Adaptation and mitigation strategies on the Superior National Forest in response to climate change:

Monitoring, Assessing and Forecasting

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2 USGS science for a changing world

Project objectives

Establish monitoring network

Gauge vulnerability of forests to climate change

Examine forest management and carbon storage

Simulate future forest productivity

Monitoring network

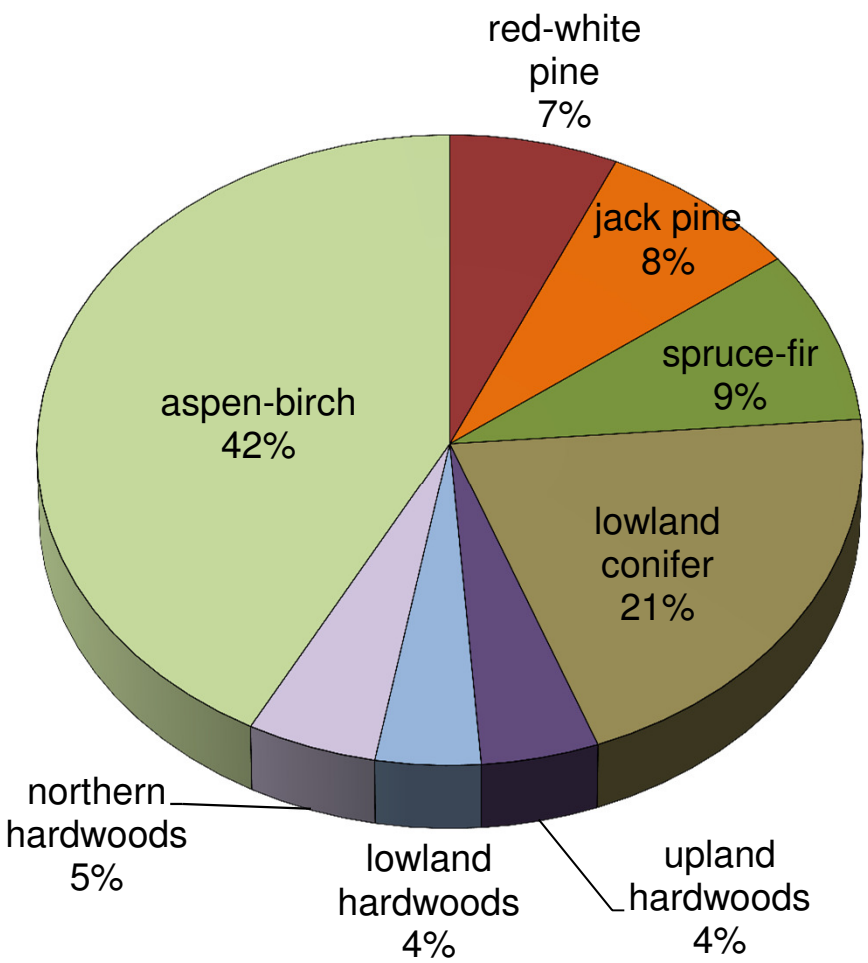
- Initiated in 2009 with John Bradford, Tony D'Amato, Nick Jensen, and Bruce Anderson.

