

# Forests Changing Fast!

## The Hemlock Removal Experiment



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# Acknowledgements

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- Dave Orwig
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- Mark VanScoy
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  - NSF LTER Program
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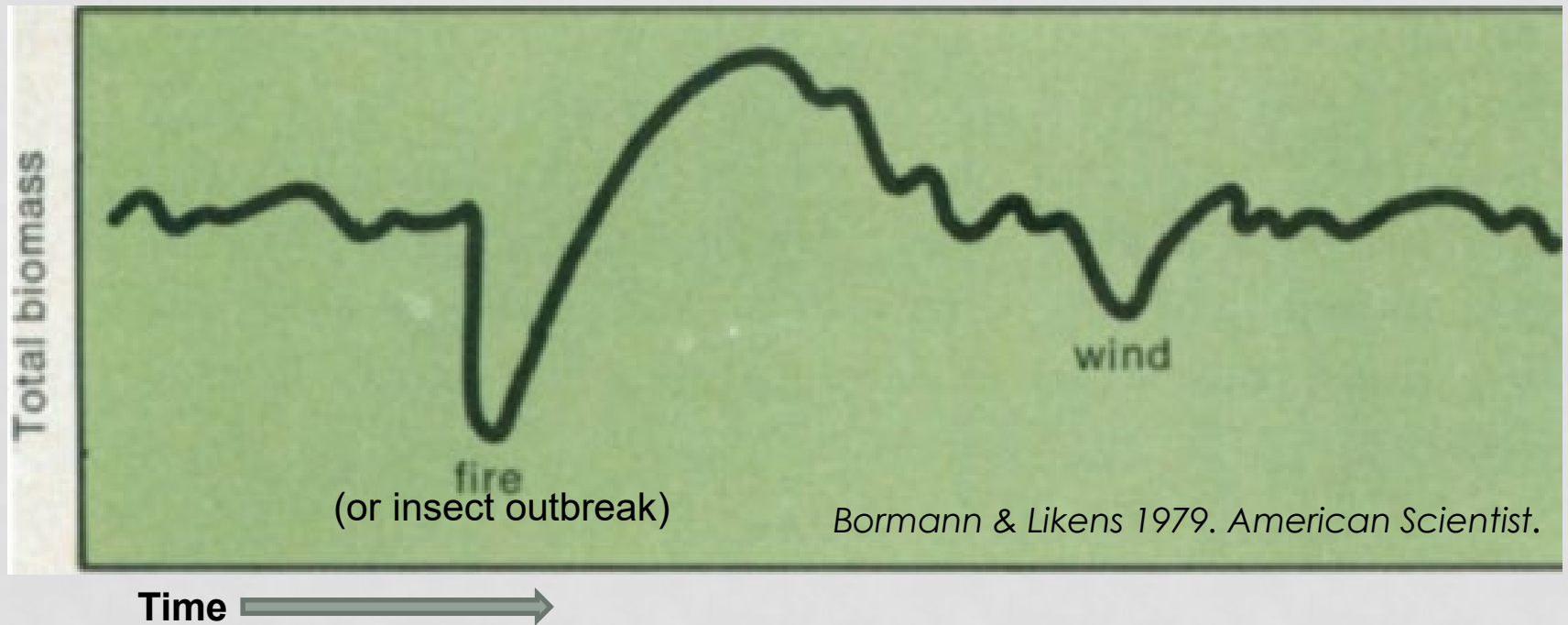


Forests change slowly,  
most of the time.

*What changes have you  
seen in your 'Our  
Changing Forests'  
plot(s) so far?*

Forests change slowly,  
most of the time.

But sometimes, change  
happens fast!





# Hemlock loss from the hemlock woolly adelgid



Why Do an Experiment?

# Why Do an Experiment?

- Compare before & after
- Compare to a control
- Determine the treatments



# What Do the Treatments Mean?

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Kill hemlock standing:  
GIRDLED

Harvest  
hemlock  
forest:  
LOGGED



Untreated  
hemlock  
forest:  
HEMLOCK  
CONTROL



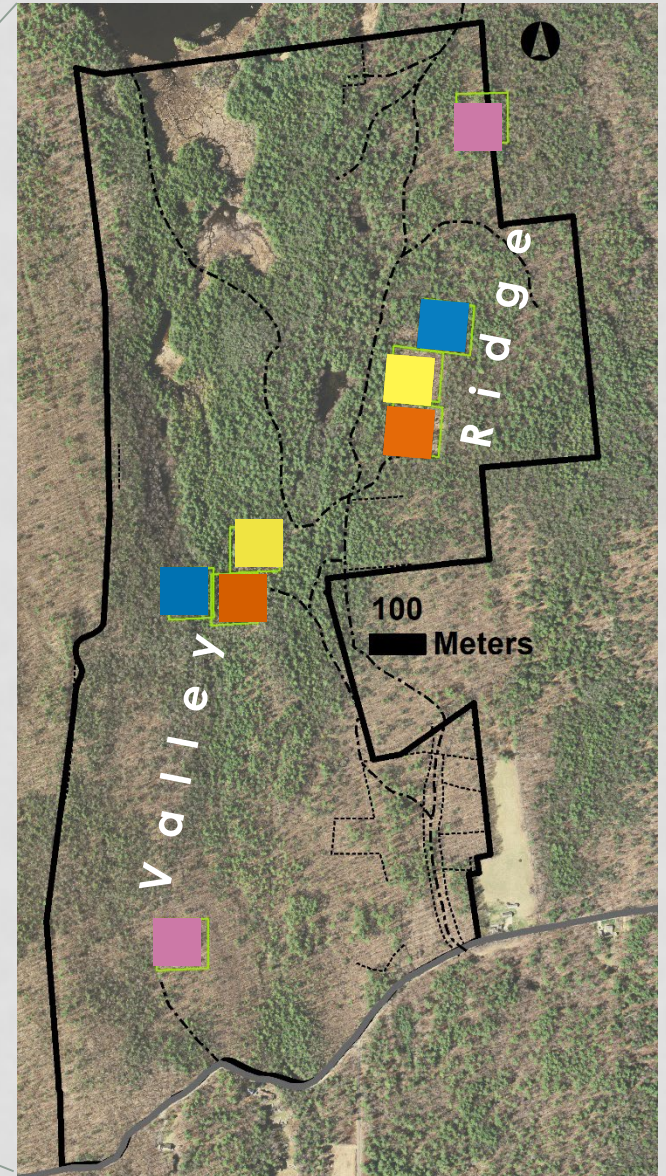
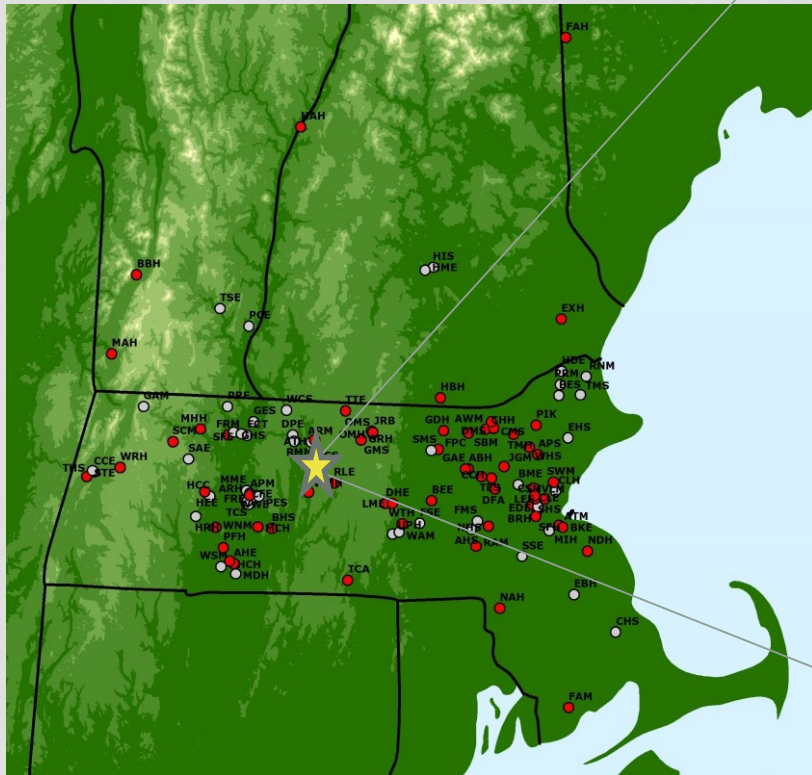
Fast-forward  
forest after  
hemlock:  
HARDWOOD  
CONTROL





