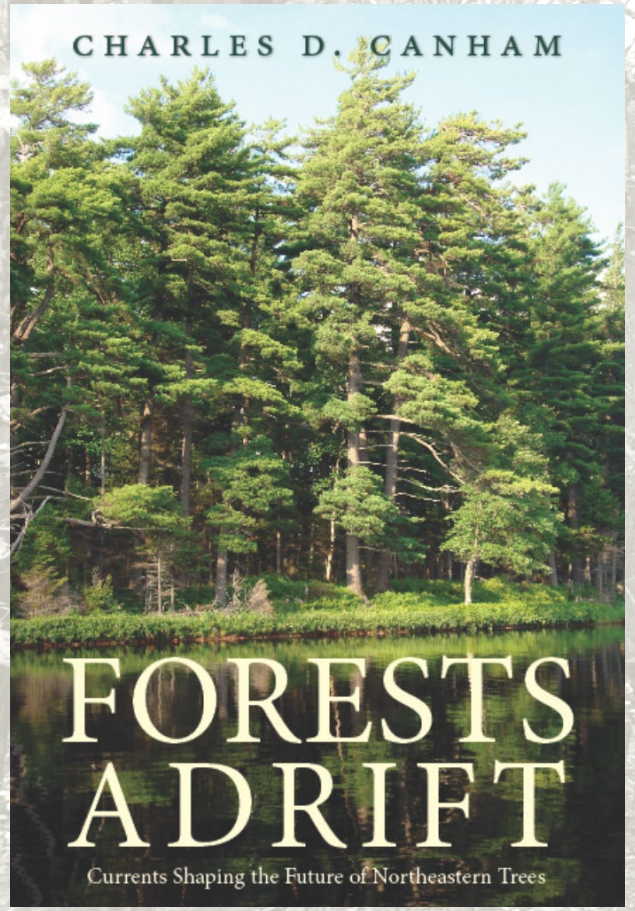
# Peering into the Future:
# *Currents that will shape Catskill forests over the next 50 years*

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# What do I believe… (after 45 years of research)

- Forests have enormous demographic inertia – change is slow (in the absence of direct human intervention)… *so historical legacies are important!*

- Some changes are inexorable – the broad outlines of succession are predictable, and are defined by shade tolerance

- But the notion of "steady state" is largely meaningless (both practically and theoretically).

- And forests are "computationally irreducible" – there are no shortcuts to predicting future states – you have to track the entire journey, with all of its twists and turns, from where ever you are now

# Currents that keep me on watch

- Historical legacies that still shape forest dynamics
  - Early forestry and agriculture
  - 20th century fire suppression
  - The fall and rise of white-tailed deer

- New currents
  - A sea-change in logging
  - Climate change

- To worry about another day
  - Air pollution
  - Invasive plant species
  - Pests and Pathogens

# Legacies of European agriculture

1700

1800

? Have the forests truly “recovered”?

1900

1850

# A branch in the river…

## ❖ Succession on former cultivated fields

- Fairly rapid colonization by trees with intermediate-sized wind-dispersed seeds (red maple, white pine, white ash)
- Oaks largely absent except along edges (from seed source in hedgerows)

## ❖ Succession on abandoned pastures

- Long period of oldfield succession dominated by little bluestem grass
- Oaks present throughout because scattered oaks in the pastures served as local seed source

# Legacies of early forestry

*Teamster hauling bark*, courtesy of Lester St. John Thomas

Harvest methods may have been low-tech,
but Catskill forests were thoroughly exploited….