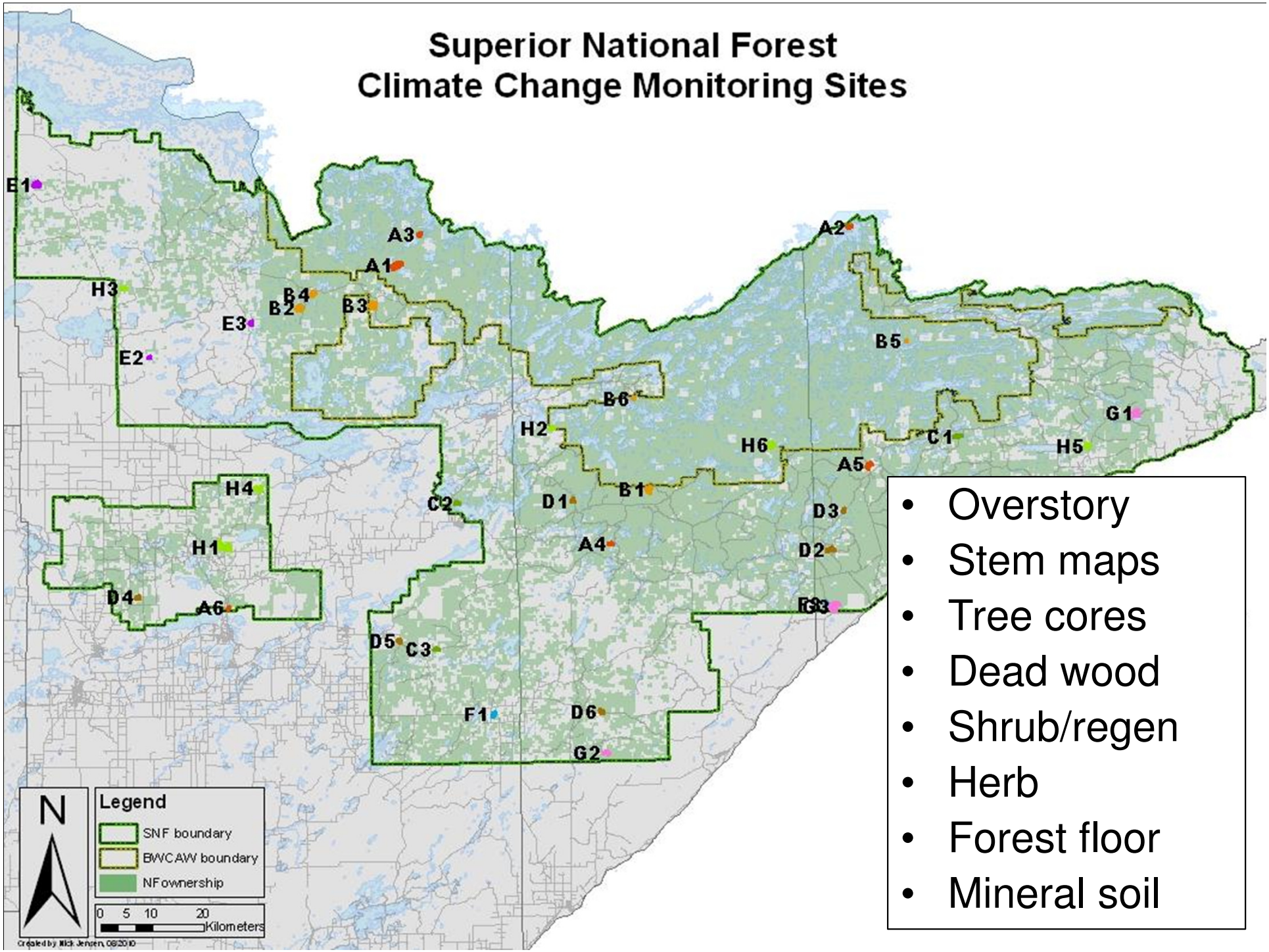
Vegetation structure

Carbon storage

Historical growth patterns

SNF Forest Composition (USDA FIA '04-'08 data)



