

# Resilience of wildland forests in the Eastern U.S.

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Highstead Foundation



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Adaptation and mitigation capacity of wildland forests in the northeastern United States



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# Climate change, forests, and adaptation

- “Anthropogenic climate change has caused drought-induced tree mortality of up to 20% in the period 1945-2007 in three regions in...North America”
- “Anthropogenic climate change has increased the area burned by wildfire above natural levels...from 1984-2017 by double for the Western USA”
- “Forest insect pests have expanded northward and severity and outbreak extent has increased in northern North America...due to warmer winters...and longer growing seasons...”

- IPCC (2022)

Forests are changing due to climate change

Climate change is impacting our forests, but you can take action now to prepare forests for change and reduce risks.

> Learn More

<https://forestadaptation.org/>

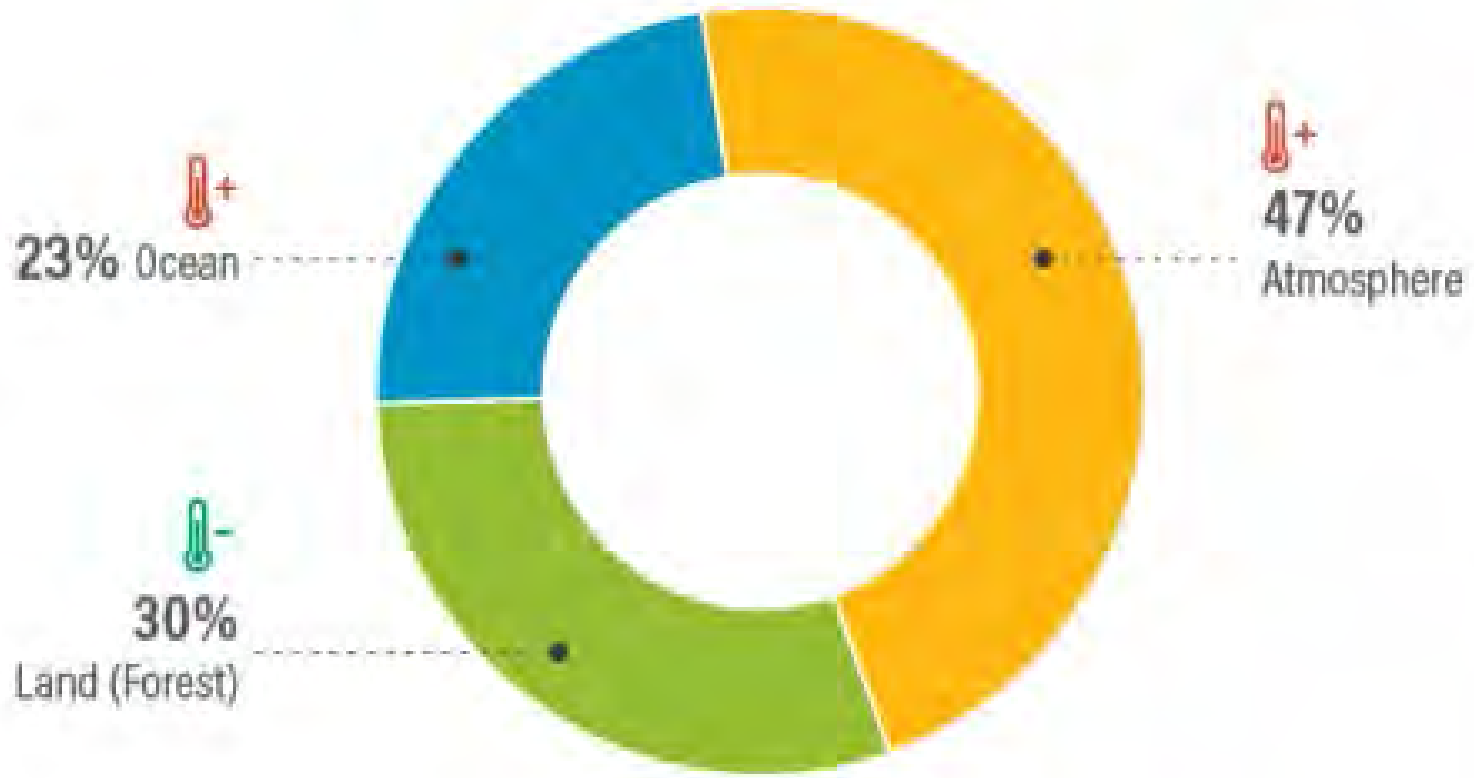


# Terms

- **Climate mitigation in forests**– enhancing carbon storage/sequestration to alleviate potential adverse effects of climate change
  - Carbon **sequestration** – the rate at which carbon is taken up by plants from the atmosphere
  - Carbon **storage** – the accumulated carbon stored in the forest as a result of sequestration
- **Climate adaptation in forests** – maintaining high levels of **structural, compositional, and/or functional complexity** to enhance the ability of an ecosystem to respond or adapt to changing conditions
  - resilience** – The capacity of an ecosystem to return to the pre-condition state following a perturbation.
  - resistance** - the capacity of a system to absorb disturbance or stress and remain relatively unchanged

# The role of forests (and forest condition) in mitigating climate change

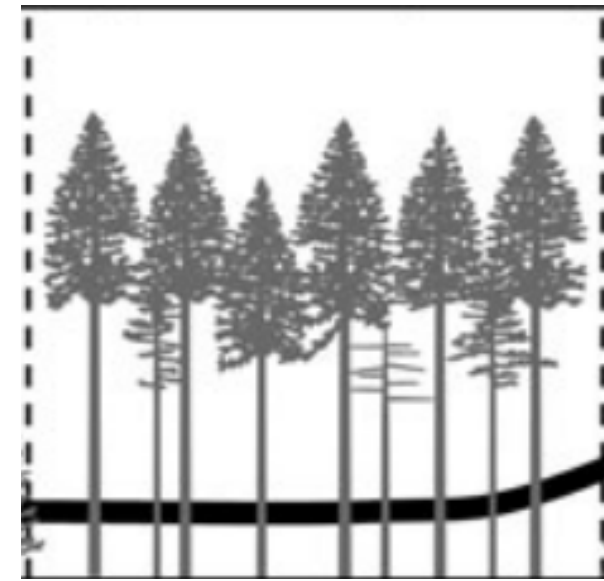
Forests currently absorb 30% of all CO<sub>2</sub> emissions. The rest end up in the ocean or atmosphere, where they fuel climate change



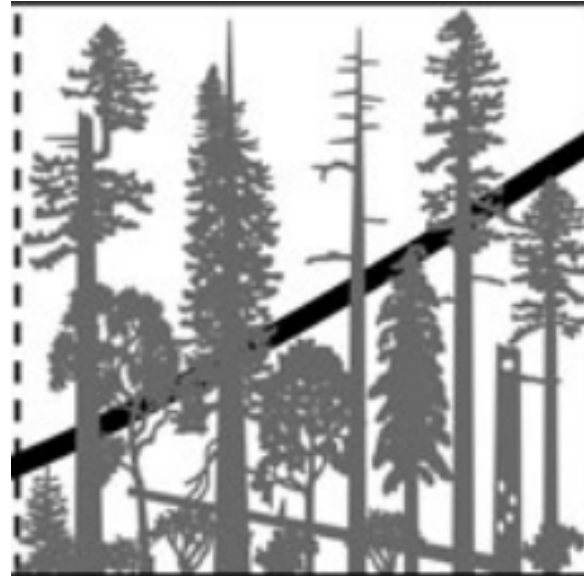
*Eucalyptus regnans* forest, Australia (Keith et al. 2009)

Source: Global Carbon Project, 2000-2018 and Cook-Patton et al. 2020.