# Where is the Experiment?

- Hemlock Control 
- Girdled 
- Logged 
- Hardwood Control 





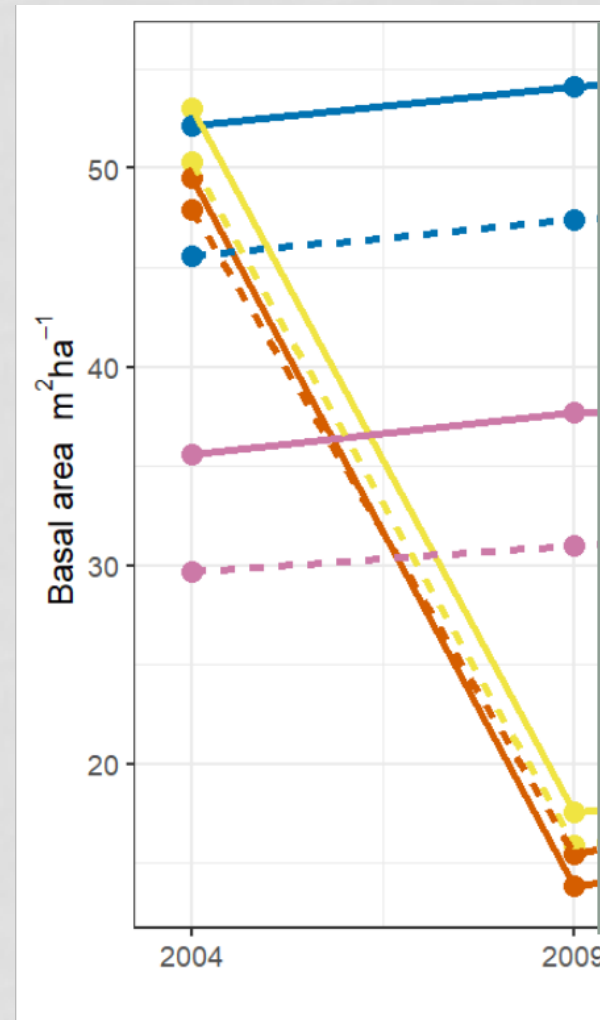
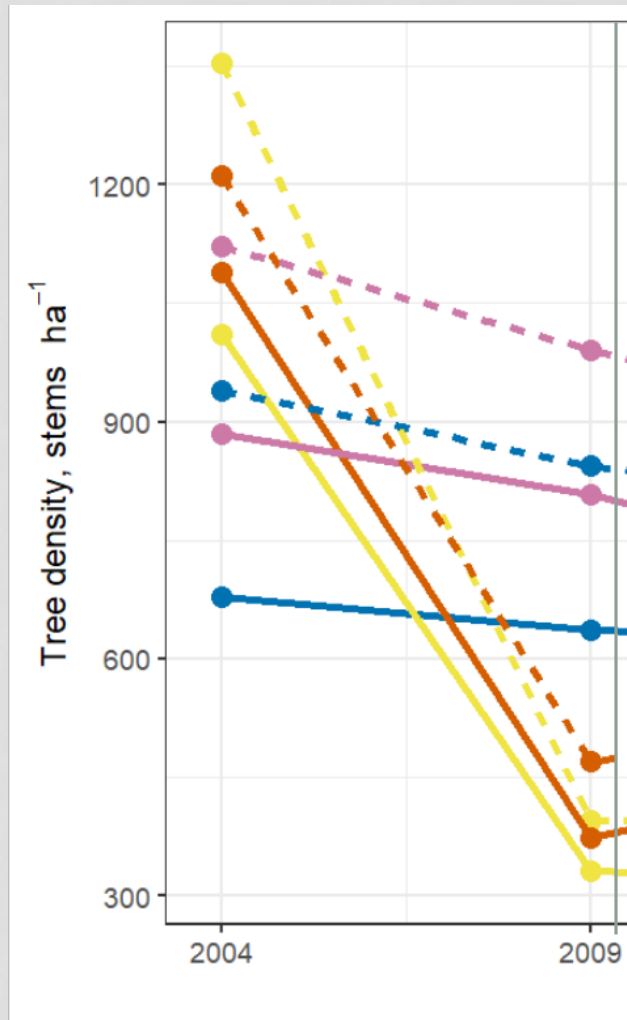
# How we did it





# What happened?

## Immediate changes: trees



block

— ridge  
- - valley

trt

● hemlock  
● girdled  
● logged  
● hardwood

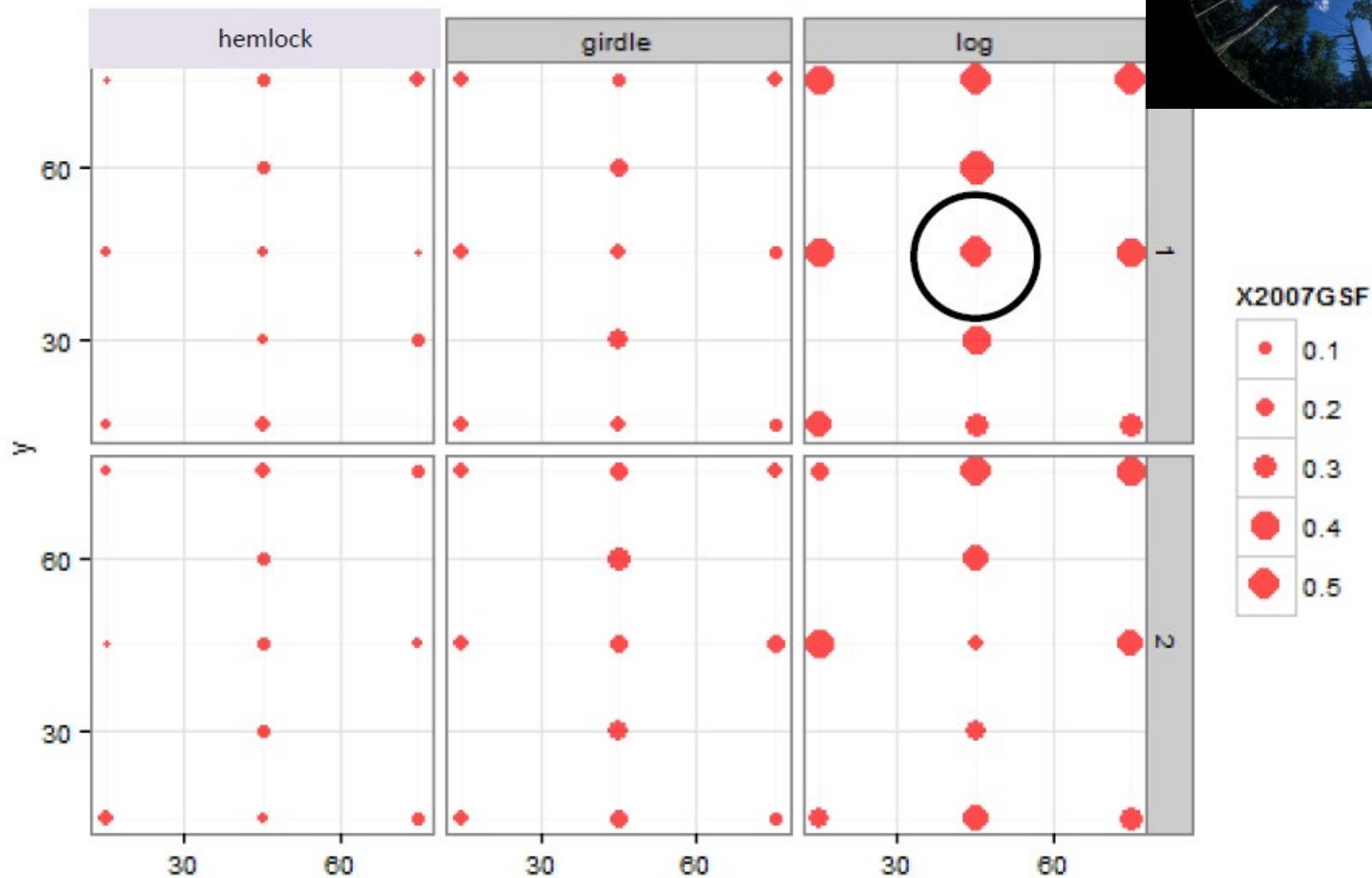
Logging or girdling removed about 70% of the trees