*But with far fewer long-term legacies than from agriculture…*

Hemlock bark for the tanning industry

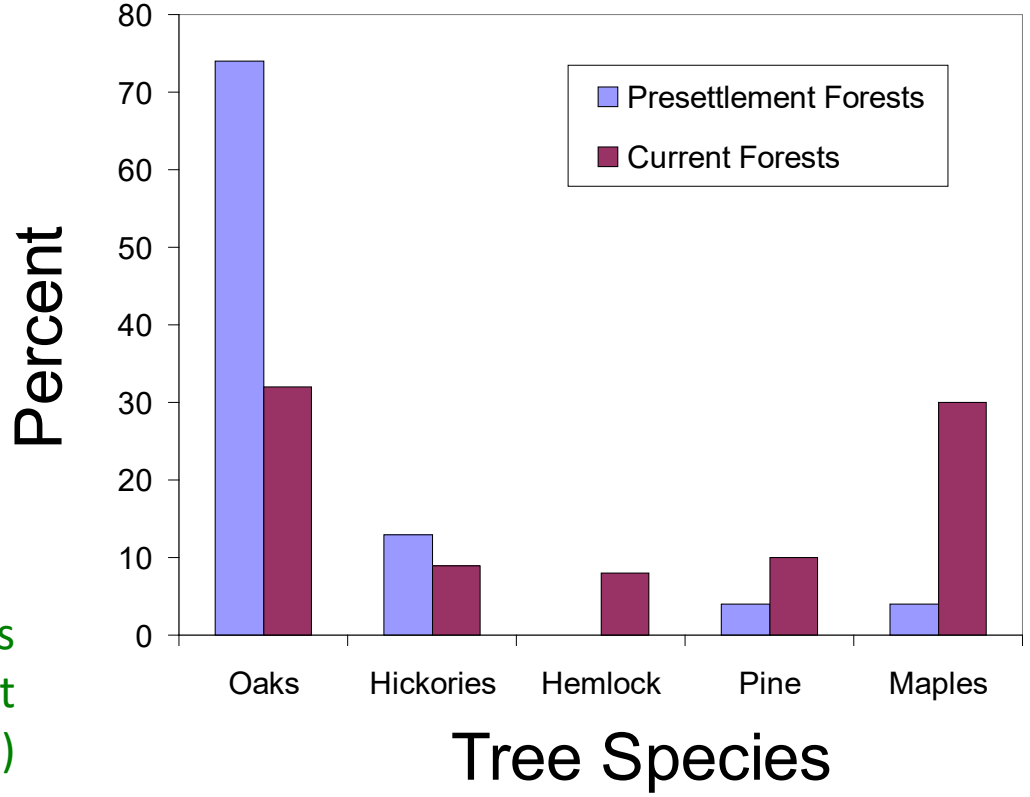
*Hemlock abundance in the Catskills has still not recovered from the tanbark harvest of 200 years ago*

# Legacies of fire suppression

- Is fire suppression responsible for a reduction in the regional dominance of oak species in many parts of the eastern US?

- Has the reduction in the abundance of oaks over the past 100 years fundamentally altered the flammability of these forests?

Composition of the Cary Institute Woods (witness trees in 1735 vs. current composition)



# The fall and rise of the white-tailed deer

White-tailed deer
(*Odocoileus virginanus*)

Presettlement density: ~ 10 / sq. mile
Current density (northern): ~ 20-40 / sq. mile
Current density (southern): > 100 / sq. mile

Deer exclosure in the
Hudson Valley

# Impacts on tree regeneration

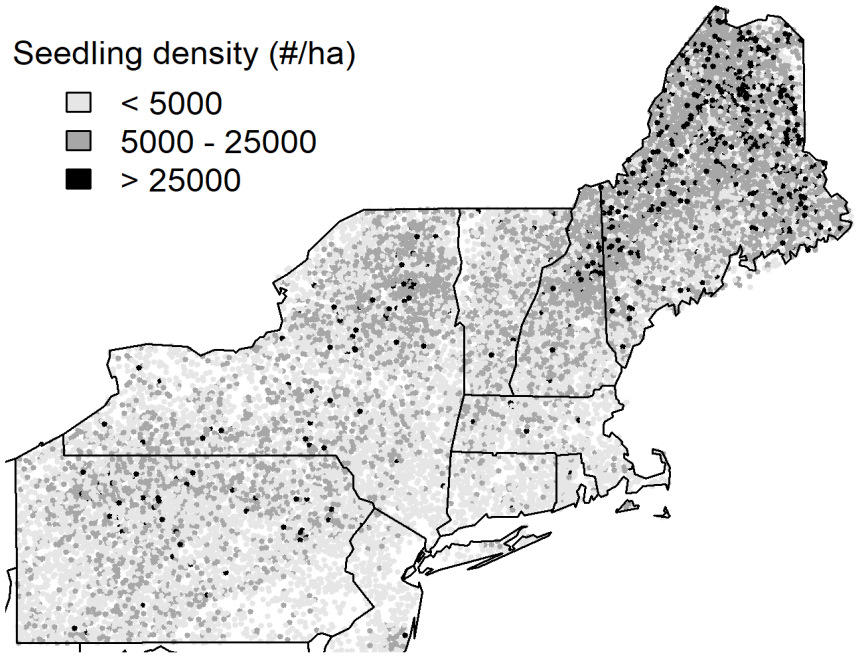
- **55%** of northeastern forests have seedling and sapling densities in the lowest density classes