# The role of structural complexity in forest adaptation/resilience



insect outbreaks  
disease  
blowdowns



taller trees and greater variation  
in tree heights

greater variety of diameter size  
classes of trees

greater densities of large live and  
dead trees

greater volume of downed logs  
(coarse woody debris)

Canopy gaps with younger  
vegetation

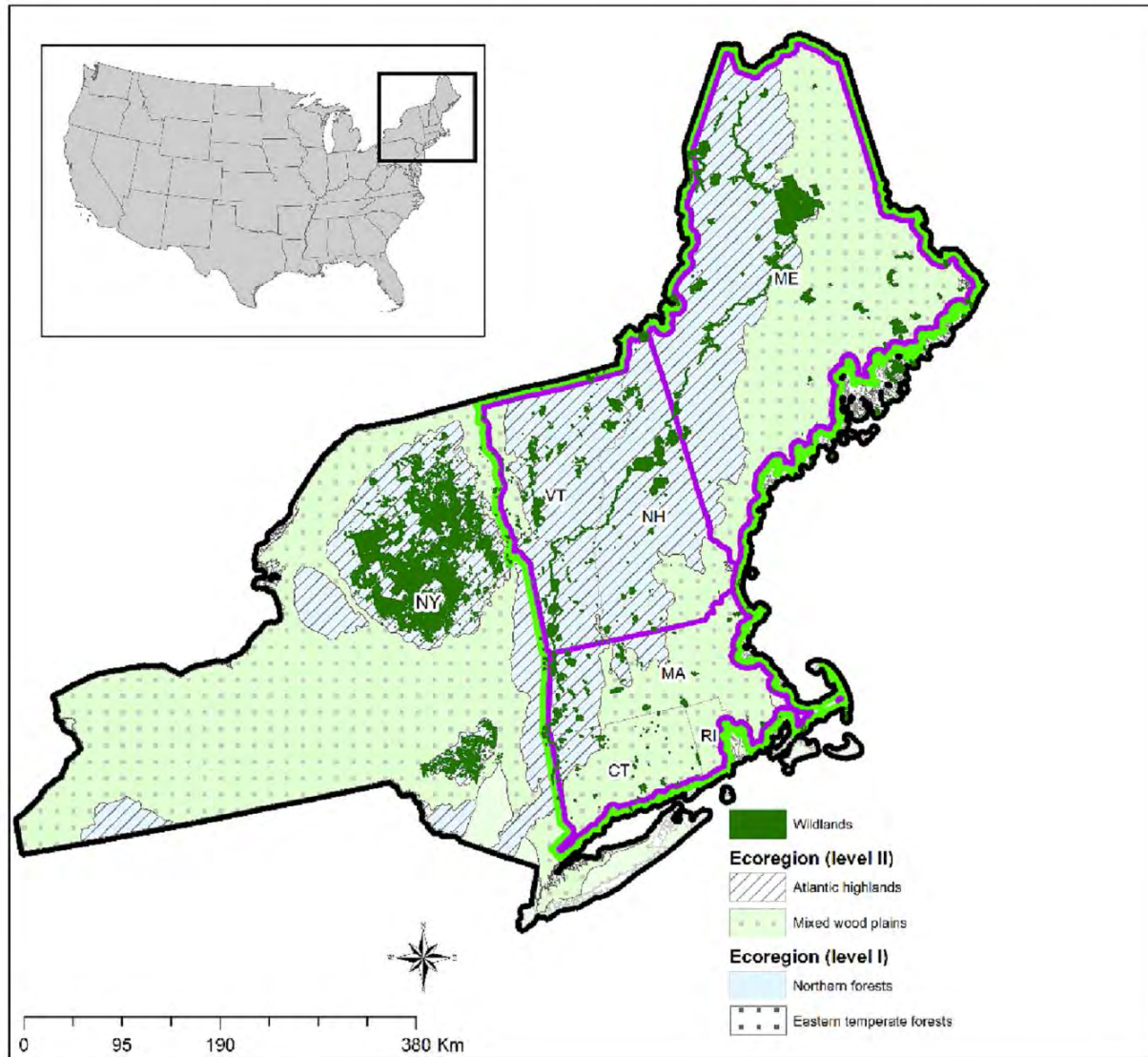
# Questions

1. To what extent do wildlands\* differ from unprotected\*\* forests in terms of:
  - a. mitigation (rate of carbon sequestration and total carbon storage)
  - b. adaptation (structural complexity and species diversity)

**\*Wildlands** - *forests that are protected from both development and timber harvesting with the intent to allow natural processes to prevail with “free will” and minimal human interference* Foster et al. 2023.

**\*\*Unprotected** - forests that are not protected from timber harvesting and other active management

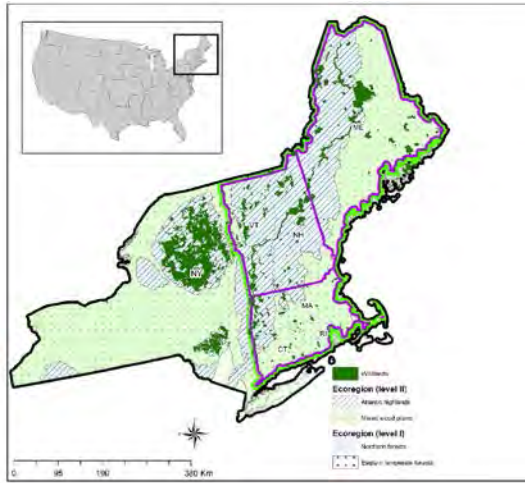
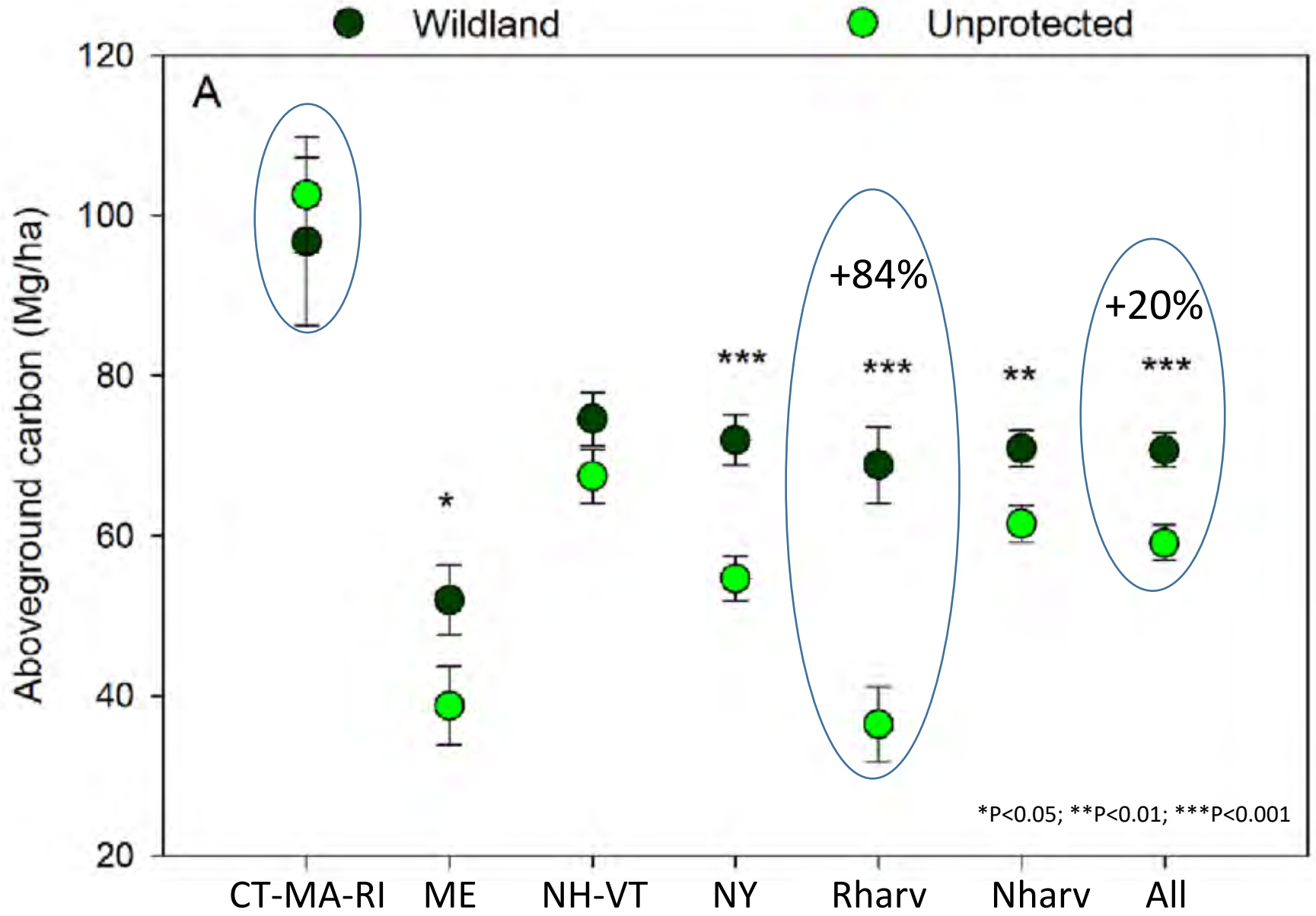
# Comparing wildlands to unprotected forests in the Northeast



