

The New York State Hemlock Initiative

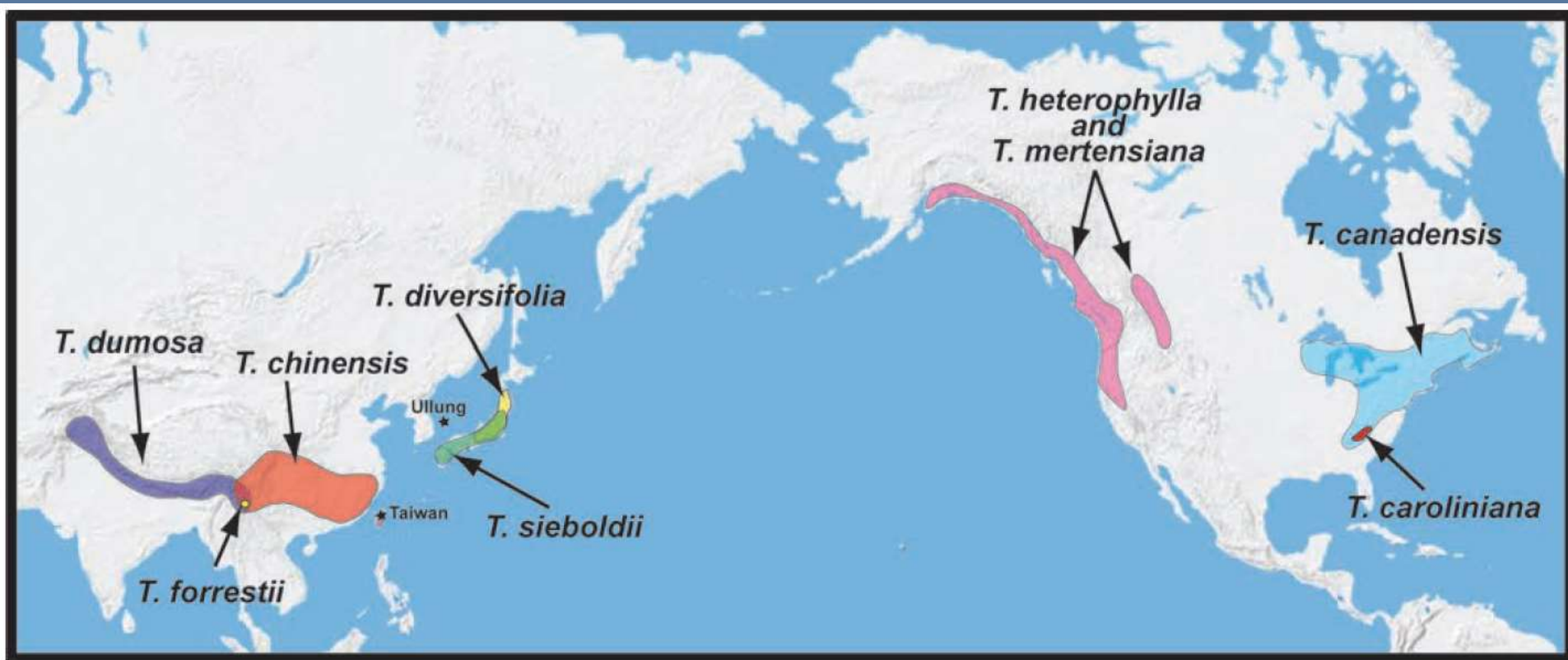
A Plan to Manage the Hemlock Woolly Adelgid

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Cornell University

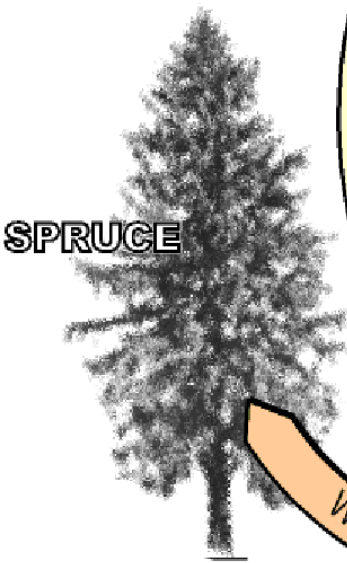
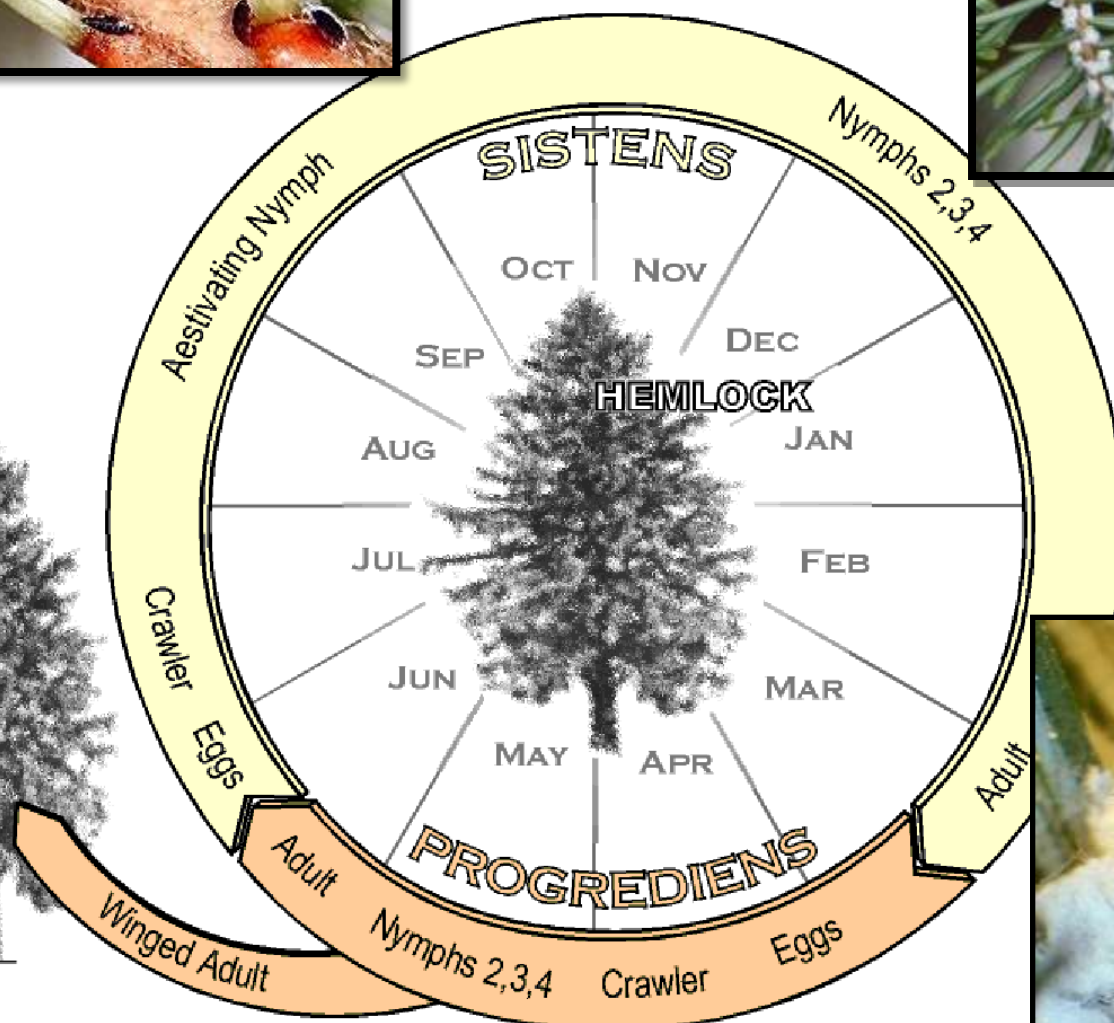




Worldwide distribution of HWA and *Tsuga* species.

