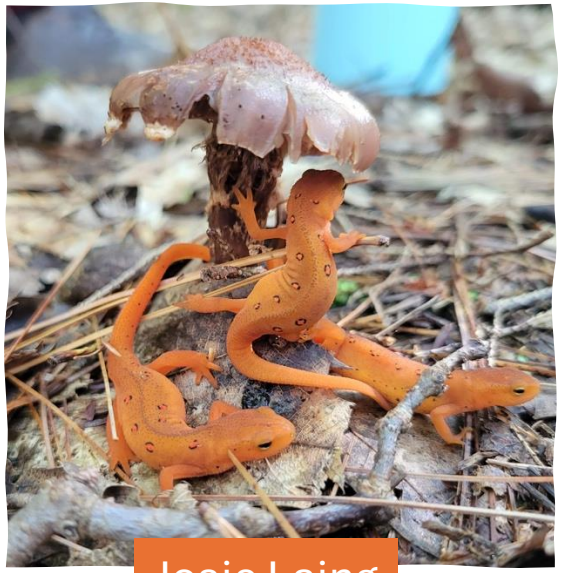
HAWTHORNE VALLEY
farmscape ecology program

Ancient Forest Project



Josie Laing



Kyle Bradford

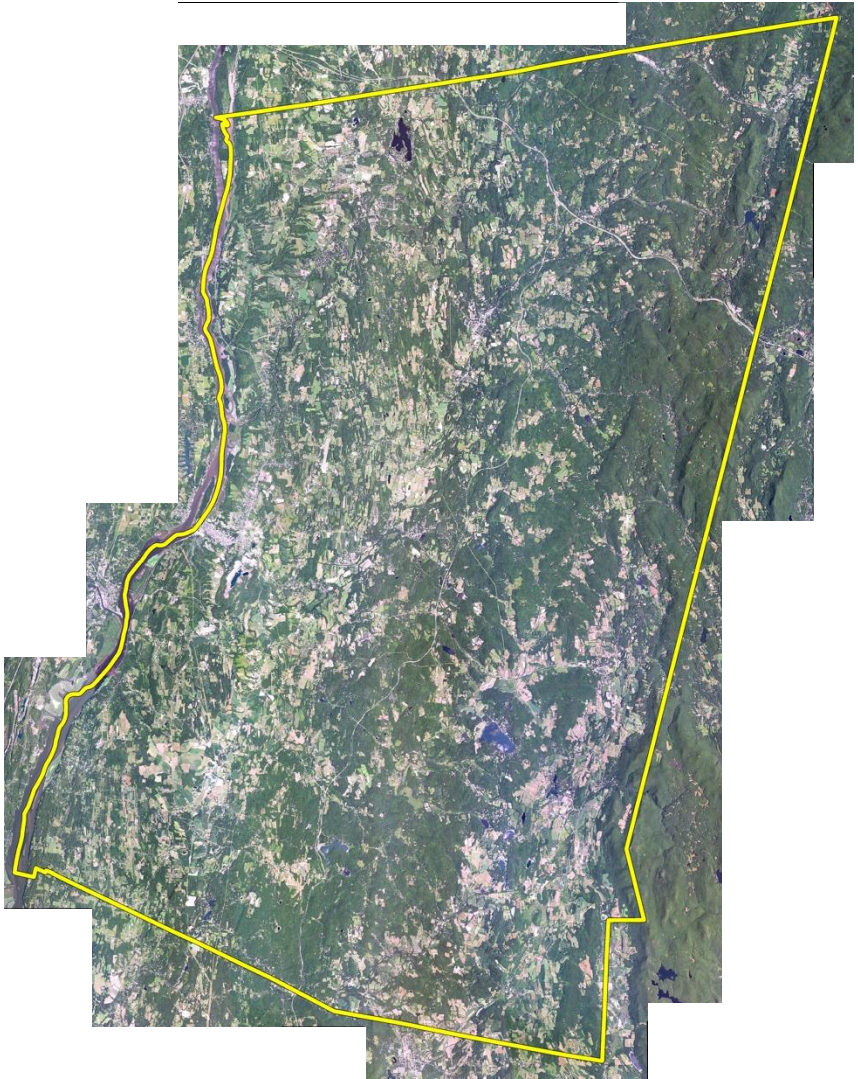


Laura Stark


Introduction
Defining Ancient Forests
Mapping Ancient Forests
Pilot Study 2024
Next Steps



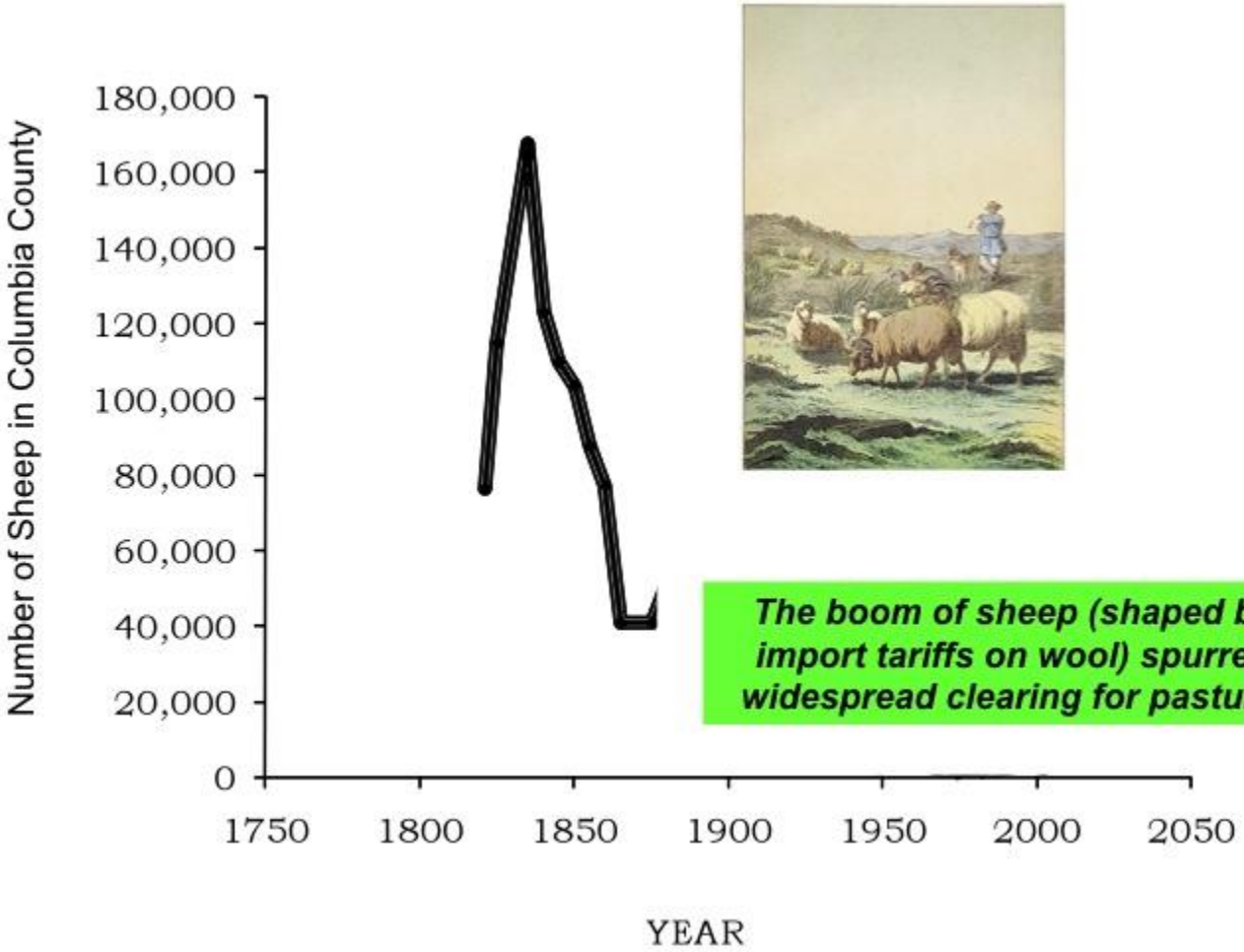
Introduction



By **1800**,
half the forests in Columbia County were likely cleared.
Remaining forests had various uses.

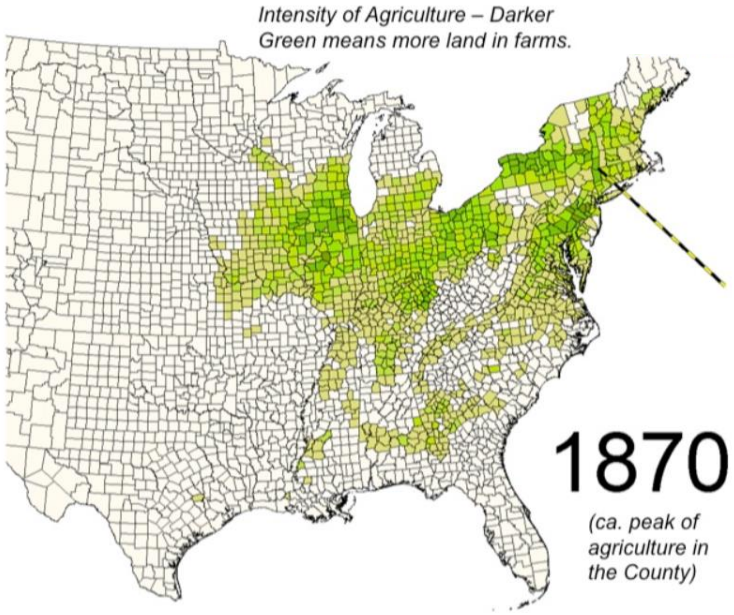


1800 1850 1900 1950

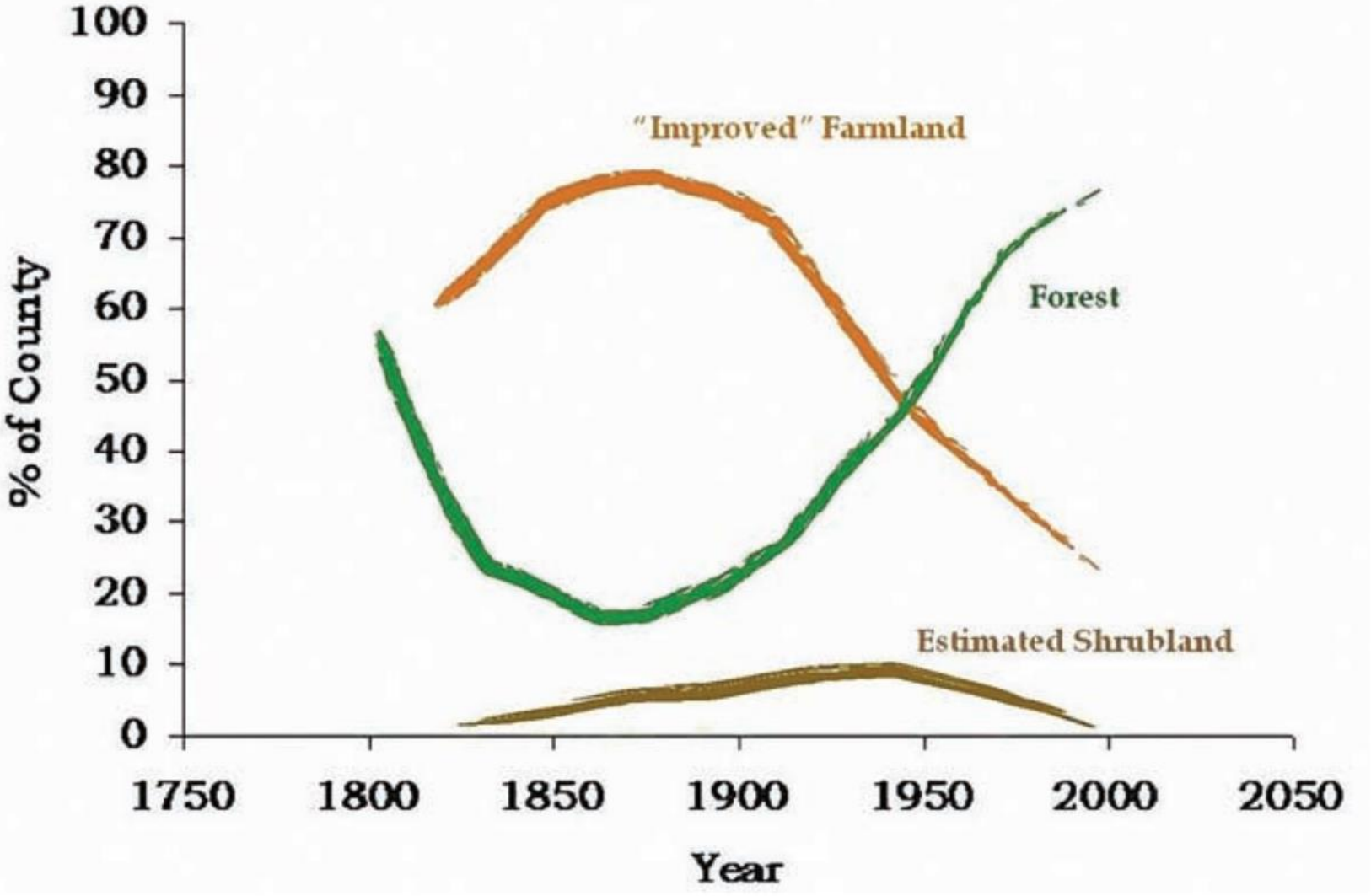

Number of Sheep in Columbia County
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1750
1800
1850
1900
1950
2000
2050
YEAR
The boom of sheep (shaped by import tariffs on wool) spurred widespread clearing for pasture.



By **1870**, agriculture peaked and 80% of forests were cleared.



1800 1850 1900 1950

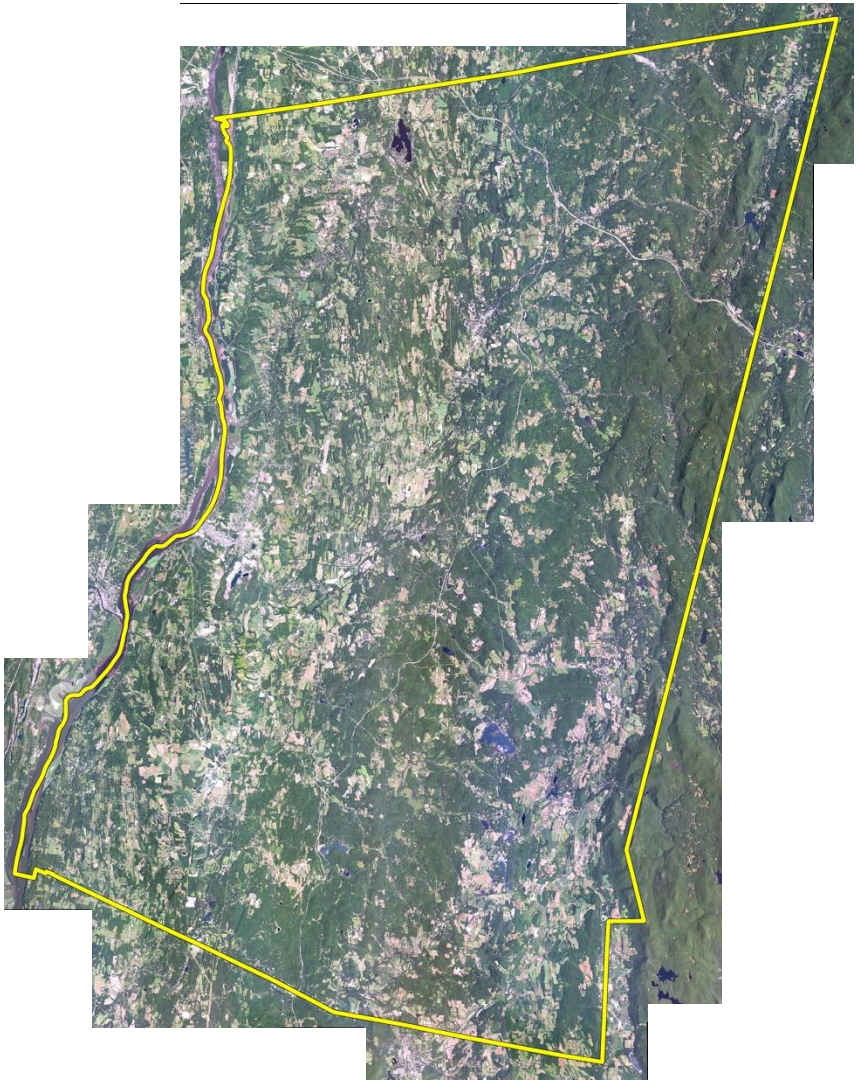

100
90
80
70
60
50
40
30
20
10
0
% of County
"Improved" Farmland
Forest
Estimated Shrubland
1750
1800
1850
1900
1950
2000
2050
Year

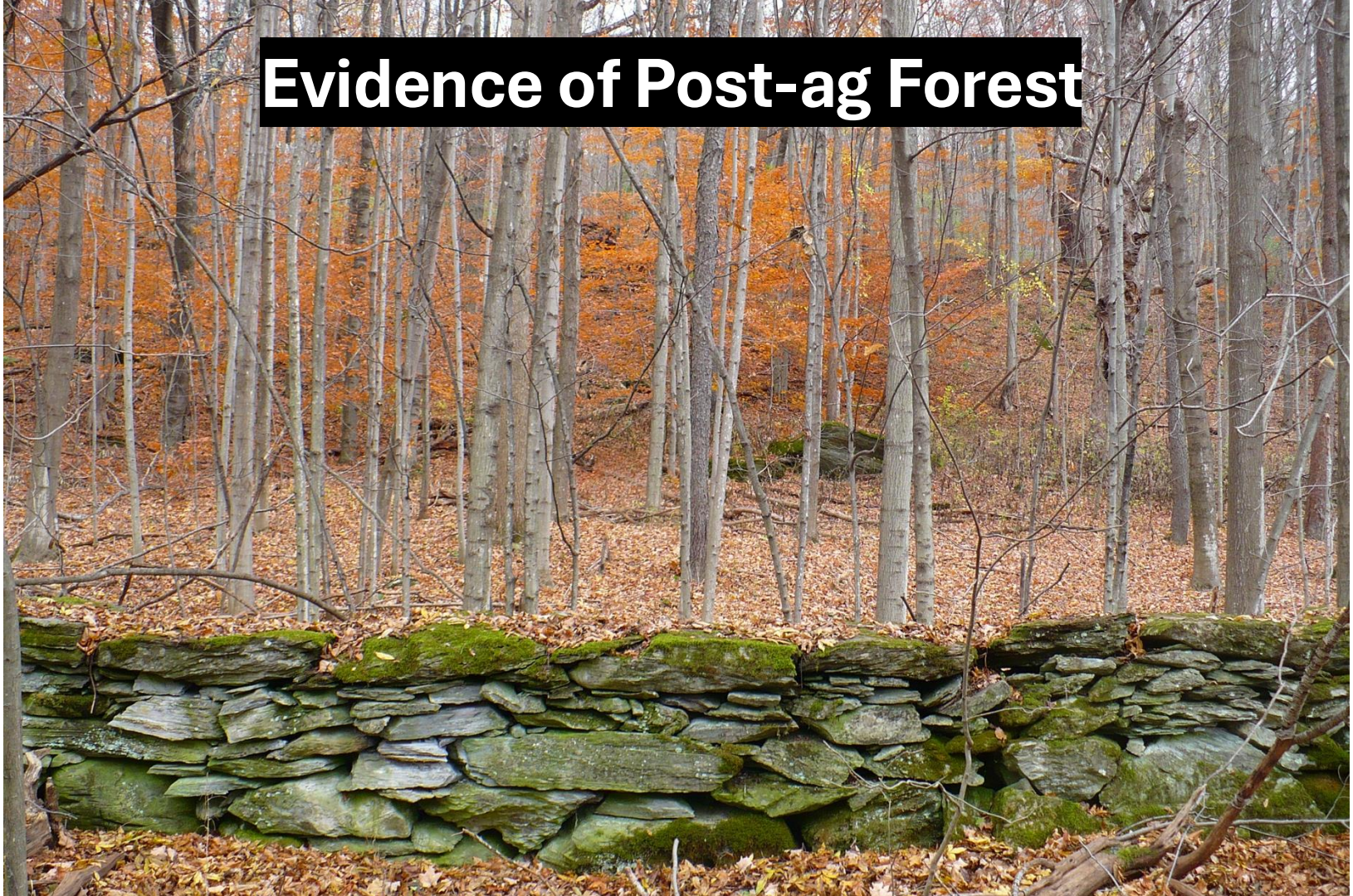


By **1942**,
we have our earliest
historical aerials.

1800 1850 1900 1950






Evidence of Post-ag Forest

White Pine Weevil



Eastern Pine Weevil © Darrah Leffler

(licensed under CC BY 4.0; https://creativecommons.org/licenses/by/4.0/).