- USDA Forest Service Inventory and Analysis dataset
- matched plots in wildlands with unprotected areas based on similarity in site and environmental conditions:
  - (Elevation, slope, light, water, temperature, nitrogen deposition, eco-subregion)

Sample size: >200 in wildlands, >200 in unprotected areas); 10% of unprotected plots showed sign of recent harvest (since 1999)

# Aboveground carbon storage higher in wildlands

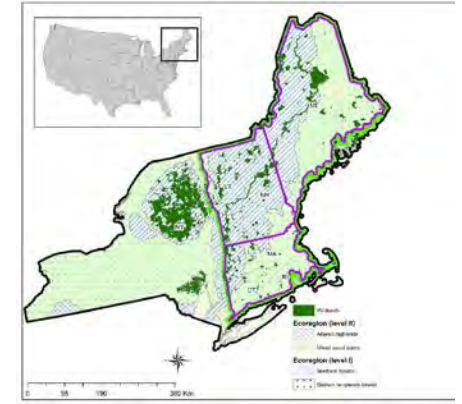
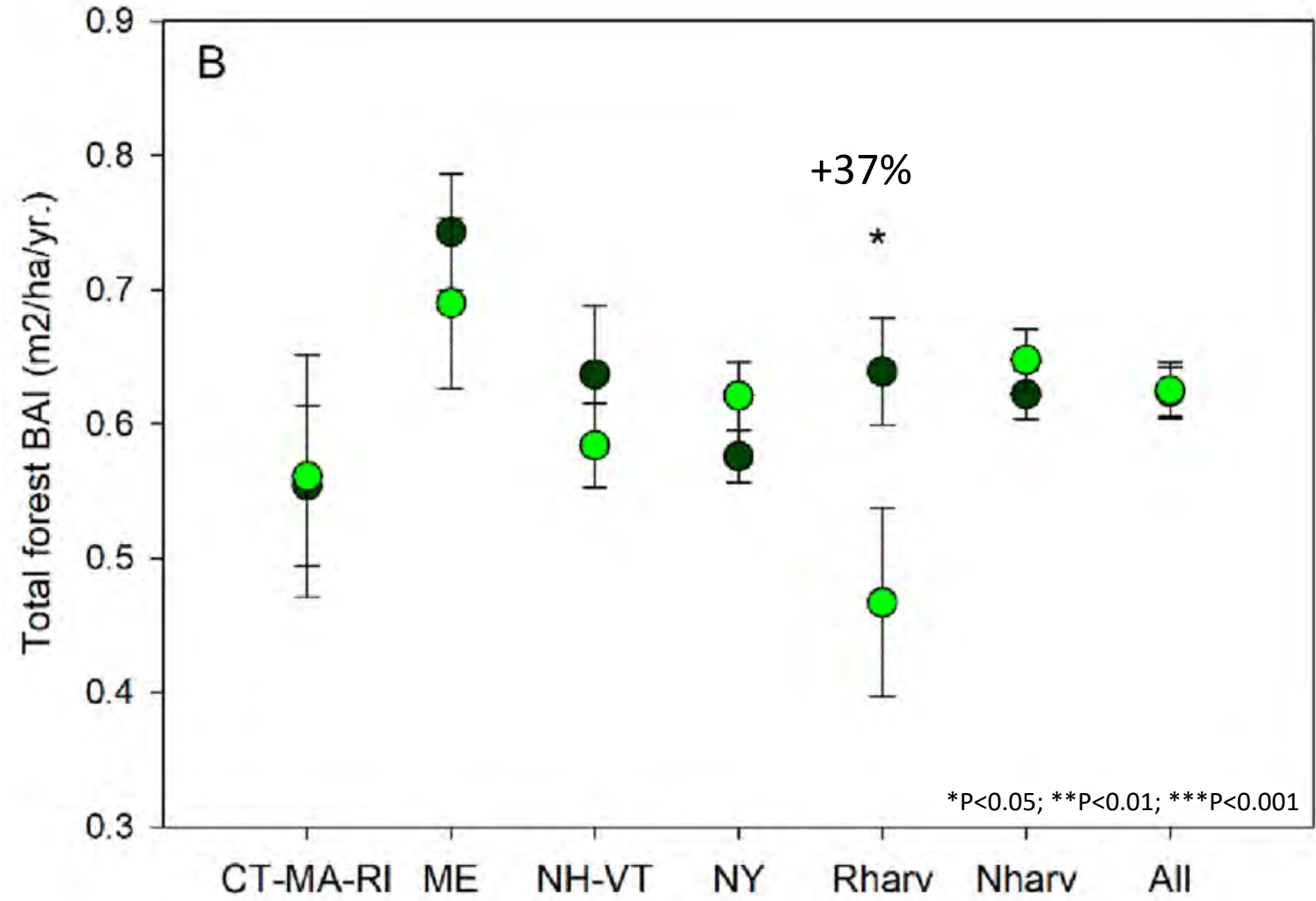


Rharv = unprotected plots with **recent tree harvesting** compared to matched wildlands.

Nharv = unprotected plots with **no sign of recent harvesting** compared to matched wildlands.