Havill 2008

Life Cycle



Impact on trees

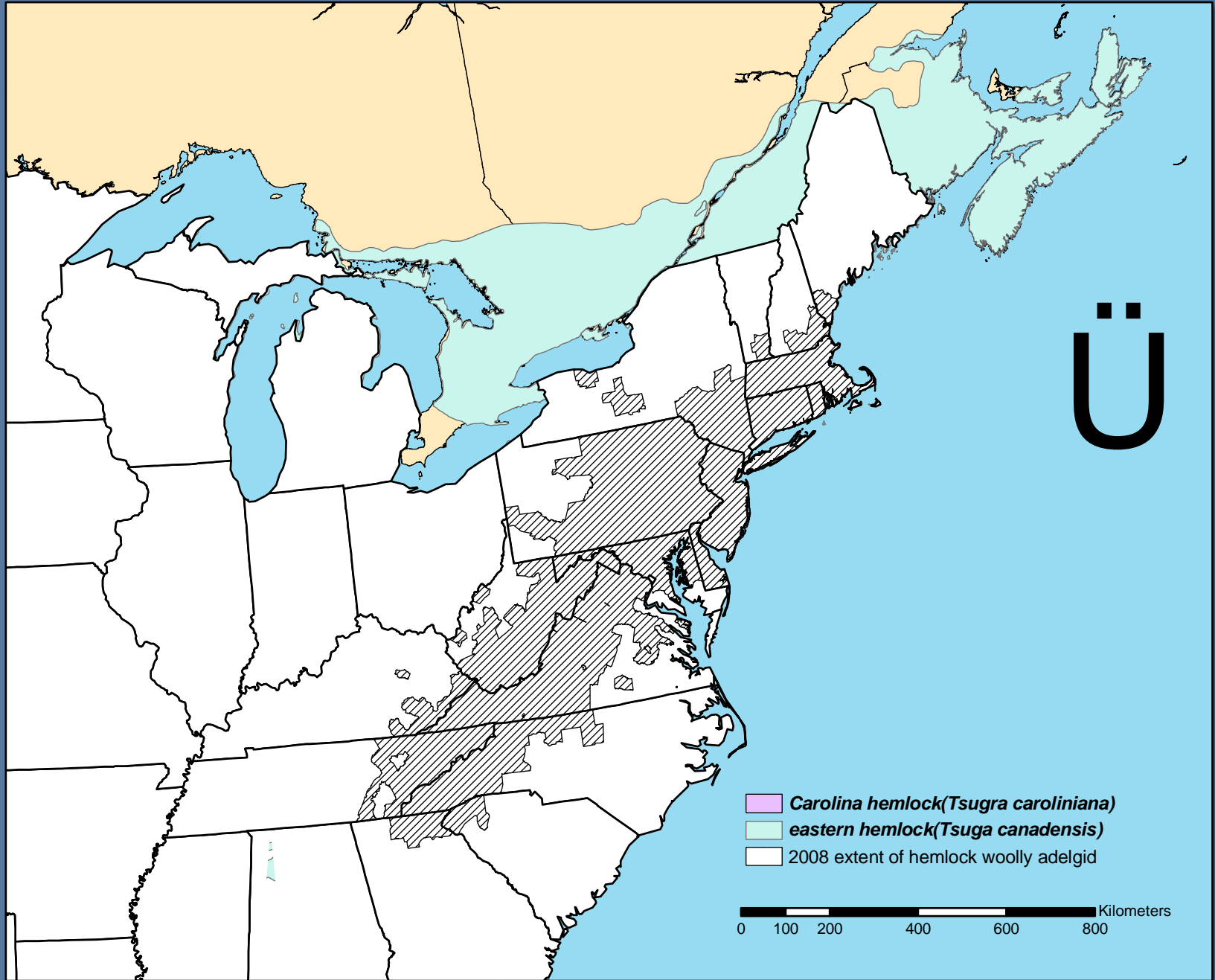


- Inserts stylets into the twig at base of needles and feeds on xylem ray parenchyma cells
- Feeding kills buds & foliage
- Usually kills trees within 4 to 10 years, it takes longer in cold areas.
 - Old and weak trees are first to die.

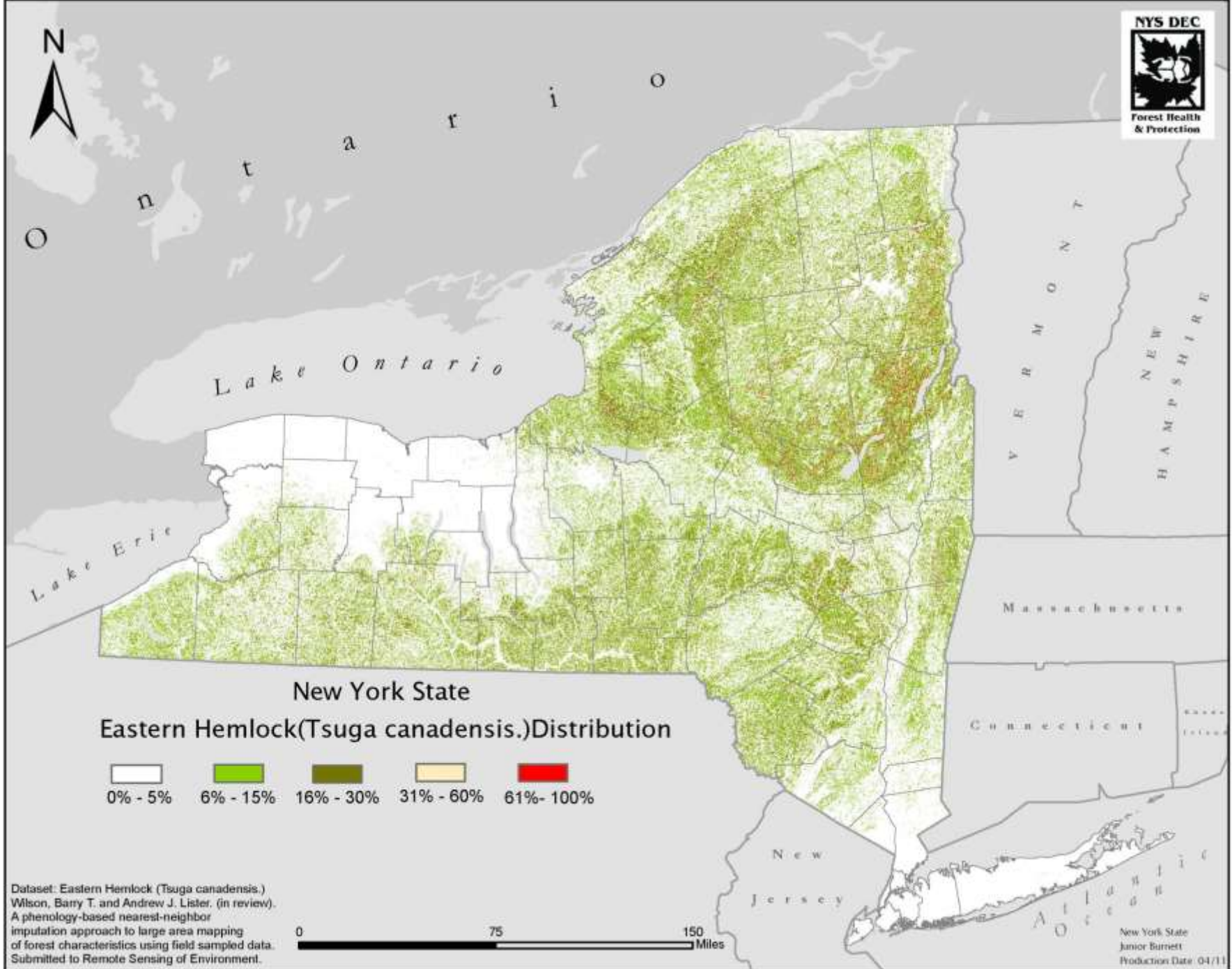
Hemlock Woolly Adelgid

The Problem

- **Asexual reproduction (all females)**
 - One individual can start a new population
 - No Founder Effect
 - High Reproductive Potential
 - 2 generations per year & up to 200 eggs/female, but generally less
 - $1 \times 100 \times 50 = 5,000$ potential progeny from 1 female/yr.
- **Native natural enemies are lacking in the eastern US**
 - Classical biocontrol efforts are ongoing
- **No documented resistance by Eastern or Carolina hemlock**



