The effects of foundation species removal on rodent community composition in eastern hemlock (*Tsuga canadensis*) forests

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- **Hemlock woolly adelgid infestation may indirectly affect small mammal community structure in eastern hemlock forests.**

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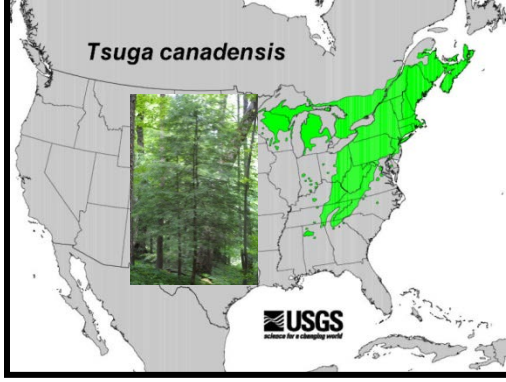
http://www.nsrcforest.org

Project Summary



The eastern hemlock is an important tree species in New England that stabilizes microclimate and supports wildlife. The loss of eastern hemlocks can potentially influence the structure of animal communities. Unfortunately, eastern hemlock abundance is declining within its range (New England-Southern Appalachia) from the effects of the invasive sap-sucking insect, the hemlock woolly adelgid. The loss of eastern hemlocks in New England forests may impact community composition of ecologically important forest-dwelling small mammals (rodents and shrews). In order to determine if small mammal biodiversity and composition differ among insect-invaded hemlock forests and healthy hemlock forests, I have examined small mammal community assemblages in New England at Harvard Forest's Hemlock Removal Experiment in Petersham Massachusetts. The experiments uses 8 90 x 90m plots with 2 plots assigned to each four treatments: 1) unmanipulated hemlock control, 2) unmanipulated hardwood control, which represents a hemlock stand 50 years after hemlock woolly adelgid invasion, 3) girdled treatment, which hemlock trees have been killed using chainsaws to simulate the effect of hemlock woolly adelgid invasion, and 4) logged treatment, which is a simulated commercial logging management plan to prevent the spread of the hemlock woolly adelgid by removing hemlock and hardwood trees. Small mammals were captured in Sherman live traps from June-July 2013 for a total of 3,480 trapping nights (number of nights × number of traps). The live traps were set at dusk and were checked early morning. Captured animals were identified, marked with non-toxic ink or Passive Integrated Transponders (PIT tags), and released (alive) back into the plots they were captured in. There was a total of 140 captures in 18 nights. The hardwood plots had the most captured species (n=10) and the most total captures (n=54). The white-footed mouse was the most captured species in the hardwood plot. These data suggest that the presences of hemlock woolly adelgid in hemlock forests does affect small mammal communities. The girdled plots had only one more species (the eastern chipmunk) than the hemlock control. The logged plots had the fewest species captured, suggesting that preemptive logging techniques used in forest management to prevent the spread of hemlock woolly adelgid may decrease the presence of southern red-backed voles, southern flying squirrels, and smokey shrews in these hemlock forests.

Background: Eastern Hemlocks

Eastern hemlock

Eastern Hemlocks are important because they…

- are abundant
- stabilize local climate
- provide critical habitat for deer and other mammals in northern forests

Background: Small Mammals

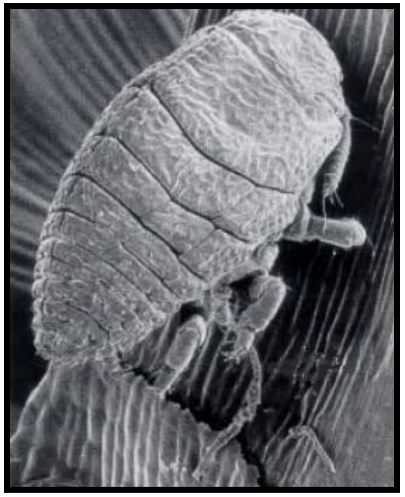
Small mammals are important because they…

- can carry Lyme disease and Hantavirus
- disperse seeds of trees and forest herbs
- food source for many animals

Top: *Dipodomys merriami*: a seed dispersing rodent.
Bottom: *Microtus longicaudus:* a plant eating rodent.