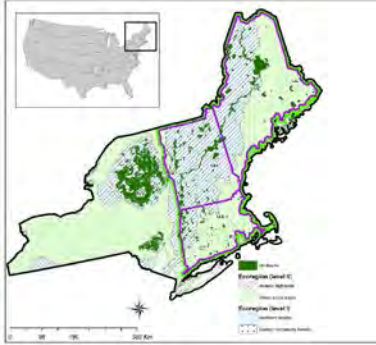


# Total forest growth rate (i.e., carbon sequestration) similar in wildlands and unprotected forests



Wilderness, Catskill Forest Preserve, NY

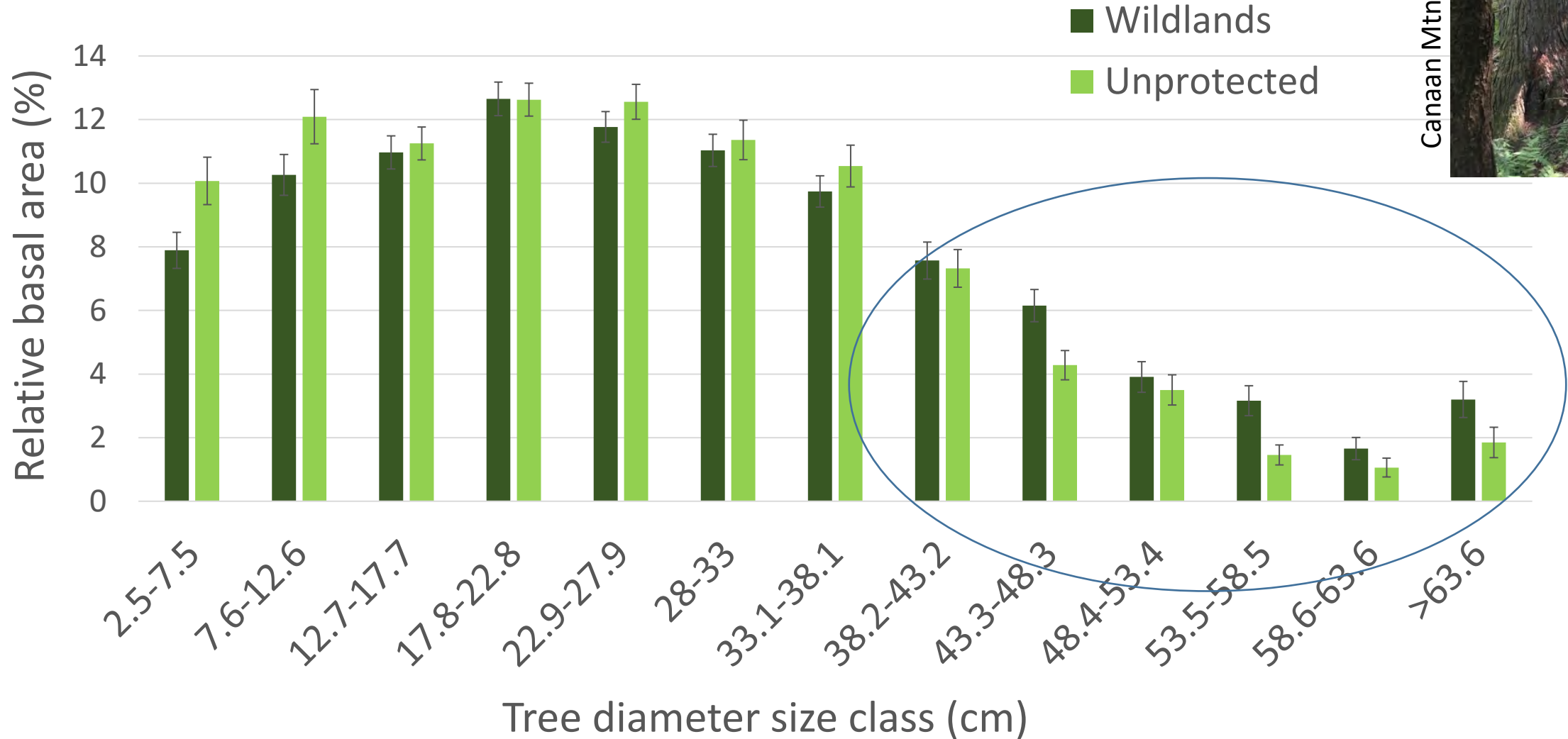
# Diameter size class diversity greater in wildlands



\*P<0.05; \*\*P<0.01; \*\*\*P<0.001

Harvard Forest

# Greater percentage of basal area in large trees in wildlands



Canaan Mtn. wilderness, CT

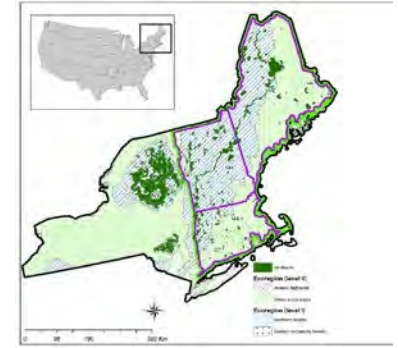
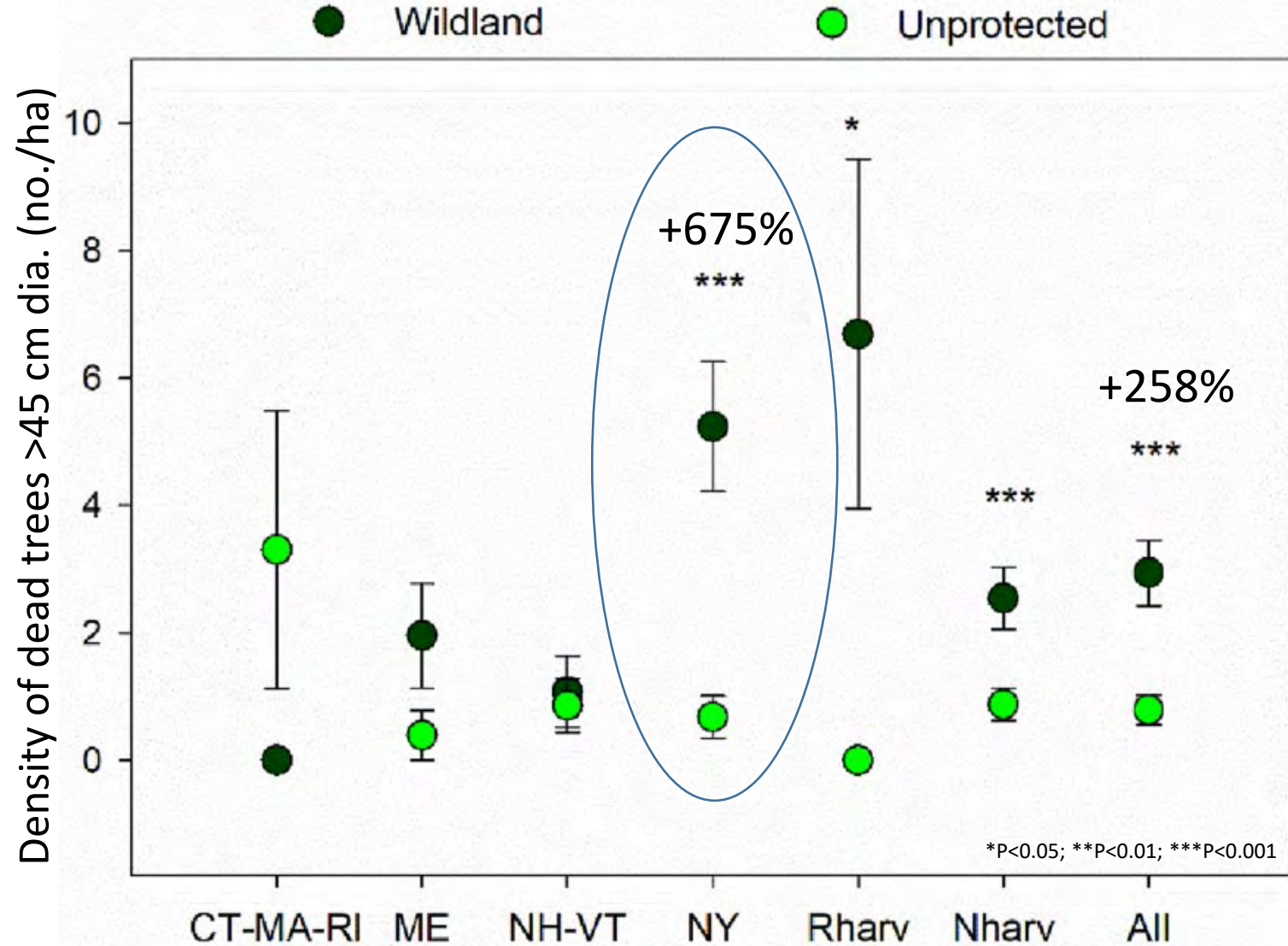