- Ancient forest will have more uneven microtopography
- Pits and mounds created from tree tip-ups











Defining Ancient Forest

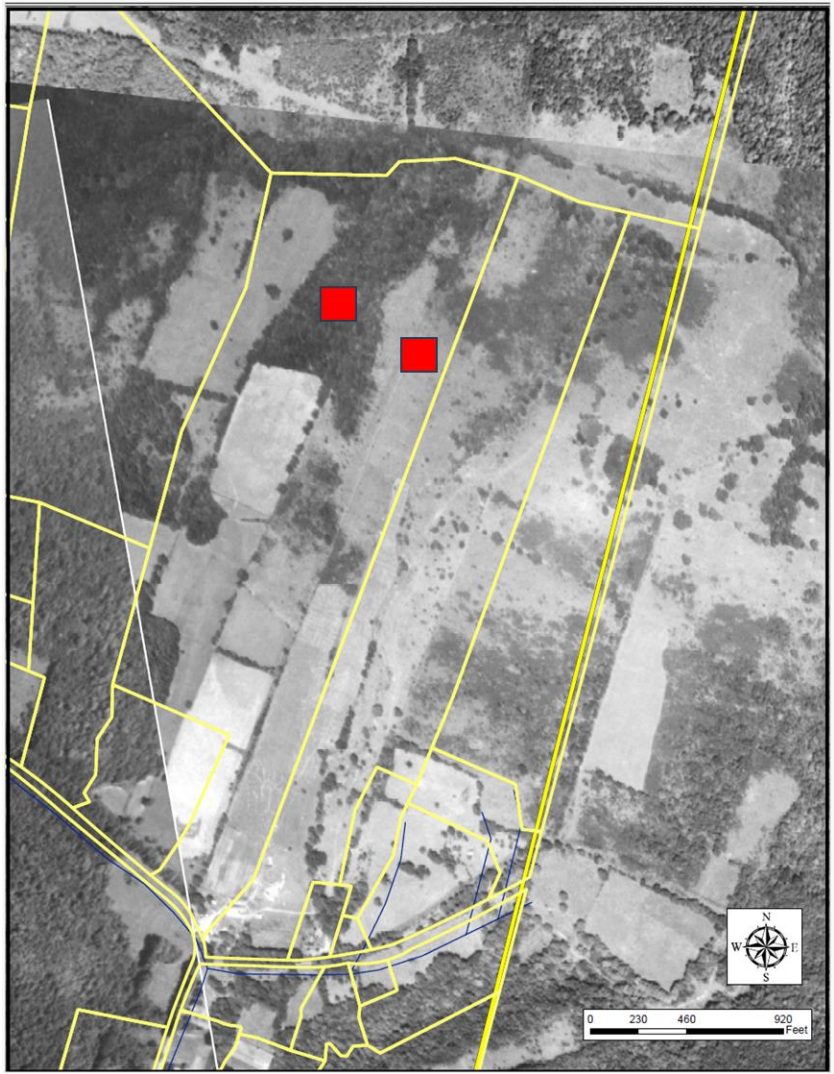
Ancient Forest Definition

1. Mature forest visible in the earliest aerial photos (1940s) available for our region.

2. No signs of past agricultural clearing (e.g., stone walls, plow lines, pasture trees or other artifacts).

3. Likely experienced some logging.

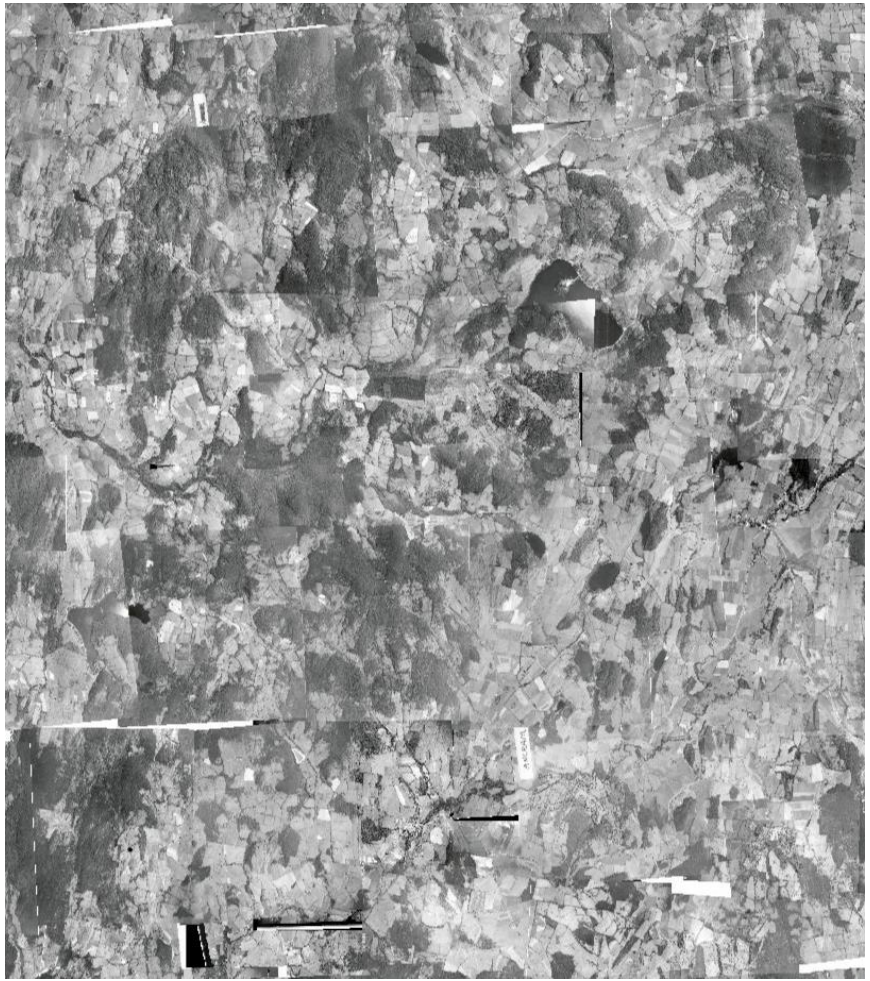
4. Big trees? Not necessarily.





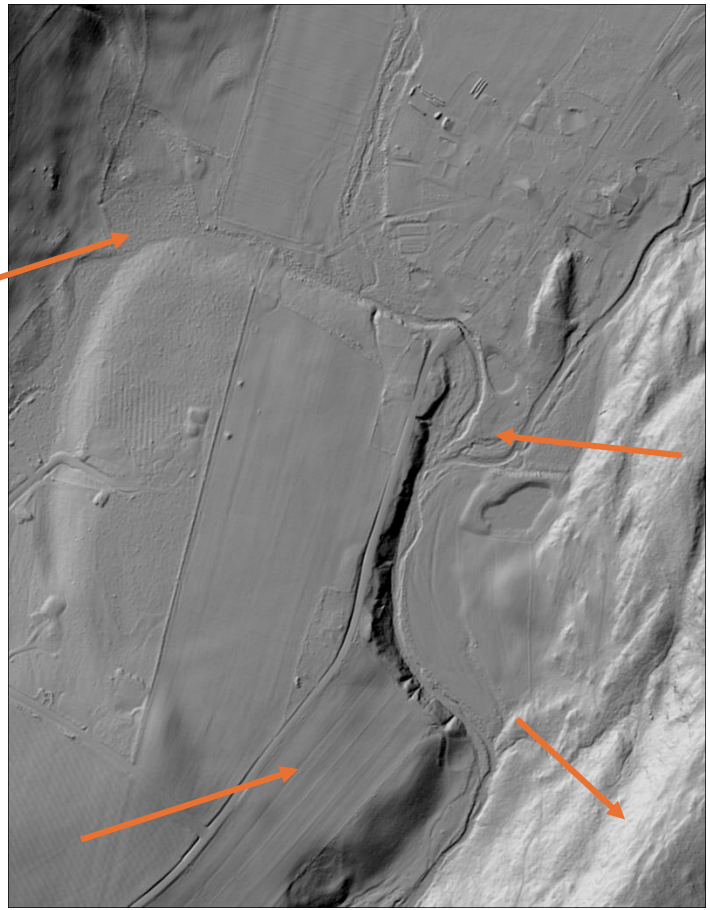
Mapping Ancient Forests

Historical Aerial Photos from the 1940s



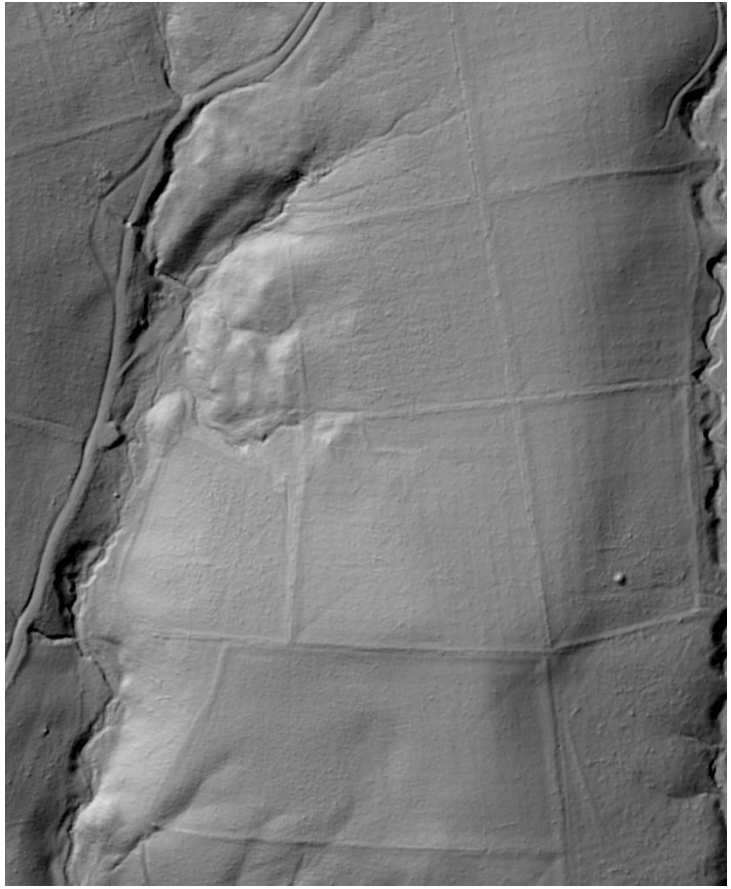
Light Detection and Ranging (LIDAR)

2016



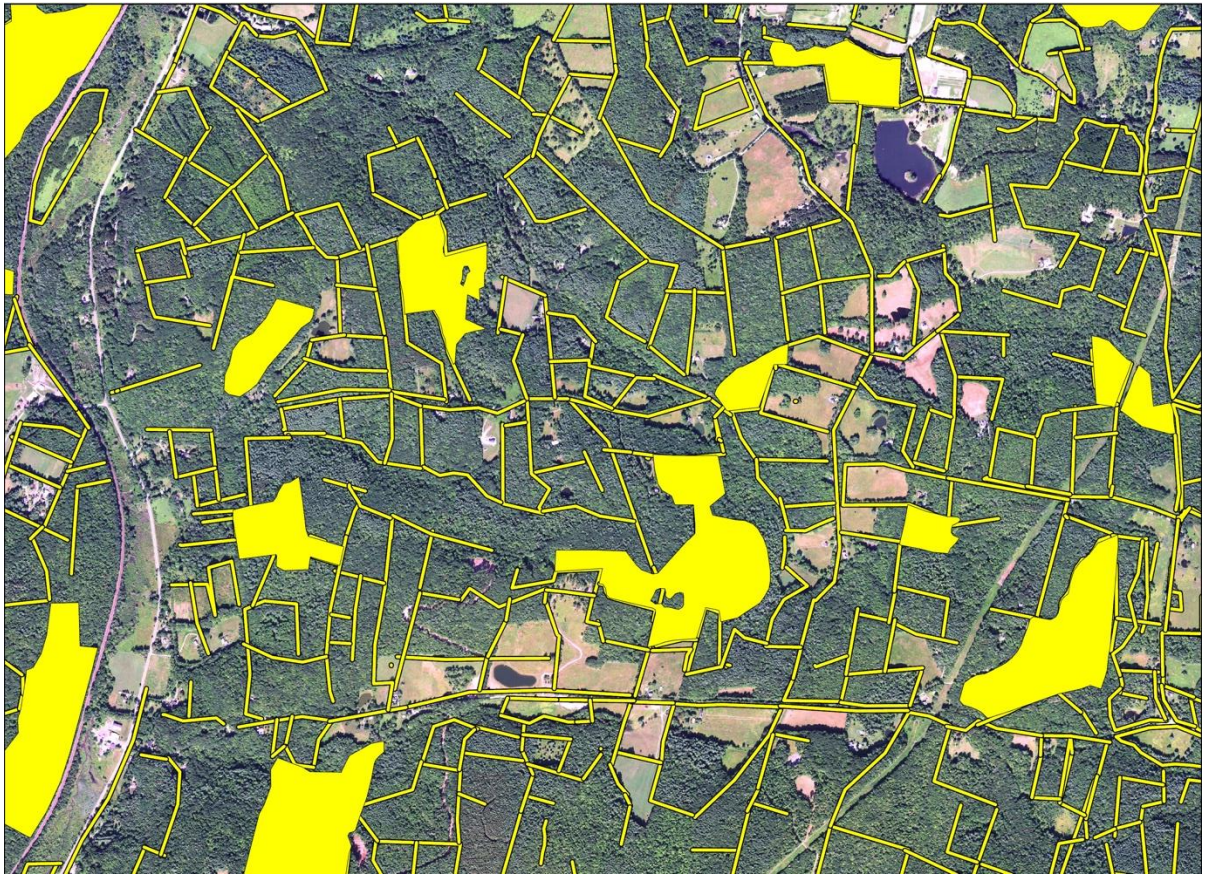


LIDAR

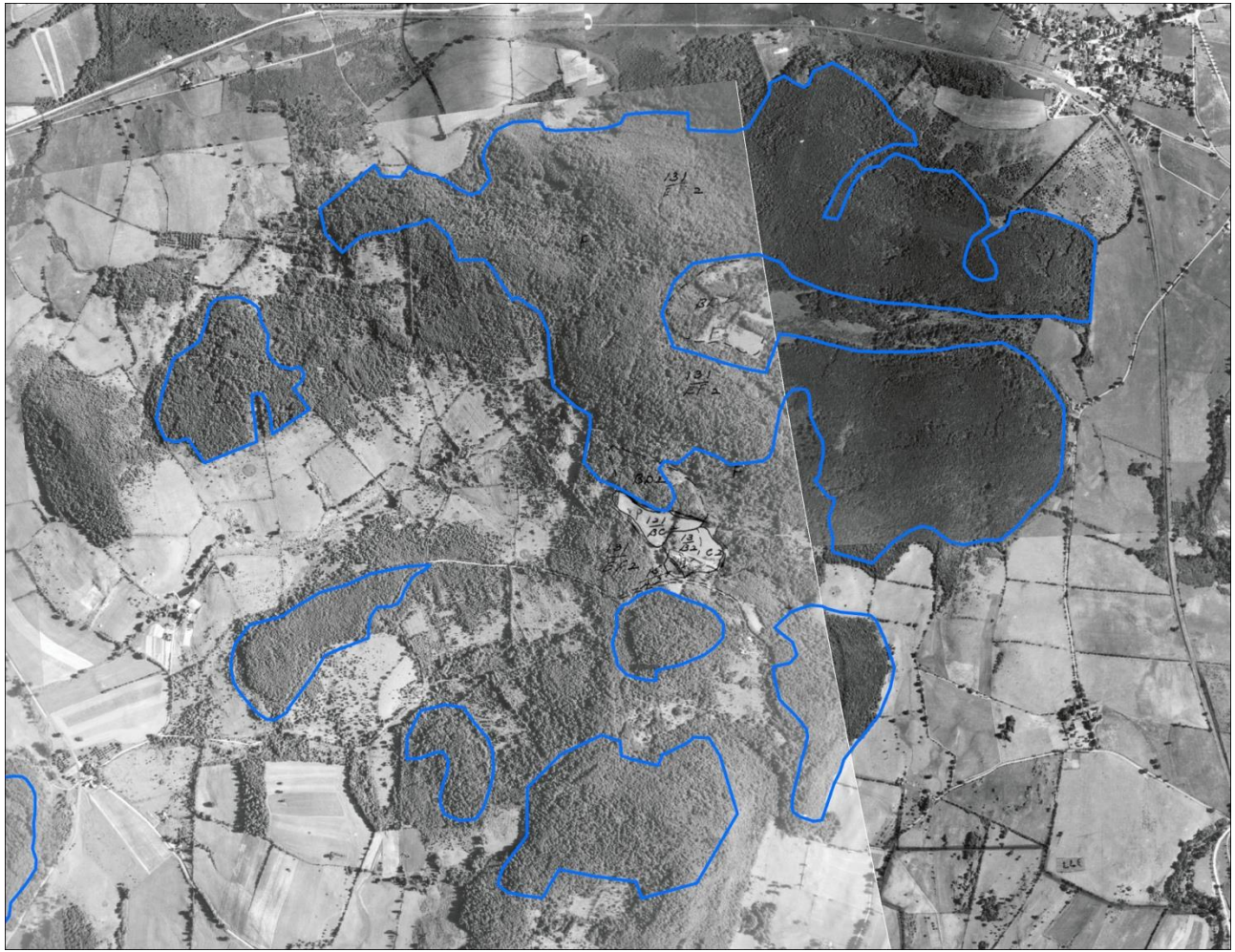




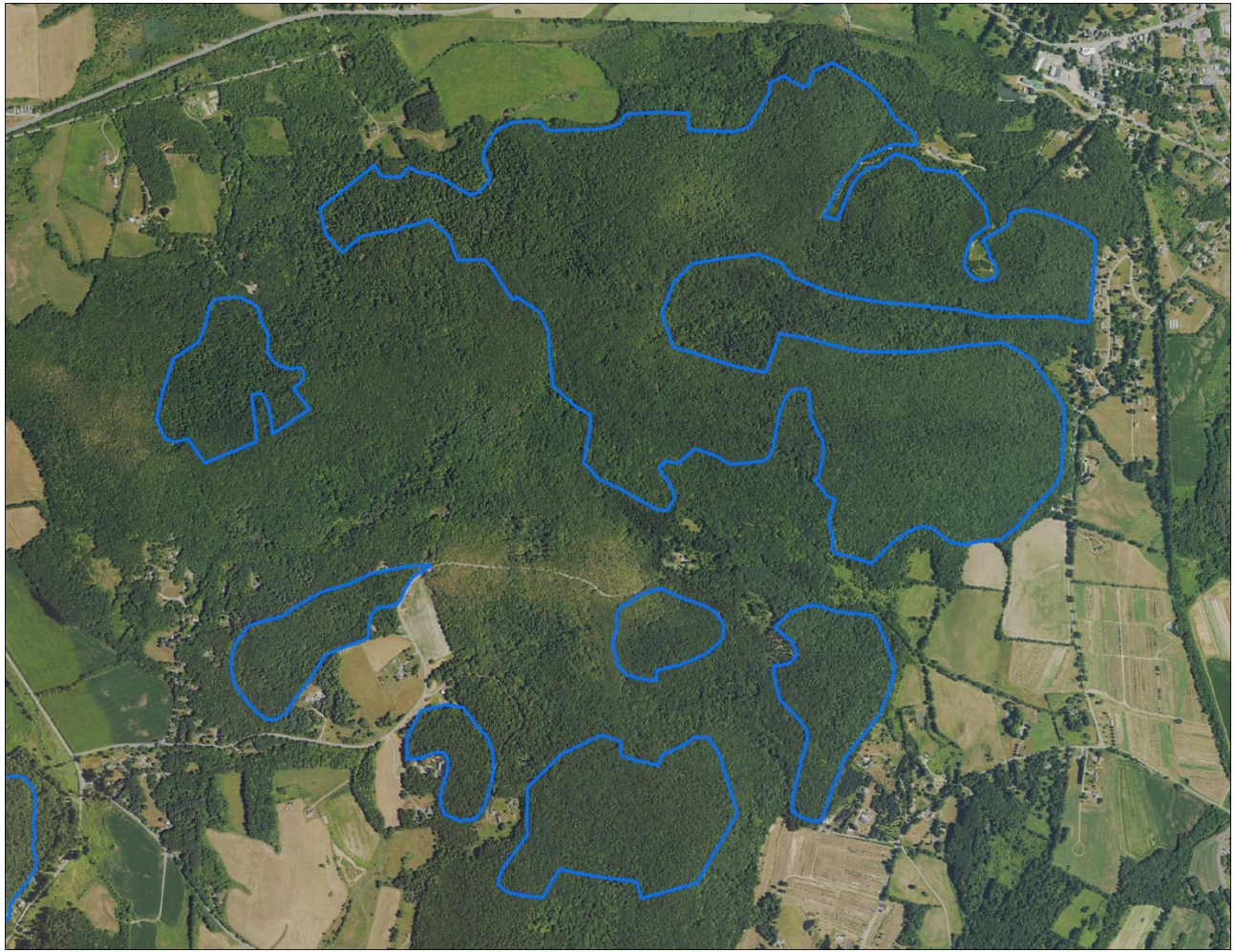
Stone Wall and Field Margin GIS Layer



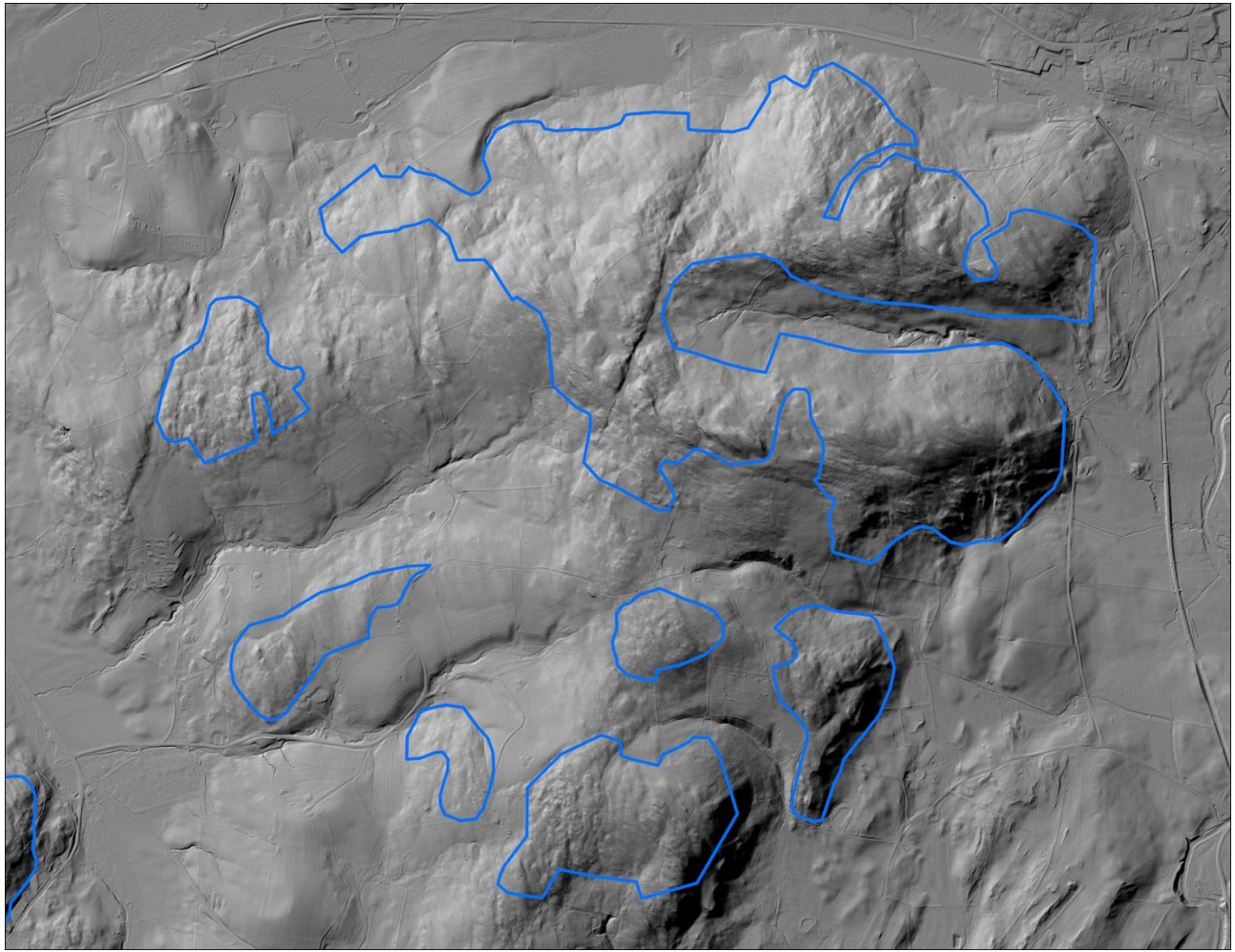
Delineating ancient forest patches.