Justification: Hemlock Woolly Adelgid Kills Hemlocks

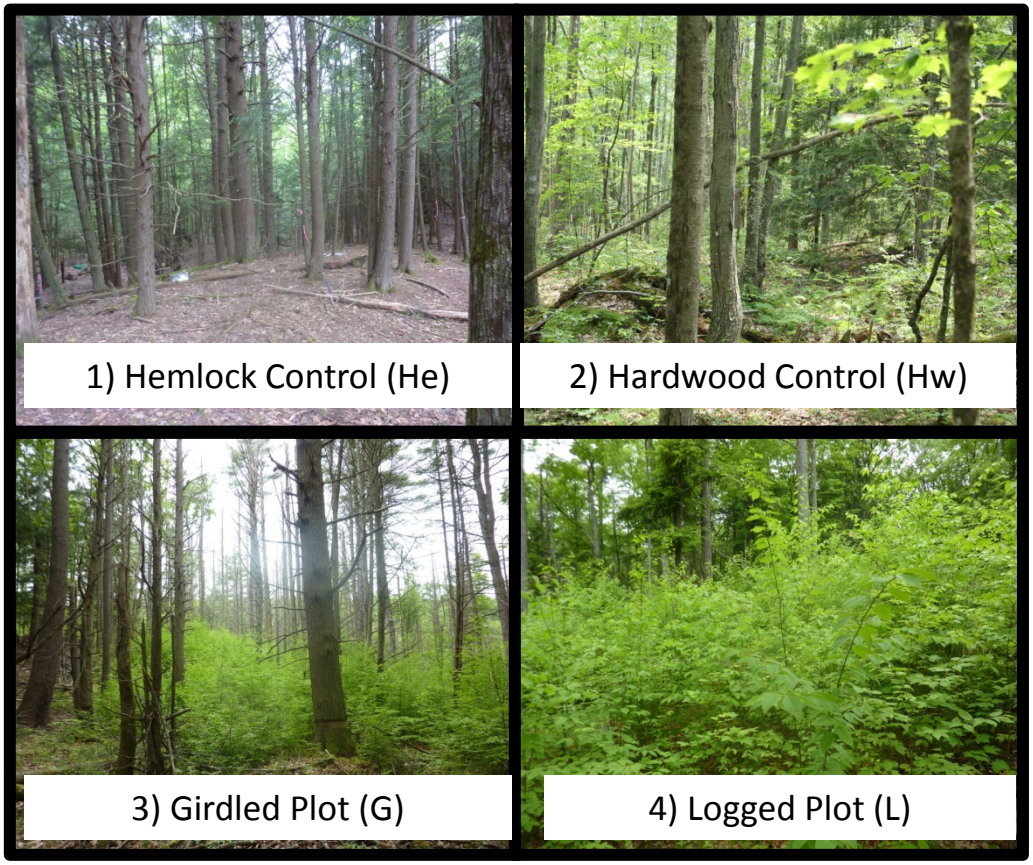
- The hemlock woolly adelgid continues to invade and destroy New England's hemlock forests.
- This project will experimentally determine if changes in small mammal populations are a result of invasion by the hemlock woolly adelgid.
- Understanding the relationship between eastern hemlocks, woolly adelgid, and small mammals can help forest managers conserve eastern hemlock stands and predict forest regeneration states if the woolly adelgid infestation continues to spread.