# Light and temperature



# Light and temperature

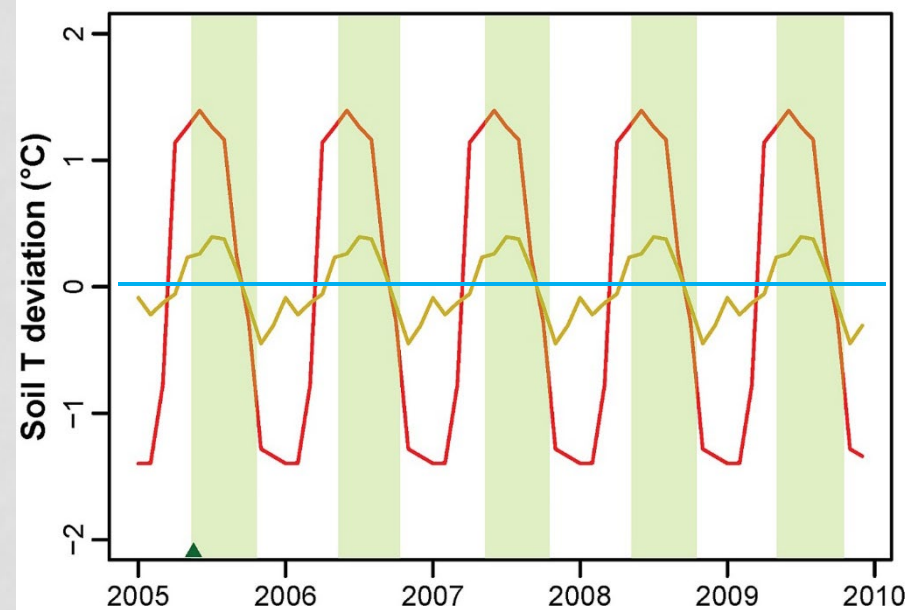
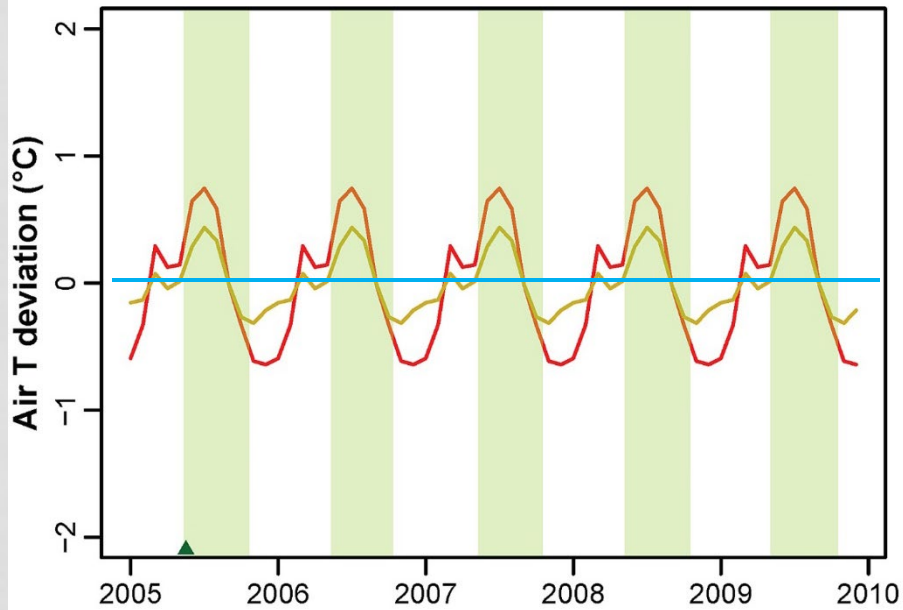
2007





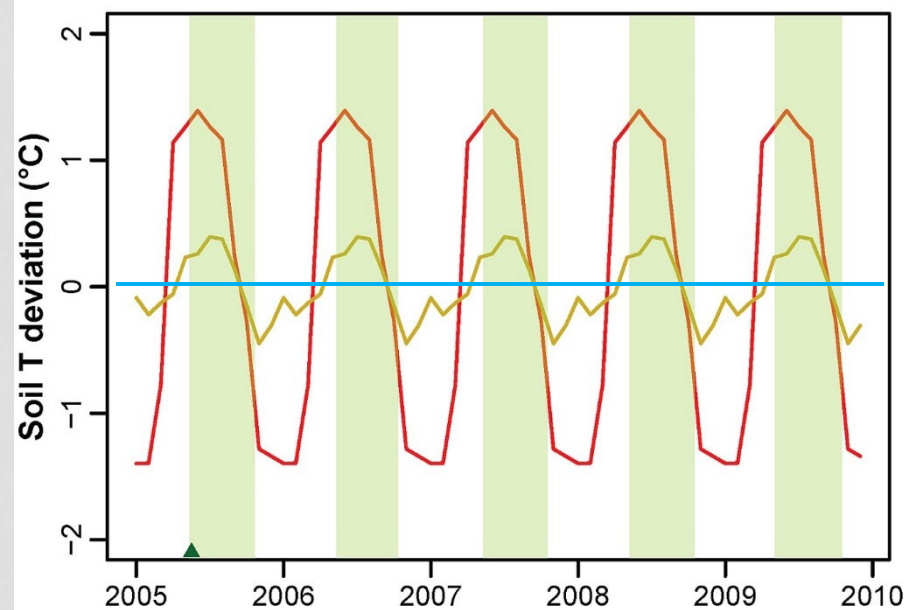
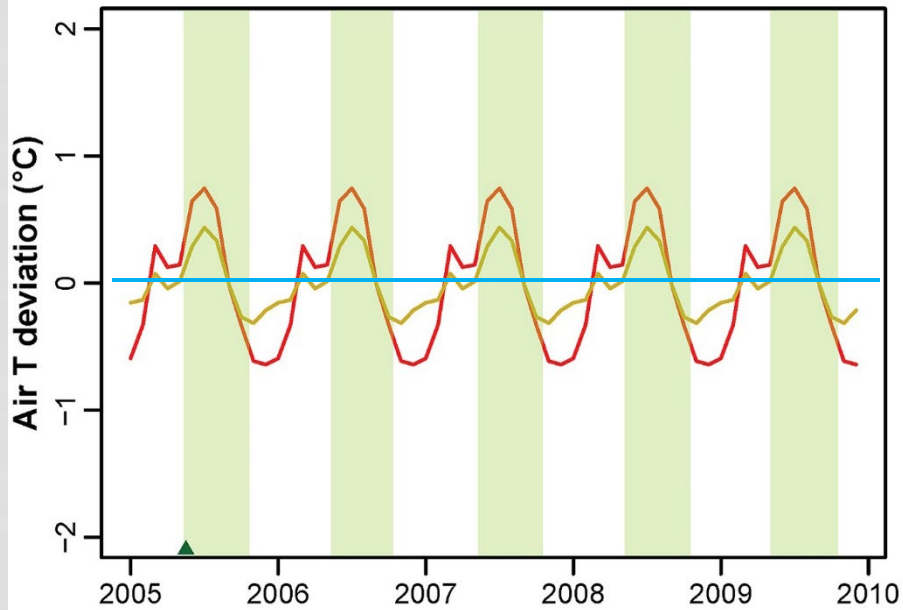
# Temperature measurements:

differences between the  
logged (red) and  
girdled (yellow)  
relative to the control



# Temperature measurements:

differences between the  
logged (red) and  
girdled (yellow)  
relative to the control





# An aside: The Trouble with Bears





# The Trouble with Bears



SIMES6

RECONYX



# The Trouble with Bears



2015-09-16 11:13:13 AM M 1/1

0 20°C

SIMES6

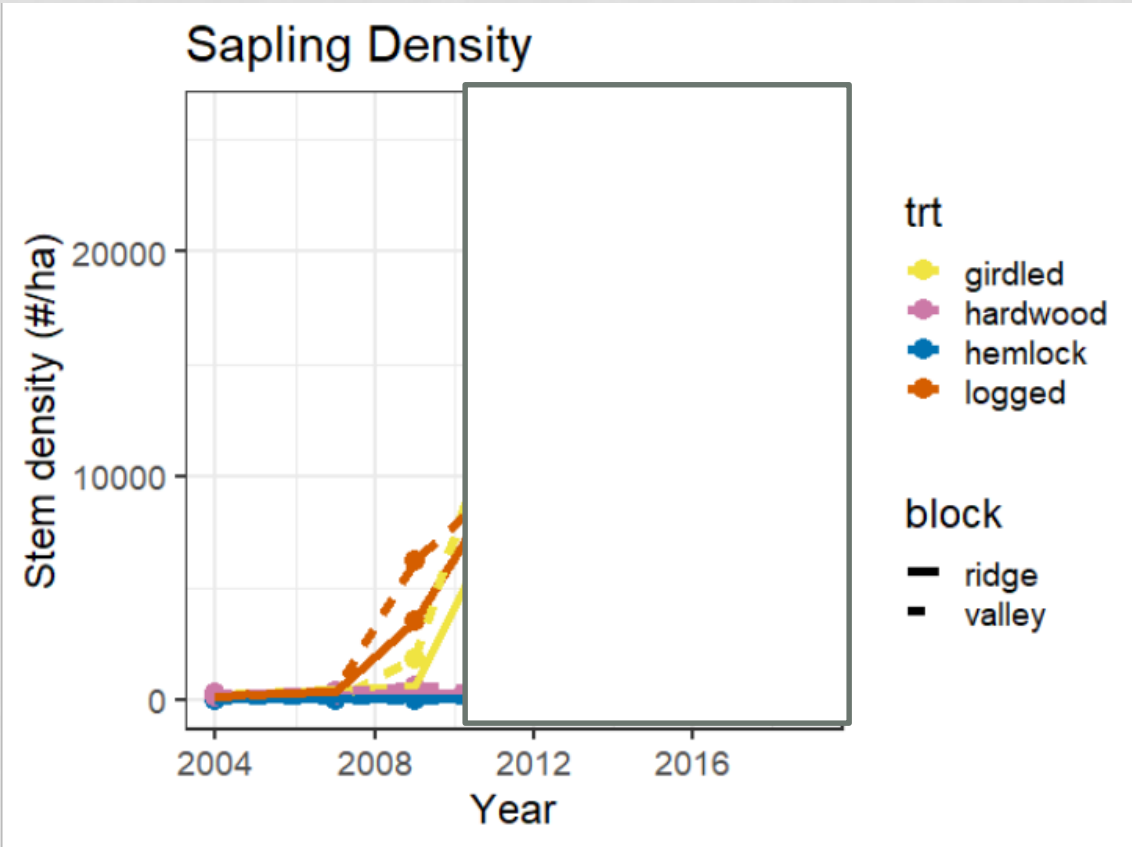
RECONIX

Back to the experiment:

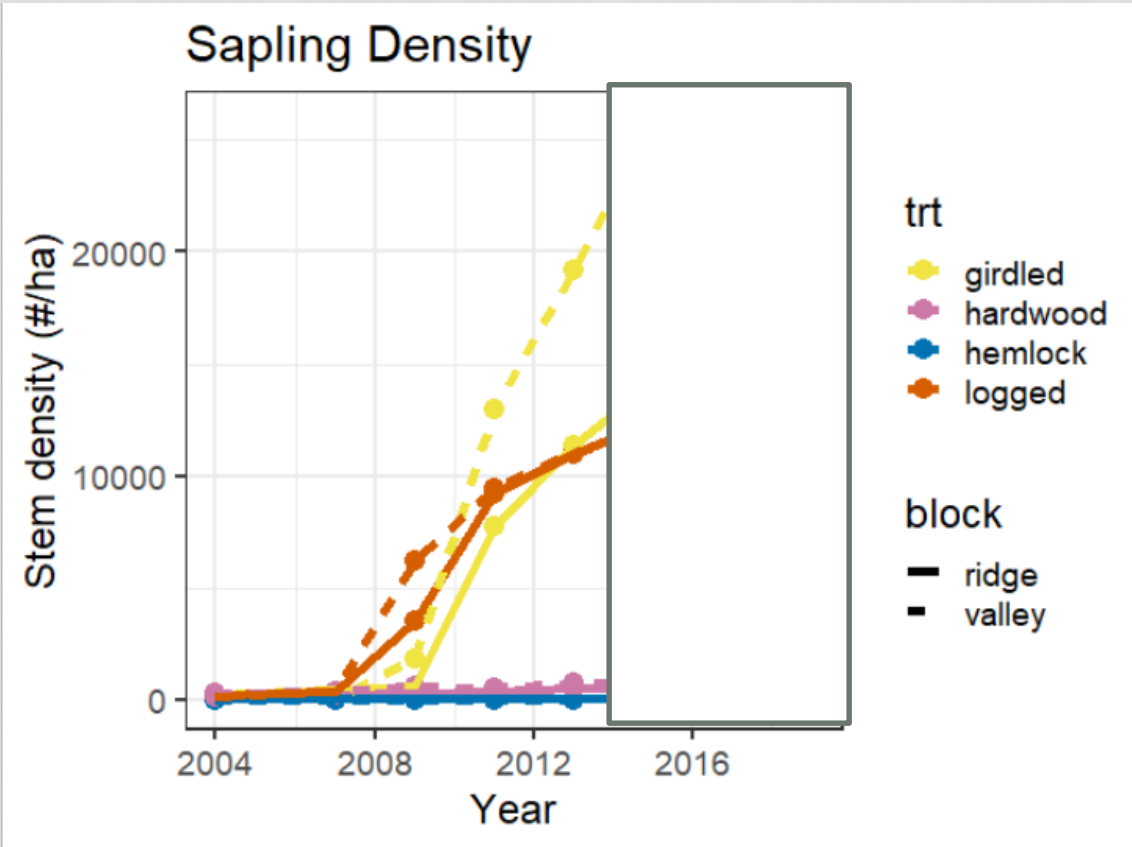
What happened when the  
deep hemlock forest  
became flooded with  
light?