Delineating ancient forest patches.



Delineating ancient forest patches.

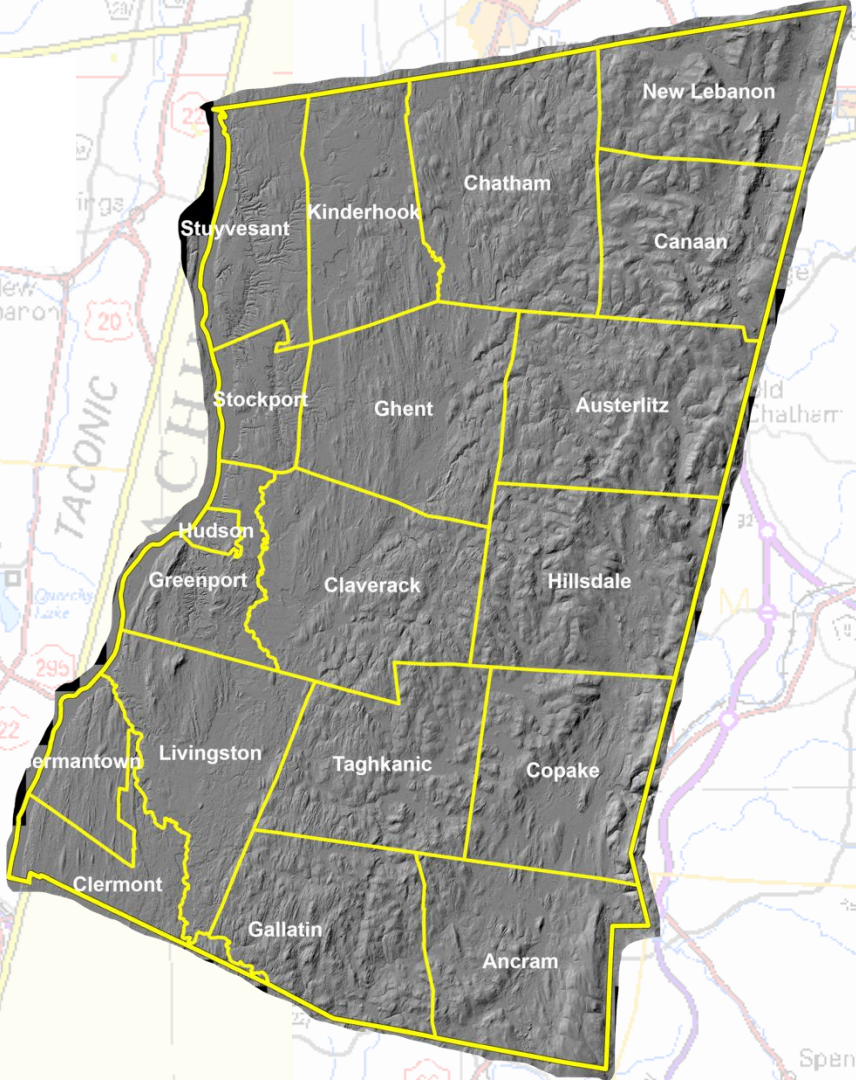


Potential Ancient Forest Map is almost ready…

How many patches of ancient forest in Columbia County?

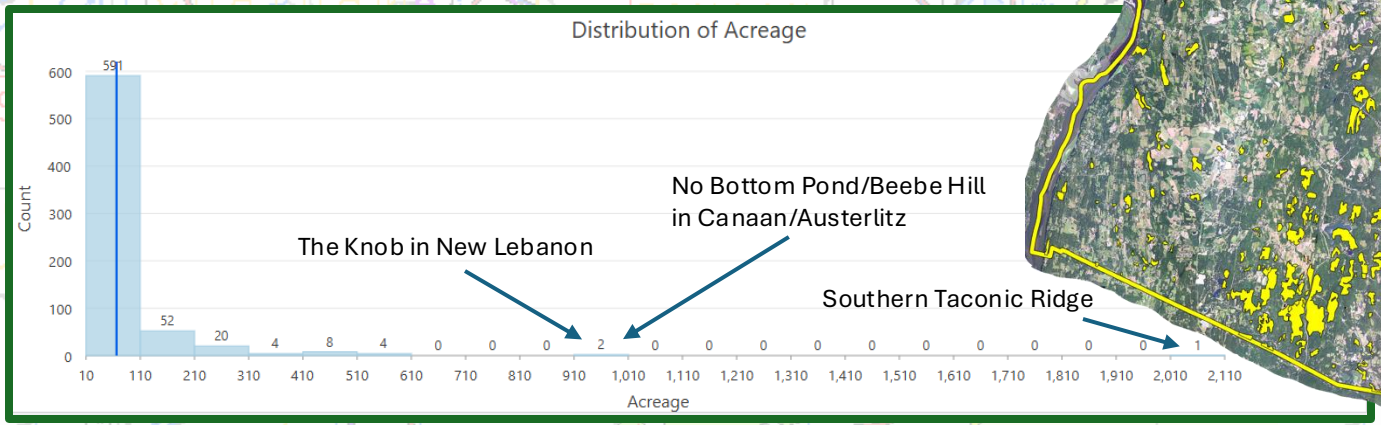
1. Minimum 10 acres

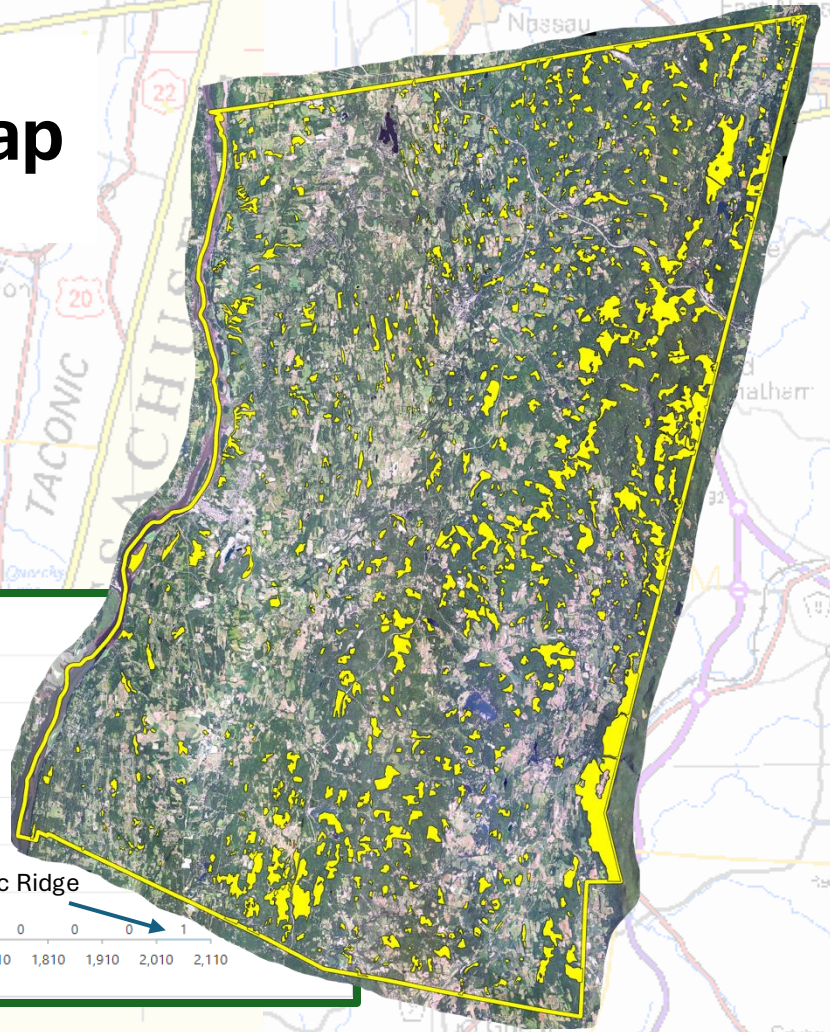
Where do you think the largest patches of ancient forest are?



Potential Ancient Forest Map

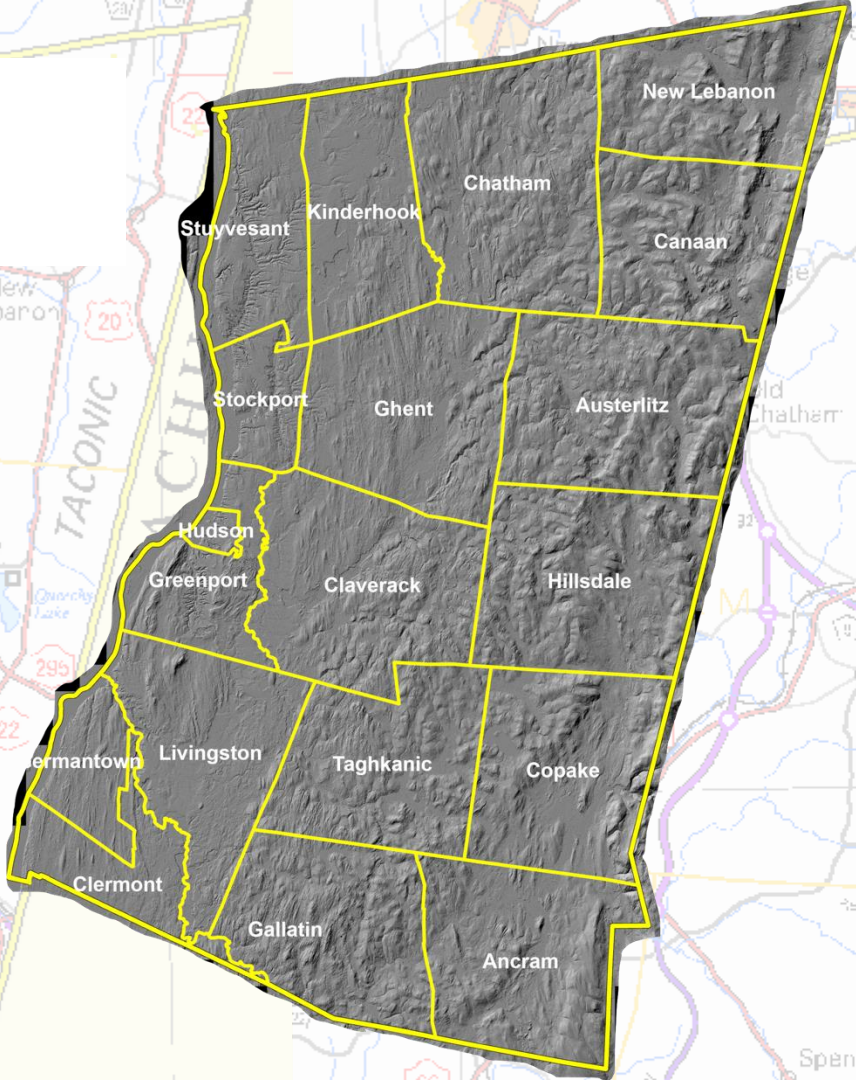
- ~700 patches
- Average size is 66 acres
- 11% of Columbia County
  - 45,154 acres total





Potential Ancient Forest Map

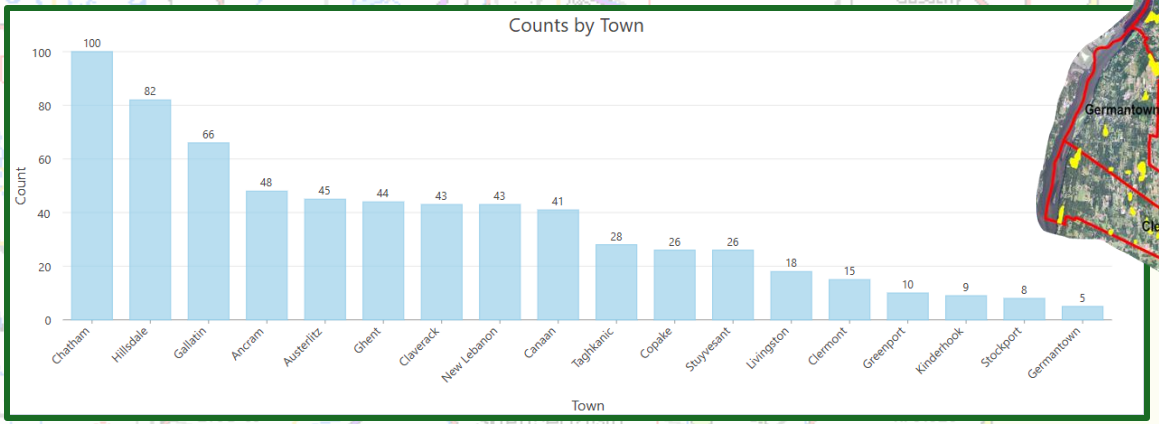
What 3 towns have the greatest number of patches of Ancient Forest?

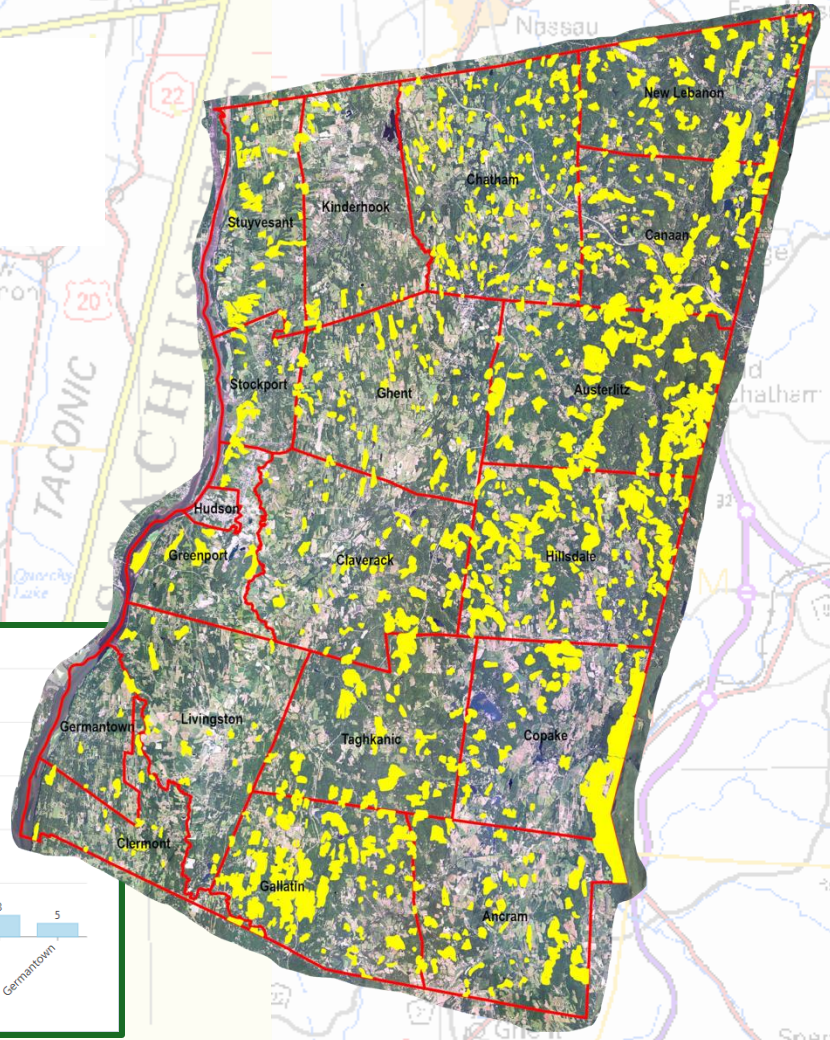


Potential Ancient Forest Map

Greatest Number of Patches

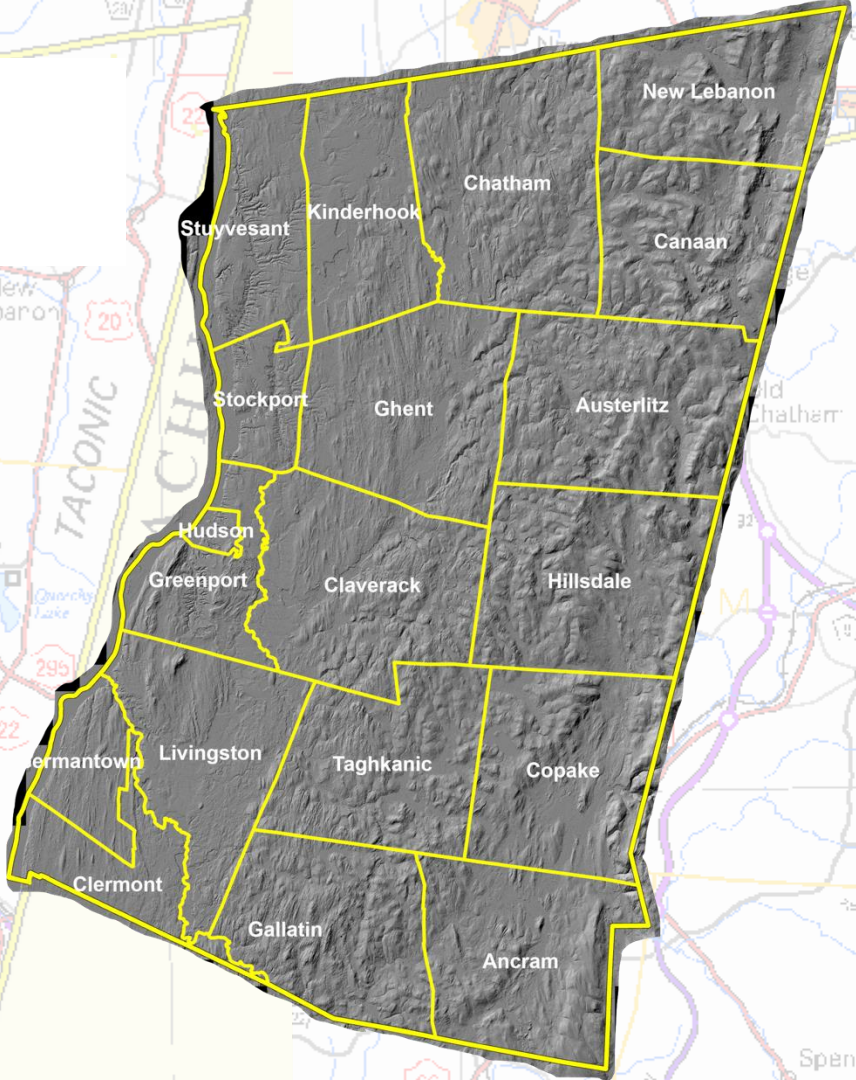
1. Chatham
2. Hillsdale
3. Gallatin





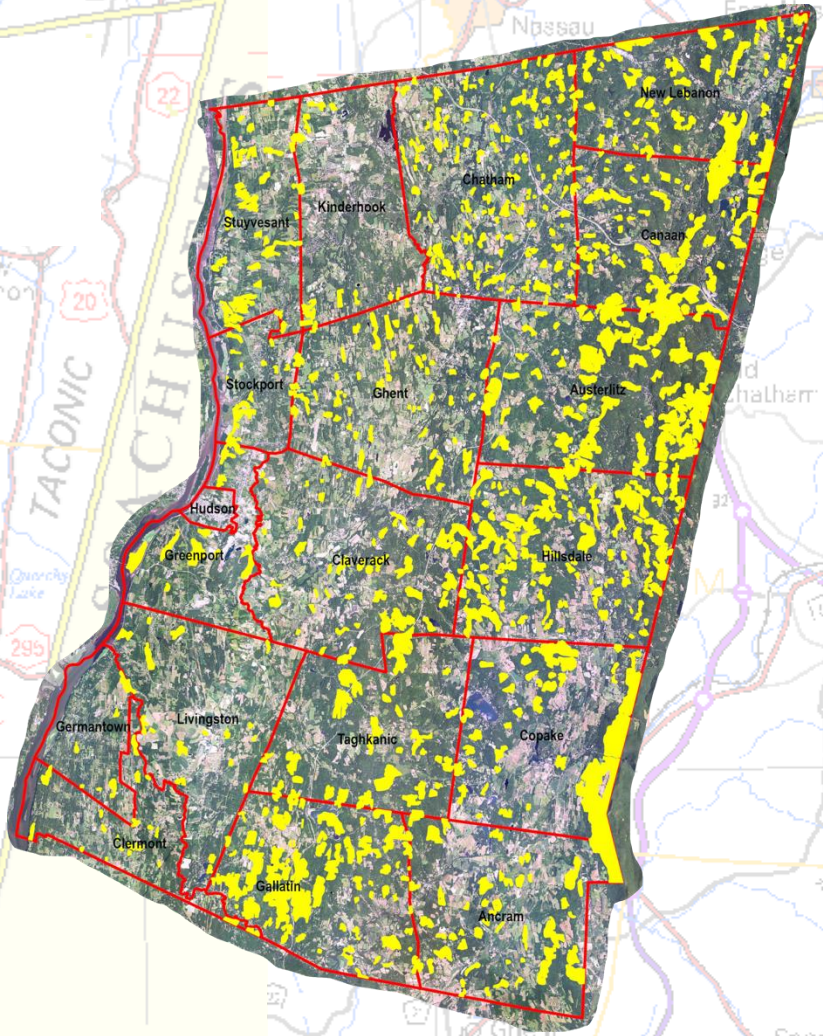
Potential Ancient Forest Map

What towns have the most ancient forest in acres?