# Maximum tree height greater in wildlands



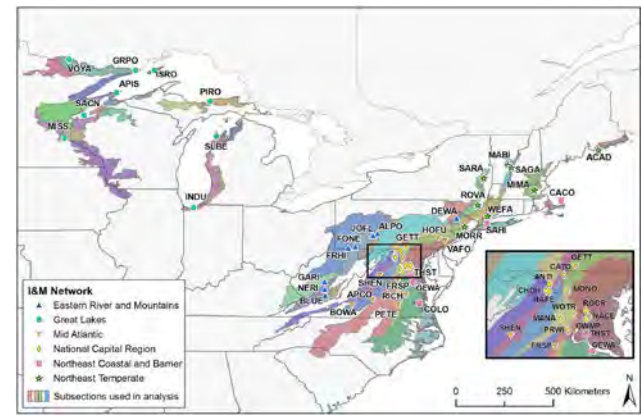
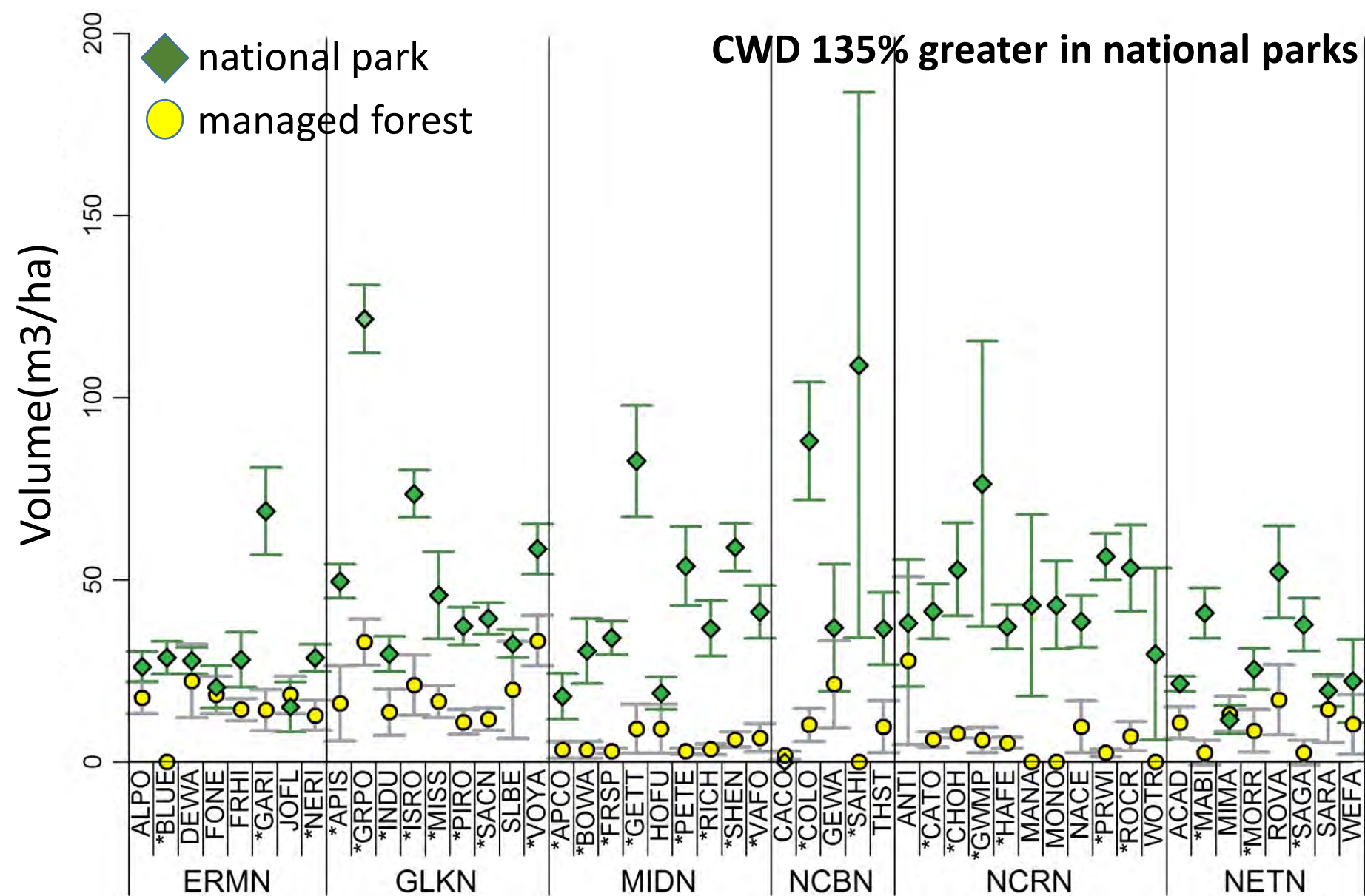
Catskill Forest Preserve Wilderness, NY

# A greater number of large dead trees occurred in wildlands



Pisgah Tract, New Hampshire  
DR Foster photo

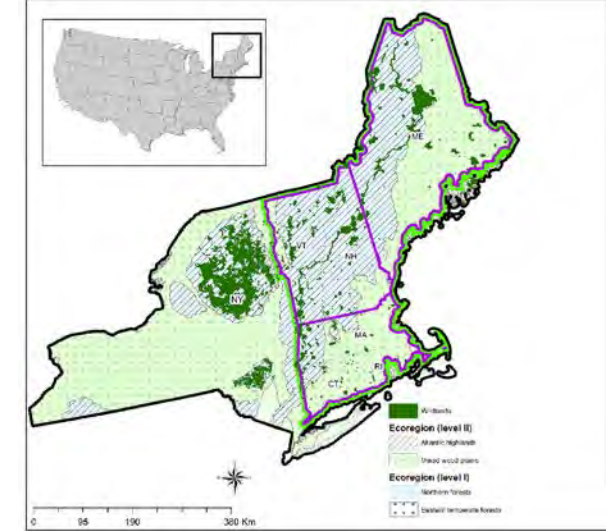
# Eastern national parks had greater amounts of coarse woody debris than surrounding forests



Pisgah Tract, NH (DR Foster photo)