# Here come the trees

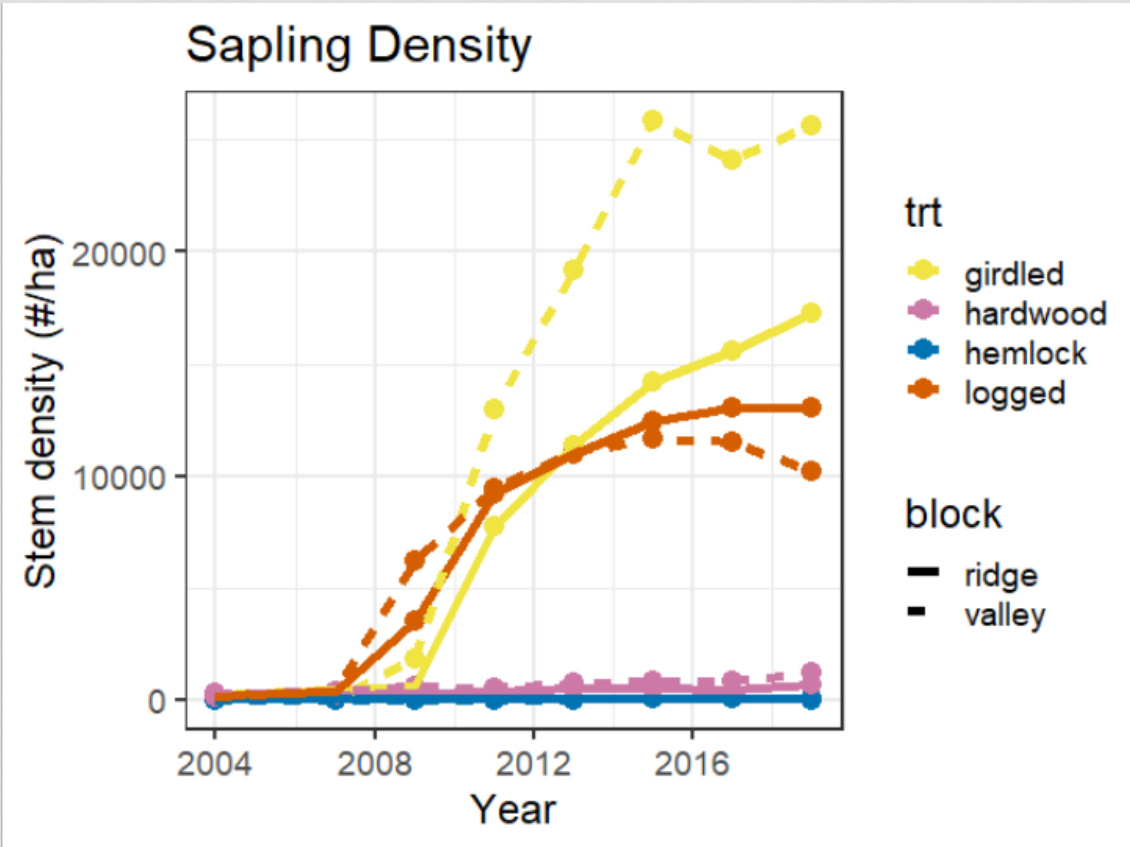


# Here come the trees

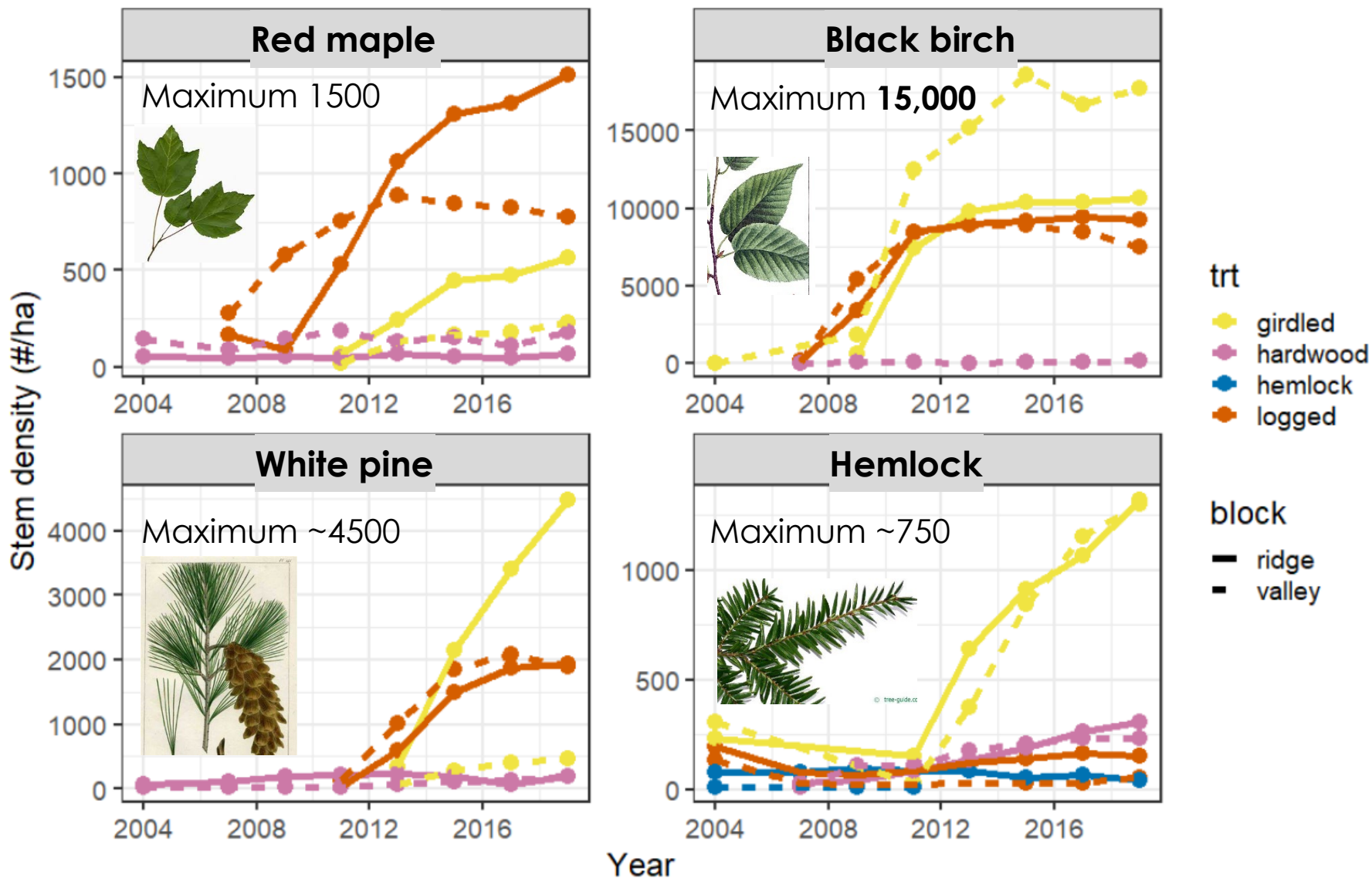




# Here come the trees



# Sapling Density *Which species have a chance at the canopy?*

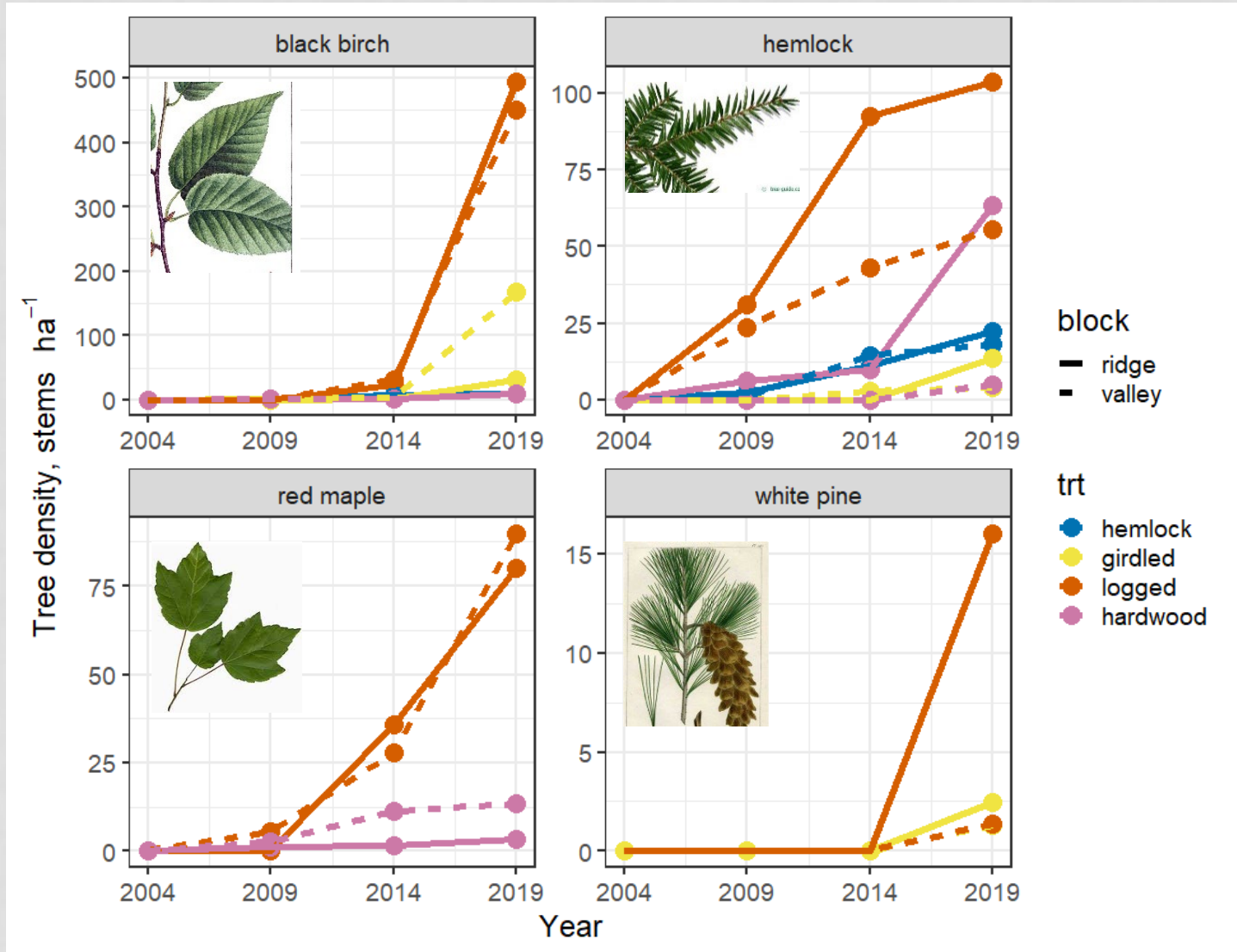




# How many saplings have 'graduated' into trees by 2019?

Things are changing faster in the logged plots; will the girdled plots show similar trends but just a bit later?

Could hemlock, maple, and pine catch up?