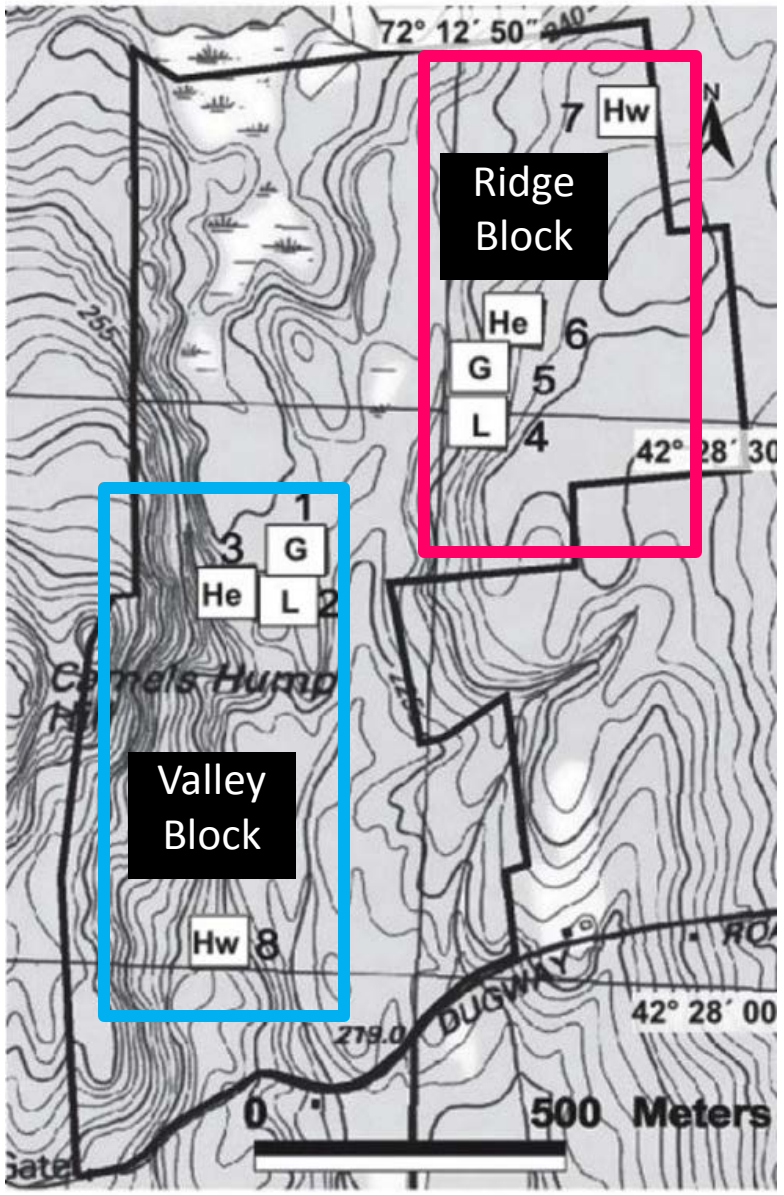
Top: *Adelges tsugae*, hemlock woolly adelgid . Bottom: Sign of woolly adelgid infestation on hemlocks (nymphs produce wool-like tufts that cover their bodies).

Methods: HF-HeRE in New England

- 4 forest treatments
- 8 (90 x 90m) plots
- 49 small mammal traps (7 x 7 array) in each plot



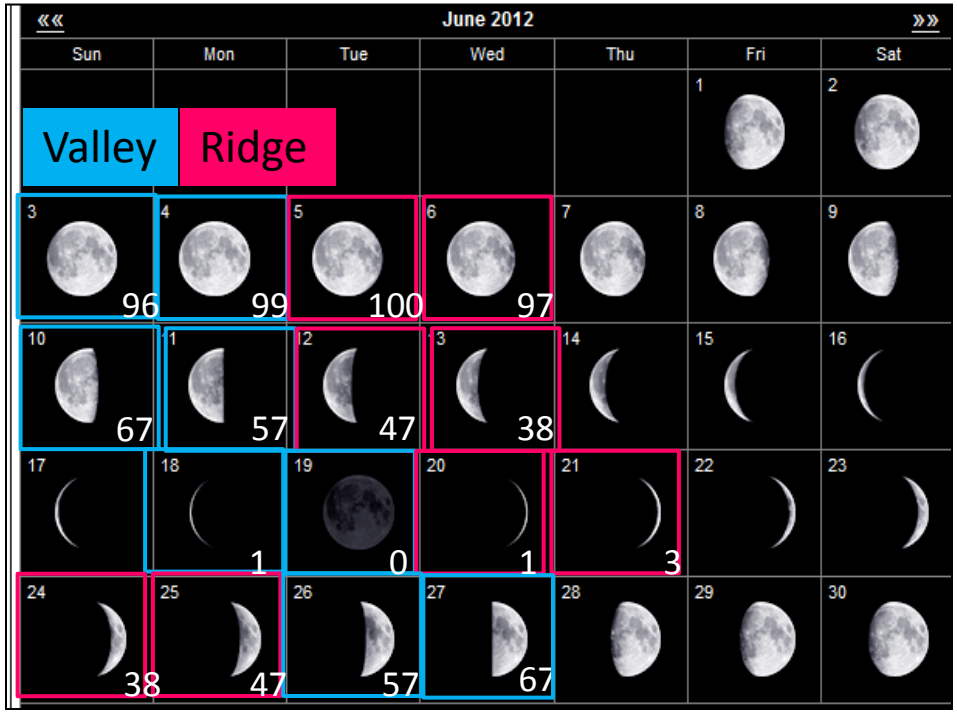
Pictures of the differences among forest canopy treatments in HF-HeRE.