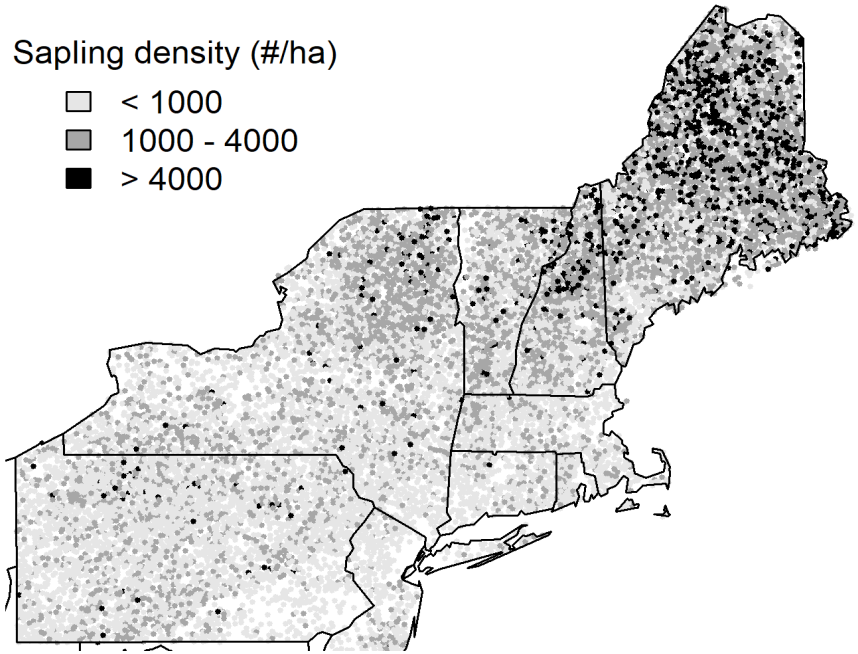
- This is close to **regeneration failure** by any standard

- Regeneration failure is even **more pronounced in recently logged forests**

- Adequate tree regeneration is highest in far north where severe winters and heavy forest cover limit deer densities…

Densities of seedlings and saplings in 33,310 FIA plots



# A sea change in logging

❖Logging accounts for >50% of all adult tree mortality in eastern forests*

❖After many years when net growth far exceeded harvests, harvest rates now equal or exceed net growth in many areas (including the Adirondacks)

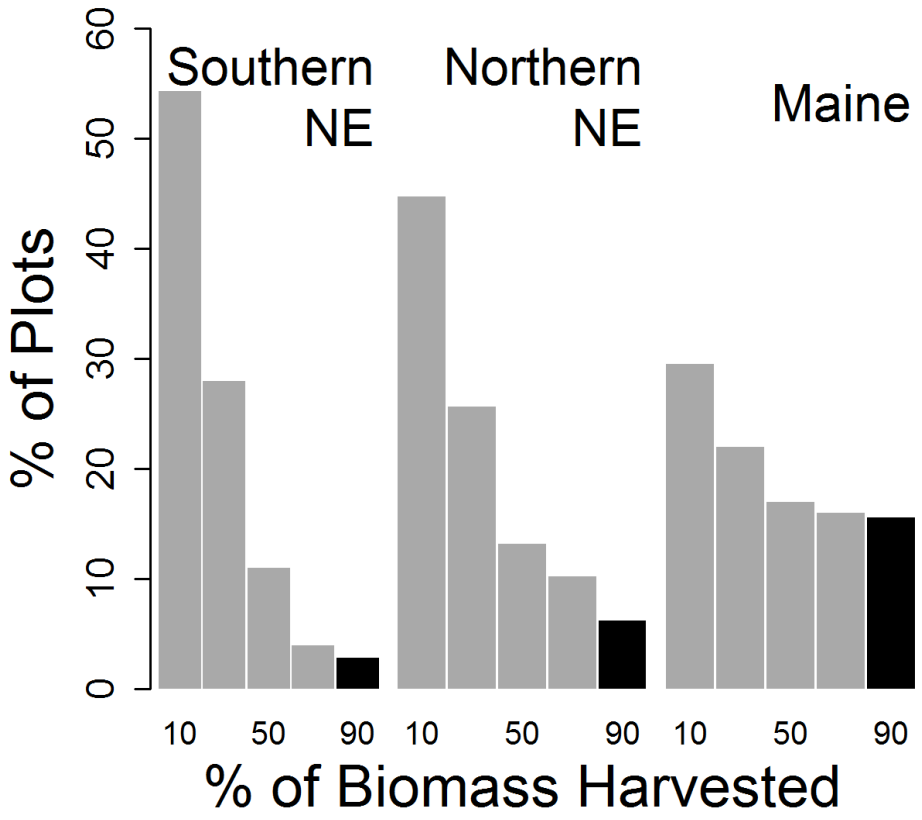
❖ this is unsustainable by any definition