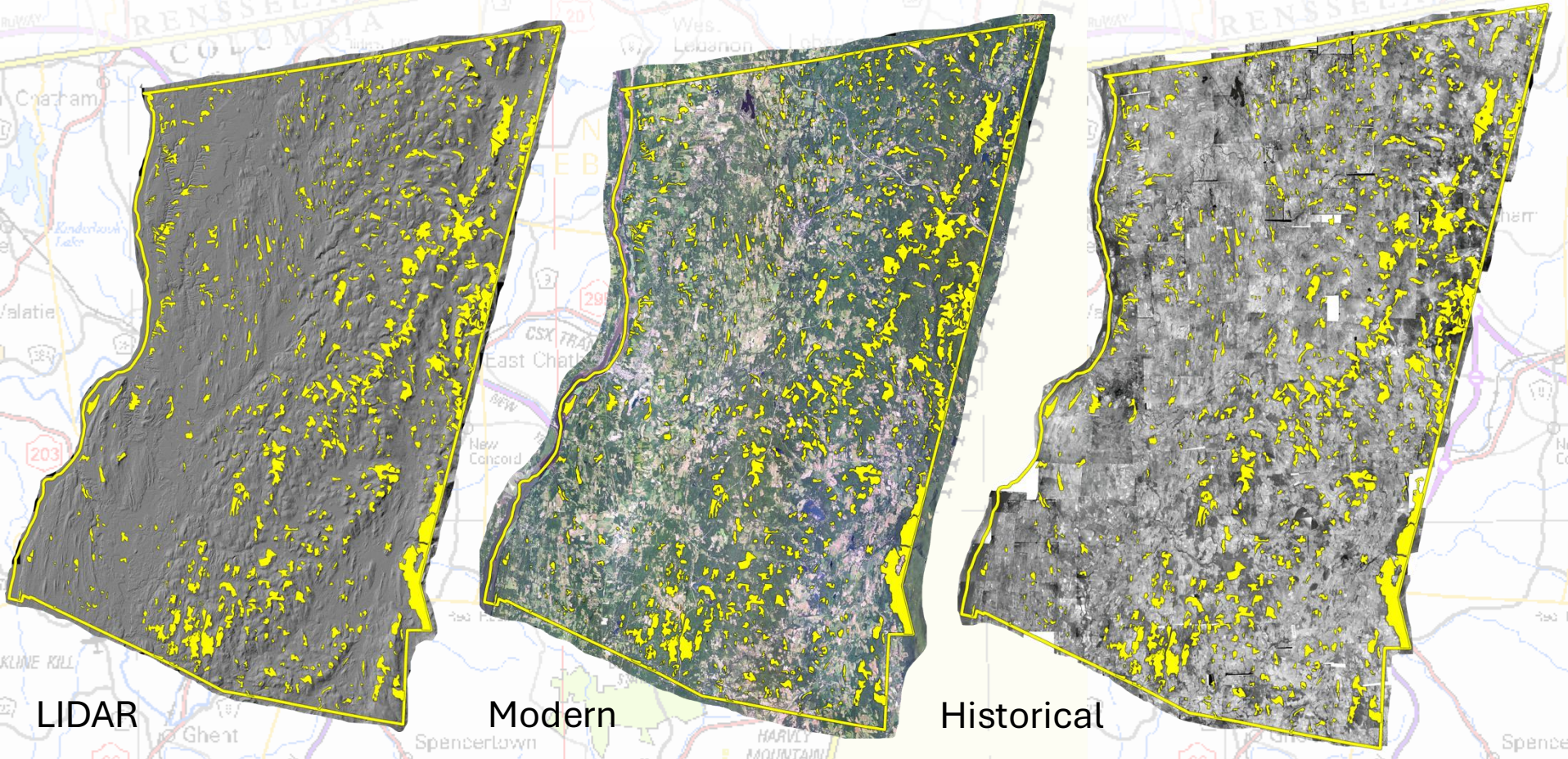


Potential Ancient Forest Map

Town	ancient forest (acres)	% of town area
Austerlitz	6000	19.2%
Hillsdale	5687	18.6%
Gallatin	5225	20.6%
Copake	4727	17.6%
Canaan	4094	17.3%
New Lebanon	3301	14.3%
Chatham	2796	8.2%
Ancram	2705	9.9%
Claverack	2276	7.4%
Taghkanic	2221	8.7%



Map of Potential Ancient Forests of Columbia County

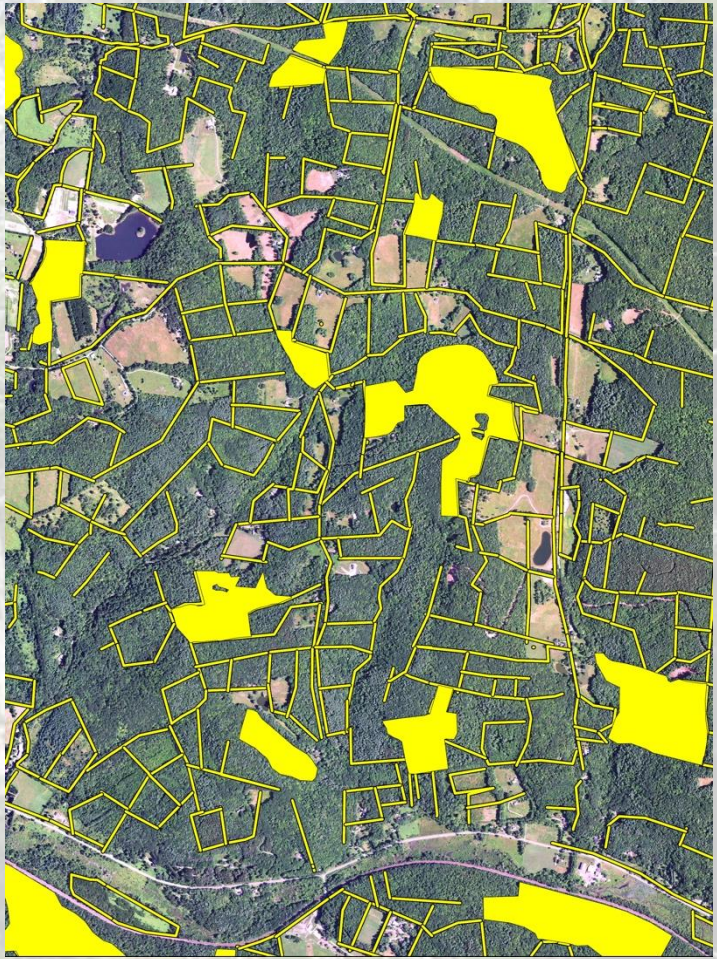


Risks to Ancient Forests



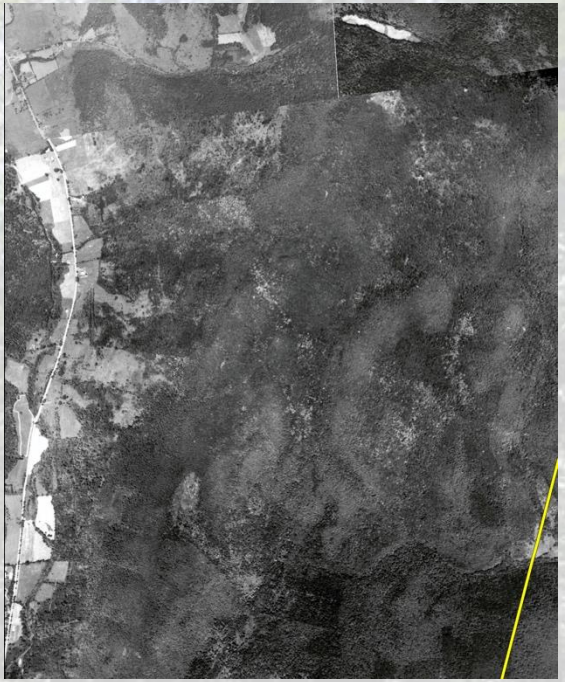
Risks to Ancient Forests

1. Lack of awareness



Risks to Ancient Forests

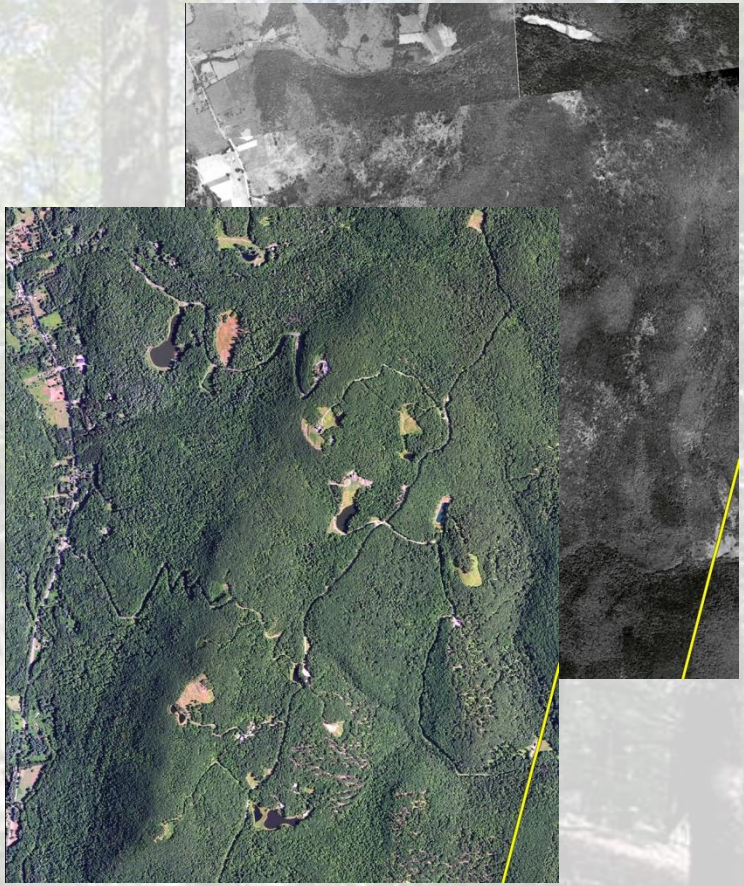
1. Lack of awareness
2. Development



Harvey Mountain, Austerlitz

Risks to Ancient Forests

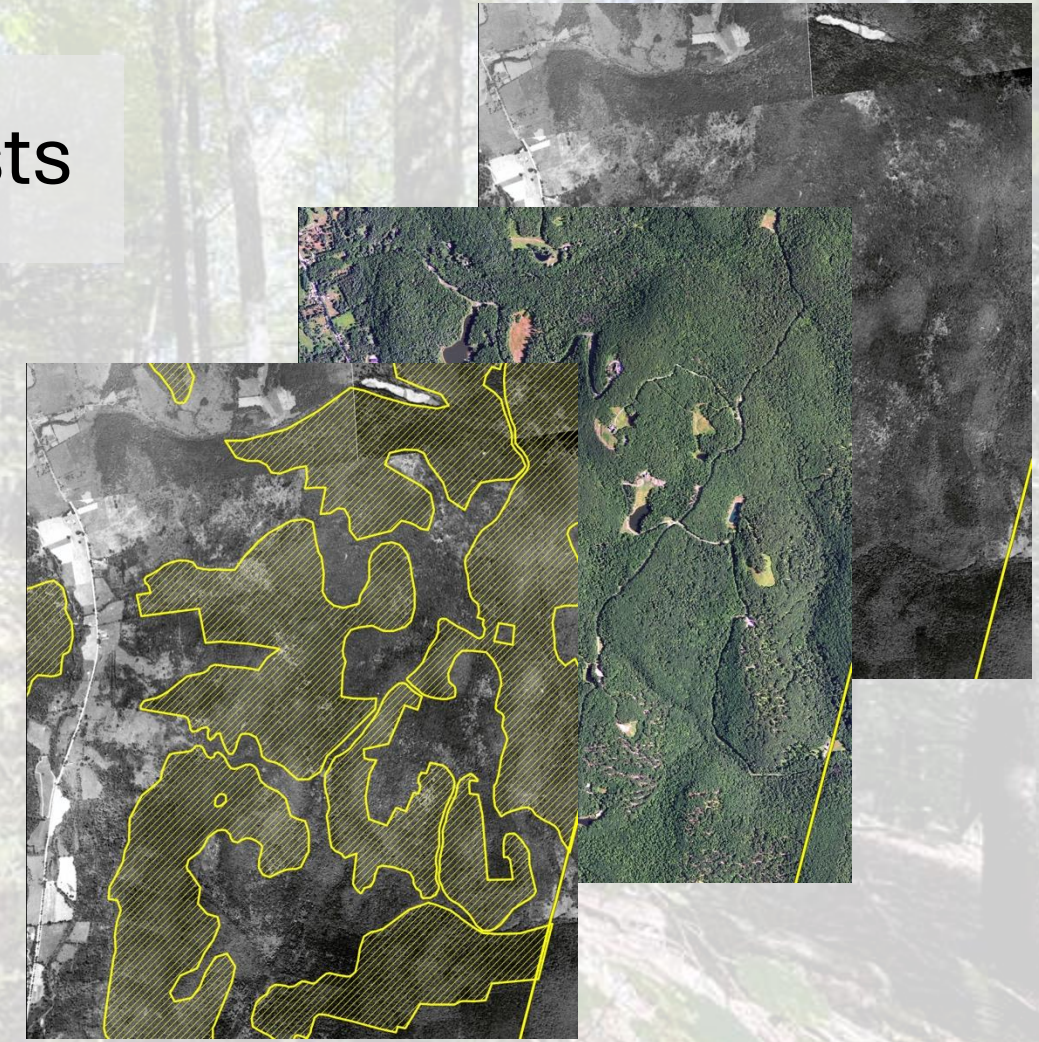
1. Lack of awareness
2. Development



Risks to Ancient Forests

1. Lack of awareness

2. Development
   - Forest fragmentation and edge effects
   - Introduce non-native and invasive plants and animals.



Risks to Ancient Forests



1. Lack of awareness
2. Development
3. Forest Health Impacts
    - Invasive plants and pests
    - Deer
    - Climate Change



Ancient Forest Project

Goals: Study, Action, and Awareness-raising

Find out how much of this habitat is left and where it is located.

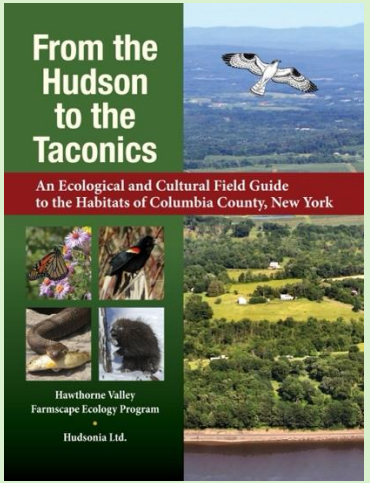
- *Create a map of all ancient forest patches > 10 acres.*

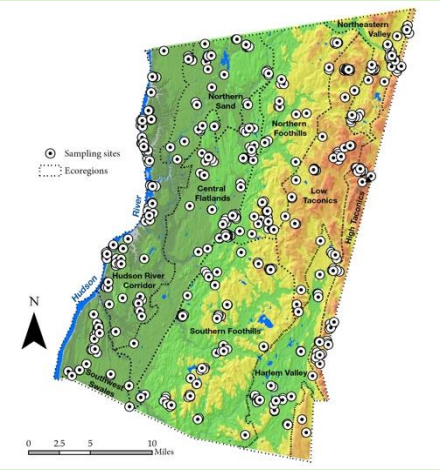
Compare biodiversity of ancient and post-agricultural forest.

- *Identify if there are taxa/species restricted or often limited to ancient forests.*

Teach a variety of audiences how to recognize this habitat and think ecologically about forest management.

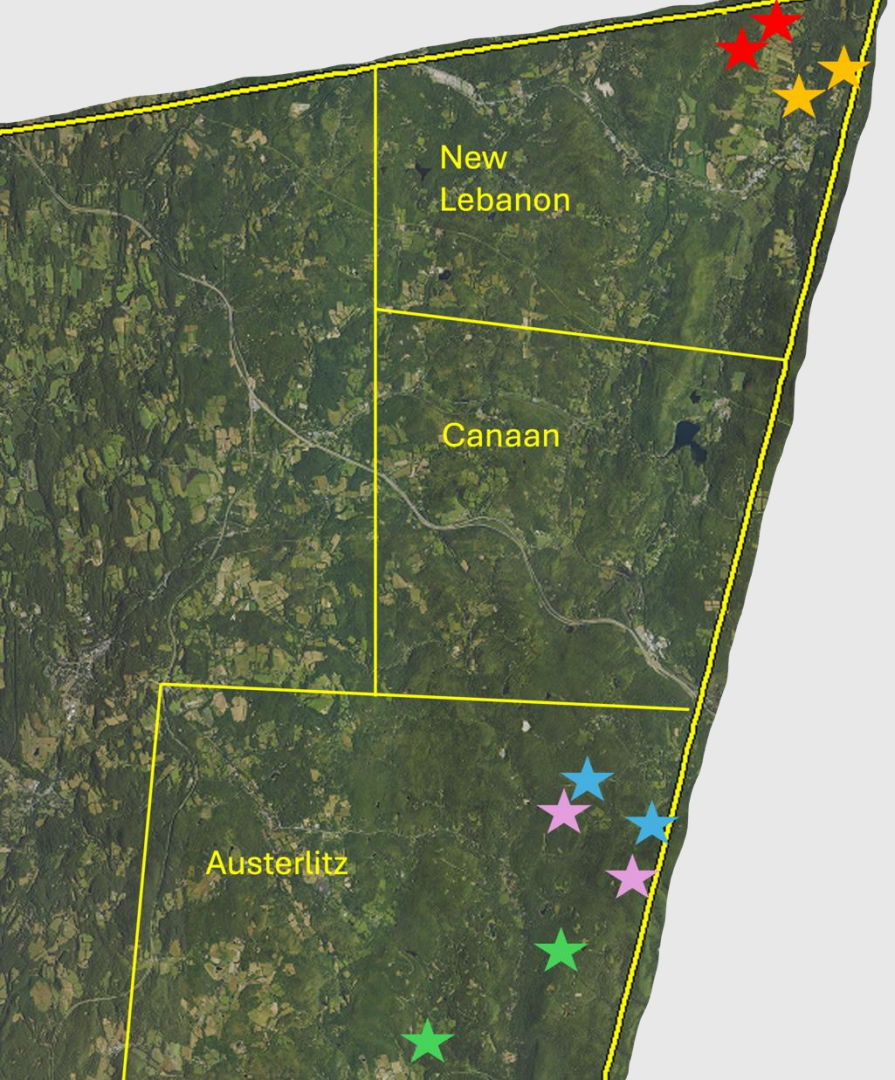
- *Share ancient forest map and ecological knowledge with land trusts, municipalities and the public.*







Ancient Forest Pilot Study 2024



Pilot Study of Ancient and Post-ag Forests

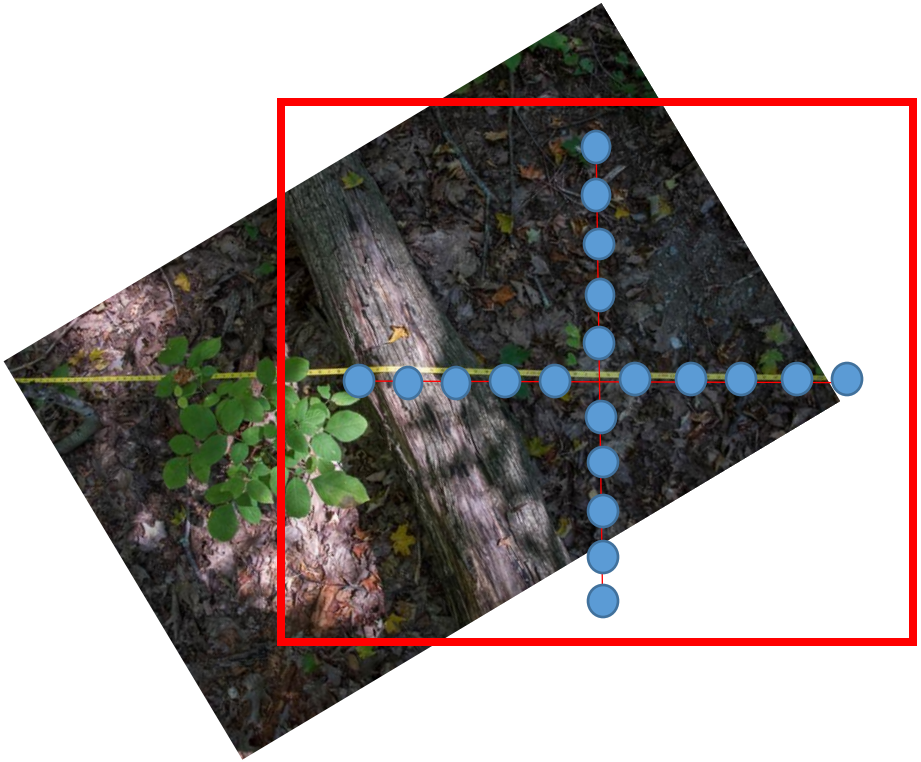
- Compared 5 ancient forests to 5 post-ag forests.
- Focused on Northern Hardwood Forest
  - Beech, Yellow Birch, Sugar Maple, Basswood, Oak, Black Birch, Hemlock, Red Maple
- 4 soil types were represented

Overall hypothesis:

We expect there to be unique biodiversity and unique communities in ancient forests.

Forest Structure

- Leaf Litter
- Downed Wood
- Basal Area
  - Snags (standing dead trees)



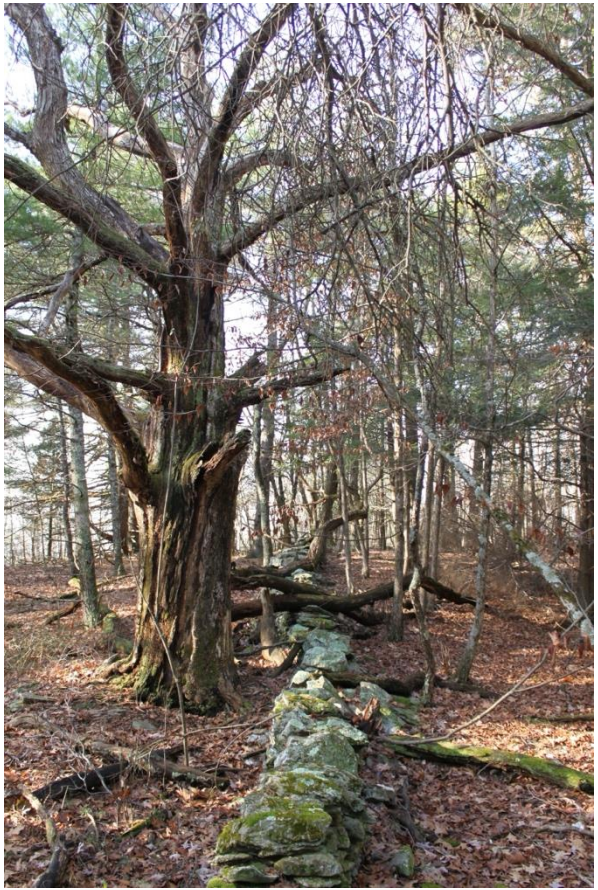
Forest Structure

Snags

- Wildlife habitat
  - Roosting sites for bats.
  - Homes for other mammals, birds, and insects.