Map of HF-HeRE located in Petersham, MA

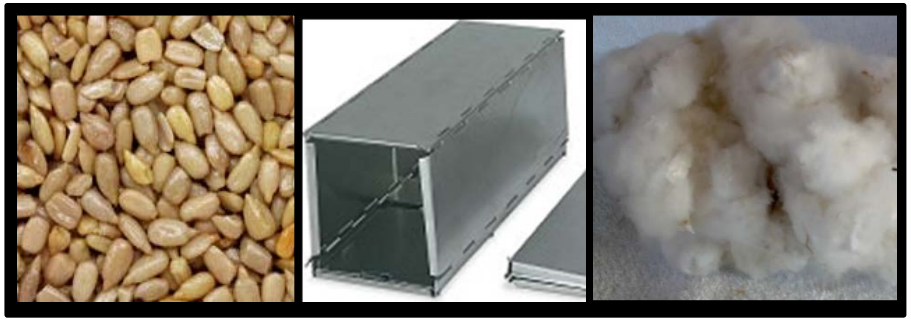
Methods: Trapping

- Because small mammal activity may be affected by moonlight availability, traps were set at different moon phases.



This is an example of a monthly trapping schedule at different moon phases. Outline colors are the blocks (Valley and Ridge) and the number in the bottom right corner is the percent of moon face showing that night (NASA: MoonPhase 3.3)

- Sherman-live traps were baited with nutritious sunflower seeds. Fresh raw cotton was provided for insulation. Animals were marked with non-toxic ink or Passive Integrated Transponders.



Picture from top-left to right : Sunflower seeds used as a high calorie bait; Sherman live-trap in which animals were captured and housed over night; fresh cotton used as insulation; marked deer mouse.

Methods: Measurements & Calculations

- Trapping effort
- Species Richness
  - Number of species per plot
- Overall captures
  - Total number of captures per plot
- Relative abundance
  - Species composition
- Population estimates
  - Mark-recapture
- Outreach
  - Presentations

Results: Trapping Effort

- 3,480 Trapping Nights
  - (number of traps x number of nights)

Top: Allyson Degrassi setting up the capture grid in the logged plot were there is dense under growth vegetation.
Left: Allyson Degrassi work getting ready to check traps and handle small mammals. Everything from the long sleeves, mask, and gloves, to the goggles are safety precautions to reduce the chance of contracting Lyme Disease Hanta virus .

Results: Species Richness
10 Species!