USFS, Northern Research Station, 2008



New York State
Eastern Hemlock (*Tsuga canadensis*) Distribution

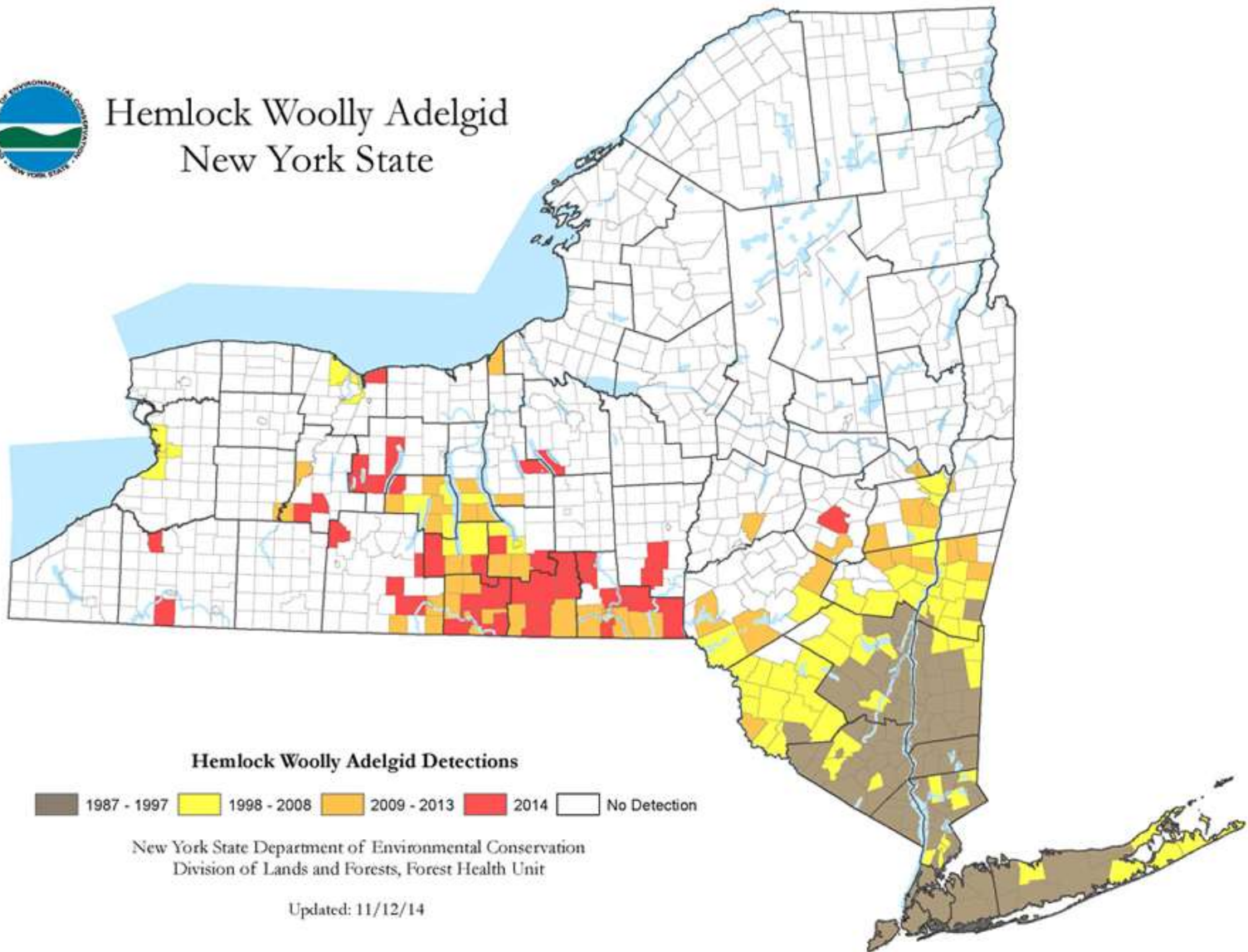


Dataset: Eastern Hemlock (*Tsuga canadensis*)
 Wilson, Barry T. and Andrew J. Lister. (in review).
 A phenology-based nearest-neighbor
 imputation approach to large area mapping
 of forest characteristics using field sampled data.
 Submitted to Remote Sensing of Environment.





Hemlock Woolly Adelgid New York State



New York State Department of Environmental Conservation
Division of Lands and Forests, Forest Health Unit

Updated: 11/12/14

Ecological Impact



Ecological Impacts

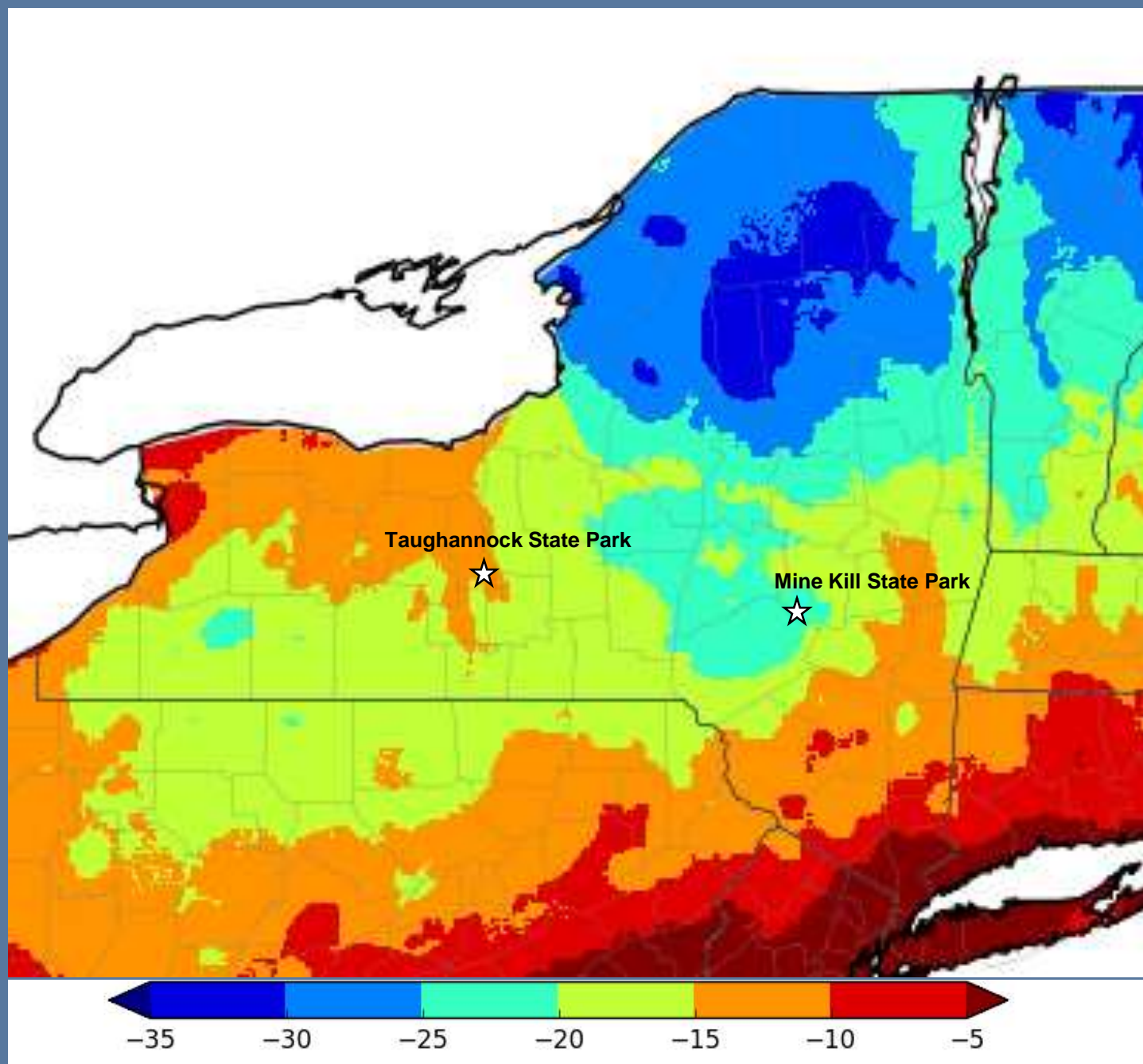
- Hemlock is a *Foundation* species in our forests
 - They occupy the base of the food web
 - They are critical species in the habitat they help create
 - Generally so common that we take them for granted
 - We depend on the ecosystems they build and maintain for a wide range of tangible and intangible services

Ecological Impacts

- **Water resources**
 - Moderate stream water temperatures for trout and other animals
 - Provide a buffer for nutrient inputs to maintain water quality
- **Soils**
 - Stabilize shallow soils especially in steep gorges
 - Soil chemistry made more acidic
- **Provide shelter for animals & plants**
 - Especially important in winter
 - Critical habitat for migrating neo-tropical birds
 - Acidic substrate for lichens
- **Mortality opens stand to invasive plant species**
 - Can impede establishment of desired forest species