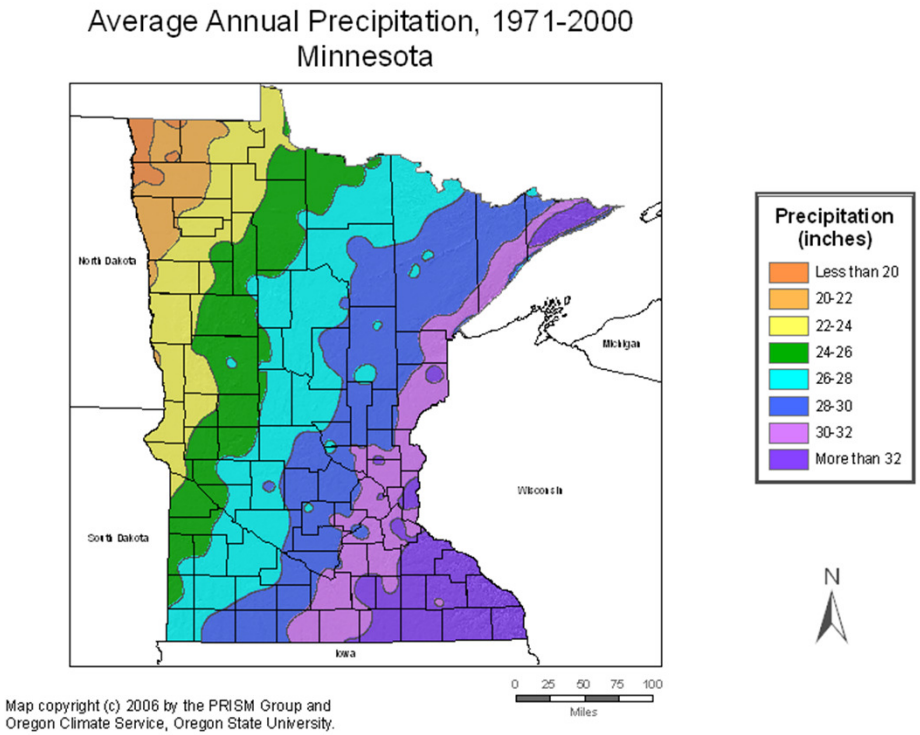


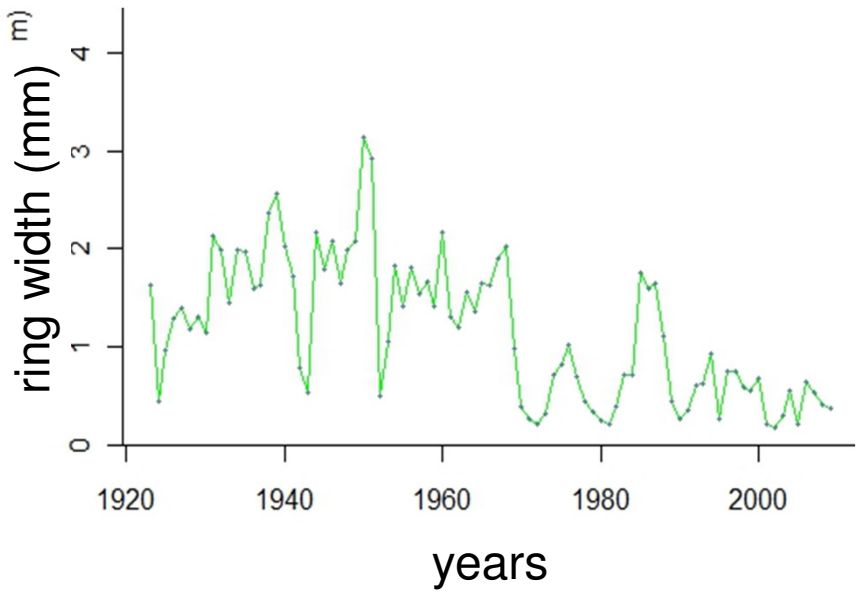
- Overstory
- Stem maps
- Tree cores
- Dead wood
- Shrub/regen
- Herb
- Forest floor
- Mineral soil