Deer mouse


White-footed mouse


Woodland jumping mouse


Eastern chipmunk


Southern flying squirrel


Red-backed vole

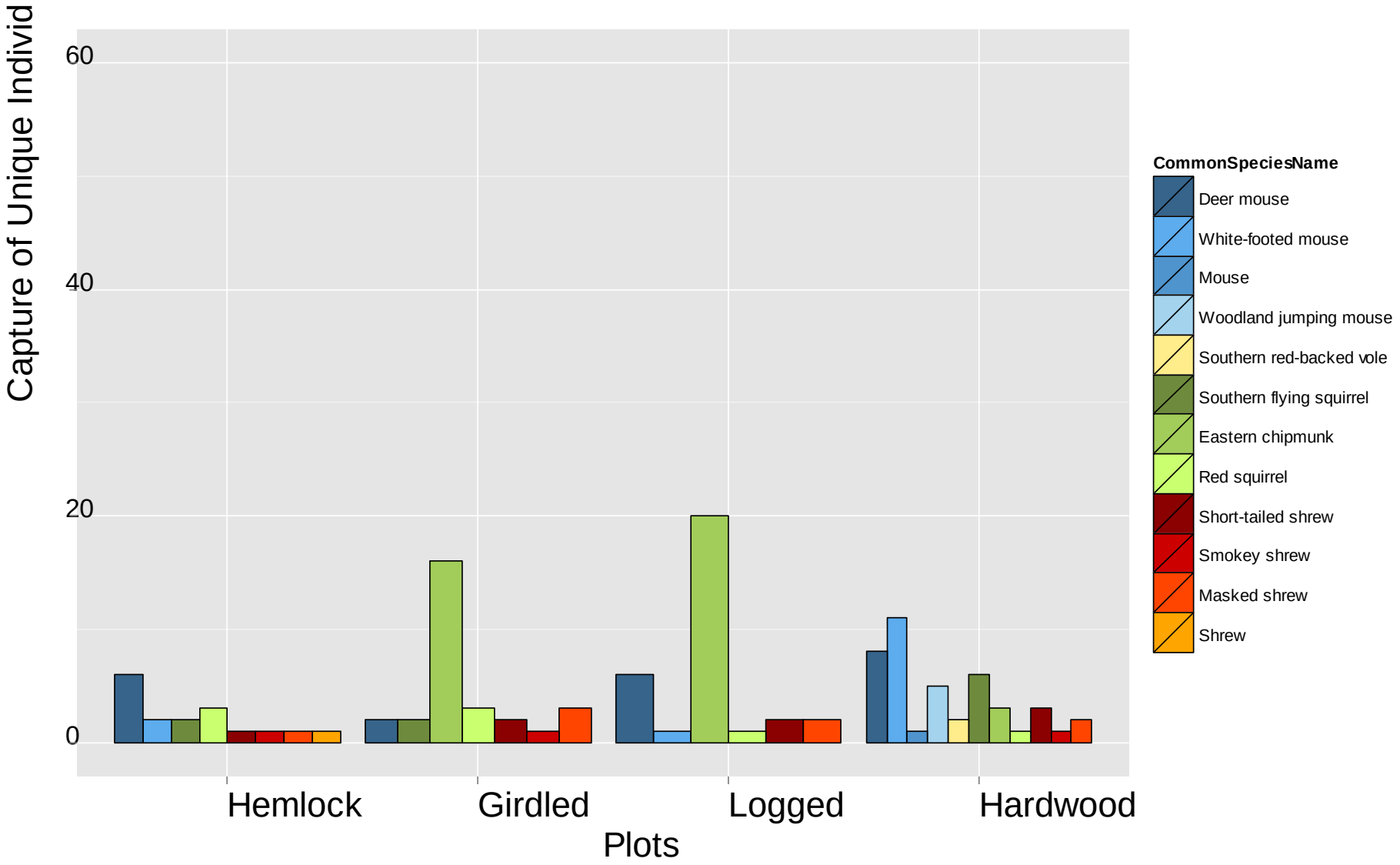

Red squirrel


Short-tailed shrew

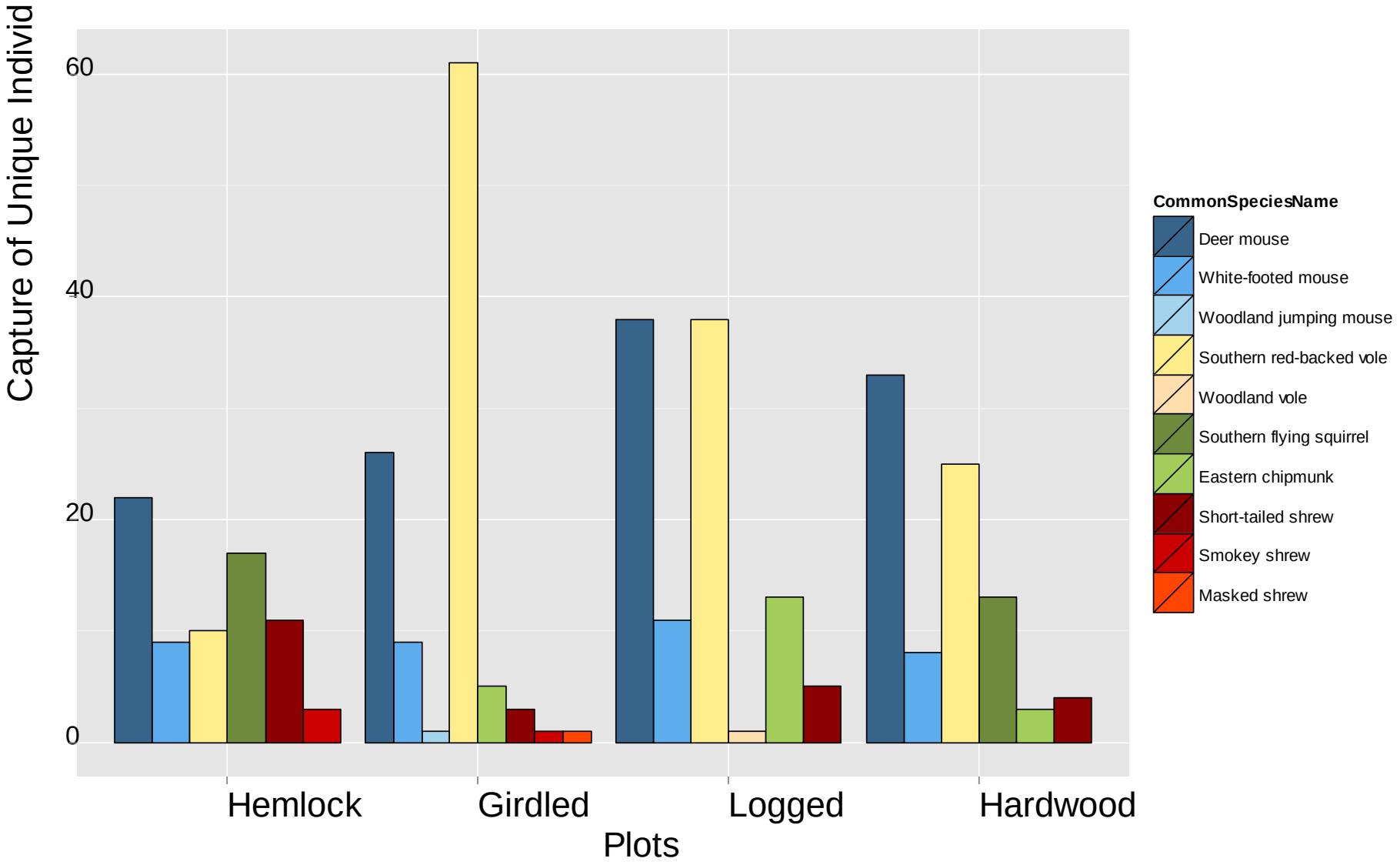

Smokey shrew


Masked shrew

In 2013, more species of small mammals in hardwood plots than in any other treatment; followed by hemlock, girdled, logged treatment.



However, in 2012, more species of small mammals were captured in girdled treatments than in any other treatment.

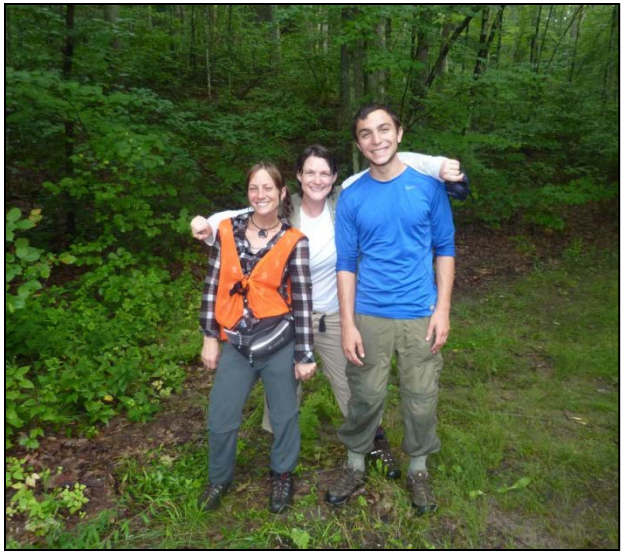


Results: Outreach

- Research Experience for Undergraduate (REU) Mentor
  - 2 undergraduate students in 2013. I was asked to come back and co-mentor 6-REU students for 2014 to continue small mammal data collection in hemlock experiments.
  - I taught “Scientific Ethic Lunch” and “How to write an abstract” and was an invited panelist for “Graduate Panel Night” for ~26 REU students in 2012- 2014.
  - I continue to work with REU students from 2013 on building posters and talks while encouraging them to attend conferences to present 2013 results.