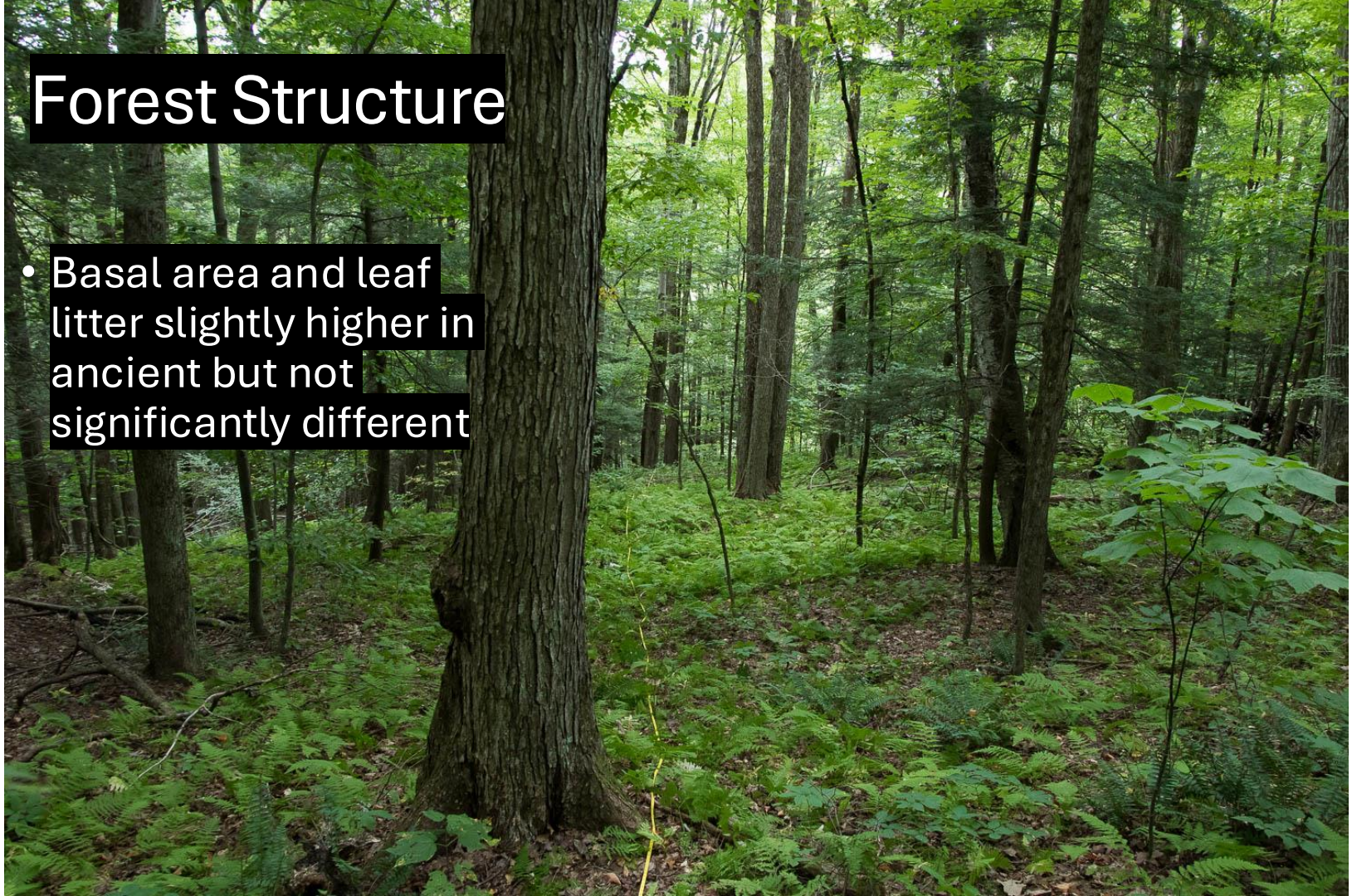
Forest Structure: Snags





Forest Structure

- Basal area and leaf litter slightly higher in ancient but not significantly different



Forest Structure: Downed Wood

- On average, we found significantly larger downed wood pieces in ancient forests.
- Downed wood is an important habitat for invertebrates (including ants) and salamanders.



Invasive Plants

- Present in:
  - 4 out of 5 post-ag
  - 1 out of 5 ancient











Focal Groups



Spring Wildflowers





Ants + Salamanders



Soil Invertebrates



Mushrooms

Focal Groups



Spring Wildflowers



Ants + Salamanders



Mushrooms



Soil Invertebrates








Spring Wildflowers

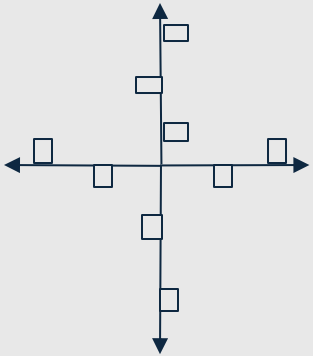
- Not surveyed completely in previous studies.
- Relationship with ant dispersal and early-flying pollinators.
- Expect to be more abundant in ancient forests.

Spring Wildflowers

Two transects running in the four cardinal directions.

40 square plots per forest site.

Species frequency and percent cover.





Starflower



Indian Cucumber



Jack-in-the-pulpit



Red Trillium



Dwarf Ginseng



Hairy Solomon's Seal



Common Blue Violet



Painted Trillium



Baneberry

Spring Wildflower Results:



The species richness of spring wildflower species was higher in ancient forests.

In general, spring wildflowers were infrequent:

- Low abundance in general
- Overabundance of deer
- Soil conditions too acidic and poor

Site Level Frequency	*# species*
Total	22
only in ancient sites (n=5)	14
only in post-ag sites (n=5)	0
in more ancient sites	3
in more post-ag sites	0
same # of sites	3
similar # of sites	3

Focal Groups





Ants + Salamanders



Spring Wildflowers



Mushrooms



Soil Invertebrates

Why are we looking at Ants?

- **Ecosystem services/functions**
  - waste collection / nutrient cycling
  - Soil turning
  - Seed dispersal
  - Food resource

11,000 plant species globally are ant dispersed





Compilation of Seeds with Elaiosomes © Hans Stuessi (licensed under CC BY 4.0; https://creativecommons.org/licenses/by/4.0/).

Aphaenogaster fulva



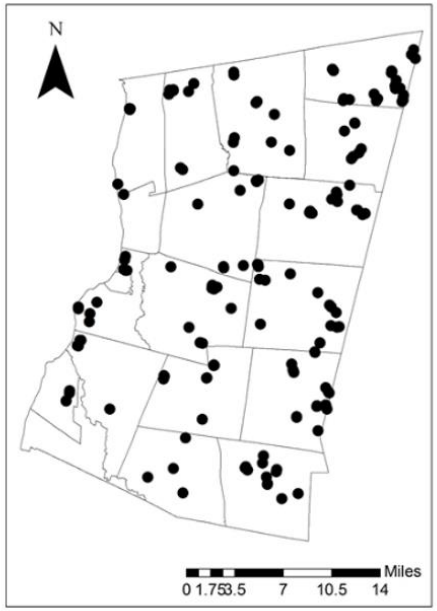
- Three species of *Aphaenogaster* in Columbia County
  - *A. fulva*, *A. picea*, and *A. rudis*.
  - All are closely related, sometimes difficult to tell apart.
  - *Aphaenogaster picea* is probably the most common.



Aphaenogaster picea



Aphaenogaster fulva












Images by Jerry Jenkins (©Northern Forest Atlas Foundation)



Common Sedge (*Carex communis*)



Long-stalked Sedge (*Carex pedunculata*)













How do we sample ants?

- Searched for ant nests in 75m x 75m plot for 1-person hour
- Look in downed wood, in leaf litter, soil, under rocks, and in acorns and other nuts
- Counted salamanders (Red Backs and Red Efts)

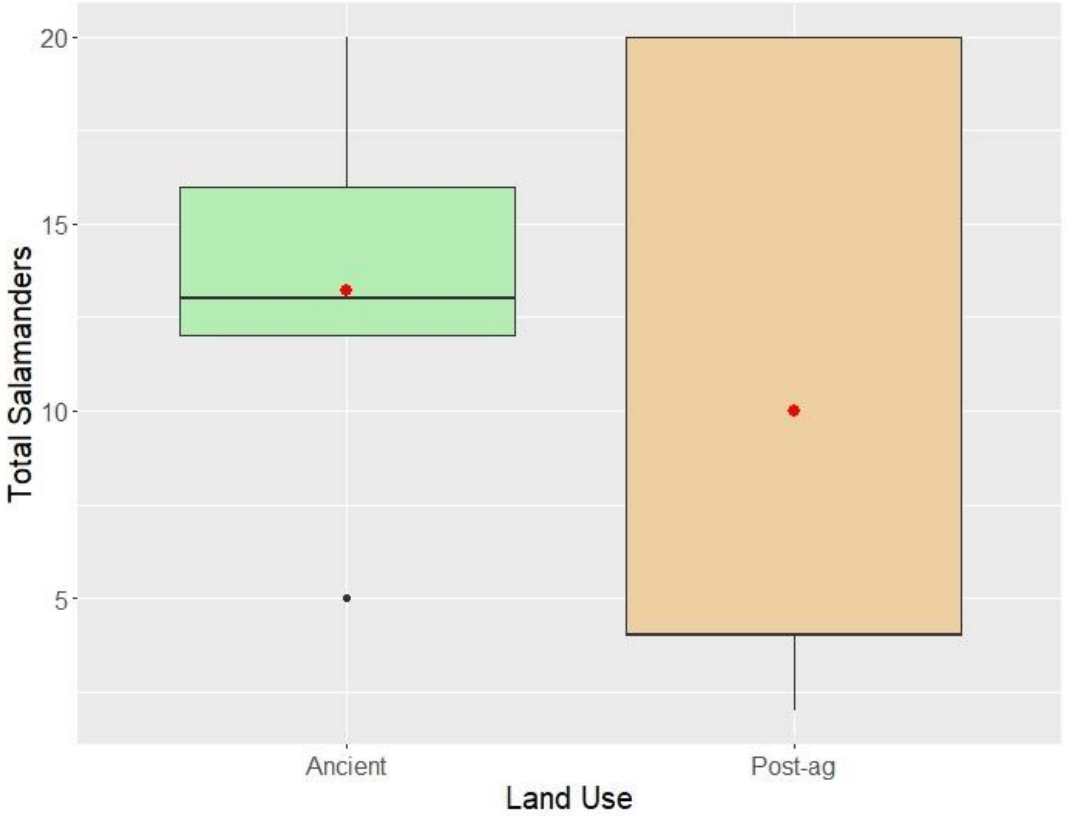






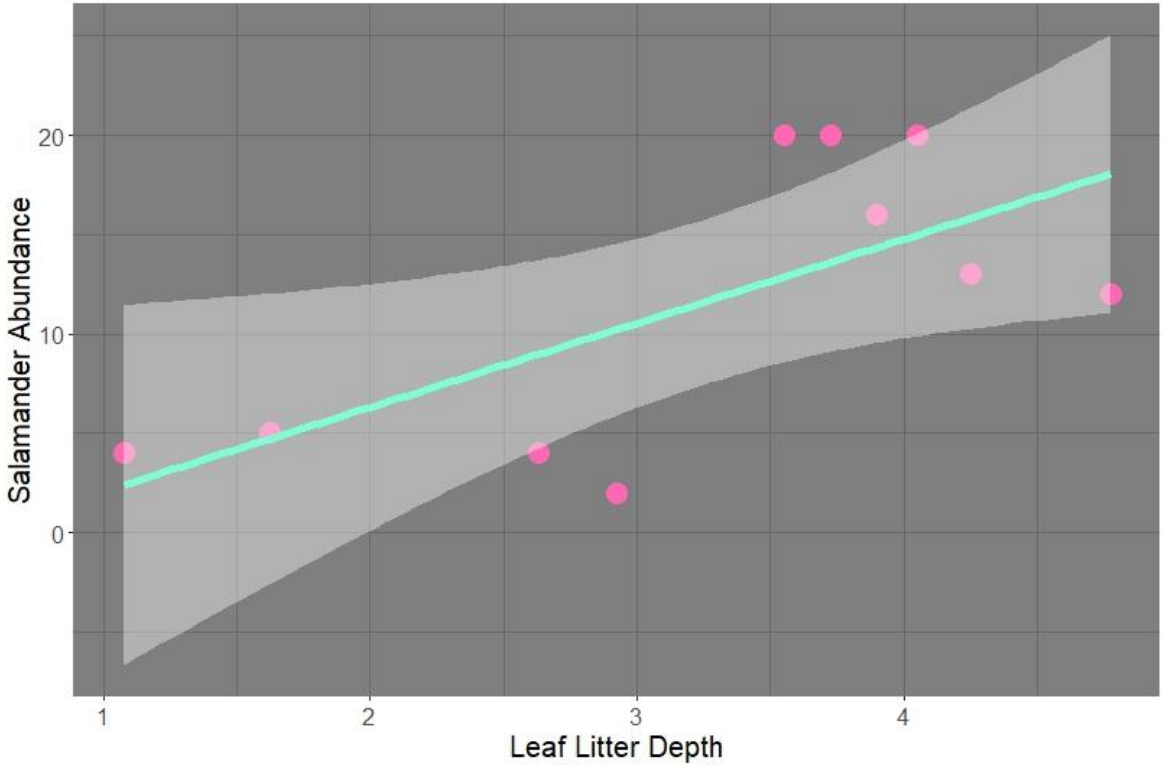
- Average salamanders found in ancient vs. post-ag forests not much different. Larger range of values in post-ag forests.





Other factors, such as leaf litter depth, may help predict salamander abundance in these forests.





Did ancient forests or post-ag forests have more ant species?



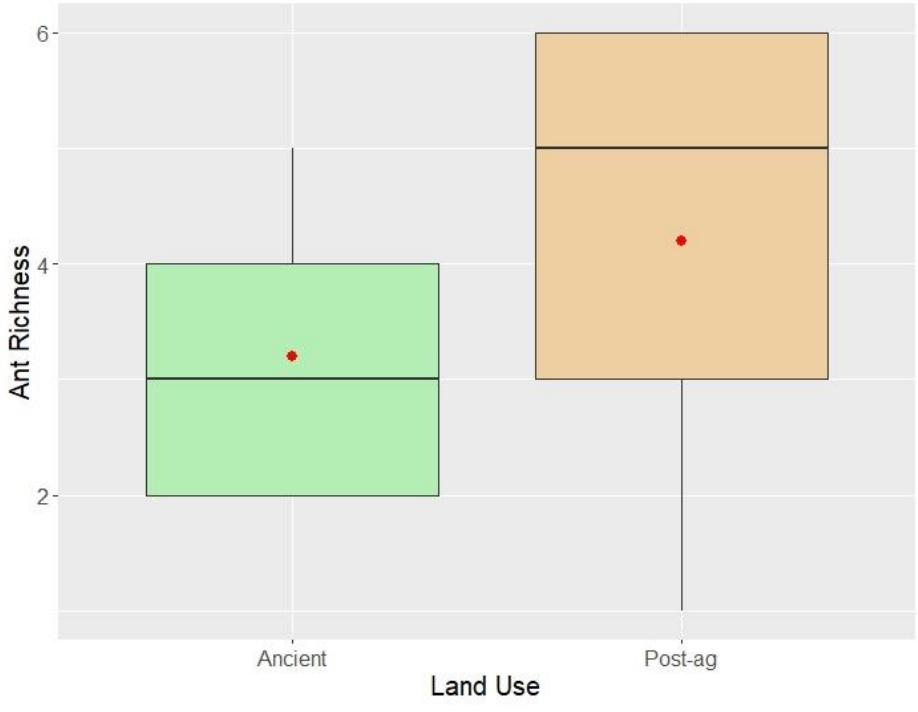
On average, Post-ag Forest had 1 more species than Ancient Forest.

Ancient = 9

Aphaenogaster picea
Camponotus pennsylvanicus
Lasius americanus
Lasius aphidicola
Lasius nearcticus
Lasius pallitarsis
Ponera pennsylvanica
Stenamma impar
Temnothorax longispinosus

Post-ag = 11

Aphaenogaster picea
Camponotus pennsylvanicus
Formica subsericea
Lasius americanus
Lasius aphidicola
Lasius nearcticus
Myrmecina americana
Myrmica punctiventris
Ponera pennsylvanica
Prenolepis imparis
Stigmatomma pallipes



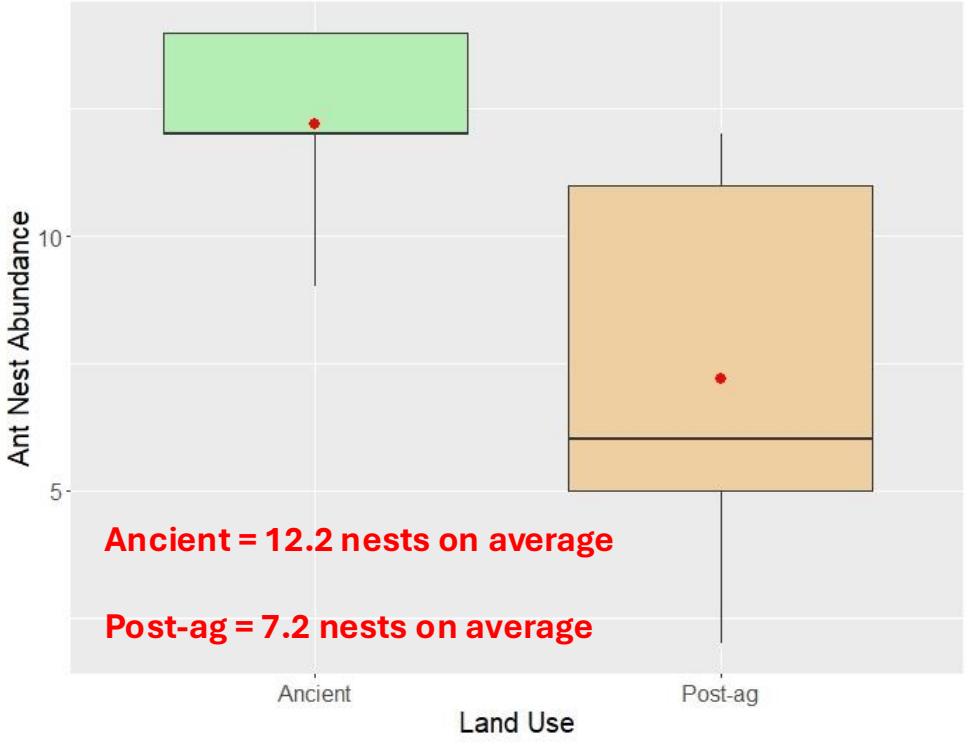








Did ancient forests or post-ag forests have more ant nests?



Ancient = 12.2 nests on average

Post-ag = 7.2 nests on average

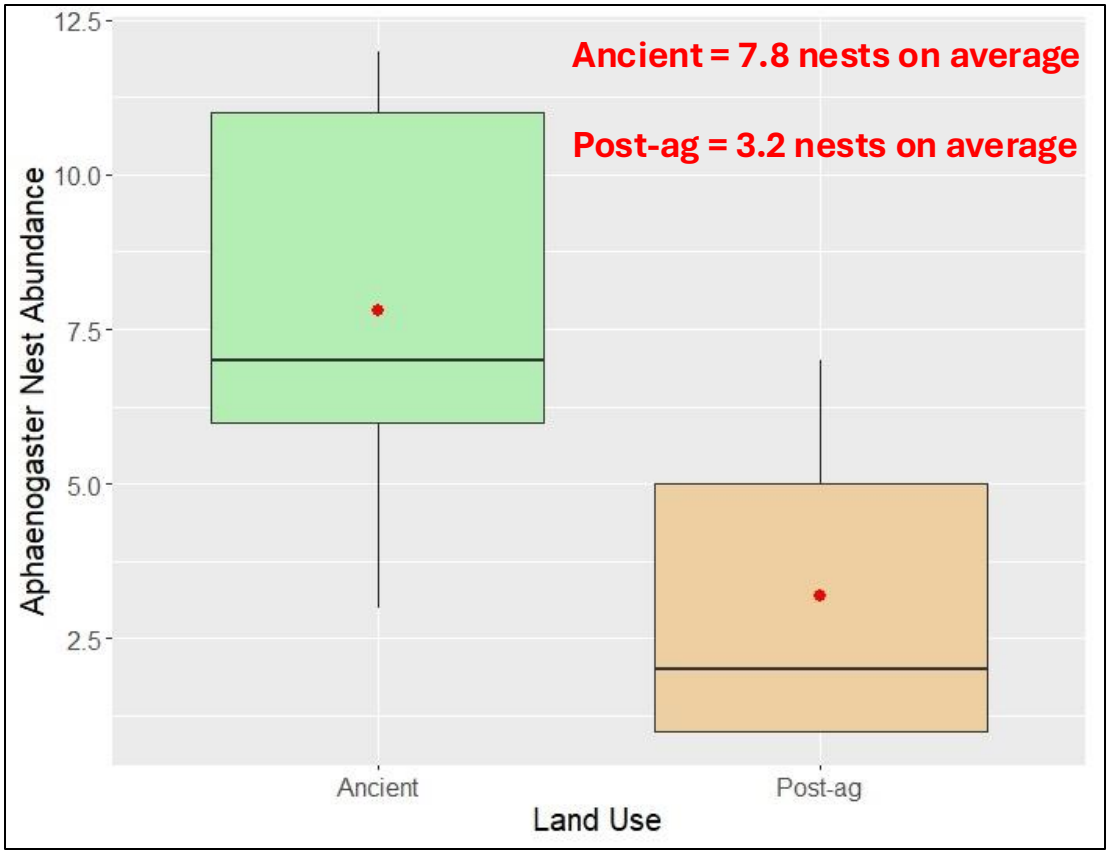




Apheanogaster Abundance

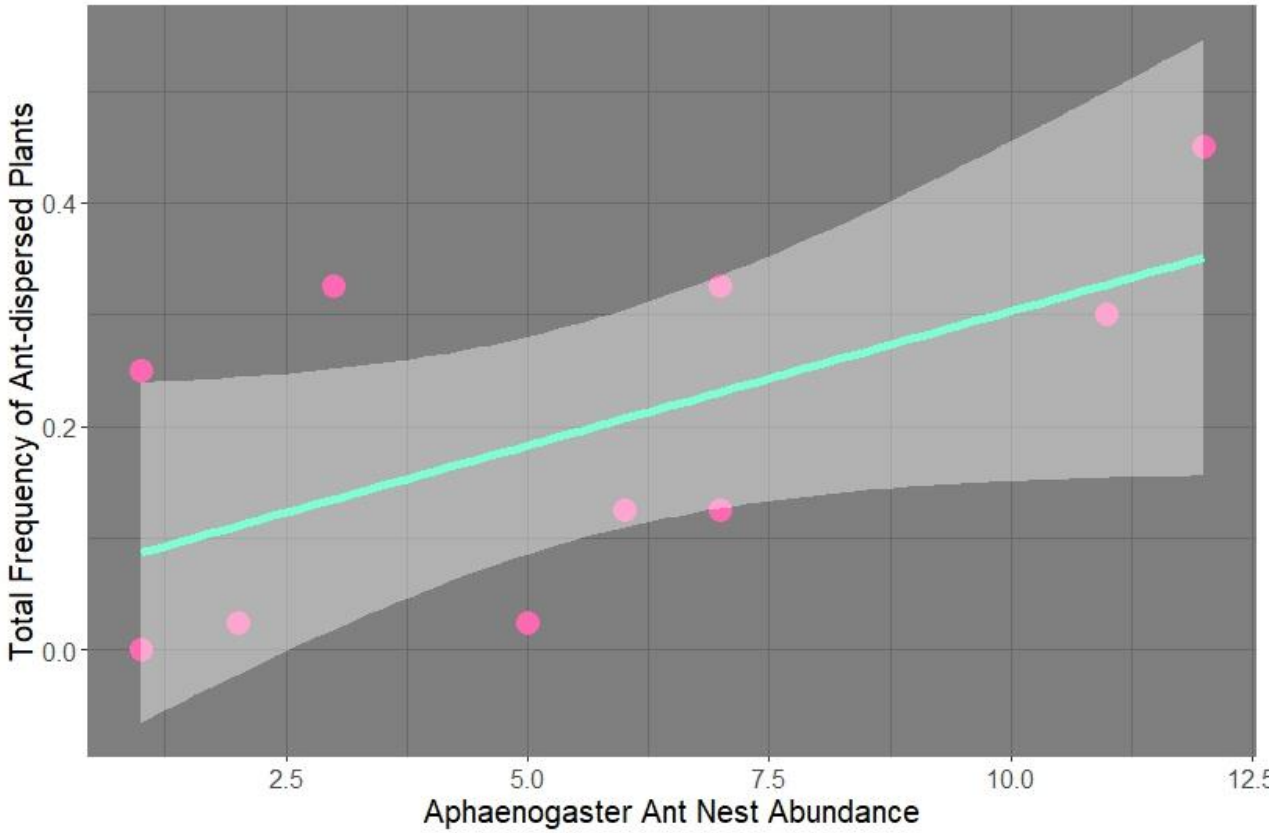
- All plots had at least one *Aphaenogaster* nest
- *Aphaenogaster* seem to be able to disperse just fine to post-agricultural forests
- How long will it take for post-ag forests to reach ancient forest levels of abundance?
- How does *Aphaenogaster* abundance affect plant dispersal?