Monitoring network

Forest vulnerability

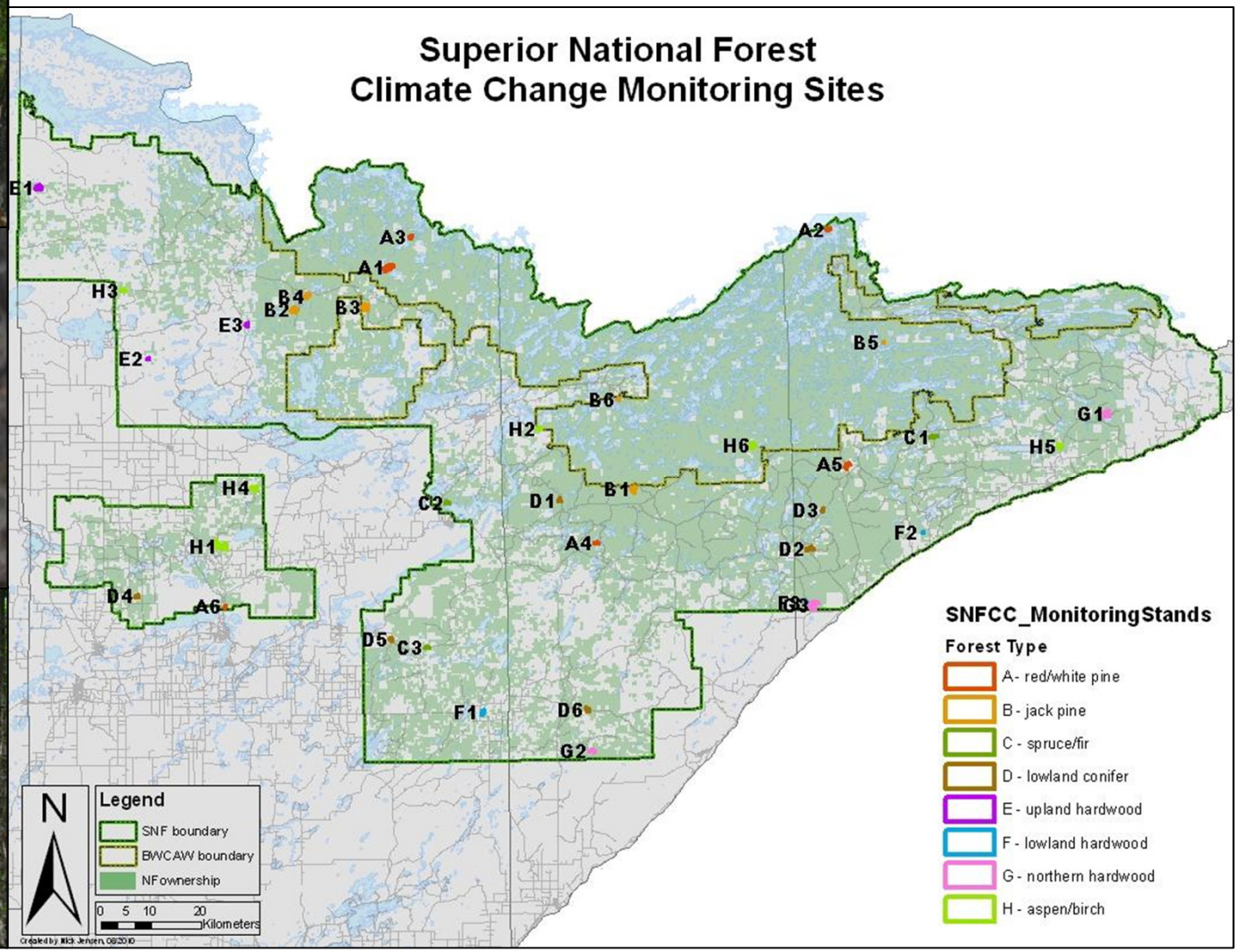
- In progress: Jane Foster, Tony D'Amato, and John Bradford
- Analyzing the resistance and resilience of forest types to increasing weather variability using tree rings