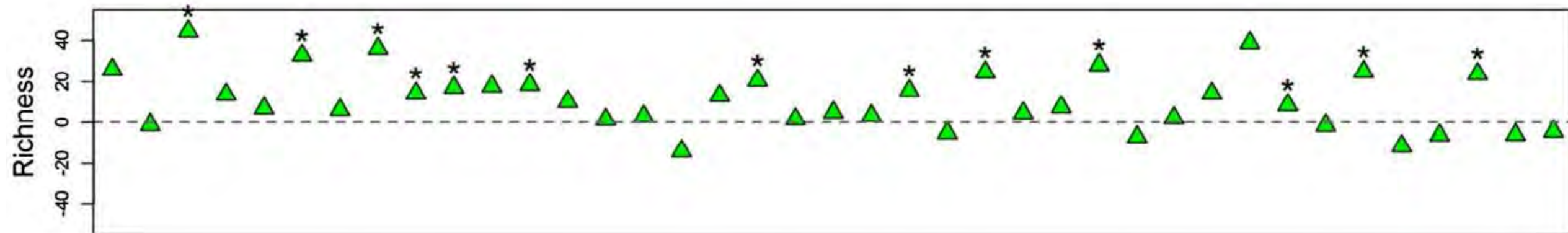
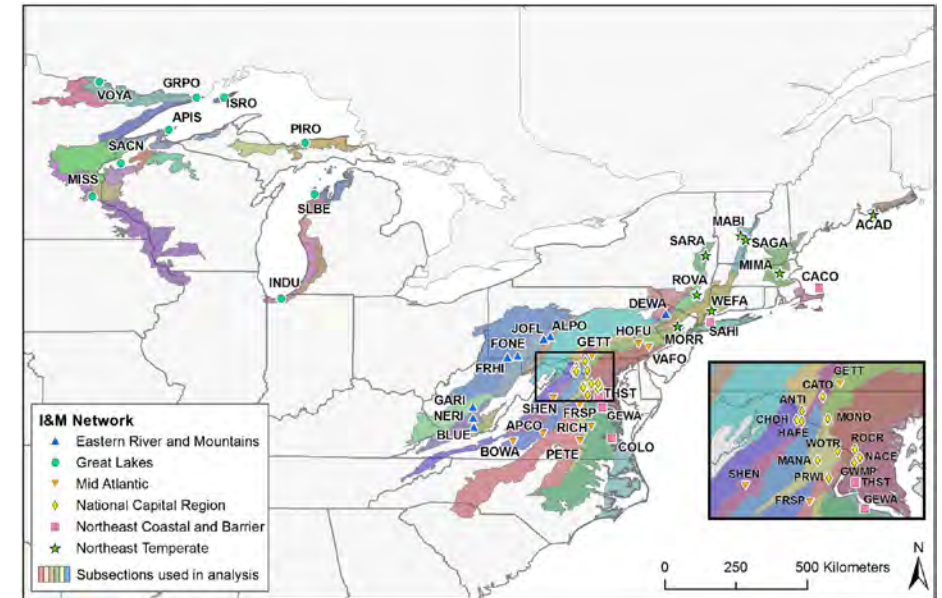
Figure from Miller et al. 2016. *Ecosphere*

# Number of tree species similar in wildlands and unprotected forests in the Northeast



\* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$

# Adult tree richness greater in eastern National Park forests than surrounding forests





# Wildlands in large protected areas provide historically relevant levels of young forest habitat

“On reserved forest land in New York [primarily the Adirondack and Catskill Forever Wild Preserves]... **3 percent** [of forest area is] in seedling/sapling and nonstocked stands.”

Widmann et al. 2012. *The forests of New York*

“The proportion **of the presettlement landscape** in seedling–sapling forest habitat...ranged from **1 to 3%** in northern hardwood forests of the interior upland” (Lorimer and White 2003. *Forest Ecology and Management*)



Lye Brooke Wilderness, Vermont

← natural gaps →

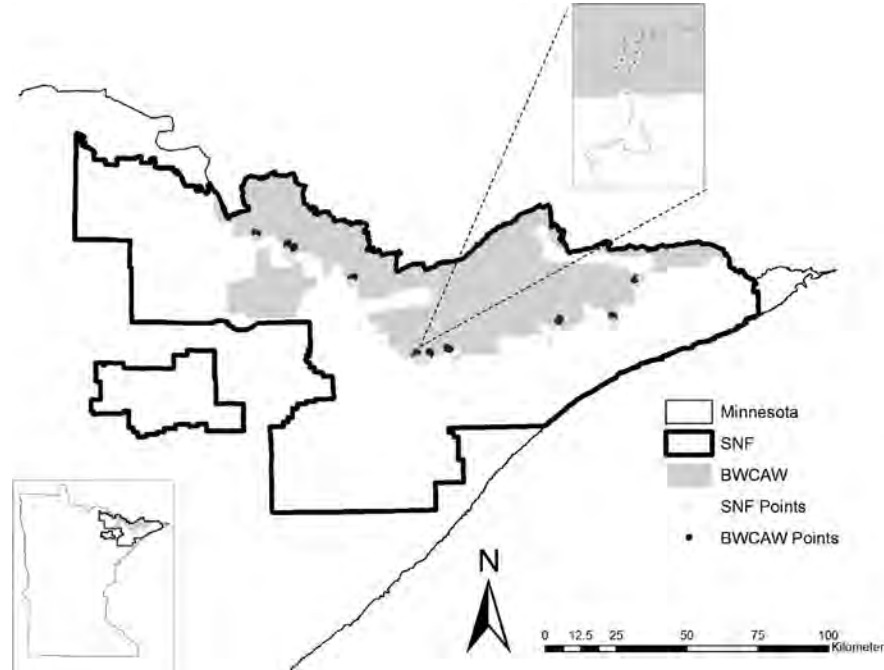


Pharaoh Lake Wilderness, Adirondack Preserve, NY

# Wilderness forests: high densities and diversity of forest birds across broad landscapes

- Total density of birds
- Total number of bird species
- Abundance of individual species

Wilderness forest



Zlonis and Niemi 2014. *Forest Ecology and Management*



David Turgeon



Andy Reago and Chrissy McClarren

“the richness of early-successional forest species did not vary between wilderness and managed forest...”

“Our results suggest the need...to reexamine the rush to incorporate more management for climate [change] in northern temperate forests that are not specifically being managed for wood products and to consider instead the multiple benefits of stricter protection and allowing natural processes to do more”

Faison et al. 2023. *Forest Ecology and Management*



Thunder Ridge Wilderness, Virginia

# Biodiversity in Northeastern Old Growth Forests: A Brief Review

Liz Thompson, Ecologist  
September 22, 2023



# Wildlands in New England

*Past, Present, and Future*

## Values of Wildlands

- Intrinsic value
- Complexity: Resilience
- Complexity: Biodiversity
- Carbon Storage
- Quiet space
- Reference
- 30x30