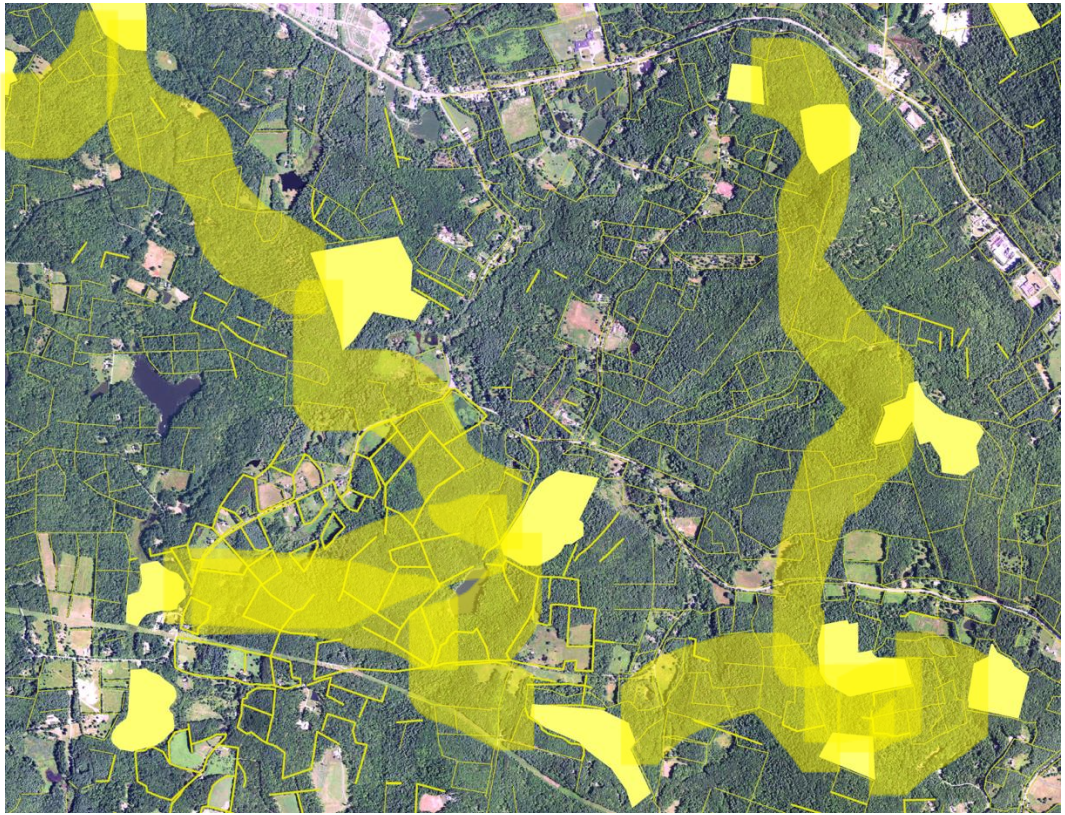





Total Frequency of Ant-dispersed Plants
0.0
0.2
0.4
2.5
5.0
7.5
10.0
12.5
Aphaenogaster Ant Nest Abundance

Aphaenogaster Nest Abundance Implications

- *Apaenogaster* seem to disperse just fine into post-ag forests. BUT, so far, our results show lower abundance in post-ag forests compared to ancient forests.
- Ant-dispersed plants getting to post-ag forests may be more of a problem than a lack of their seed dispersers.
- Conserve ancient forest remnants and connections with post-ag forest to help facilitate dispersal.



Focal Groups



Ants + Salamanders



Spring Wildflowers



Mushrooms



Soil Invertebrates

Mushrooms in Ancient Forests

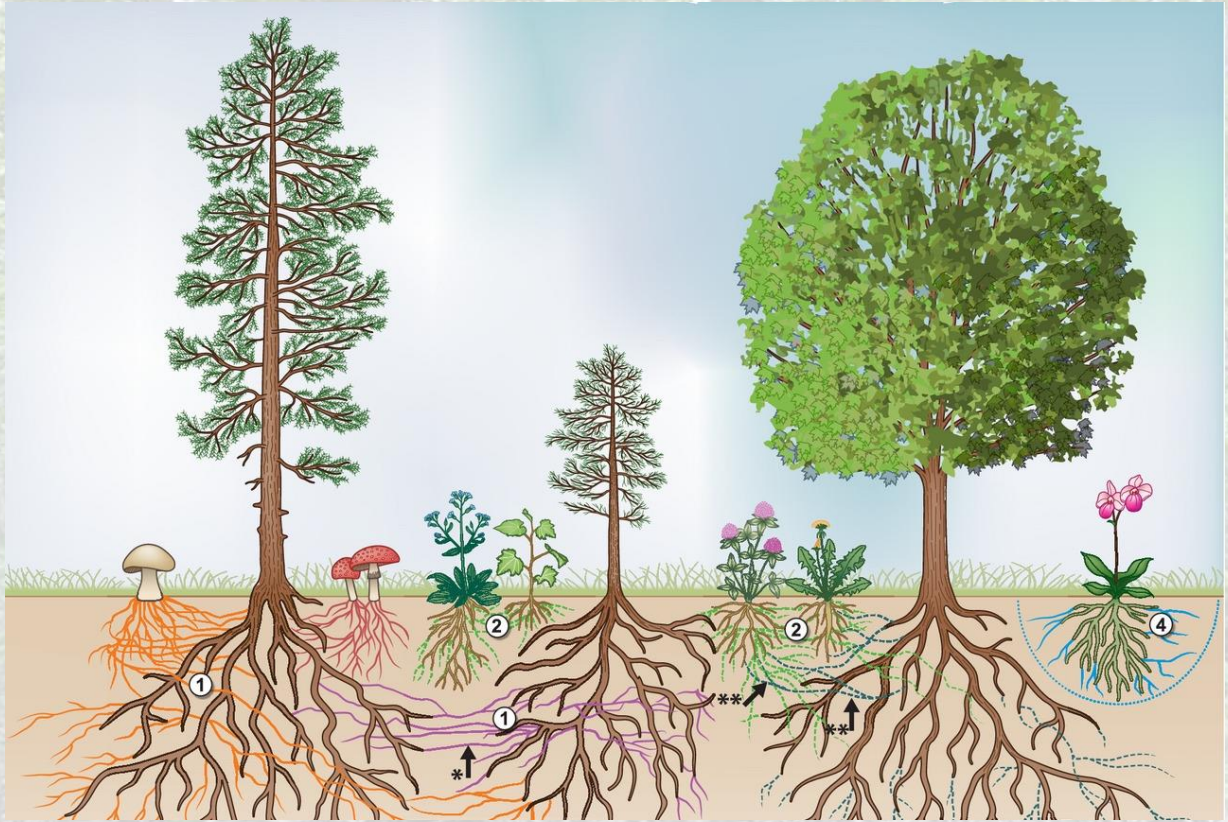
Fungi are foundational to forest ecosystems:

- Decomposition
- Support plant establishment and survival
- Carbon sequestration
- Soil stabilization
- Food resource
- Remediator of pollutants

Are fungi affected by land use history?

Do ancient forests hold unique species or higher diversity?

Mycorrhizal Fungi



Four kinds of mycorrhizal fungi: Arbuscular, Ecto-mycorrhizal, Ericoid, and Orchid (van der Heijden, 2015)

Ecto-Mycorrhizal Fungi



- Sensitive to disturbance
- Dispersal requires proximity to established network and colonized tree partner (often old trees)

EcM Ancient Forest Tree Species:

- Oaks (Chestnut, Swamp White, Black, White)
- American Beech
- Eastern Hemlock
- American Basswood
- Yellow Birch

Ancient Forest Mushroom Hypothesis

1. Higher species richness in ancient sites.
2. More mycorrhizal species in ancient sites.



Moss Bell (*Galerina hypnorum*)

Survey Methods

- 3 visits (once a month) 1-4 hours each time
- ~2 acre plots
- Recorded every mushroom found, taking notes and photos
- ID with books and online resources.



Mushroom Results:

Estimate of several thousand species in the Northeast.

Conservative estimation for Columbia County is ~700

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Estimate of several thousand species in the Northeast.

Conservative estimation for Columbia County is ~700

# species…	Ancient	Post-ag
only in	119	54
more frequent (>2x) in	35	10
similarly freq (1-2x) in	17	
same freq (1x) in	41	

Observed a total of 276 species.

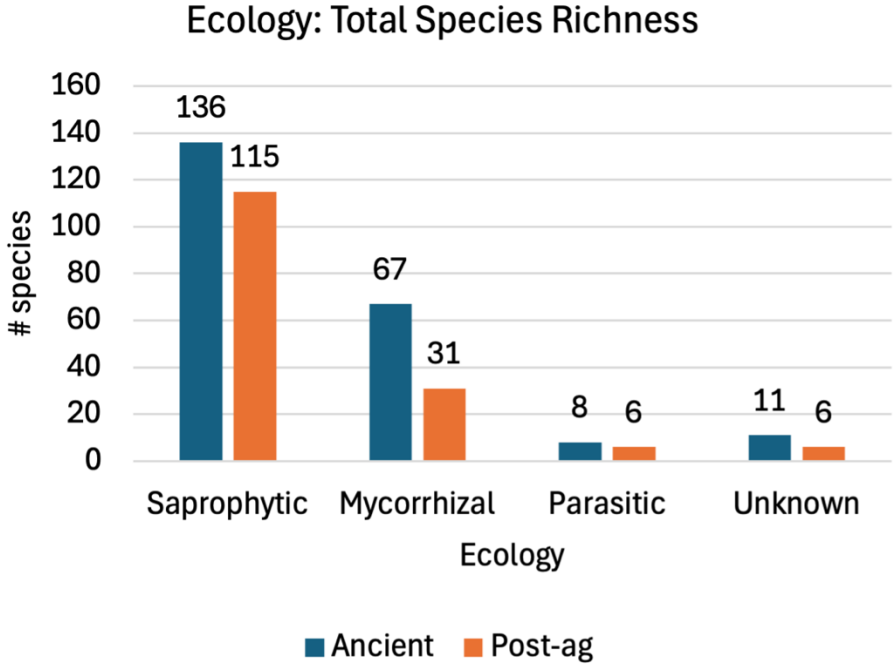
Total in Ancient Sites: 222

Total in Post-ag Sites: 157

Shared Species: 103

- ★ Species richness was higher in ancient sites. *p=0.027*
- ★ Around half of the total species found were only in ancient sites.

Mushroom Results: Species Richness & Ecology



★ More mycorrhizal species in ancient sites:

p = 0.006728

Only in ancient: 45

Only in PA: 9

In both: 22

Unknown Ecology



Vermilion Waxcap



Ramaria



Goblet Waxcap

★ More species of an unknown ecology in ancient:

p= 0.03



Meadow Waxcap



Heath Waxcap



Shining Waxcap



Orange-gilled Waxcap



Parrot Waxcap



Witches' Hat



Golden Waxcap

Mycorrhizal species found only in and more frequently in ancient forest sites





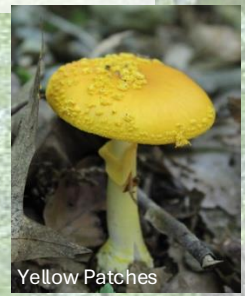














Webcaps (*Cortinarius*)



Small Chanterelle



Inocybe tahquamenonensis

Amanita Mushrooms





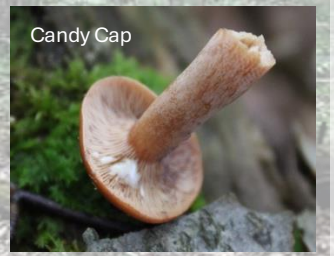


Boletes







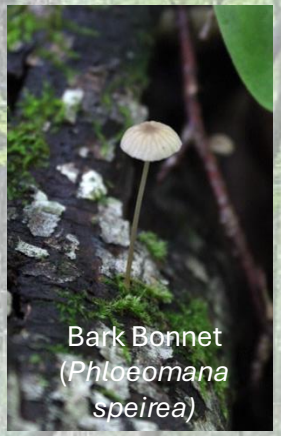


Milkcaps (*Lactarius*) & Brittlegills (*Russula*)



Saprophytic mushrooms found only or more frequently in ancient forest sites


Toothed Jelly


Bark Bonnet (*Phloeomana speirea*)

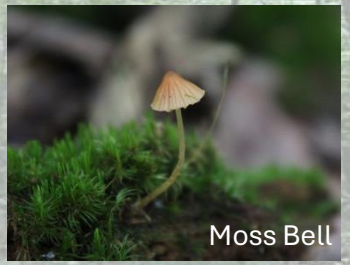

Orange Bonnet (*Mycena acicula*)


Unicorn Entoloma


Tricholomopsis sulfureoides


Hedgehog Scalycap


Bear's Head Tooth


Moss Bell




Dog Nose Fungus


Hairy Earthtongue (*Trichoglossum*)




Yellow Deer Mushroom

Other mushrooms found…

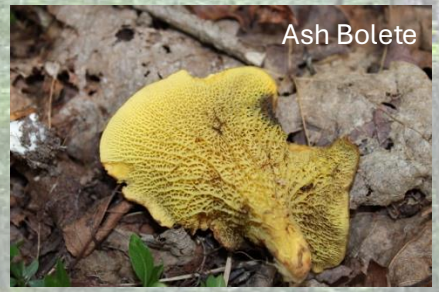

Mock Oyster


Mycena subcaerulea


Bleeding Fairy Helmet


Snaketongue Truffleclub




Ash Bolete


Collybia Cloud Jelly


Holywaya mucida


Collared Parachute


Blue Foot *(Psilocybe caerulipes)*

Focal Groups



Spring Wildflowers



Ants + Salamanders



Mushrooms



Soil Invertebrates

Why Soil Invertebrates?

- Diverse and abundant
- Sensitive to disturbance
- Valuable bioindicators








Marshal Hedin







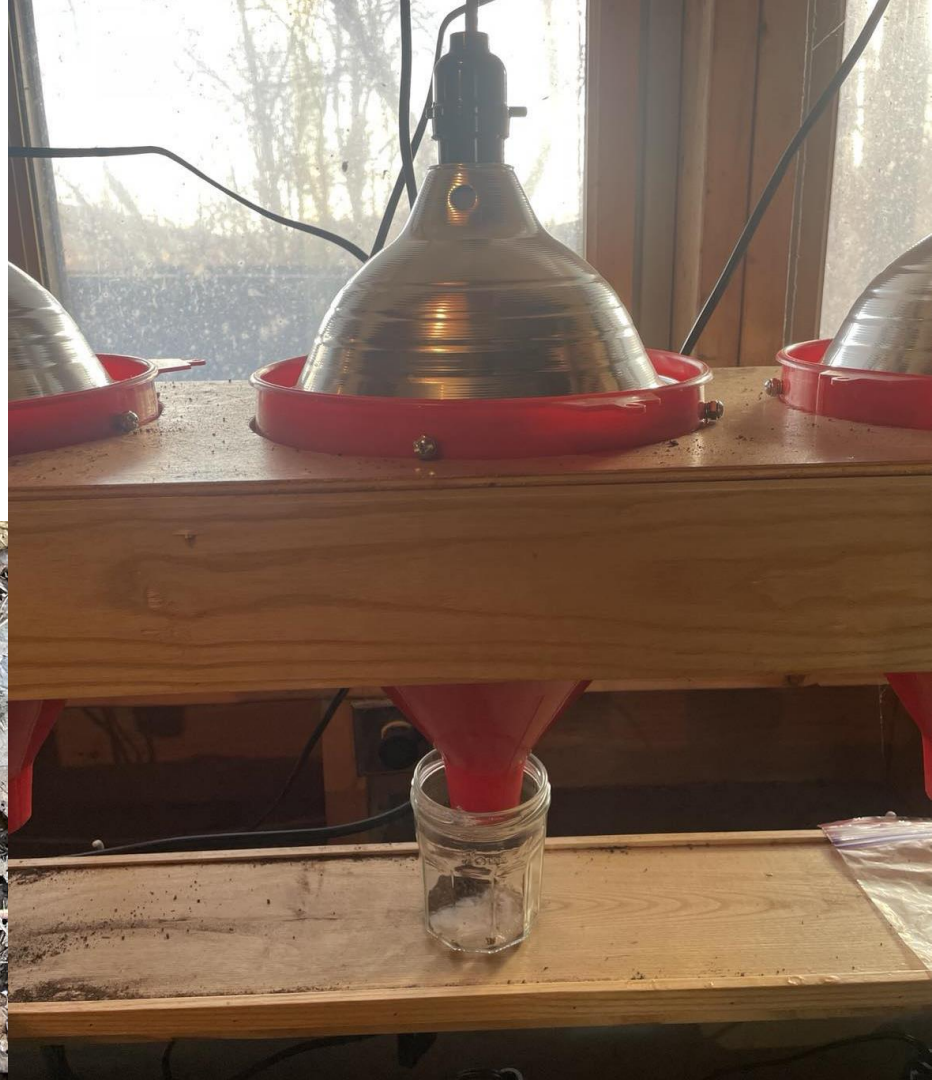

AJ Cann



Methods

- 75x75m plot at each site
- Randomized soil samples
- Processed in Tullgren Funnels for 24 hours





Results

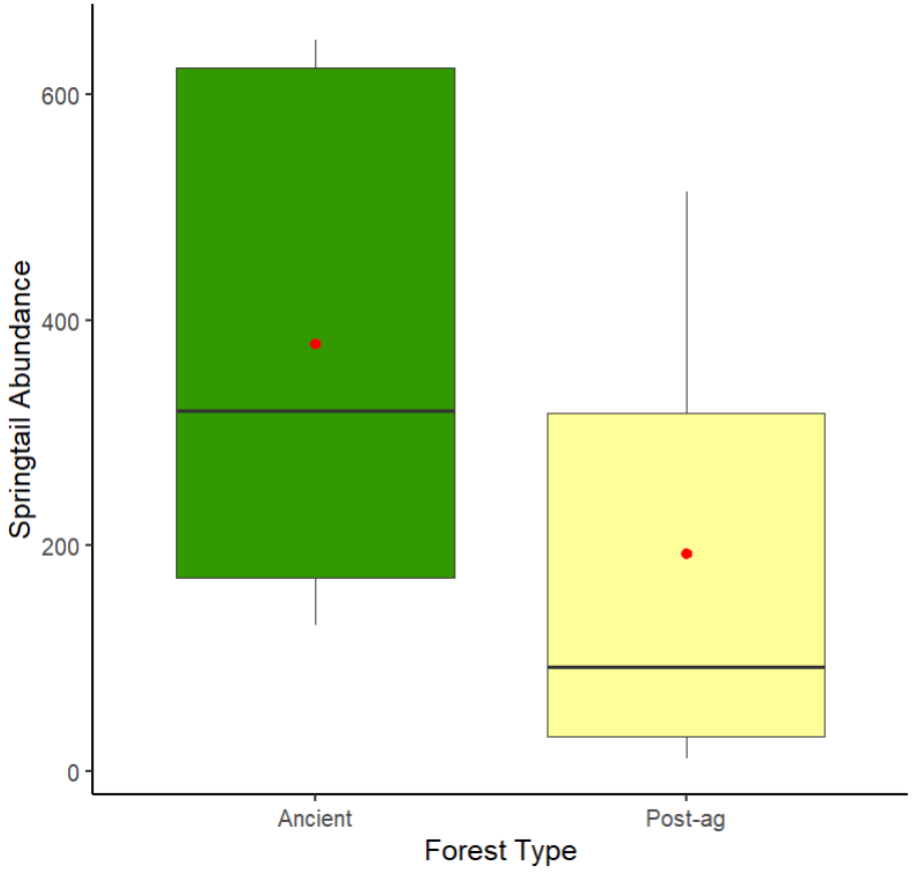
- 2,860 springtails
- 470 other invertebrates
- Too many mites to count!