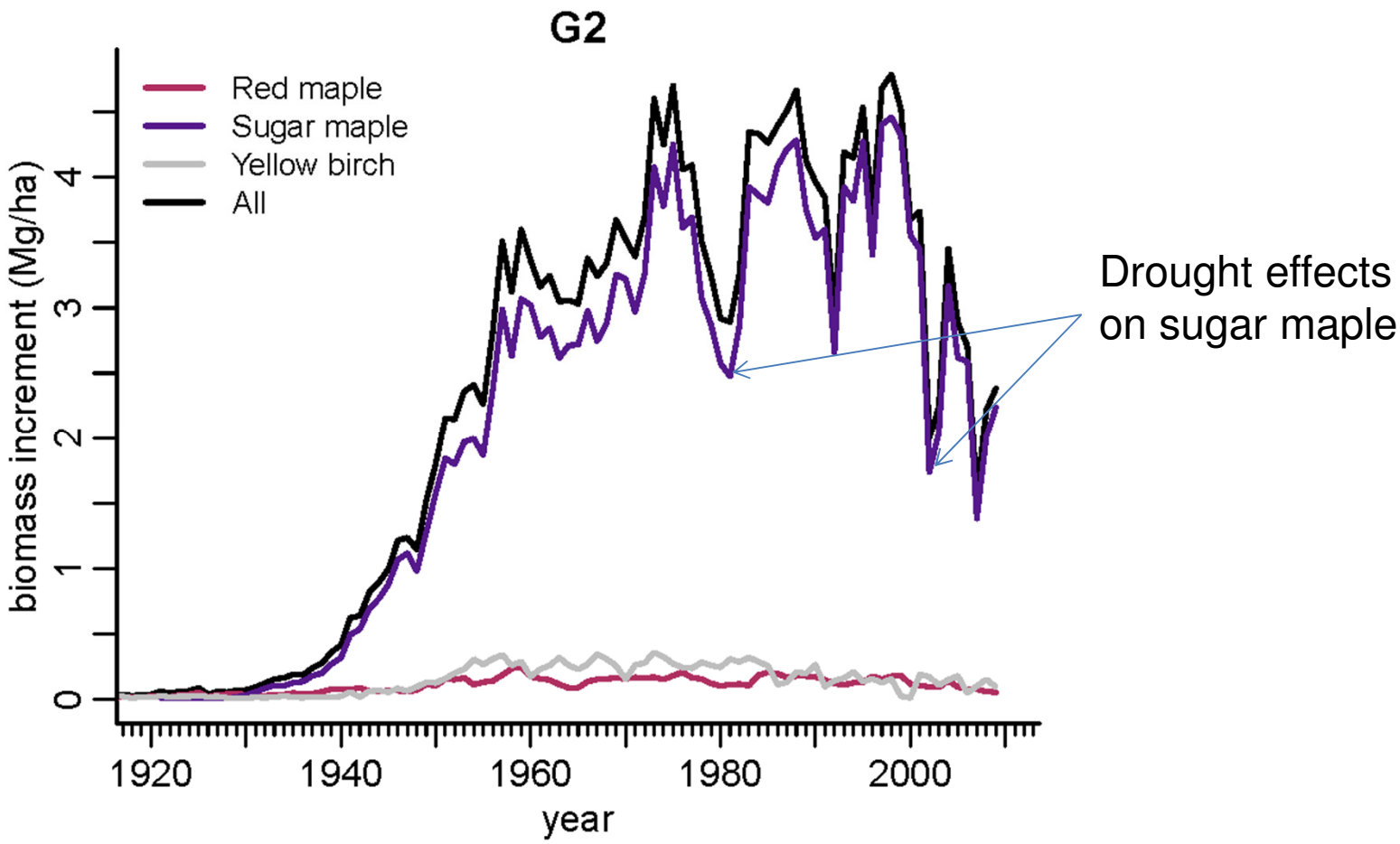
Forest vulnerability

3248 tree cores!



