Forests Changing Fast!
The Hemlock Removal Experiment

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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!

(or insect outbreak)

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?

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

Logging or girdling removed about 70% of the trees.
Light and temperature
Light and temperature
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.

Did you notice this?
An aside: The Trouble with Bears
The Trouble with Bears
The Trouble with Bears
Back to the experiment:
What happened when the deep hemlock forest became flooded with light?
Here come the trees

Sapling Density

- stem density (#/ha)
- year

trt:
- girdled
- hardwood
- hemlock
- logged

block:
- ridge
- valley

2004

2010
Here come the trees

**Sapling Density**

- **trt**
  - girdled
  - hardwood
  - hemlock
  - logged

- **block**
  - ridge
  - valley


- Stem density (#/ha): 0, 5000, 10000, 20000
Here come the trees

Sapling Density

- **trt**
  - girdled
  - hardwood
  - hemlock
  - logged

- **block**
  - ridge
  - valley

Year
- 2004
- 2010
- 2014
- 2018
Which species have a chance at the canopy?

- **Red maple**
  - Maximum 1500

- **Black birch**
  - Maximum 15,000

- **White pine**
  - Maximum ~4500

- **Hemlock**
  - Maximum ~750
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?
Forest structure changes after 15 years

[Graphs showing changes in tree density and basal area over 15 years with different treatments indicated by colors and markers.]

- Tree density, stems ha⁻¹
- Basal area m² ha⁻¹
- Block (ridge, valley)
- Treatment (hemlock, girdled, logged, hardwood)

[Images of forests at different times and conditions are shown as a backdrop.]
Forest structure changes after 15 years

What do you notice?

- **Graphs showing changes in:**
  - Tree density: stems ha⁻¹
  - Basal area: m² ha⁻¹

- **Year range:** 2004 to 2019

- **Legend:**
  - Block:
    - ridge
    - valley
  - Trt:
    - hemlock
    - girdled
    - logged
    - hardwood

- **Images:**
  - Forest scenes
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?)

$T_{0+10}$ $T_{0+70}$
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

![Graph showing changes in understory species richness over time.](image-url)
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

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<th>Red = HWA</th>
<th>Blue = no HWA</th>
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<td>Gridle</td>
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<td>Log</td>
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Red = HWA
Blue = no HWA
Light reaching the understory

Hemlock (Ridge) Plot Center
Leaf-off
2004

Hemlock (Ridge) Plot Center
Leaf-off
2014