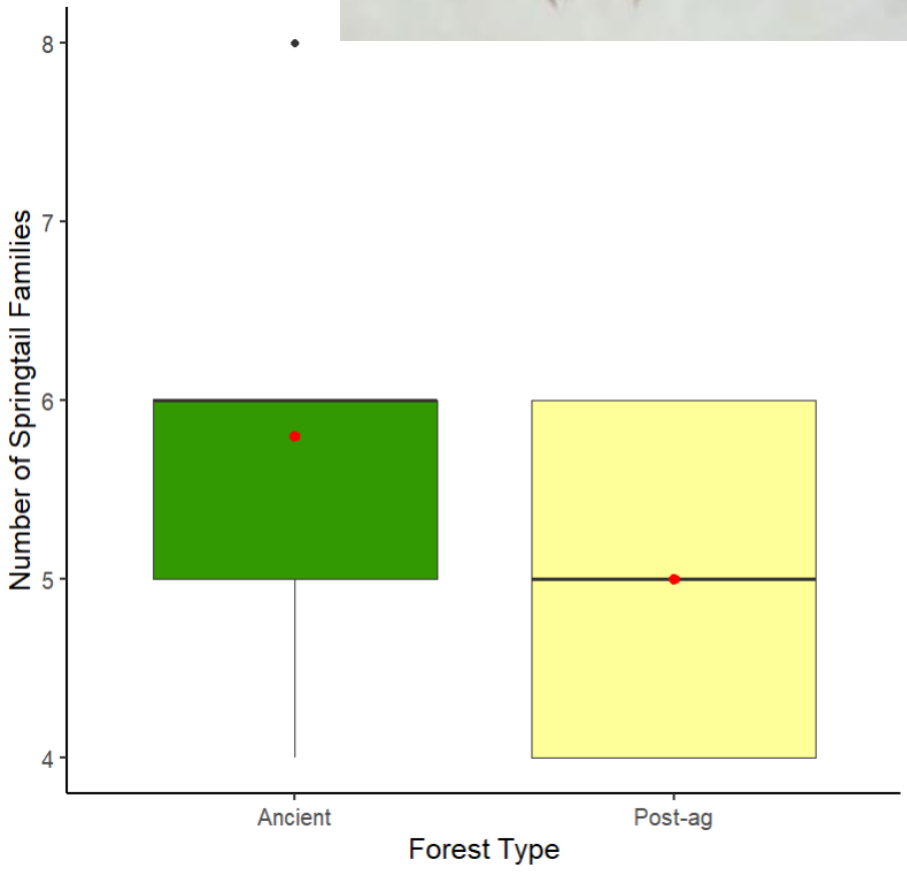




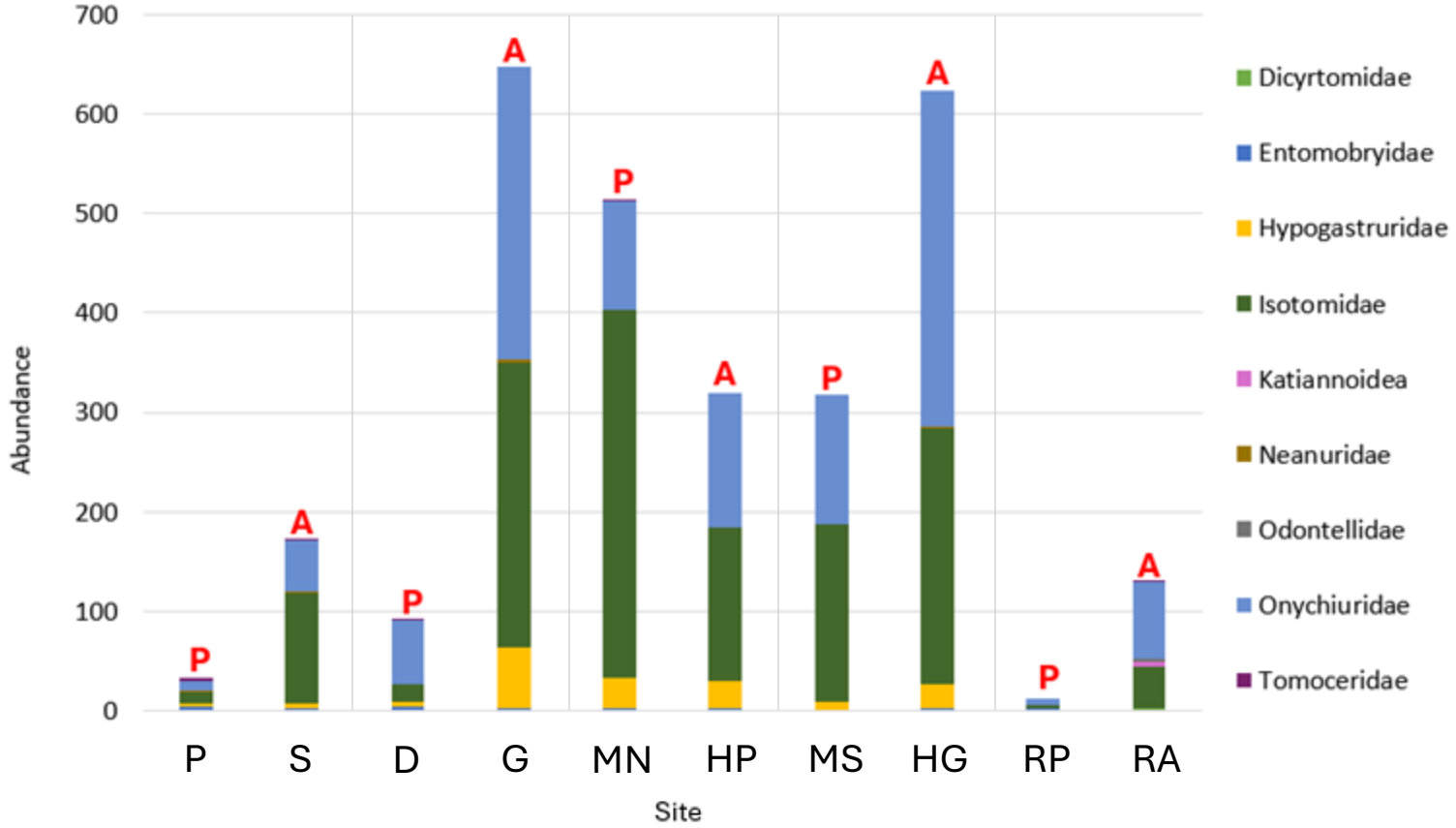
Springtail Abundance and Richness



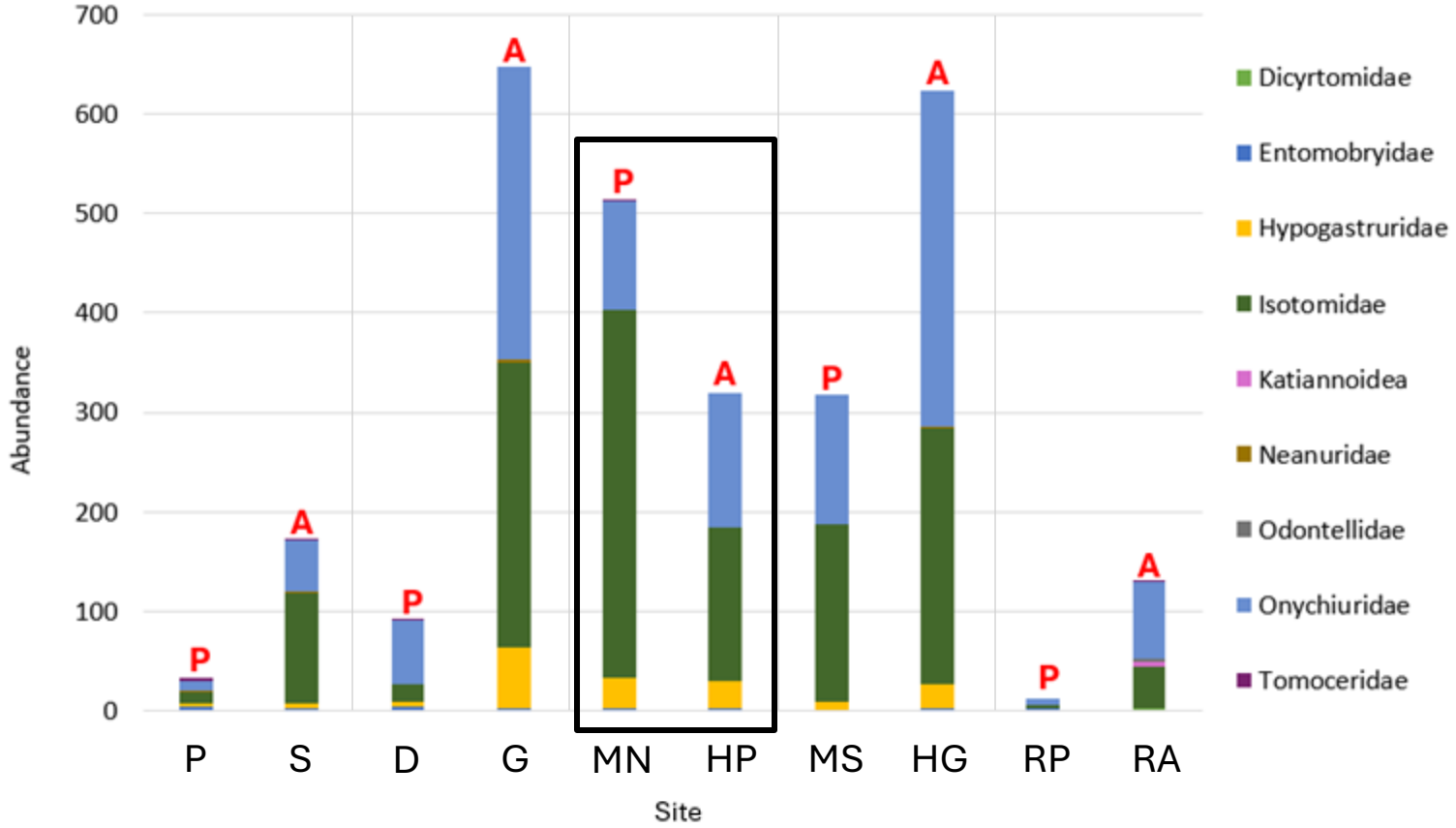




Springtail Abundance

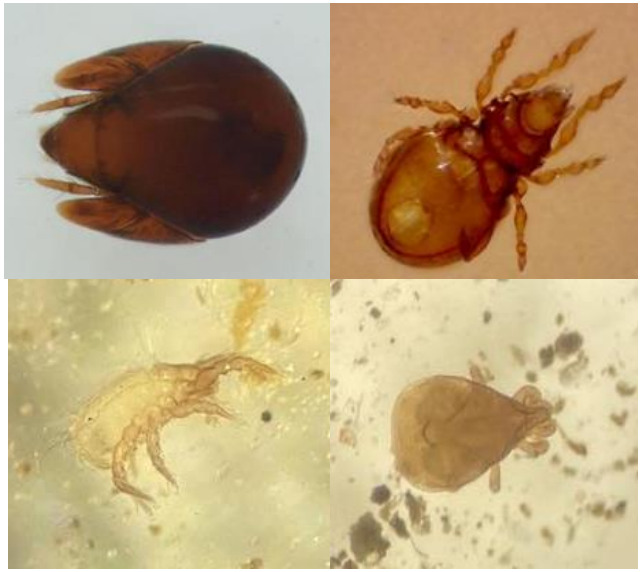


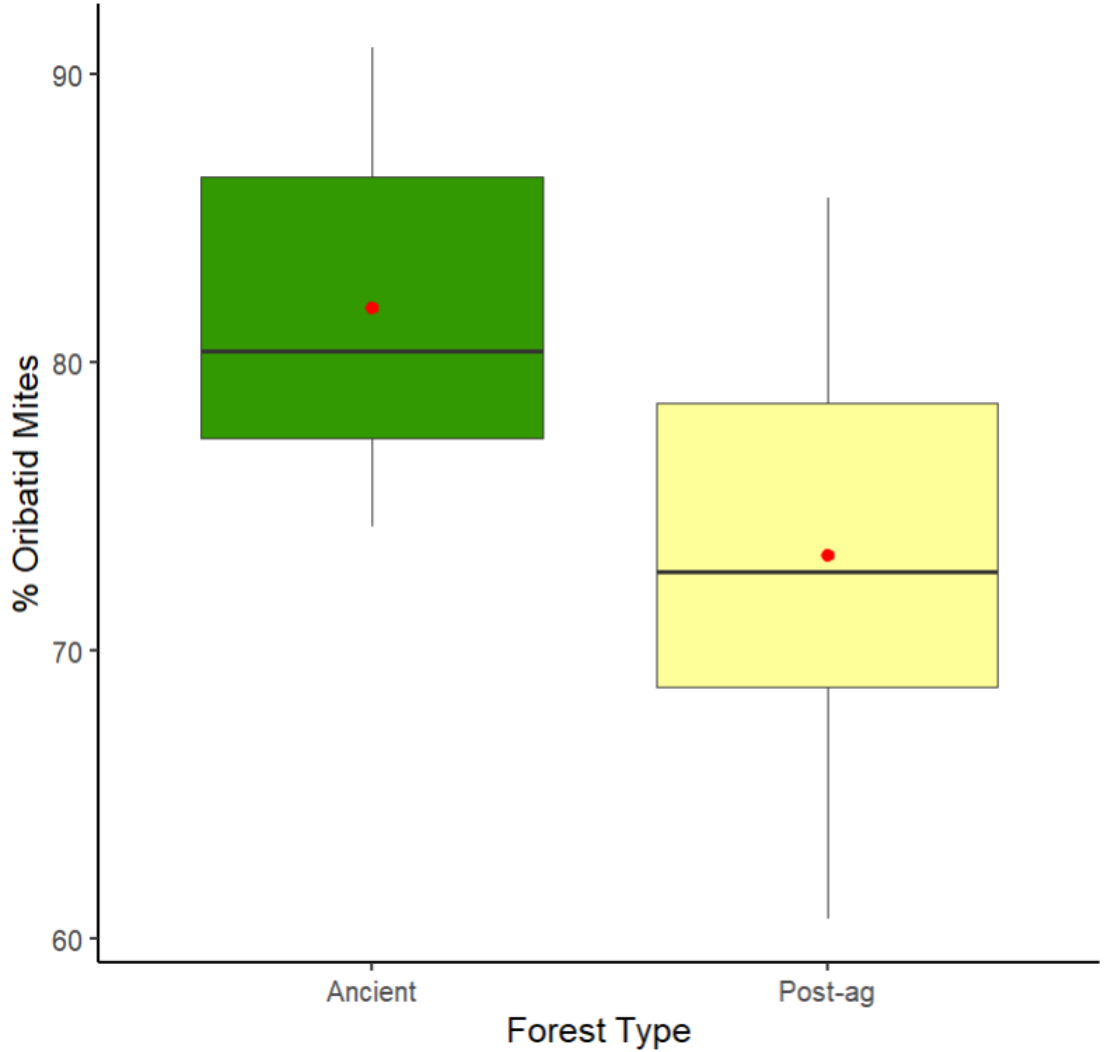
Springtail Abundance

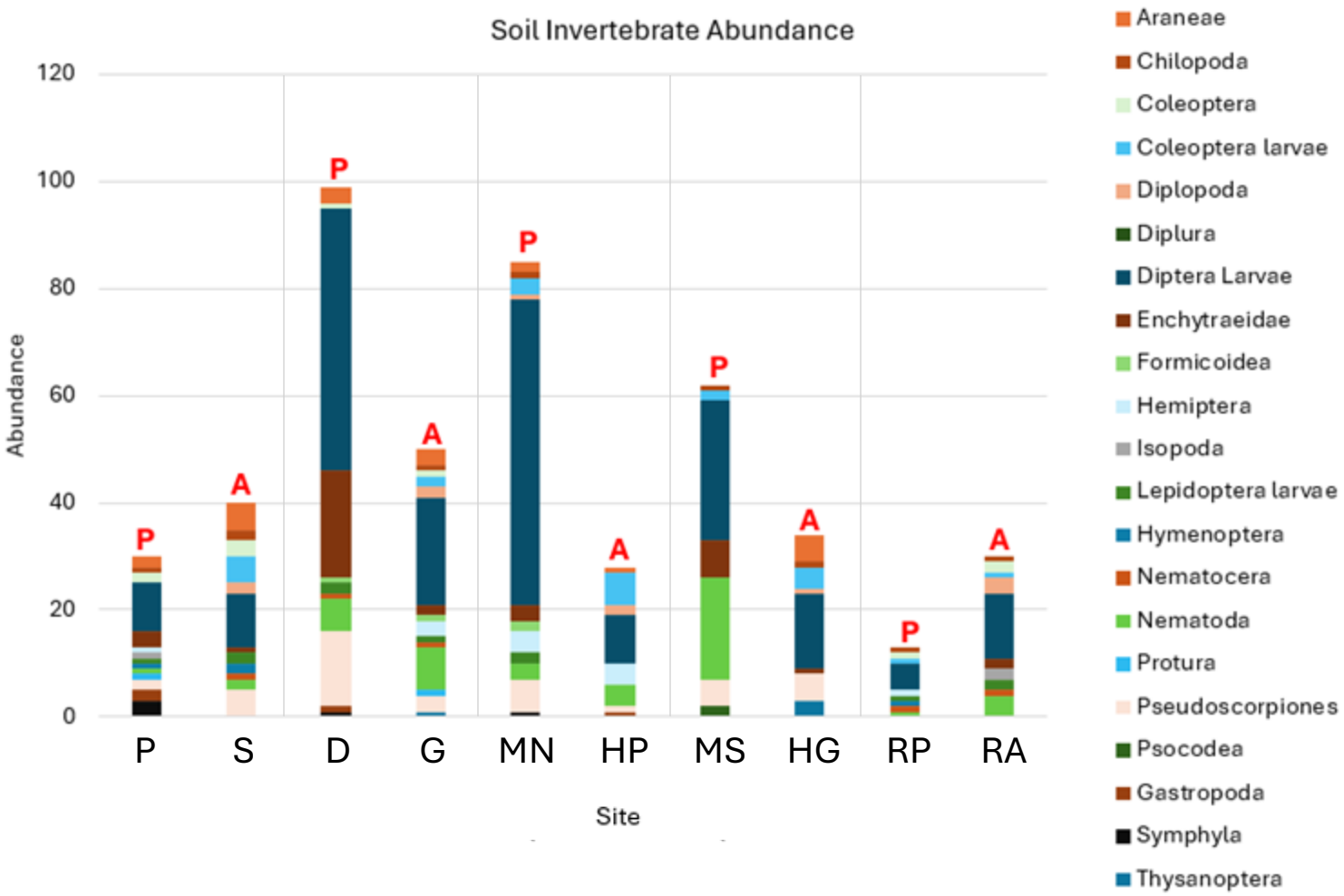


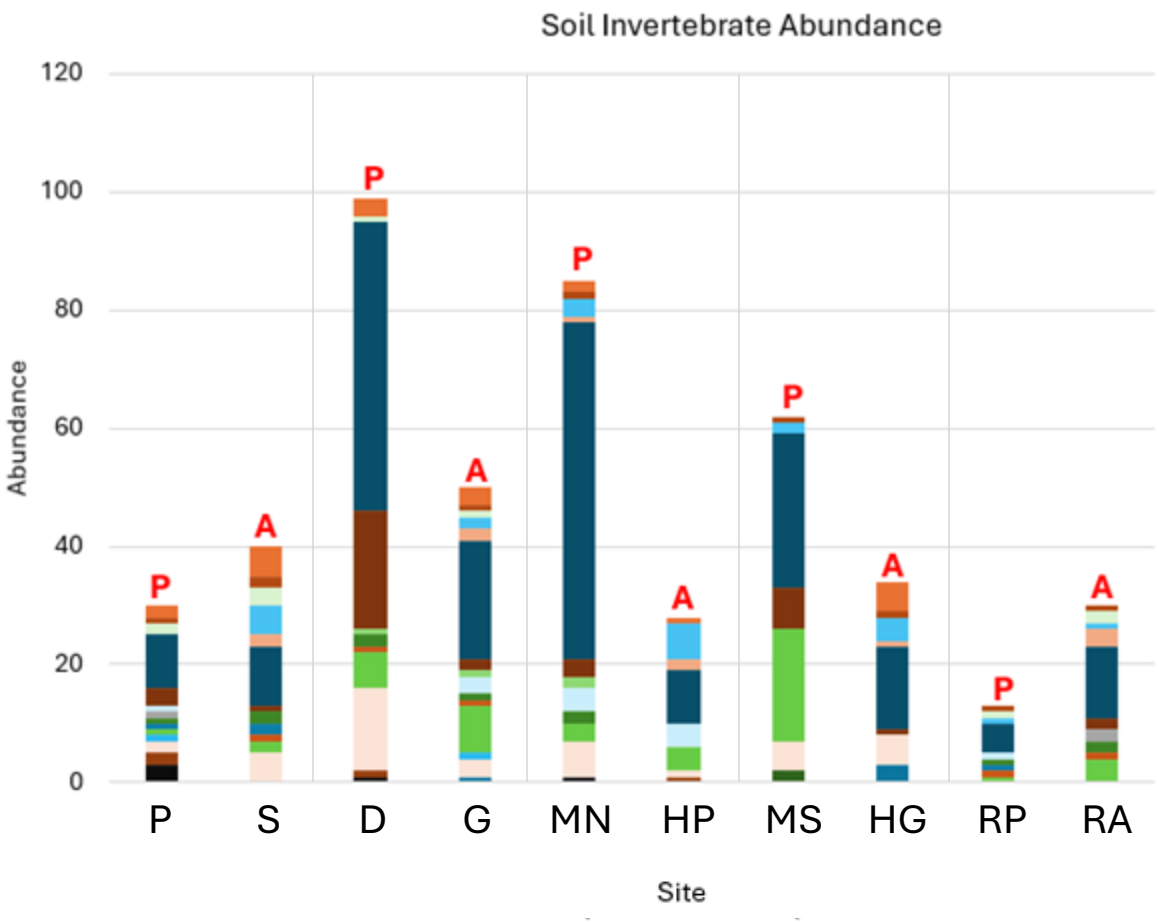
Soil Mites

- Mean density within 1cm^2 sub-sample
- % oribatid adults of total adult mites






Soil Invertebrate Abundance
Abundance
120
100
80
60
40
20
0
P
A
P
A
P
A
P
A
P
A
P
S
D
G
MN
HP
MS
HG
RP
RA
Site
Araneae
Chilopoda
Coleoptera
Coleoptera larvae
Diplopoda
Diplura
Diptera Larvae
Enchytraeidae
Formicoidea
Hemiptera
Isopoda
Lepidoptera larvae
Hymenoptera
Nematocera
Nematoda
Protura
Pseudoscorpiones
Psocodea
Gastropoda
Symphyla
Thysanoptera