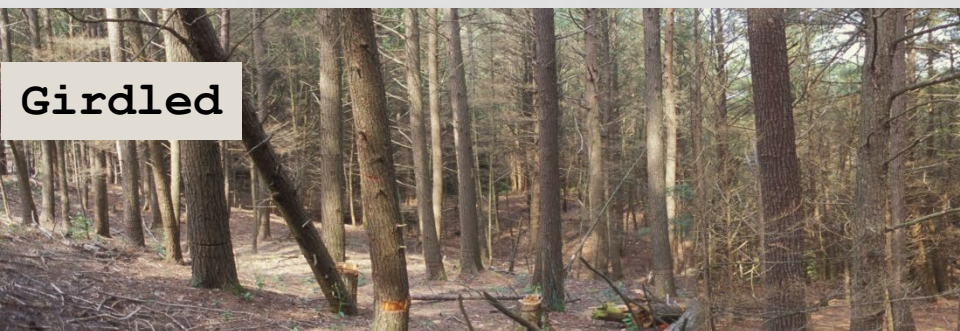


2006

Control



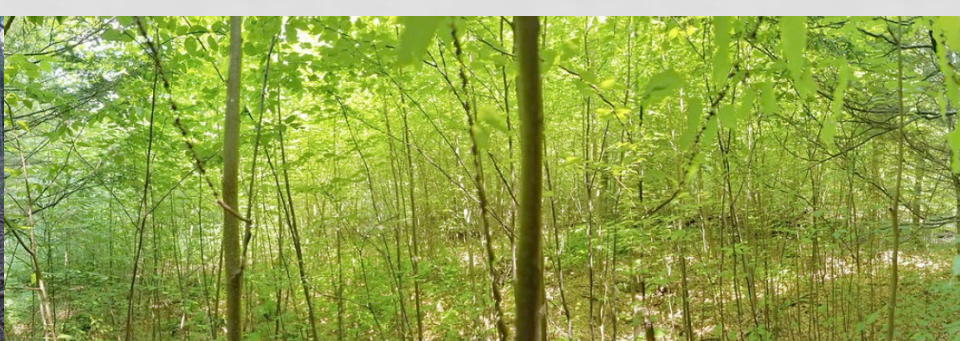
2018



Girdled



Logged

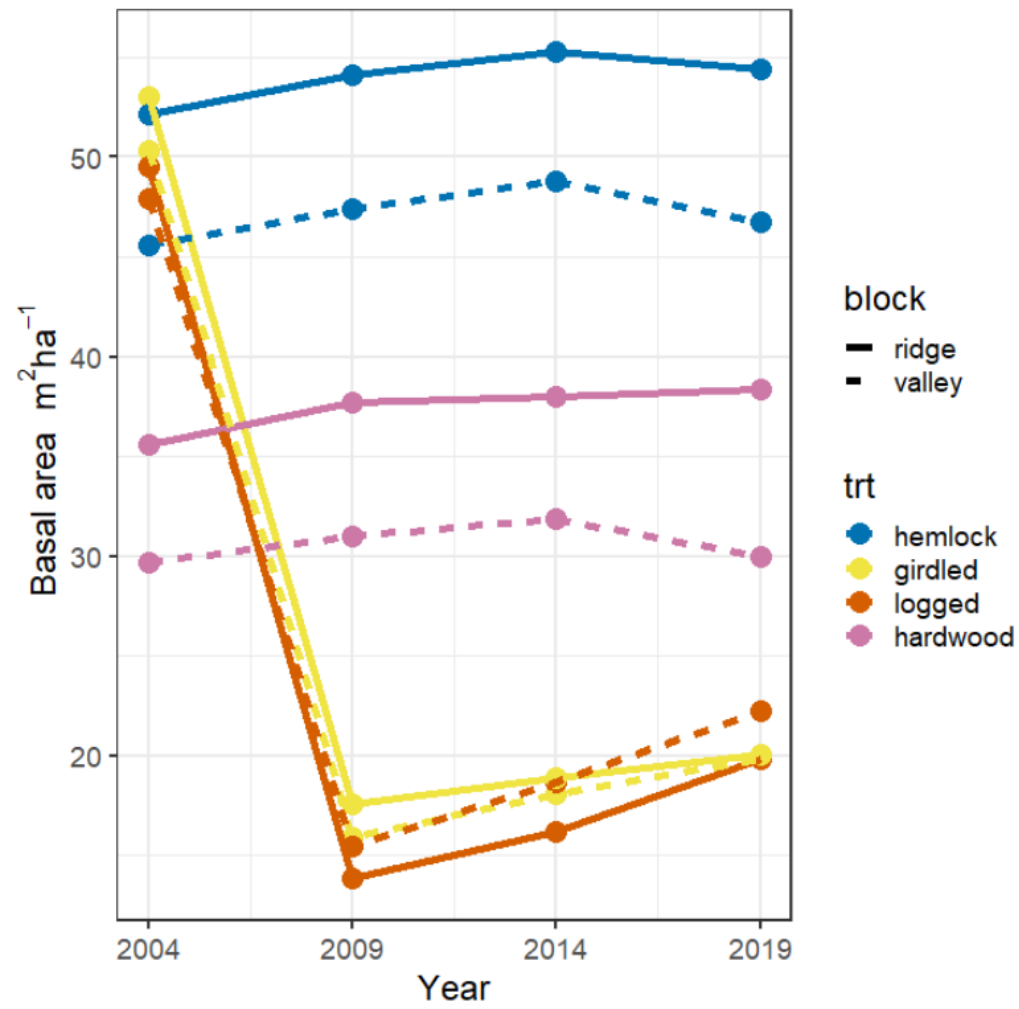
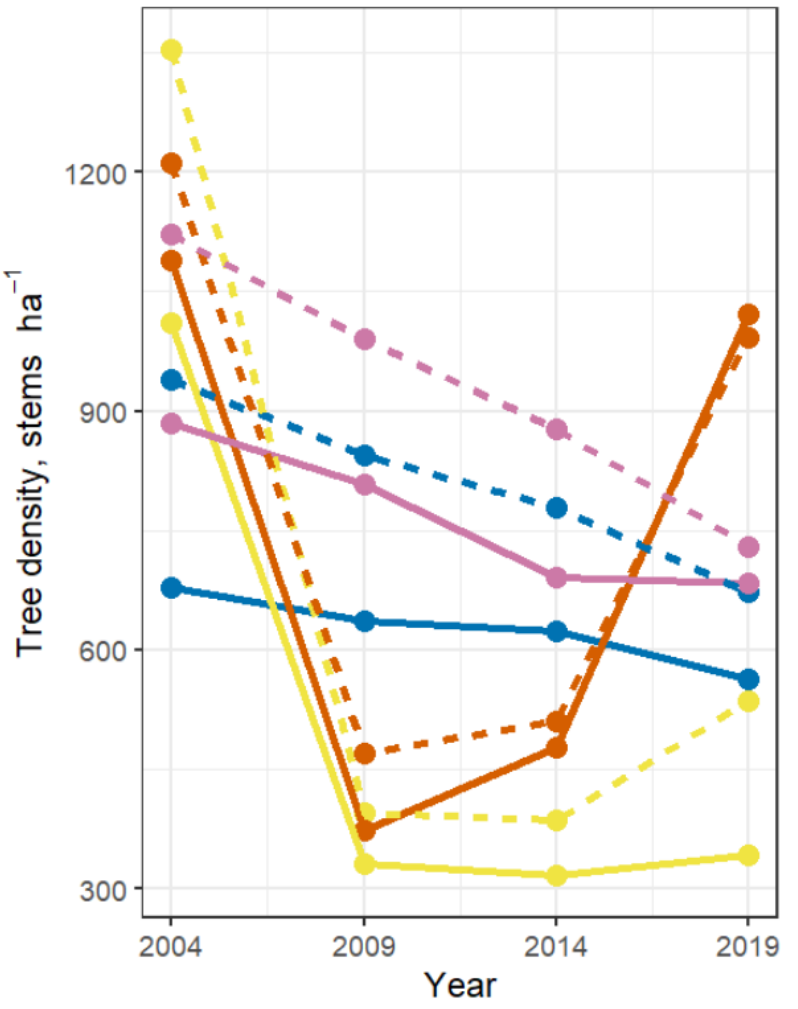


Hardwood



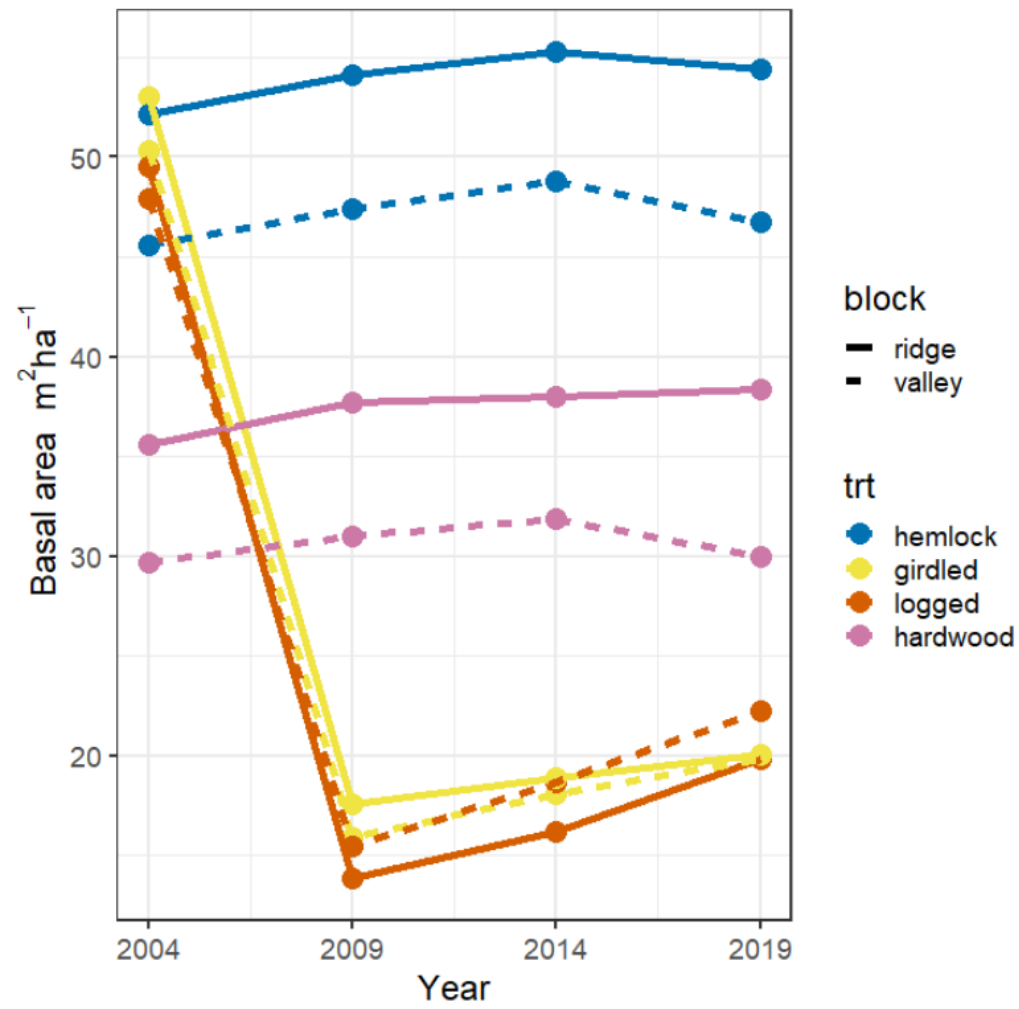
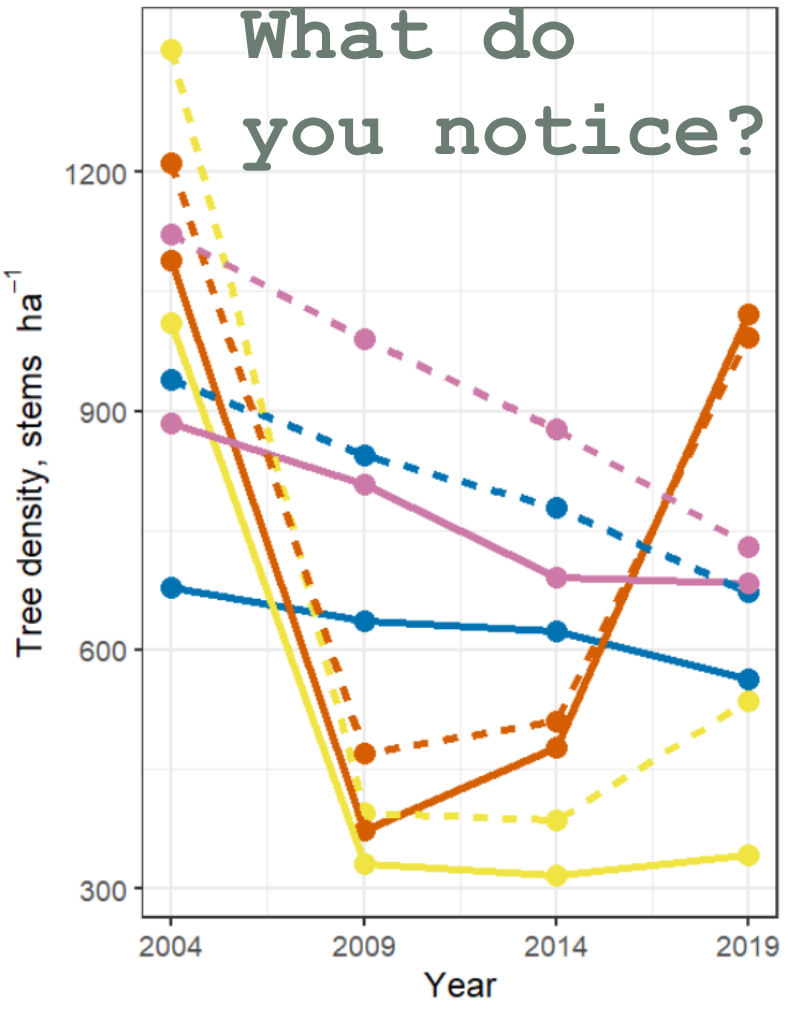


# Forest structure changes after 15 years



# Forest structure changes after 15 years

What do you notice?