**For the region from Kentucky and Virginia north to Wisconsin and Maine*

Canham et al. (2013), Regional variation in forest harvest regimes in the northeastern United States. Ecological Applications 23:515-522.

# Public perception: clearcutting is still the dominant forestry

*Frequency distribution of the intensity of harvests in different parts of the 9 northeastern states*




- Reality: clearcutting is uncommon except in certain regions and forest types (i.e. spruce/fir forests and increasingly in beech forests).

# Myth and misunderstanding of the successional dynamics of forest productivity

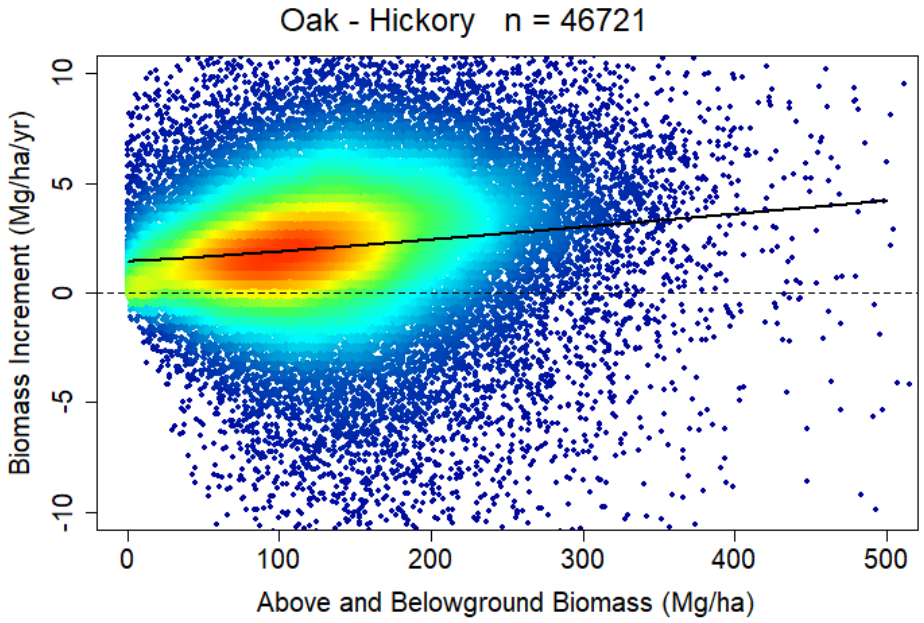
- Perception that most eastern forests are primarily “even-aged”, dating from clearcutting or land abandonment