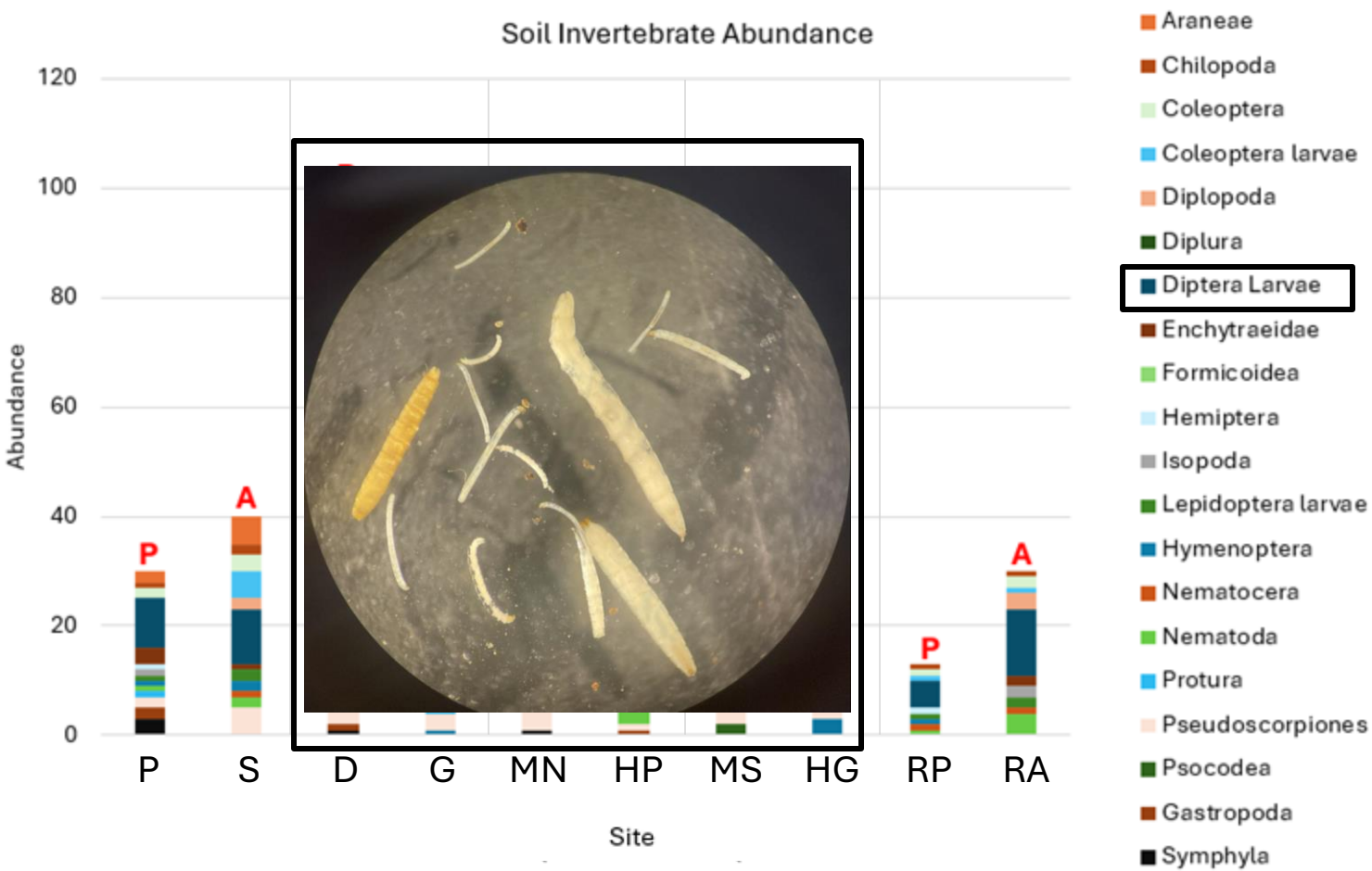

Soil Invertebrate Abundance
120
100
80
60
40
20
0
Abundance
P
A
P
A
P
A
P
A
P
A
P
S
D
G
MN
HP
MS
HG
RP
RA
Site







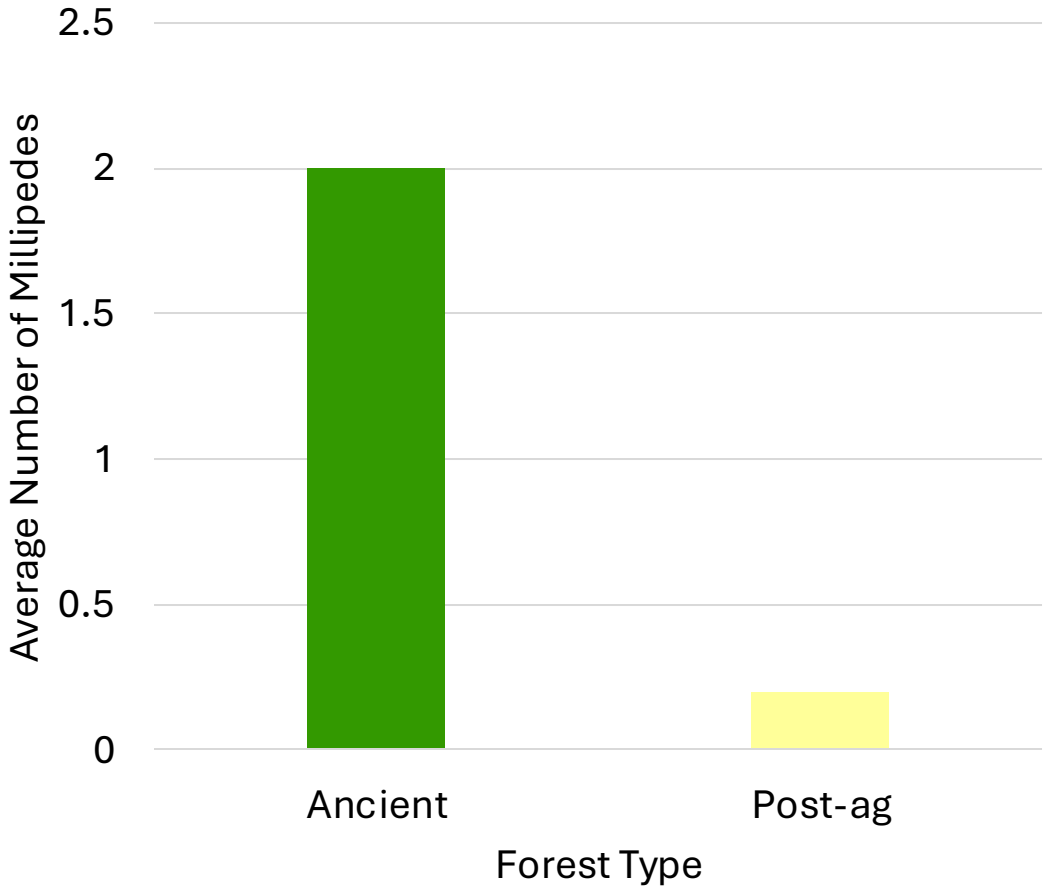



Soil Invertebrate Abundance
120
100
80
60
40
20
0
Abundance
P
A
P
A
P
S
D
G
MN
HP
MS
HG
RP
RA
Site
Araneae
Chilopoda
Coleoptera
Coleoptera larvae
Diplopoda
Diplura
Diptera Larvae
Enchytraeidae
Formicoidea
Hemiptera
Isopoda
Lepidoptera larvae
Hymenoptera
Nematocera
Nematoda
Protura
Pseudoscorpiones
Psocodea
Gastropoda
Symphyla
Thysanoptera

Millipedes

- Only found in 1 post-ag site

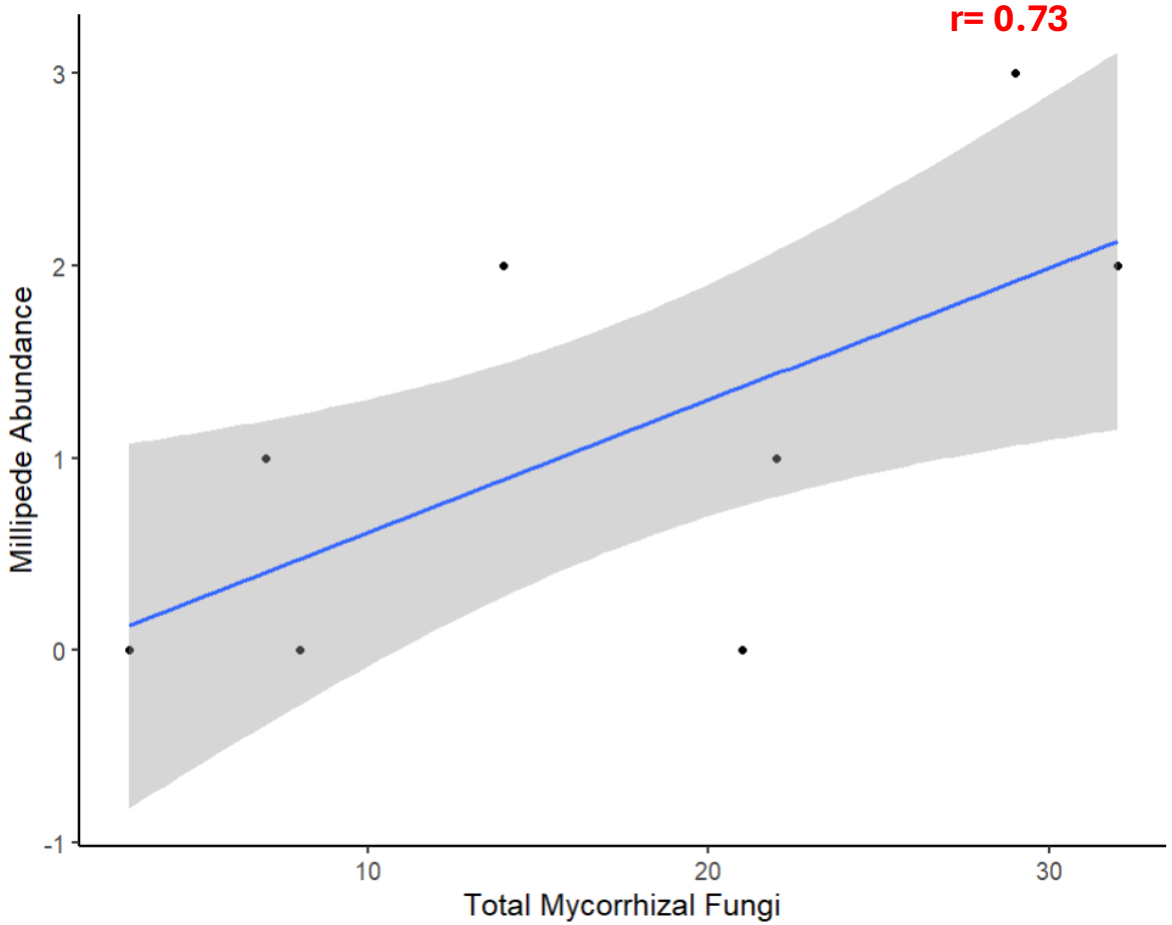




Millipedes & Fungi



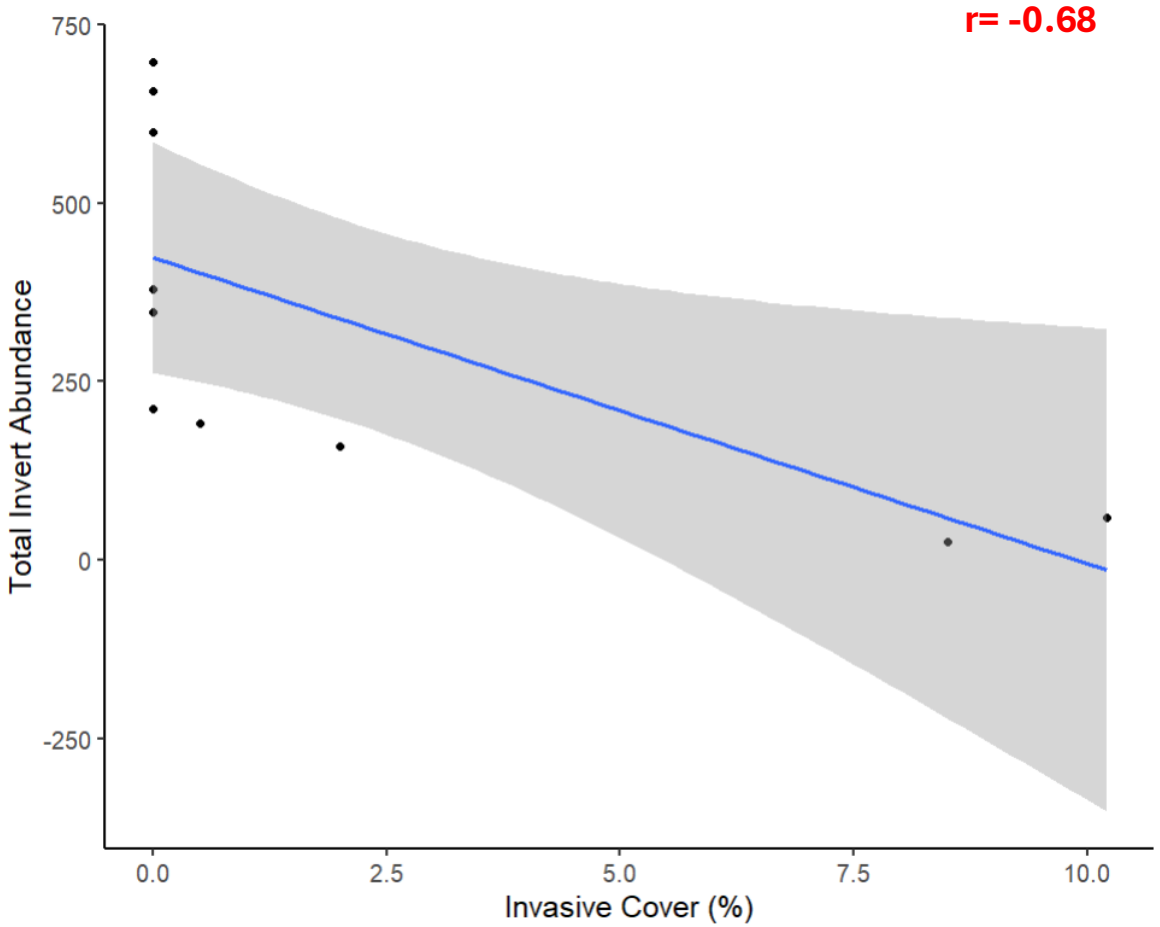




Soil Invertebrates & Invasive Plants

- Decline in invertebrates with increasing invasive plants

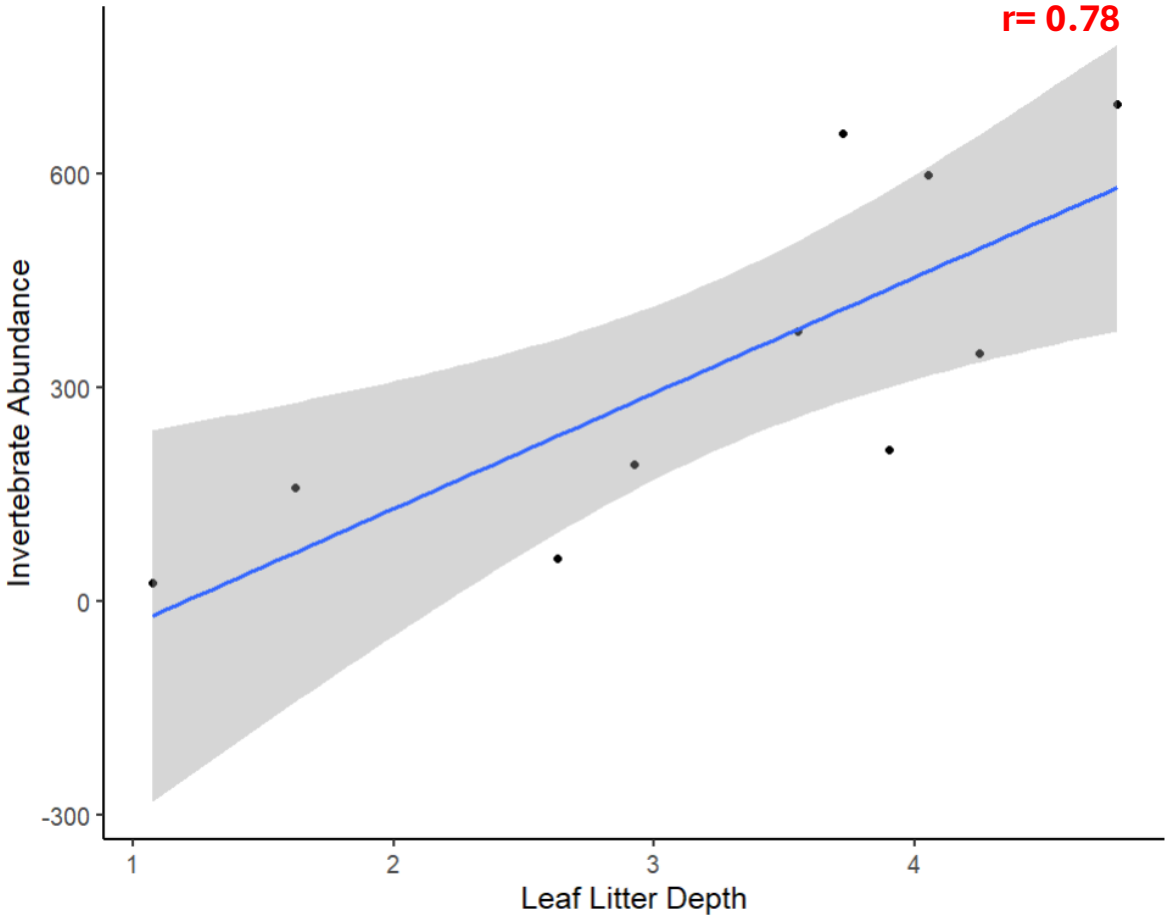




Soil Invertebrates & Leaf Litter

- Increasing invertebrates with greater leaf litter depth





Main Findings



Spring Wildflowers





Ants + Salamanders



Mushrooms



Soil Invertebrates

Main Findings

- More spring wildflower species in ancient forest.
- Spring wildflowers infrequent overall.

Spring Wildflowers



Ants + Salamanders



Soil Invertebrates



Mushrooms

Main Findings

- More spring wildflower species in ancient forest.
- Spring wildflowers infrequent overall.

Spring Wildflowers

- *Aphaenogaster* is present in post-ag forests but at lower abundance.
- Salamander abundance slightly higher in ancient, but difference not significant.

Ants + Salamanders



Soil Invertebrates



Mushrooms

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Ants + Salamanders

- More species found in ancient forests.
- More mycorrhizal species found in ancient forests.

Mushrooms



Soil Invertebrates

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- More spring wildflower species in ancient forest.
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Spring Wildflowers

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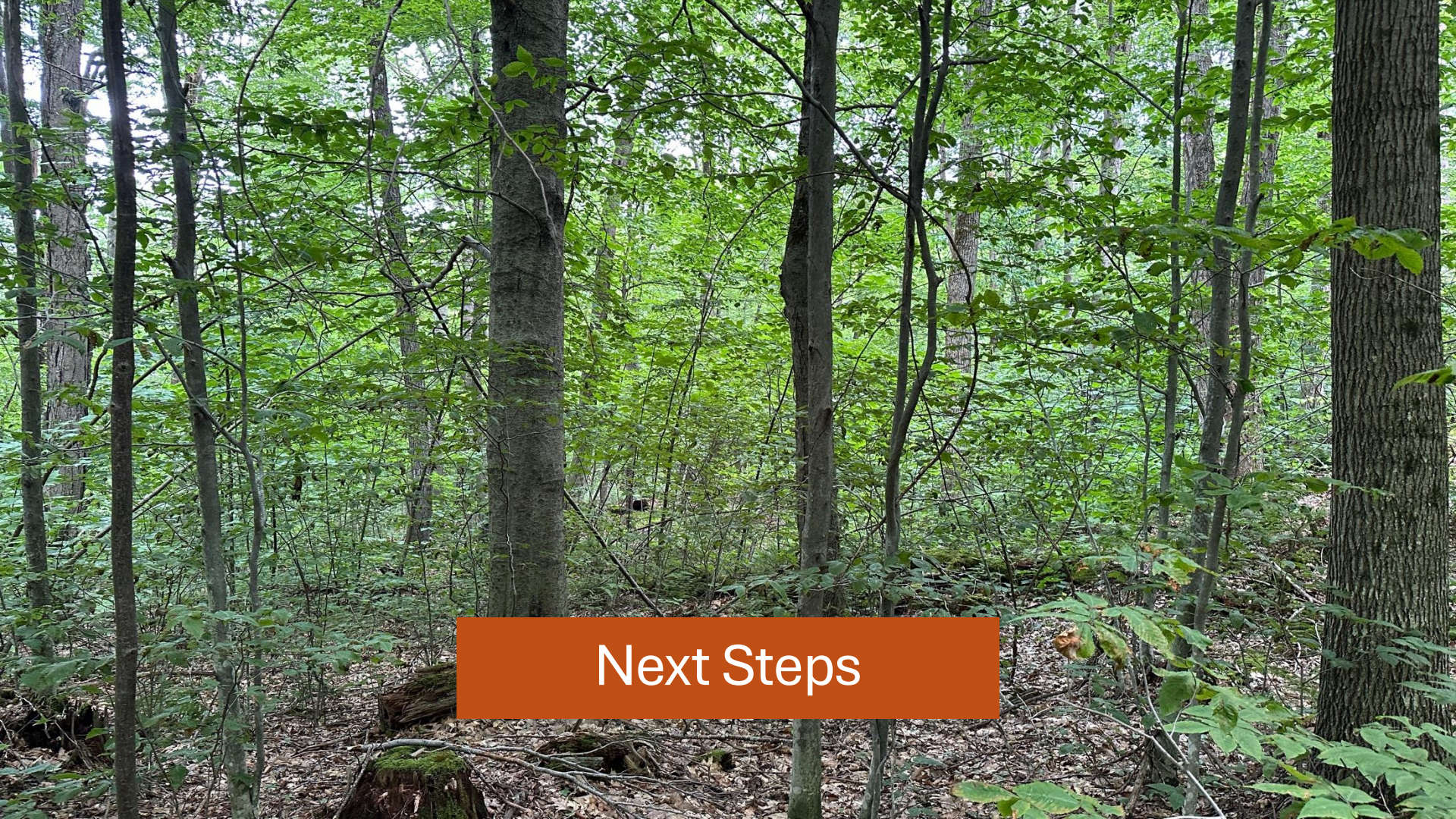
Ants + Salamanders

- More species found in ancient forests.
- More mycorrhizal species found in ancient forests.

Mushrooms

- More millipedes & slightly more springtails & mites in Ancient Forests
- Associations with mycorrhizal fungi, invasive plants, leaf litter

Soil Invertebrates


Next Steps

Next Steps

- Ideally expand study to oak-dominated southern foothills
  - 10 Post-Ag sites
  - 10 Ancient sites
- Continue mapping
- Focus on spring flowers, mushrooms, ants, salamanders, and other soil invertebrates
- Continue to fundraise



Acknowledgments

- Our colleagues.
- All the private land owners who let us sample their land.
- All of our private donors who make our research and free public outreach possible.
- An anonymous donor for ancient forest mapping support.
- Volunteers
  - Paul Wagner (stonewall mapping).
  - Otis Denner (1940s aerial image scanning and georeferencing).