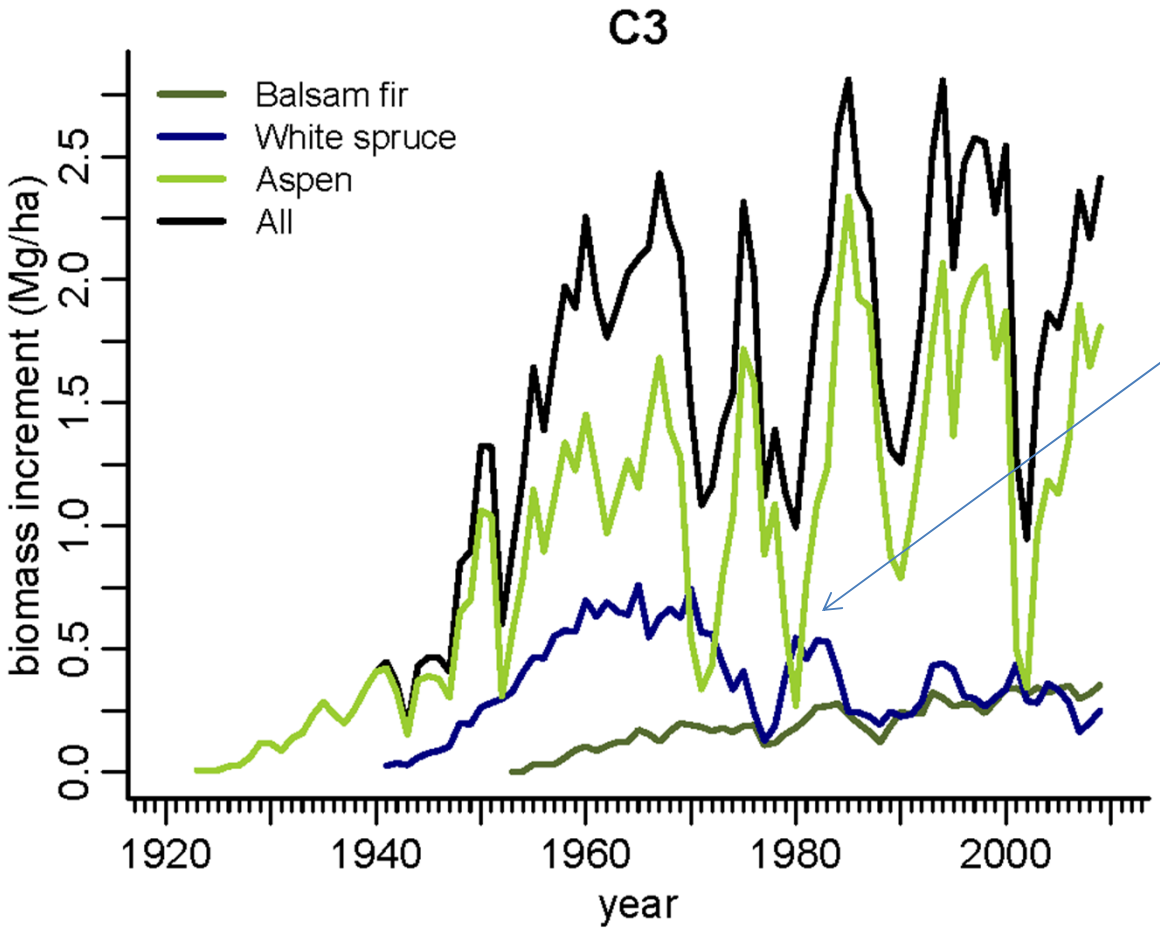
Forest vulnerability

- Tree ring data is aggregated to show stand patterns of biomass growth in response to weather and insects.



Forest vulnerability

- Mixed forests may foster resistance to changes in growth when insects affect only some species.



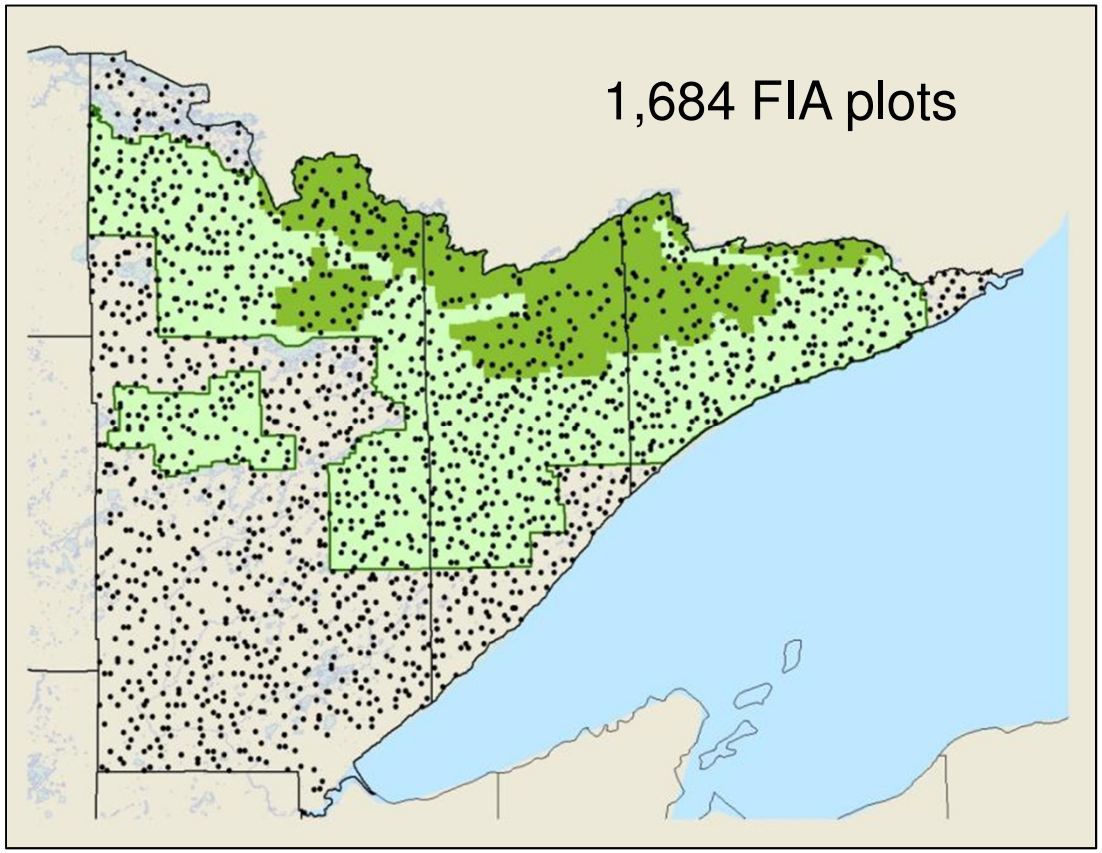
Forest tent caterpillar outbreak on aspen