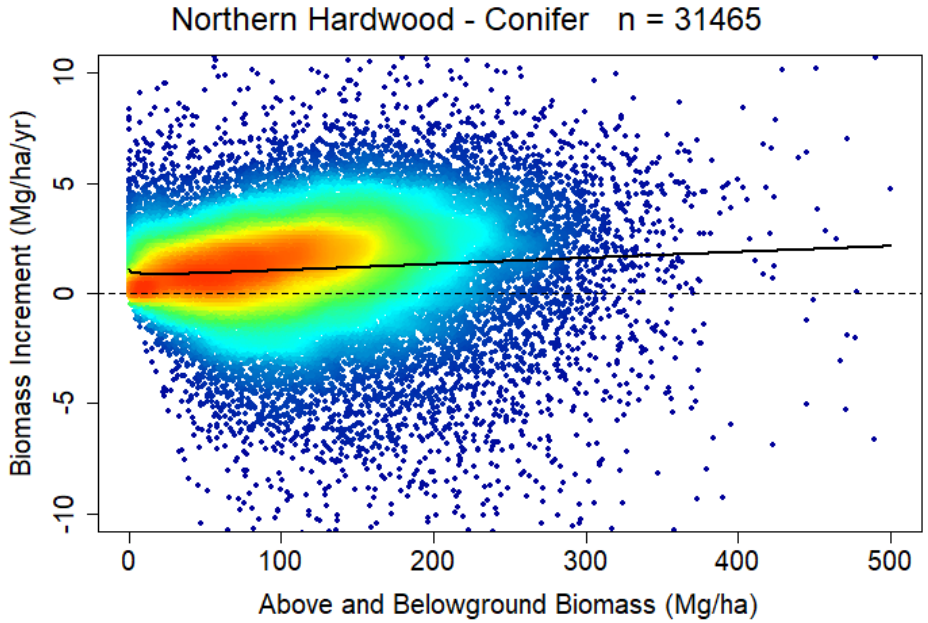
- With concerns that eastern forests are “maturing” and losing their potential to store carbon

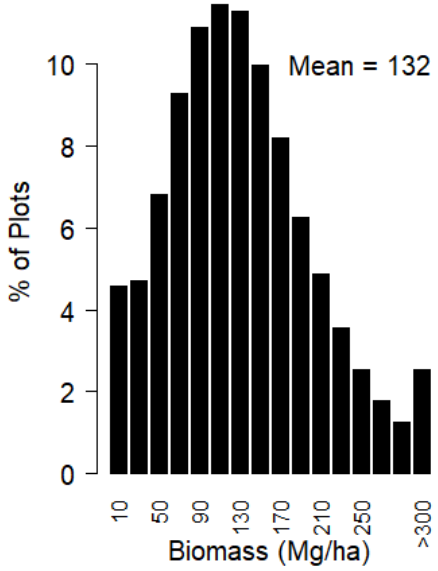
- Leading to proposals to increase rates of logging, ostensibly to increase rates of carbon sequestration

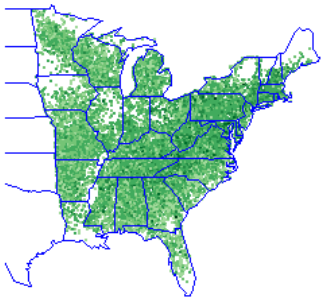
*(None of these are actually supported by the data…)*

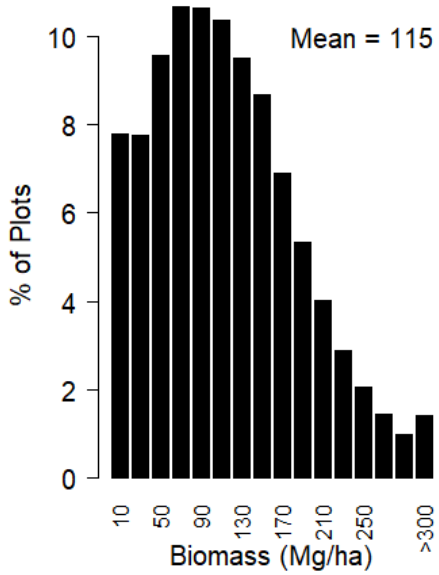
# Biomass increment as a function of stand biomass in eastern forests (FIA data)

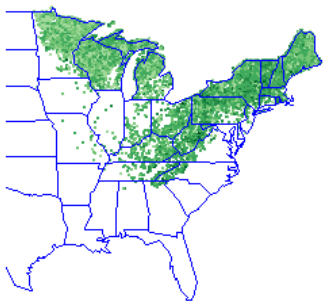




# Implications of selective logging regimes…

- Partial harvesting favors succession towards forests dominated by shade tolerant tree species:
  - Beech and sugar maple
  - Eastern hemlock, red spruce, and balsam fir

- Regeneration by oaks is still problematic
  - They need more light
  - Problems with deer browsing