An Integrated Conservation Initiative



# A Review of Reviews

*a few highlights*

- Davis 1996
- Lapin 2005
- Barton and Keeton 2018
- Maloof 2023

# Factors influencing Biodiversity

- Structural Complexity
- Area
- Age
- Soil integrity

# Structural Characteristics and Biodiversity







Photo: Shelby Perry



Photo: Shelby Perry



Black Bear Mountain, Adirondack Park

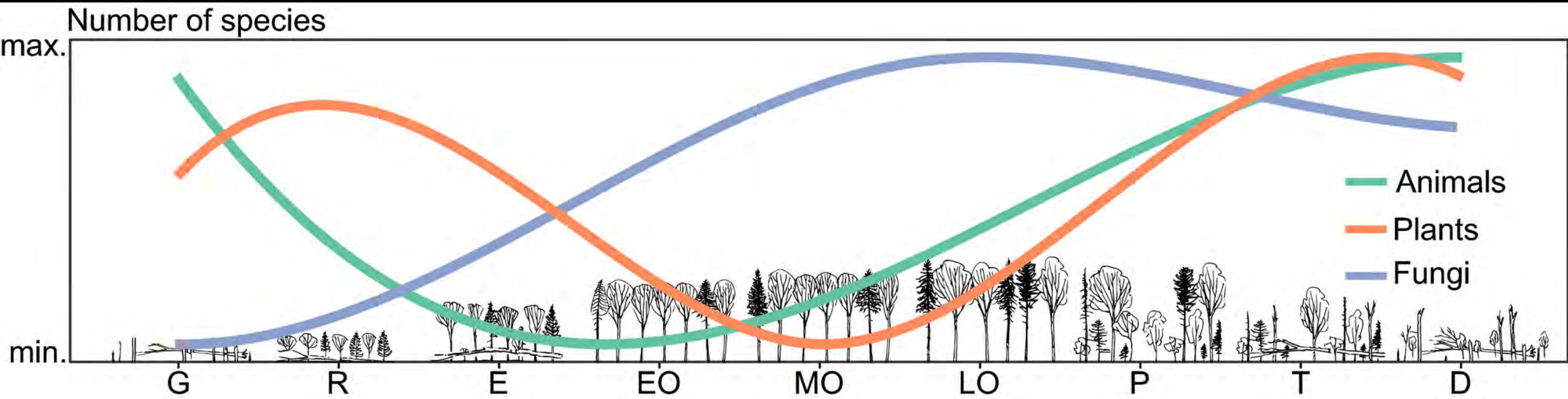
Photo: Eric Sorenson



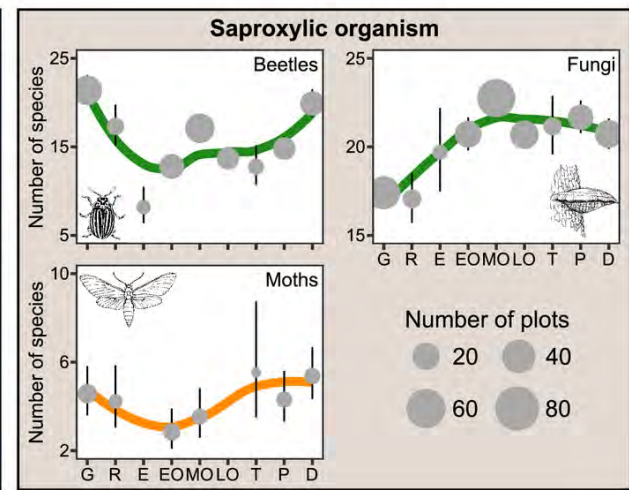
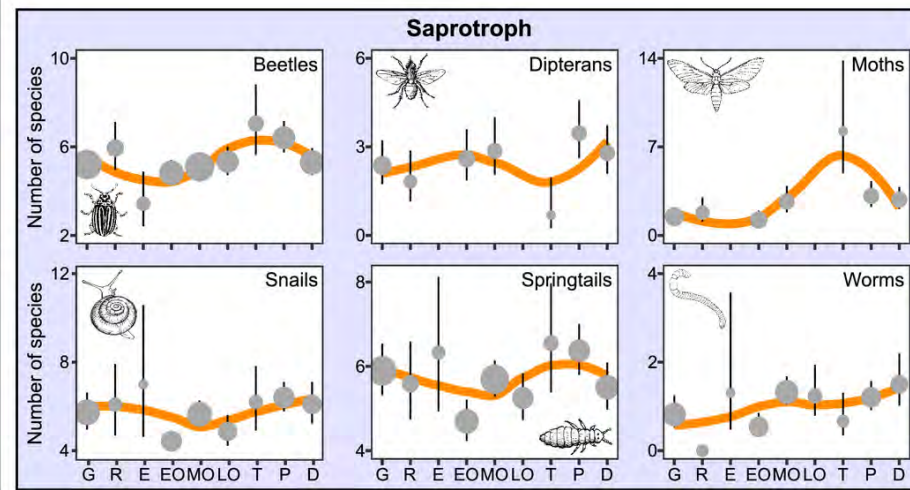
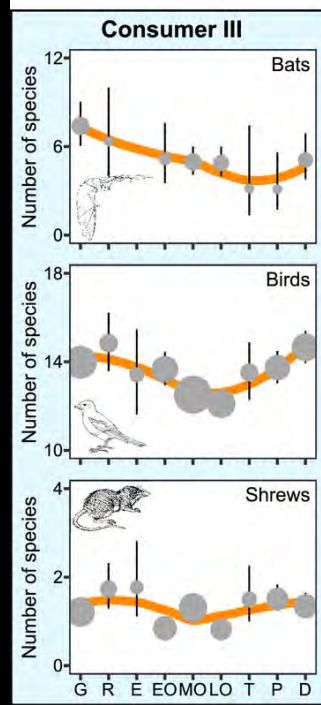
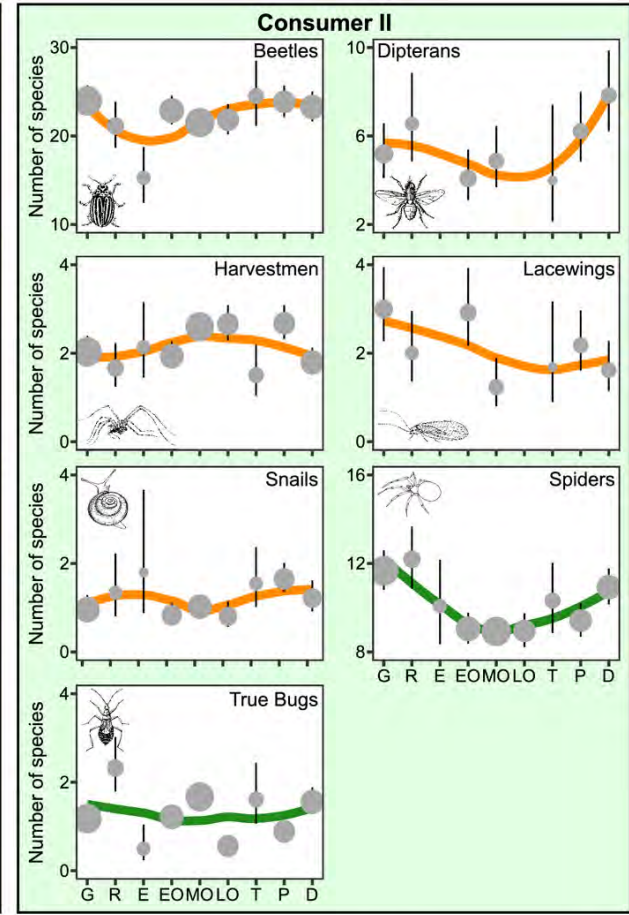
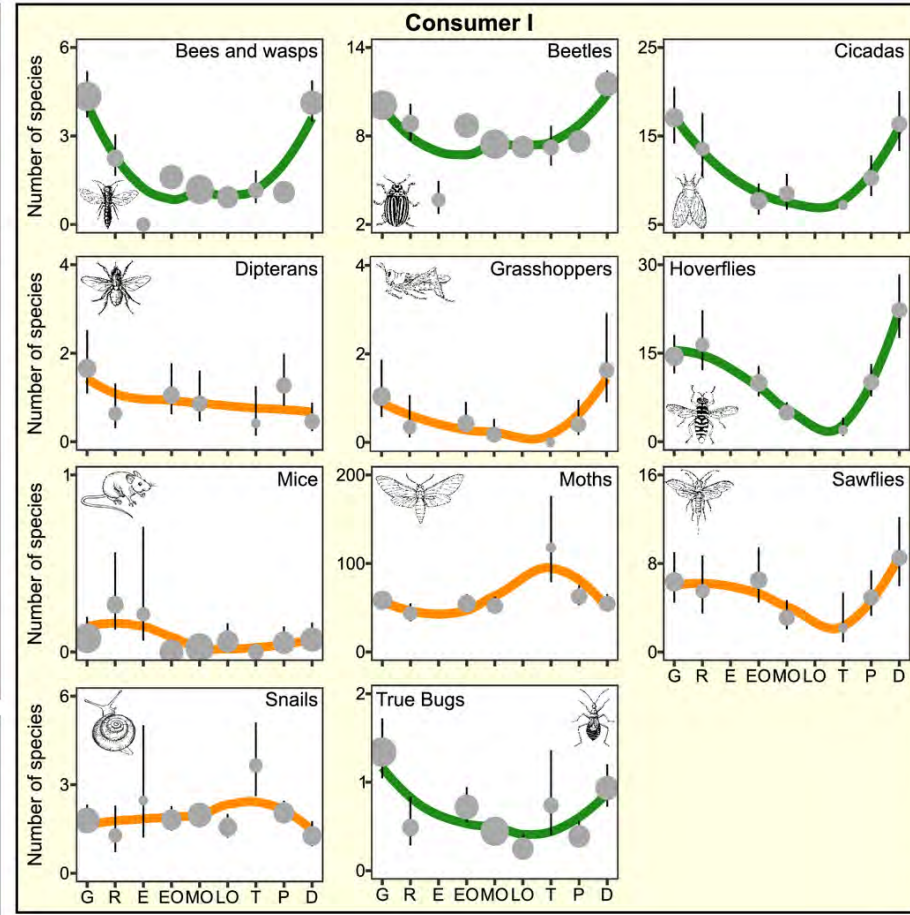
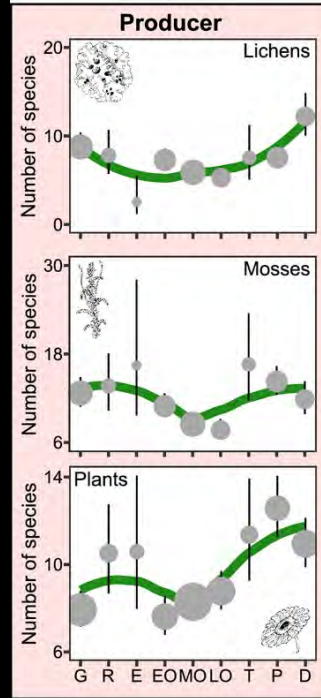
# Summary Data