2012 REU student Beth Kennett and I hiking into the forest to set traps

2013 REU students Amy Balint and James Leitner and I after a great morning collecting data.

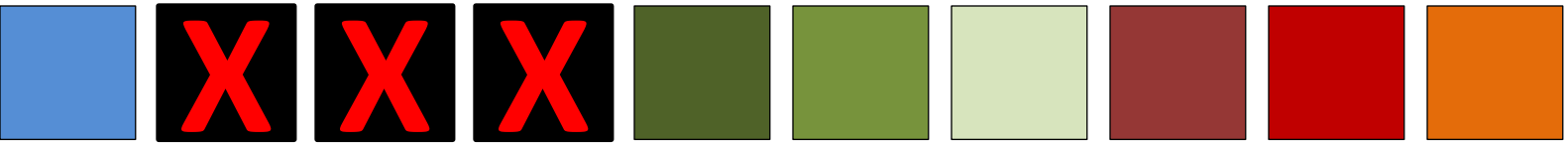


Results: Outreach

- Volunteer Instructor for VT Fish and Wildlife
  - I teach population dynamics and conservation in Hunter's Education. I discuss the importance of habitat conservation and use the hemlock woolly adelgid threat as an example of how changes within the forests impact other wildlife life species.
- Developing Workshops for Students with Learning Disabilities
  - Working with University of Vermont's ACESS program to develop workshops on "How to Succeed in Science with Learning Disabilities"
- Vermont Math and Science Fair Judge
  - 2013 & 2014
- Website
  - I created a website that describes my research in detail. I hope that the creation of the website will encourage the public to become more aware of the loss to hemlock forests due to the hemlock woolly adelgid.
  - Once I collect more data, I will make it available for use.
  - I have also posted links to NSRC on my website in order to increase collaboration among scientists and non-scientists .
  - http://www.uvm.edu/~adegrass/
- Presentations
  - I was an invited speaker at Ecological Society of America (ESA)
  - EcoLunch at University of Vermont

Hemlock forest support mice, flying squirrels, red squirrels, and shrews.

Hemlock



Hemlock woolly adelgid removes white-footed mice and adds chipmunks.

Girdled

Preemptive logging removes flying squirrels and masked shrews, but adds chipmunks.

Logged

In ~50 years after the hemlock woolly adelgid kills hemlocks trees, there may be mice, voles, flying squirrels, chipmunks, and shrews present in regrowth hardwood.

Hardwood

2013 results differed from 2012 results; there was ~8-fold decrease in captures from 2012 to 2013 and no red squirrels were captured in 2012. Voles and masked shrews were not in hemlock plots in 2012.

Hemlock

In 2012, the adelgid treatment plots did not contain flying squirrels, but did contain woodland jumping mice, chipmunks, and masked shrews.

Girdled

In 2012, preemptive logging removed flying squirrels, smokey and masked shrews, but added chipmunks.