# Climate Change

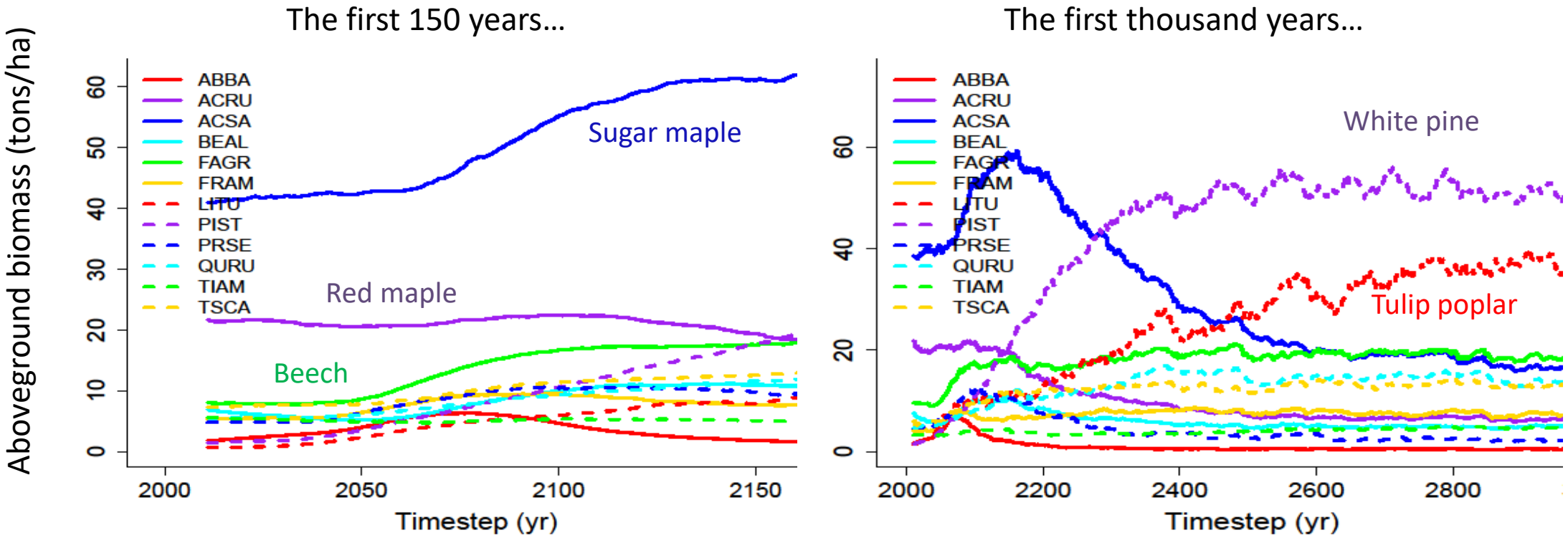
## Demographic responses of the 50 most common eastern tree species to variation in climate: A verbal summary

- Sapling and adult growth
  - 48 of 50 species show variation in growth along either temperature or precipitation gradients
  - Shapes of the response functions sometimes mirrored current distribution of abundance of species along the gradient, **but often did not**
  - All 14 species examined in a separate study using 23,000 tree cores from northeastern states showed **strong local adaptation/acclimation** to local, long-term climatic conditions site

- Sapling and adult survival
  - **25 of the 50 species showed NO variation in survival along either temperature or soil water deficit gradients**

- Seedling recruitment and survival
  - **Seedling survival shows much stronger sensitivity to climate**, with patterns that closely mimic current patterns of species distribution along at least a temperature gradient

# **Results:** Climate change matters, but will take a long time to play out…




- Predicted changes in abundance of the dominant tree species of northern hardwood forests of the eastern US
  - *Assuming a 3 degree C increase in temperature over the next 100 years*
  - *With the current regional harvest regime*

# Peering ahead – thoughts on the future…

- Tree species distributions will change over the next 50 years **even in the absence of climate change!**
  - Reflecting successional dynamics triggered by past land-use practices, under current or future harvest regimes, and the impacts of introduced pests and pathogens

- The near-term (50 - 100 year) effects of climate change on the distribution and abundance of individual tree species are weak, and will be mediated by a host of other processes
  - Logging, pests and pathogens, and other causes of mortality may actually accelerate response to climate change by creating canopy tree turnover and opportunities for colonization by new species

  - Changes in landowner behavior (harvest practices) in anticipation of climate change and/or pests and pathogens are likely to be as important as the direct effects of climate change on trees

Photo: Carl Heilman