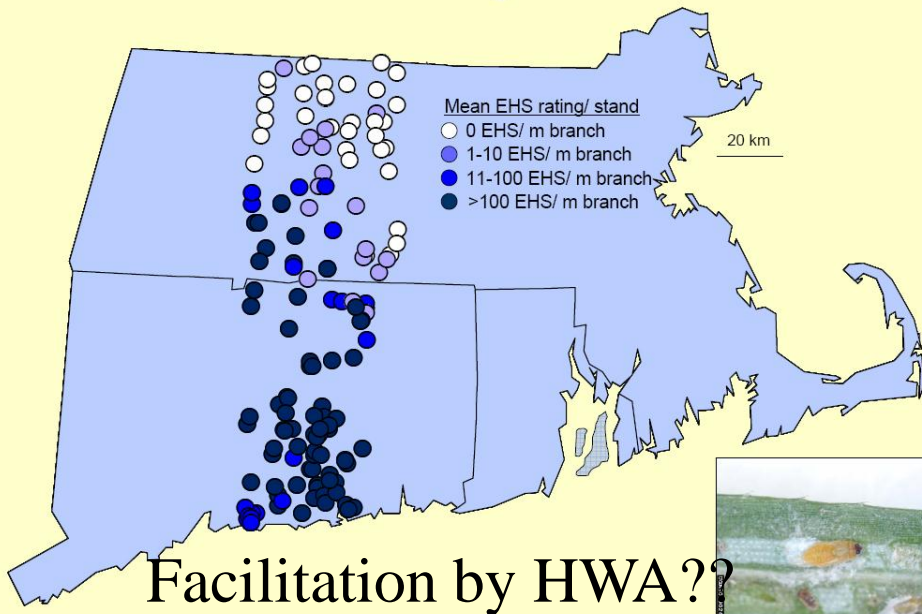
**Often co-occur with HWA on same
tree: uncertain consequences**



Initial surveys - scale



2007 survey – scale





Summer 2012

Julia and Vincent examined
Interactions of HWA + EHS
On tree growth,
Foliar chemistry
Insect density

Southern Appalachian forests dying rapidly!



W. Blozan

Holmes et al. 2010 From 1999-2008: HWA caused tens of millions of dollars in economic losses in residential property values alone!