**The Woolly Bully arrives:  
now what?**

# Hemlock Removal Experiment: a dynamic experimental design

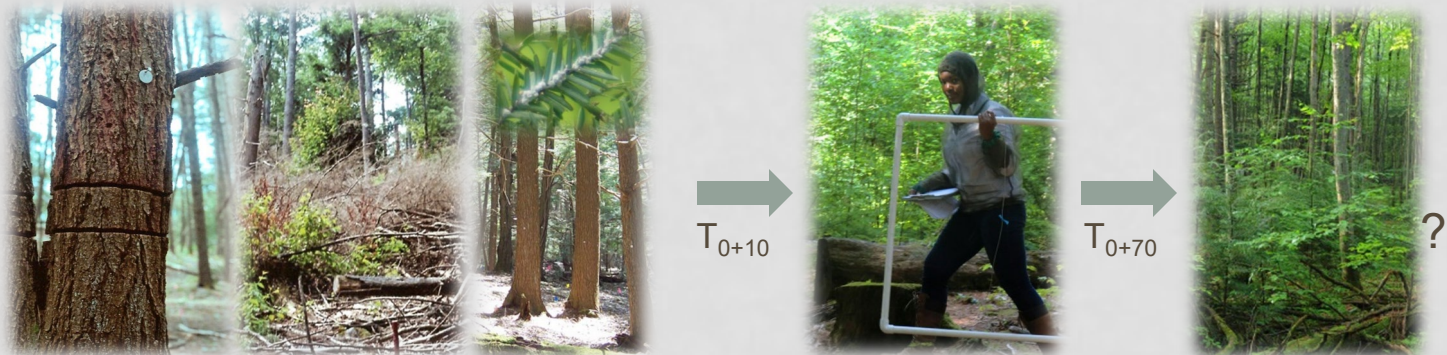
Phase I (pre-adelgid)



Phase II (control becomes treatment)



The Distant Future (was the hardwood treatment a good reference?)





After 15 years, we have  
learned a lot, but we  
are still early on for a  
*long-term* experiment!



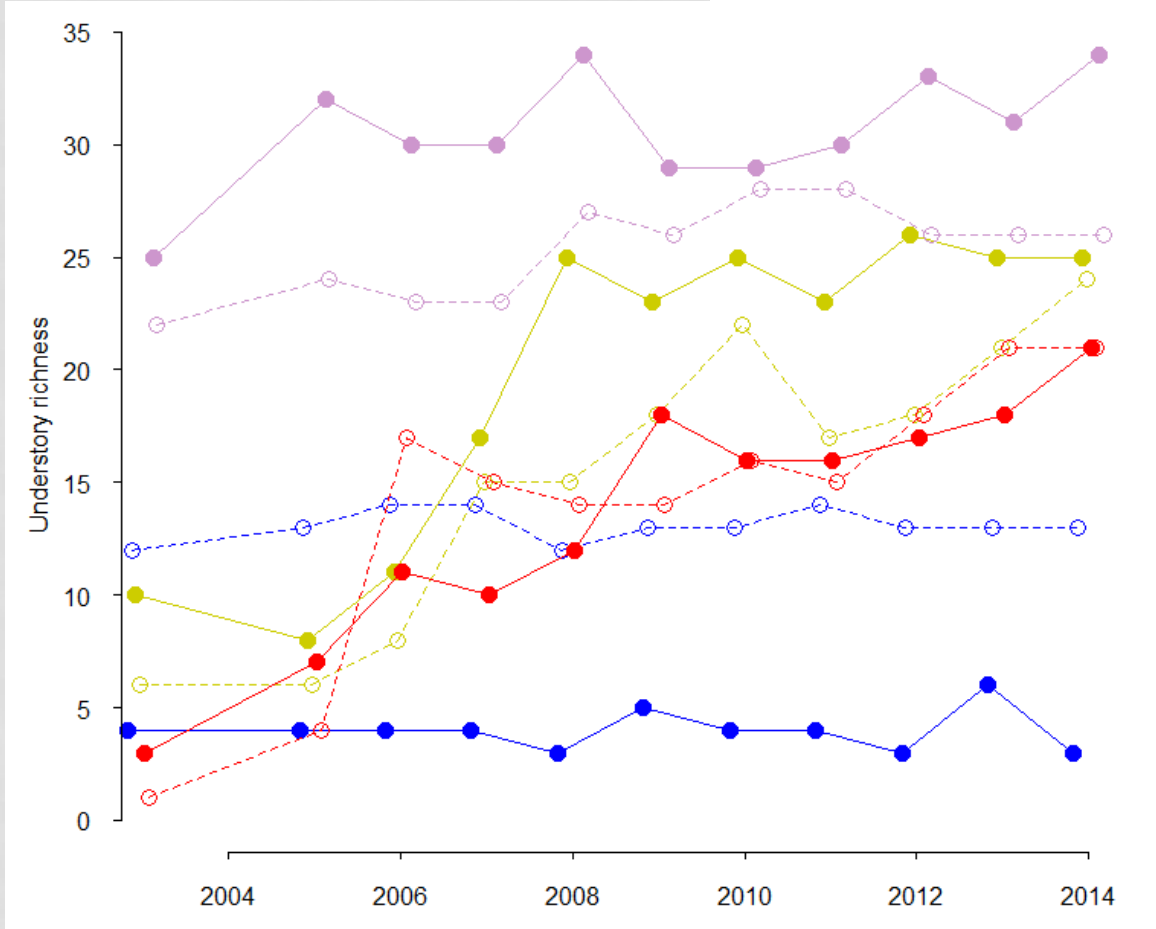
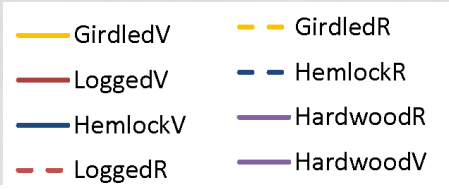


**THANK  
YOU!**



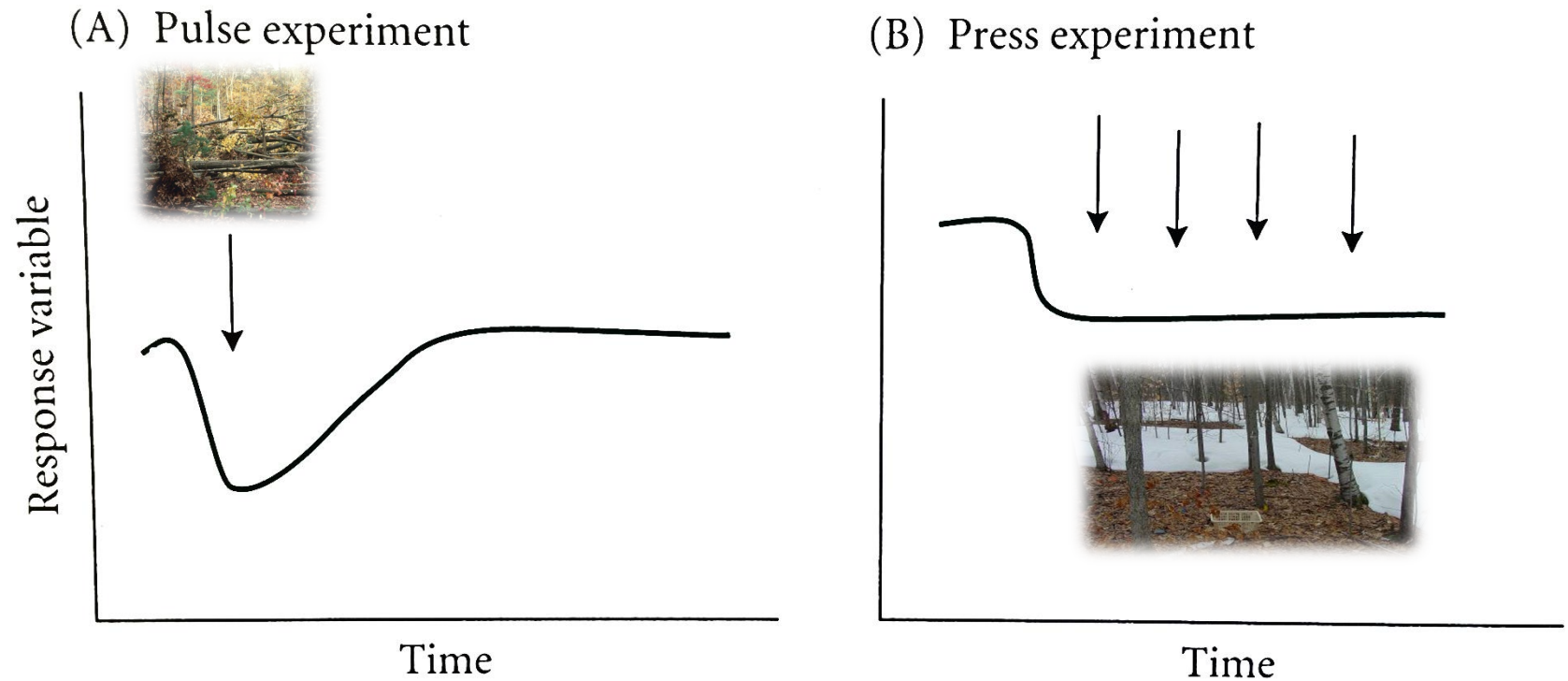
(extras)