## *The Takeaways*

- Species Richness greatest in young and old forests
- Many taxa show a U-shaped curve in richness and abundance over time
- No known OG obligates in the Northeast
- Some taxa (groups, species) are more abundant in OG than in young forests



Hilmers et al. 2018



Number of plots

● 20 ● 40

● 60 ● 80

# Taxonomic Groups

- Vascular Plants
- Fungi
- Lichens
- Bryophytes
- Invertebrates
- Amphibians and Reptiles
- Birds
- Mammals





Hobblebush, *Viburnum lantanoides*  
Smugglers Notch, Mount Mansfield State Forest, Vermont



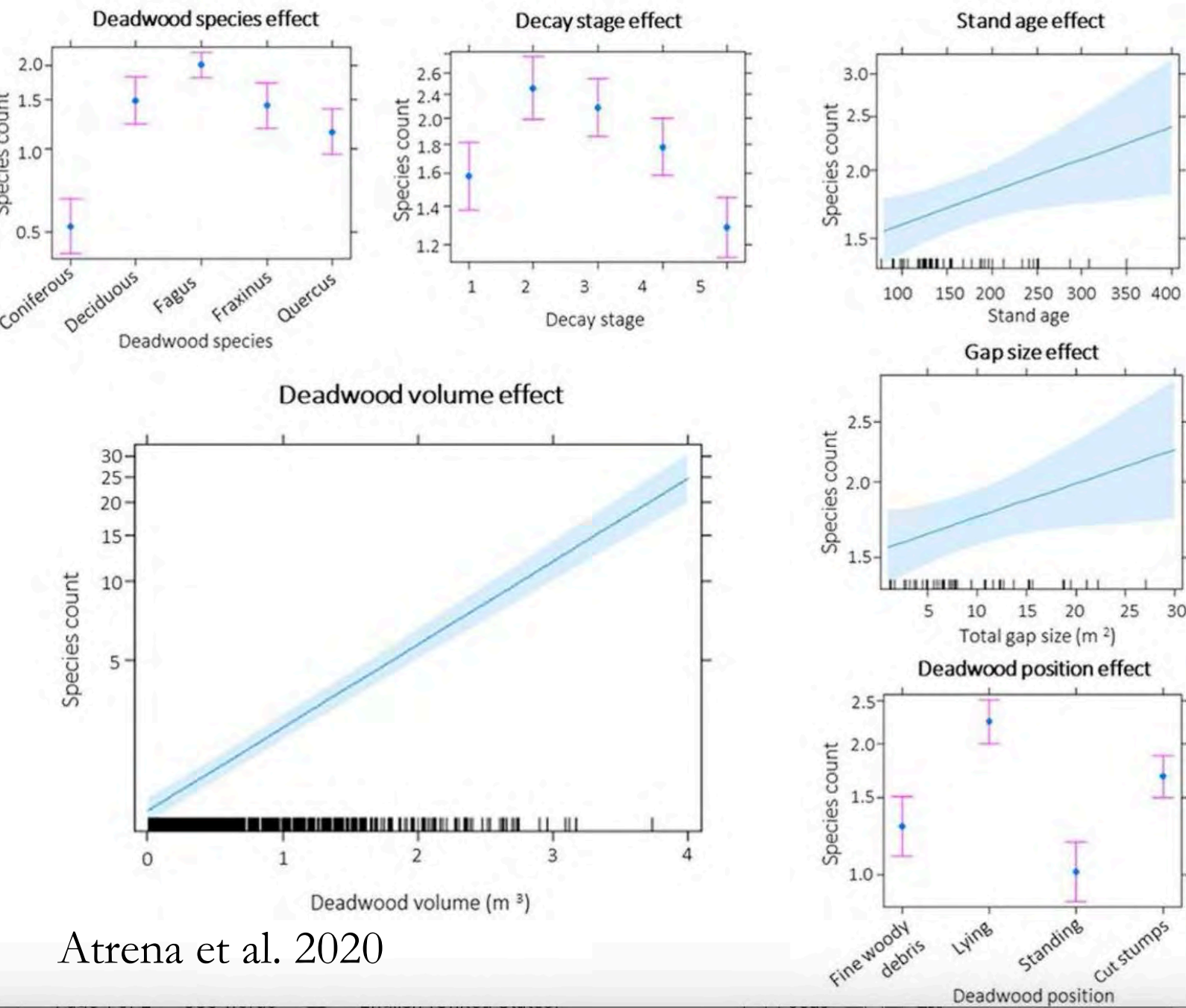


Goldie's wood fern, *Viburnum lantanoides*  
Woodbury Mountain Wilderness Preserve



Shaggy scalycap, *Pholiota* sp.  
Krusch Preserve, Cambridge, VT

# Deadwood properties are the main drivers of fungal richness





Artists's bracket, *Ganoderma* sp.

Down hemlock root

“Fire Swamp,” Jericho



Artists' bracket, *Ganoderma* sp.  
Krusch Preserve, Cambridge, Vermont



Lung lichen, *Lobaria pulmonaria*  
Photo: Bob Zaino





Photo: Eric Sorenson



Feather flat moss, *Neckera pennata*  
Woodbury Mountain Wilderness Preserve





Salmon-eggs, *Trichia decipens*  
Krusch Preserve, Cambridge, Vermont



Blackburnian warbler-*Setophaga fusca*  
Photo: Bryan Pfeiffer



Vernon Black Gum Swamp, Vermont





Black bear, *Ursus americanus*  
Trail cam photo: Marty Wall



64°F / 18°C



05/21/2012 18:53









Questions?