Natural Control of Insect Populations

- **Host Tree Resistance**
 - Many factors involved, most poorly understood for trees
- **Abiotic Factors**
 - Temperature, humidity
- **Biological Control**
 - Predators, Parasites, and Pathogens
- **Additive effect of all agents involved**



Northeast Regional Climate Center, Cornell University, 2014



HWA Biological Control Program

- HWA first found to be a problem in Eastern United States around 1951
- Classical Biological Control program initiated in 1993
- No Parasitoids or specific pathogens?
- Work has focused on Coccinellid and Derodontid beetles from Eastern Asia and the Pacific Northwest.
 - Six species have been released to date, two in NY

Laricobius nigrinus

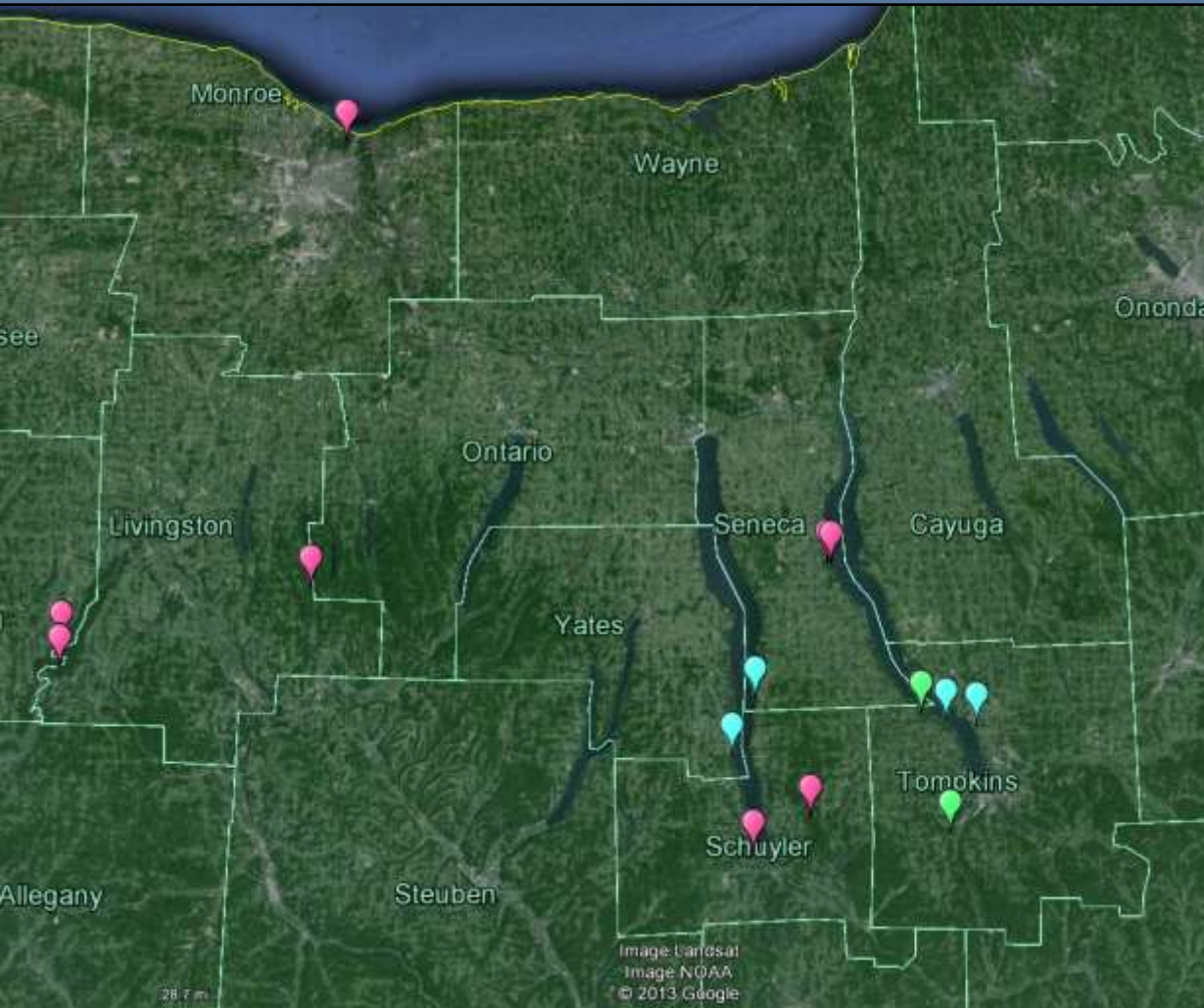


- Native to Pacific Northwest
- Good synchrony with HWA
 - Adults feed on developing sistens
 - Larvae feed on progrediens eggs and early instar nymphs
- Released in 16 states on east coast since 2003.
- Establishment at many locations.
 - Banner Elk, NC
 - Spread over 30 miles since first introductions in 2003
 - Over 12,000 collected in two weeks for release
 - Delaware Water Gap, Northern NJ and PA populations are growing since releases began in 2006
 - New York, first releases in 2009, established at three of the earliest release locations

Laricobius nigrinus releases in NY 2009 to 2013

- 15 locations: 2009, 2012, 2013, 2015

- Two biotypes:
 - Puget Sound
 - Idaho
 - Established at three sites – F5 generations



Field Insectary Establishment in NY

- Hedges are easy to collect from, foliage is close to ground
- Planting hemlocks in convenient locations across the state
 - Wait for them to become infested then release predators
- Utilize established hemlock hedges – need to find them



Leucopis argenticollis

- Diptera: Chamaemyiidae
- Second most abundant predator of HWA in the Pacific NW
- Holarctic distribution – native to New York
- Larvae feed on both *Progrediens* and *Sistens* eggs.
- Seems to be adequate niche separation in PNW with *Laricobius nigrinus*





Leucopis cage experiment on Skaneateles Lake

Biocontrol in North Carolina



Hemlock Hill, Banner Elk, NC – First release of *Laricobius nigrinus* 2003

Chemical Control Strategies

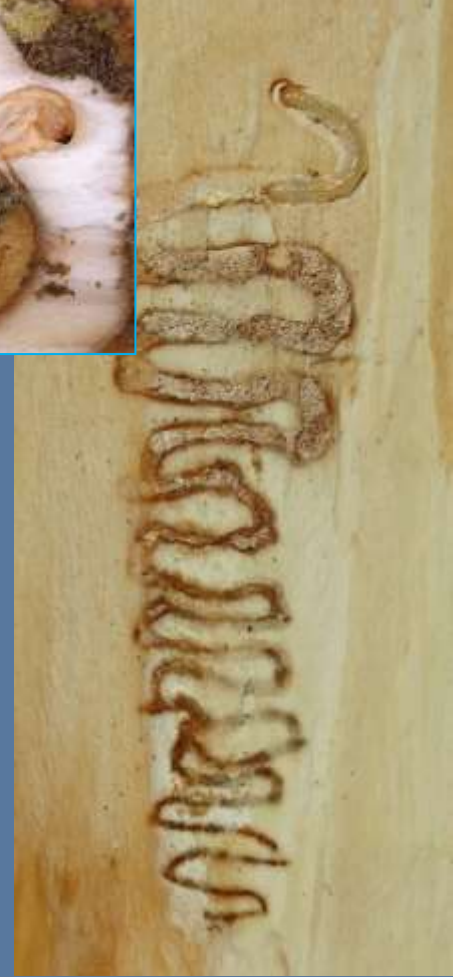
- Conserve Genetic Resources
 - Identify magnificent individuals
 - Maintain genetic diversity across the landscape
- Conserve Aesthetic Resources
 - Parks and viewsheds
- Maintain ecosystem functions
 - Conserve unique natural areas for obligate organisms

NYS Hemlock Initiative

- Housed in the New York Invasive Species Research Institute at Cornell University.
- Identify and engage stakeholders
- Identify priority hemlock stands
- Survey and map
- Develop and implement best management practices
 - assess management efficacy.
- **Establish hemlock gene conservation strategies.**
- Develop and implement biocontrol program to grow and redistribute natural enemies
 - Locate hemlock hedges across the state