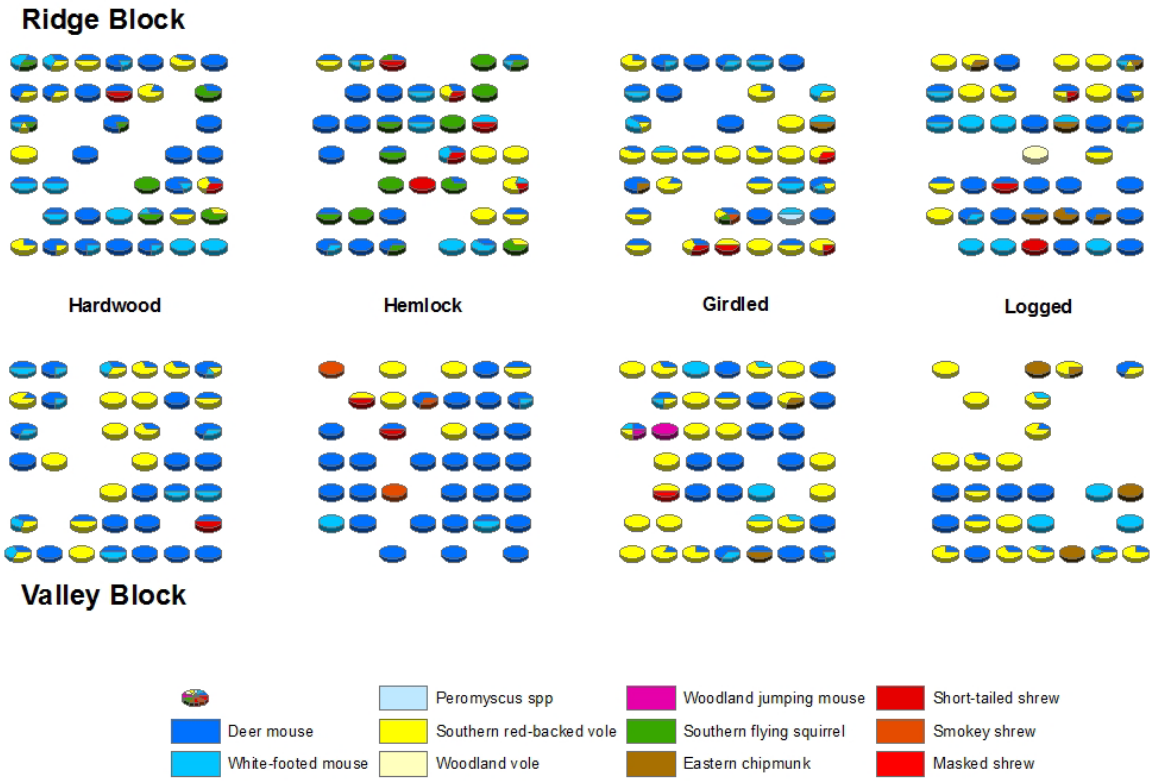
Logged

In 2012, the hardwood controls contained mice, voles, flying squirrels, chipmunks, and only one species of shrews. These results suggests that mammal species composition in hemlock forests may be changing as a result due to the hemlock woolly adelgid.

Hardwood

Future directions

- Mapping small mammal movement
  - Using Geographic Information Systems (GIS), I will map small mammal movement within each treatment to determine if hemlock woolly adelgid affects small mammal distributions and if the effects are unique to particular species.



This is an example of a where individual species were captured within each treatment.

Future directions

- Mapping small mammal habitat associations
  - Using digital imaging, I will calculate percent cover of rock, soil, leaf litter, woody debris, vegetation, and canopy cover for each grid location . Using GIS, I will map microhabitat characteristics against small mammal captures to determine if hemlock woolly adelgid invasions affect small mammal microhabitat associations.

List of products

This project was supported by the Northeastern States Research Cooperative through funding made available by the USDA Forest Service. The conclusions and opinions in this paper are those of the authors and not the NSRC, the Forest Service, or the USDA.

- Peer-reviewed publications
  - The effects of foundation species removal on rodent community composition in eastern hemlock (*Tsuga canadensis*) forests (expected 2016)
  - The effect of hemlock woolly adelgid on microhabitat habitat association of small mammals in New England forests (expected 2016)
  - The effects of hemlock woolly adelgid on small mammal nightly activity in New England forests (expected 2016)
- Other publications
  - Doctorial Dissertation: The effects of hemlock woolly adelgid on small mammal ecology in New England forest (expected 2016)
- Conference presentations
  - The effects of foundation species removal on small mammal community composition in eastern hemlock (*Tsuga canadensis*) forests (expected poster at American Society of Mammalogists Annual Conference 2015).
  - The effects of hemlock woolly adelgid small mammal community composition in eastern hemlock forests (expected talk at Ecological Society of America Annual Conference 2015)
- Websites
  - This project is posted on my website: http://www.uvm.edu/~adegrass/research.html
- Databases
  - I will make my data available on my website: http://www.uvm.edu/~adegrass/research.html
  - My data are archived in Harvard Forest's Data Archives and will be available after I publish http://harvardforest.fas.harvard.edu/data-archives
- Leveraged grants that resulted from your NSRC funding
  - American Society of Mammalogists Grant-In-Aid 2014
  - Travel Grant from University of Vermont 2013