# Understory species richness





# Pulse vs. Press experiment



**Figure 6.4** Ecological pulse and press experiments. The arrow indicates a treat-

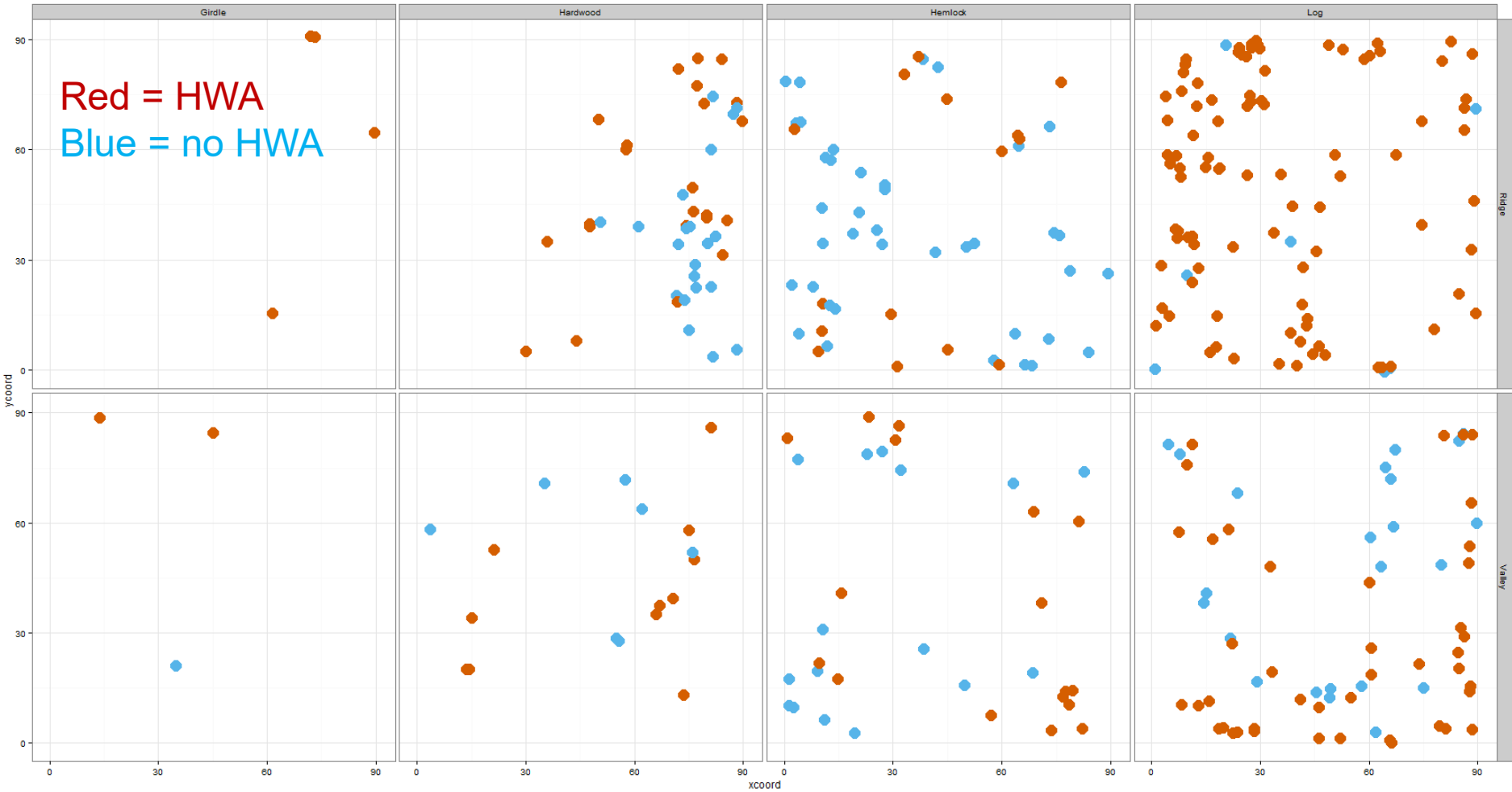
# HWA infestation 2014. Sampled trees only.

28% infested 2009

65% infested 2014

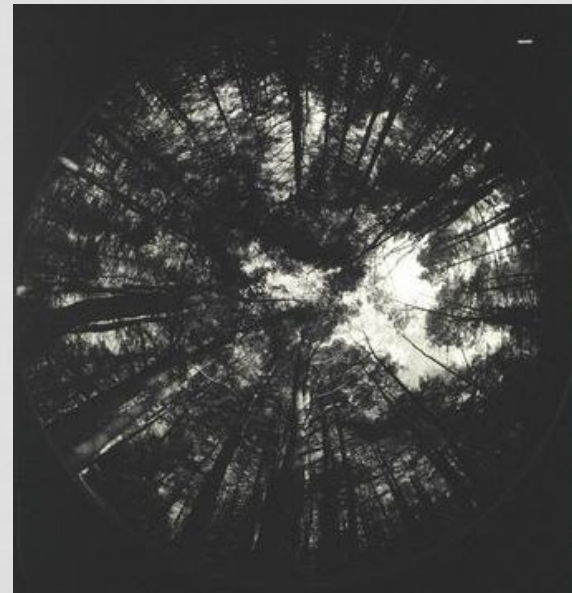
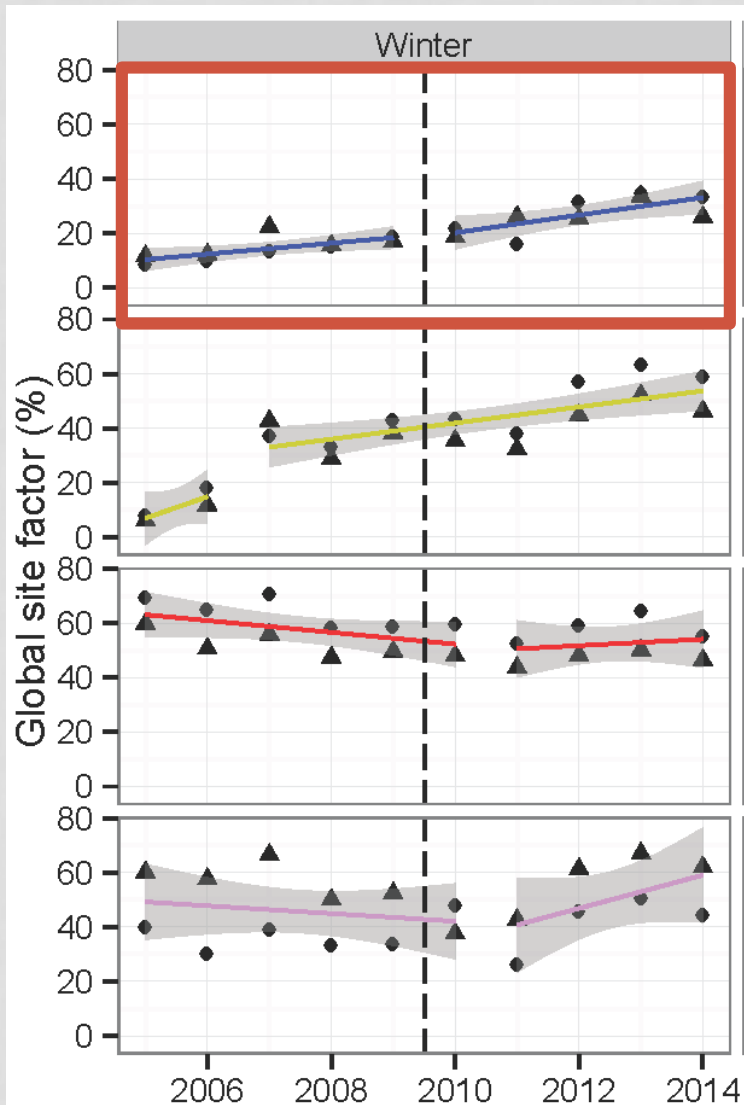
Girdled

Logged





# Light reaching the understory



Hemlock  
(Ridge)  
Plot Center

Leaf-off

**2004**



Hemlock  
(Ridge)  
Plot Center

Leaf-off

**2014**