Emerald Ash Borer



June/July
Oviposition

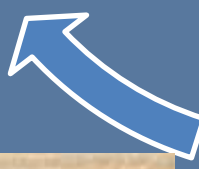
Summer/Fall
Larval growth

May/June
Adult Emergence
Ovary maturation

Winter
Pre-pupae

Early spring
Pupation

1-Year Life Cycle







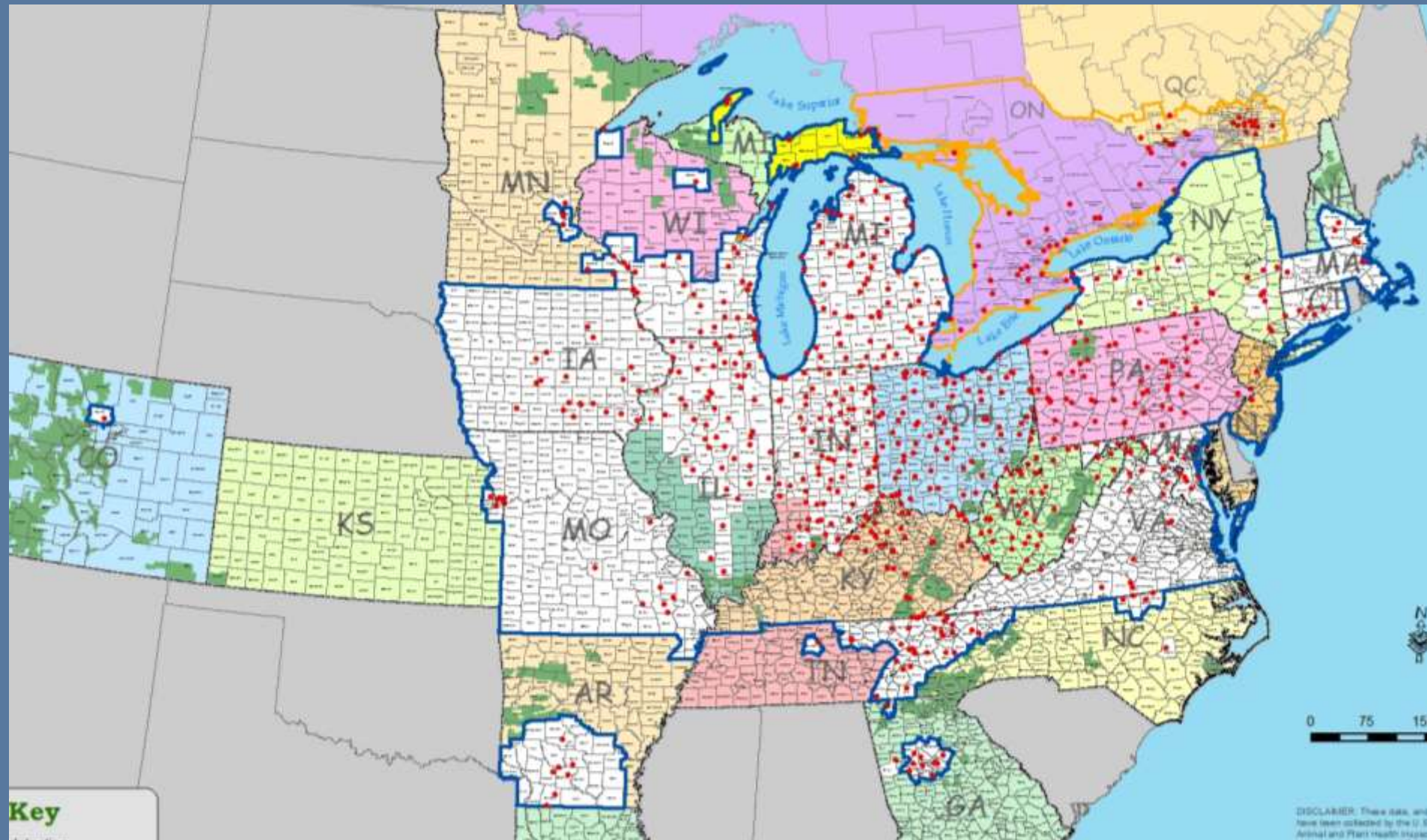


Signs & Symptoms

- Canopy thinning



June 2015



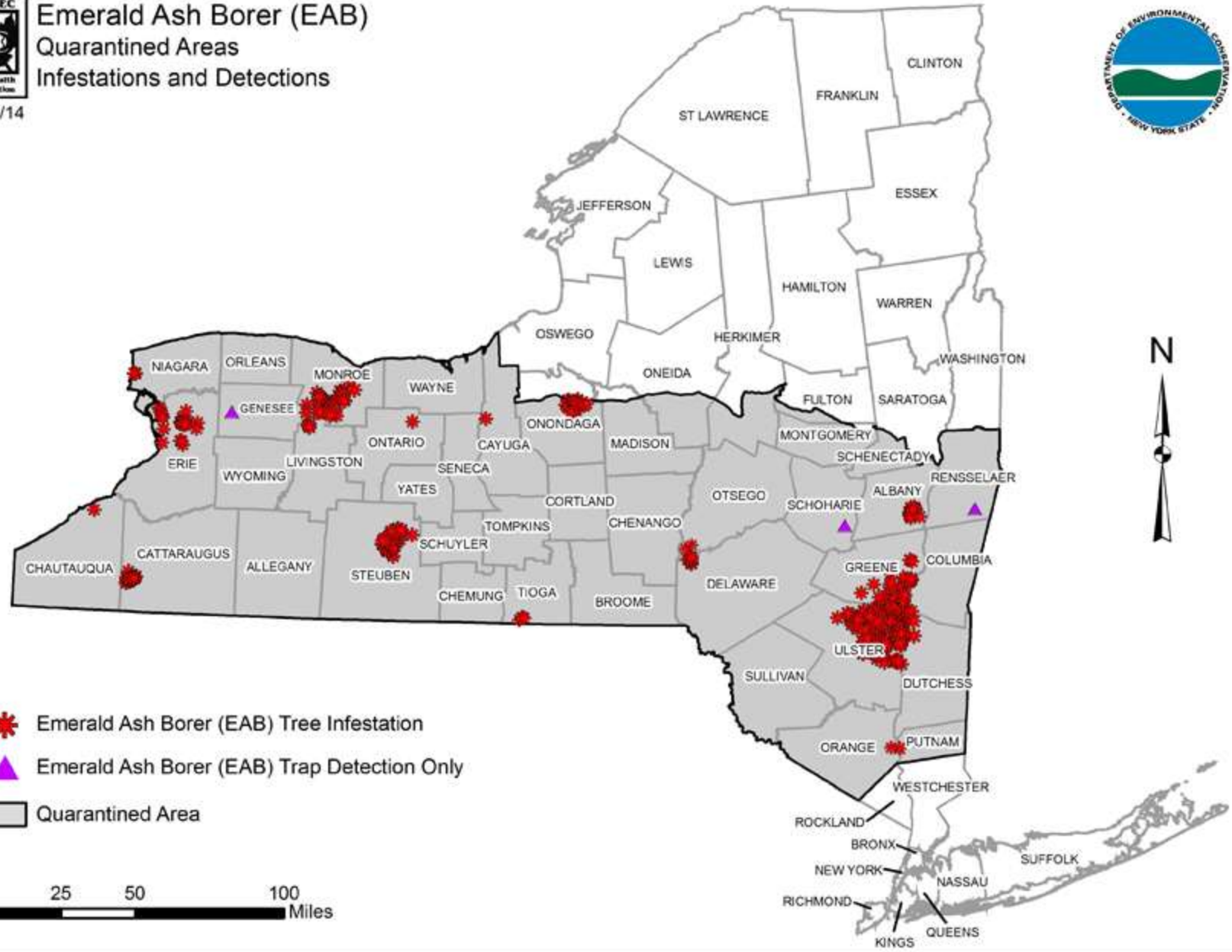
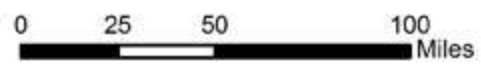


Emerald Ash Borer (EAB) Quarantined Areas Infestations and Detections

03/11/14



- Emerald Ash Borer (EAB) Tree Infestation
- Emerald Ash Borer (EAB) Trap Detection Only
- Quarantined Area



Emerald Ash Borer (EAB) Quarantine Boundaries

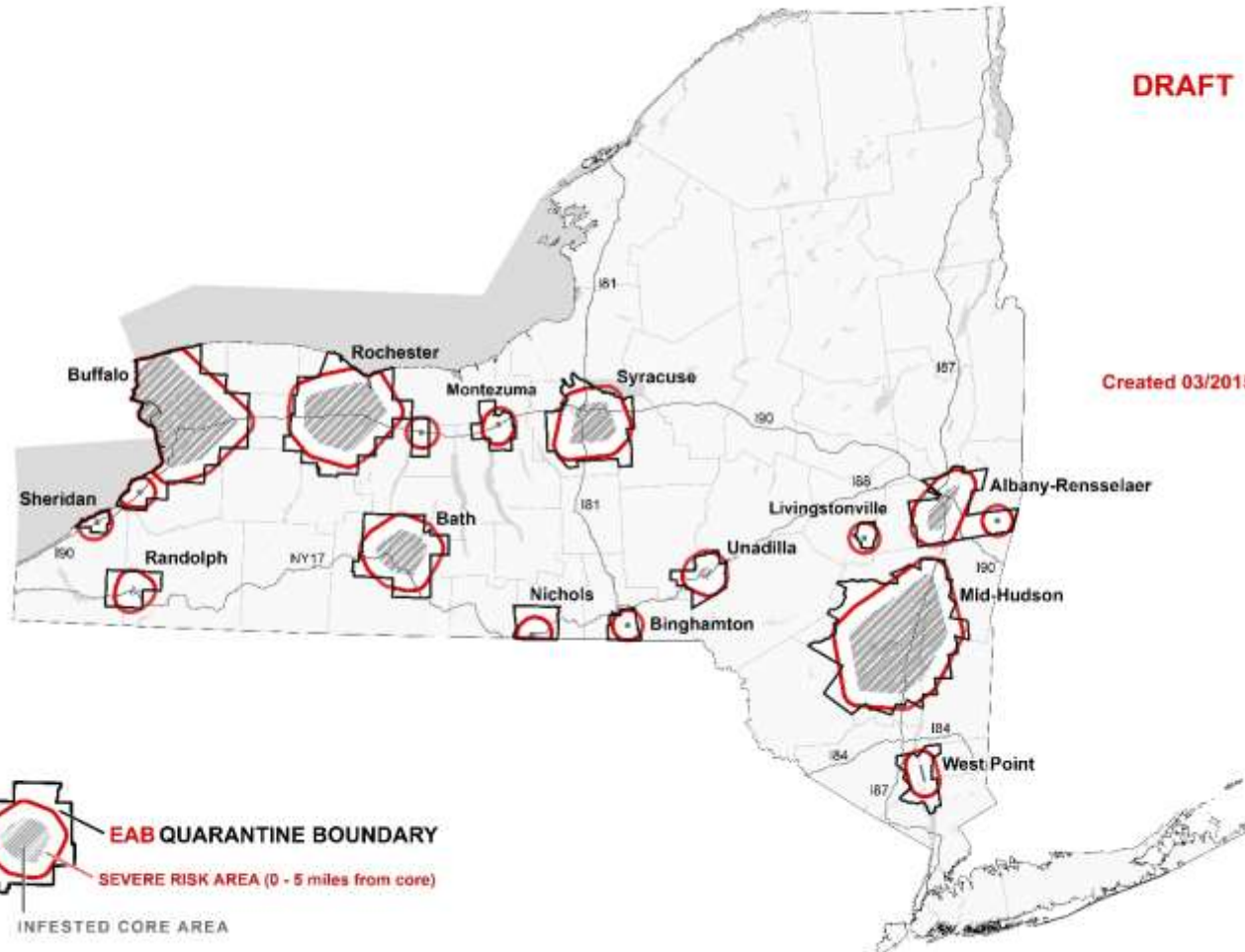
Albany-Rensselaer, Bath, Binghamton, Buffalo, Livingstonville,
Mid-Hudson, Montezuma, Nichols, Randolph, Rochester,
Sheridan, Syracuse, Unadilla, West Point



Department of
Environmental
Conservation

Agriculture
and Markets

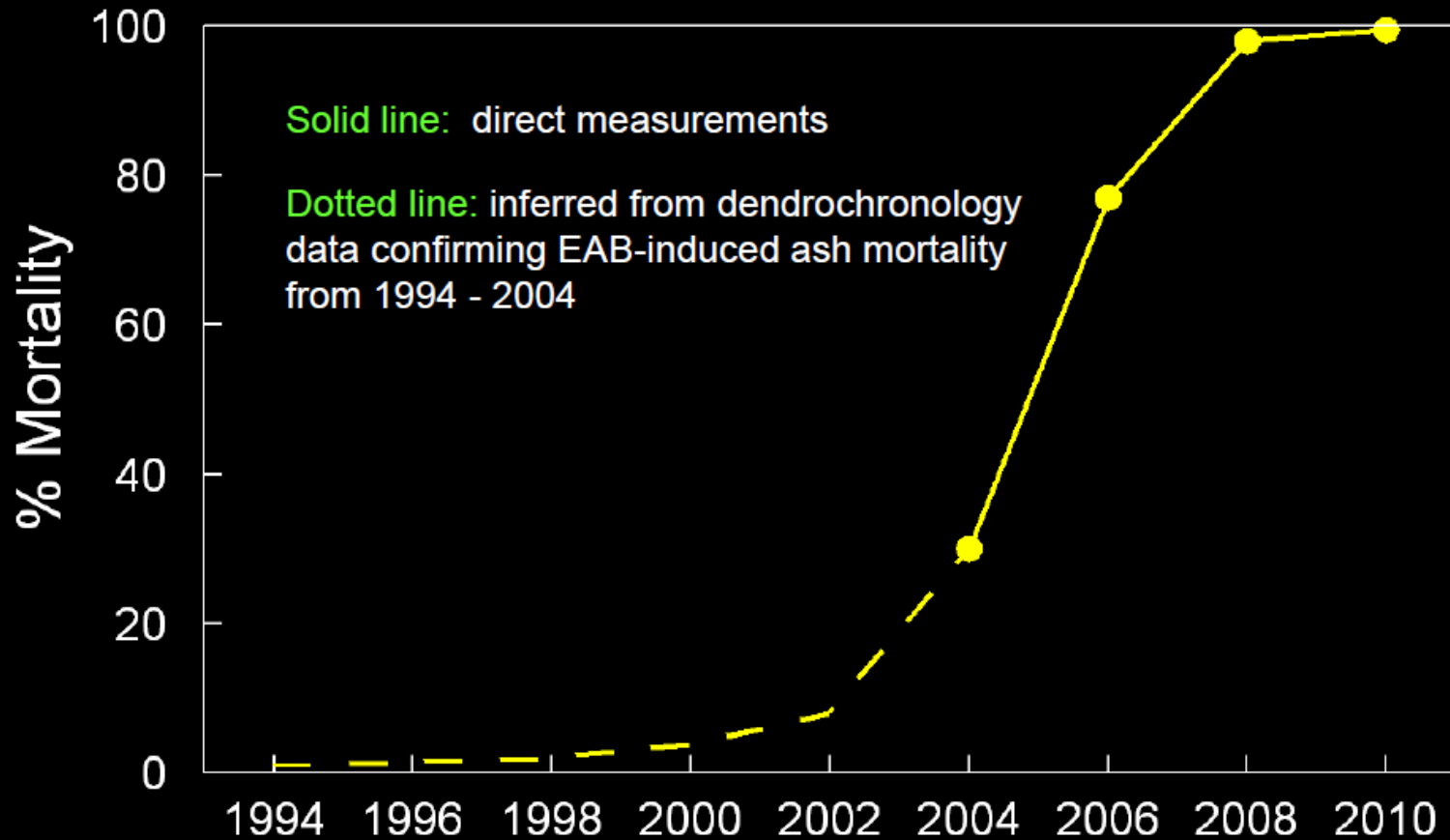
DRAFT



Created 03/2015

EAB-Induced Ash Mortality in the Upper Huron River Watershed, SE Michigan

Exponential Increase in Ash Mortality (> 4 inch dbh)



Dan Herms, Ohio State University, 2012.

What are MY objectives?

1. **Restore ALL ash species to the North American landscape.**
2. **Mitigate the Economic Impacts of Emerald Ash Borer.**

Restore Ash on Landscape

- **The 3 point plan**

- 1. Establish Biological Controls***

- 2. Identify and incorporate resistance***

- 3. Conserve the ash genome***

Mitigate Economic Impacts

- **Proactive planning**
 - Tree inventories/ EAB Cost Calculator
 - Identify priorities for management
- **Engage communities**
 - Inter-municipal cooperation
- **Develop novel management techniques**
 - Pesticide treatments
 - Wood utilization



Alien Forest Pest Explorer

www.fs.fed.us/ne/morgantown/4557/AFPE/

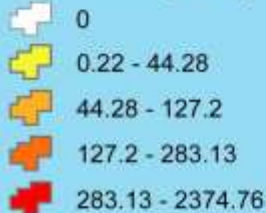
Host Tree Volume Map Emerald Ash Borer *Agrilus planipennis*

Alaska

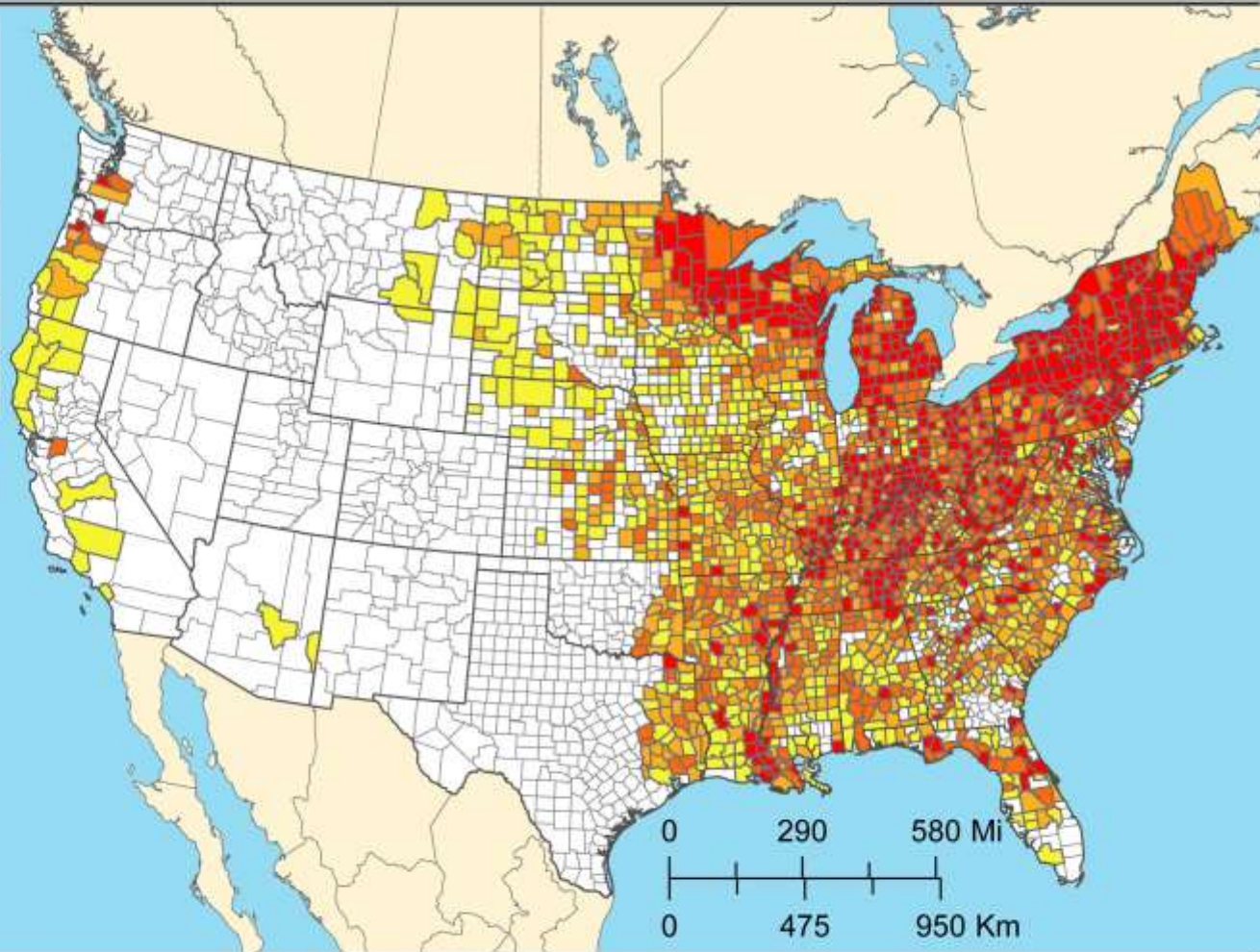


0 90 180 Mi
0 375 750 Km

Host Volume (m³/ha)



Map created on 6/9/2009



0 290 580 Mi
0 475 950 Km



Northern
Research
Station



Eastern Forest
Environmental Threat
Assessment Center



Forest Health
Technology
Enterprise Team



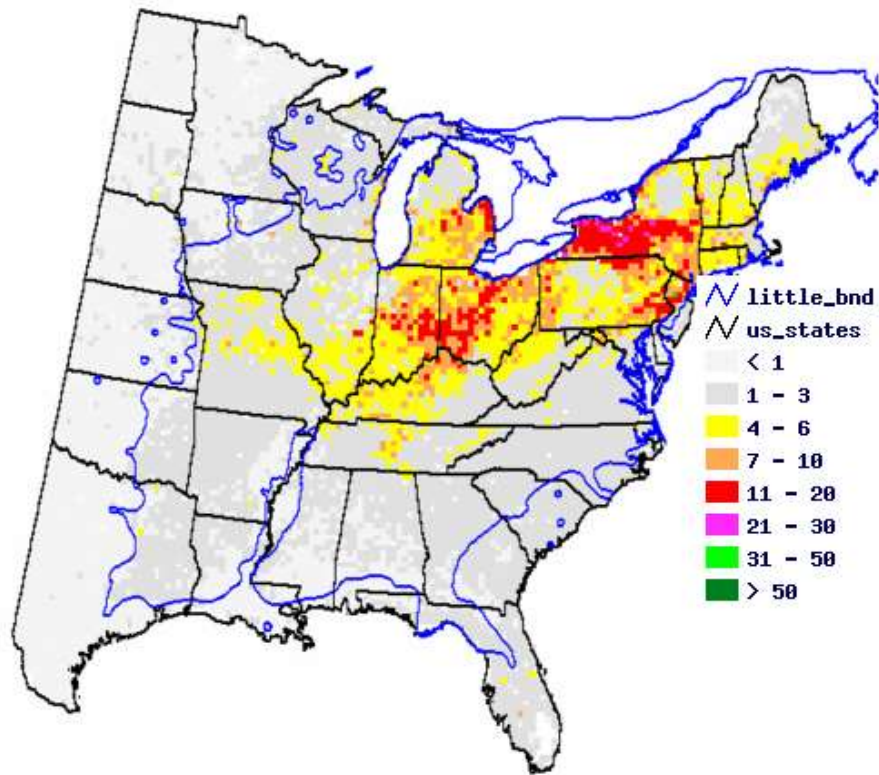
RSAC Remote Sensing
Applications
Center

White Ash Habitat Shift - 2100

Climate Scenario Menu

Choose Climate Scenario from Menu

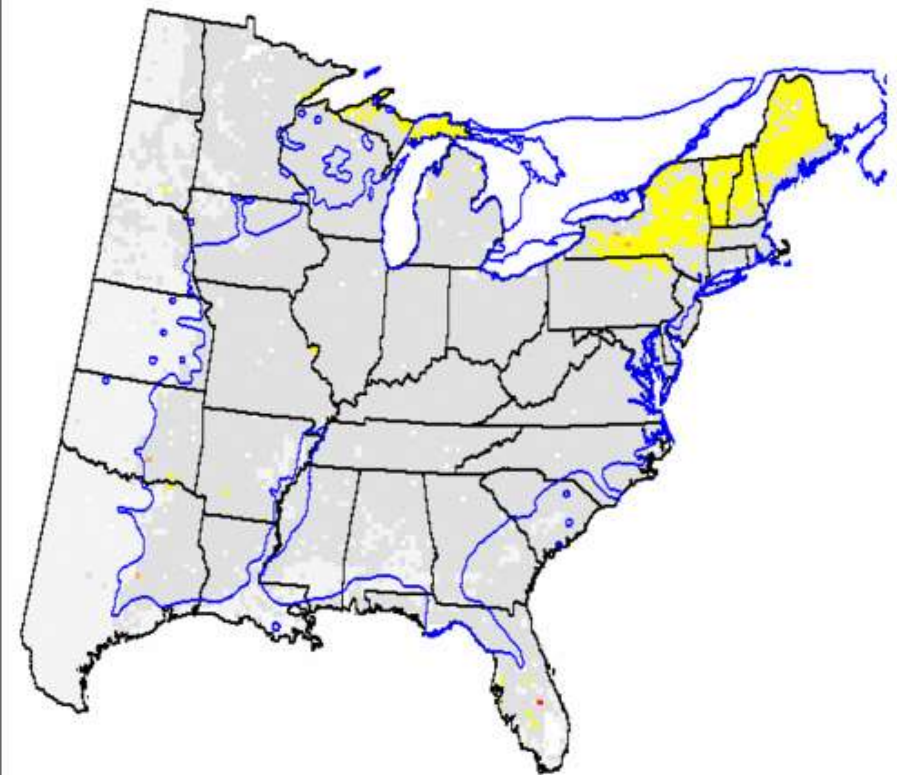
Current Modelled



Climate Scenario Menu

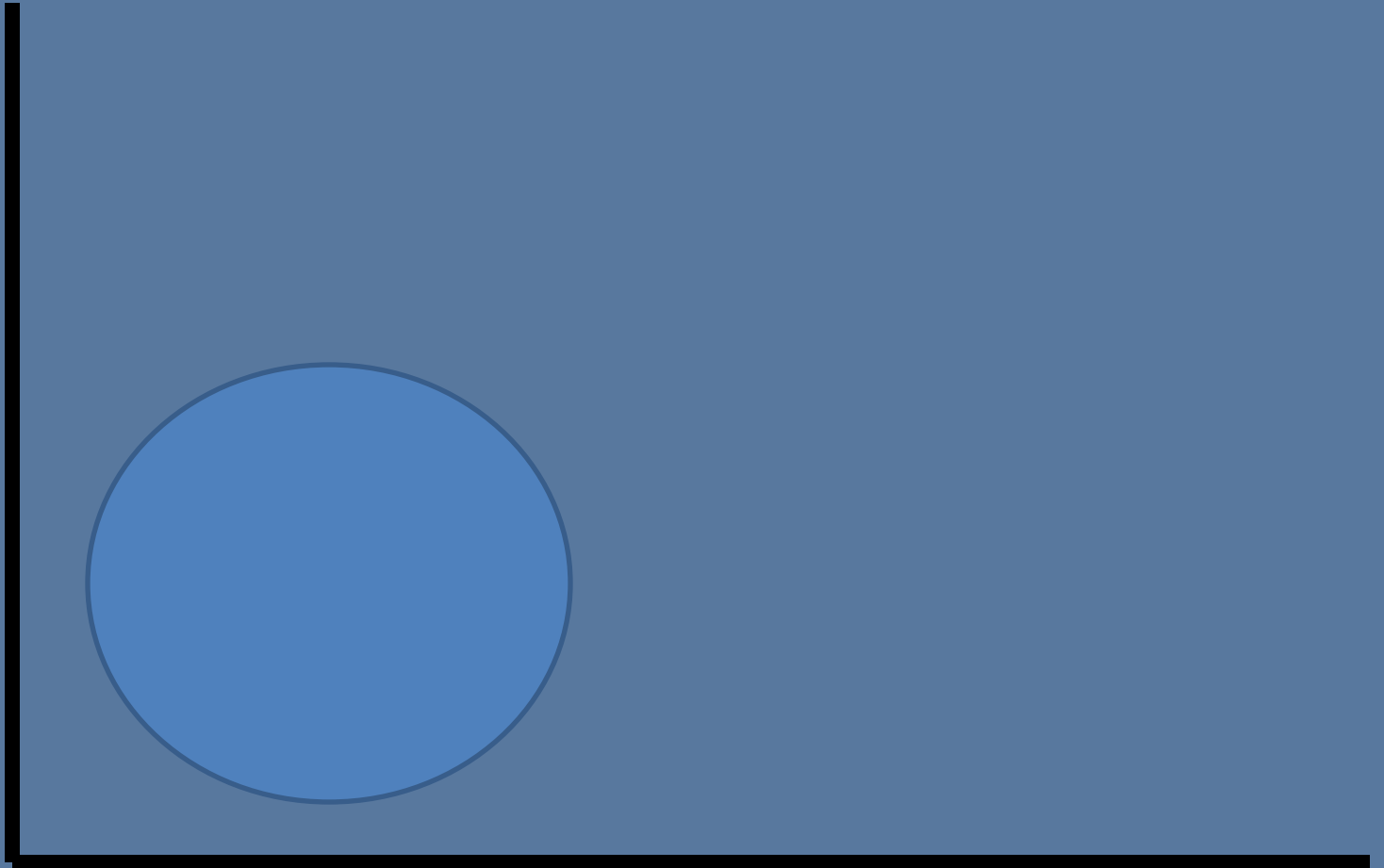
Choose Climate Scenario from Menu

Hadley - High



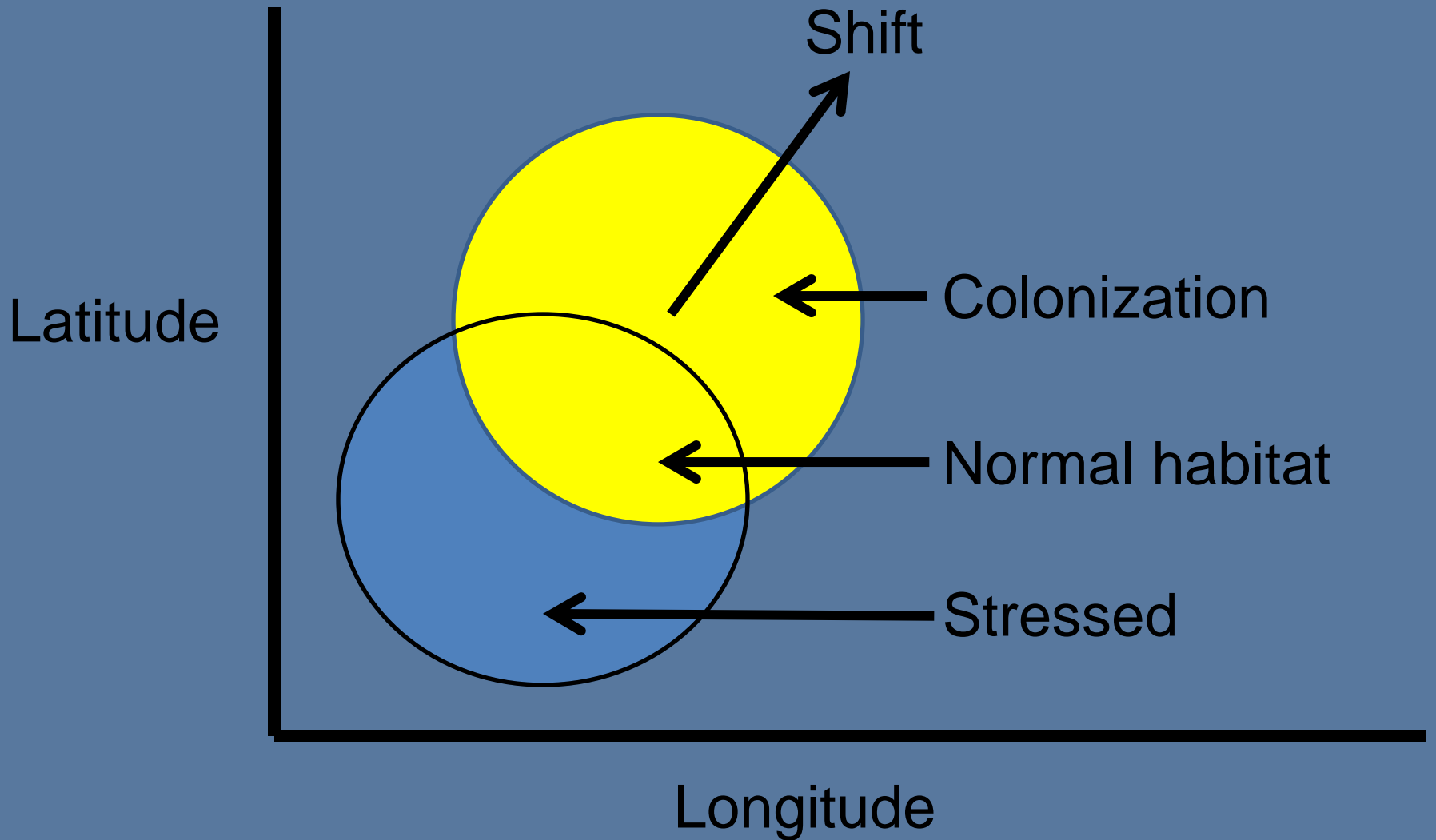
Current Habitat

Latitude



Longitude

Habitat Shift





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