Carbon storage model

- Project with John Bradford, Grant Domke, Nick Jensen, and Tony D'Amato.
- Influence of harvest, natural disturbance on carbon storage?

- 8 forest types
- 11 carbon pools

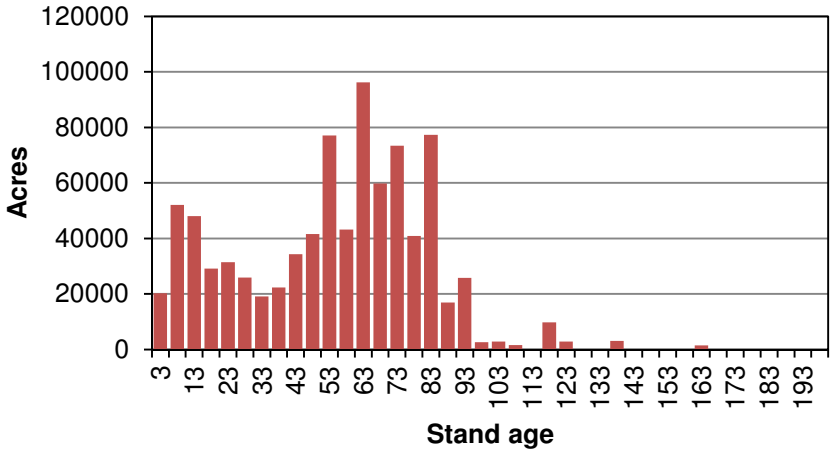
- Management and disturbance scenarios

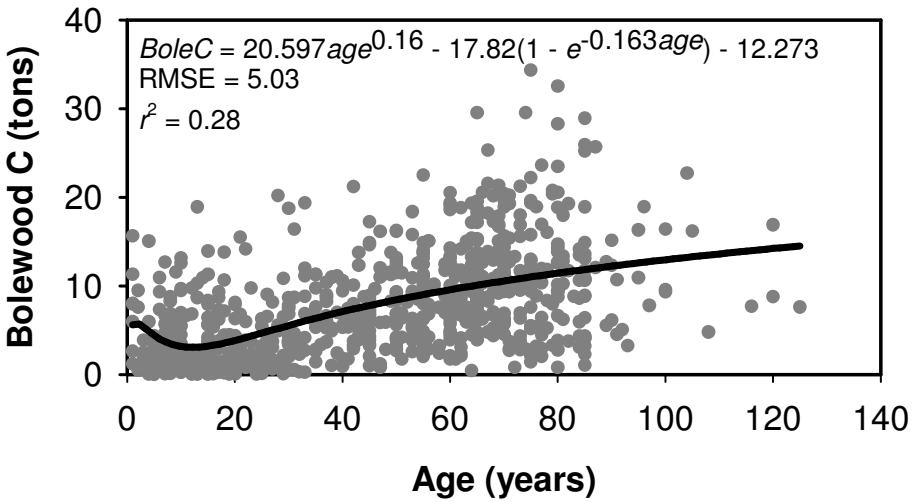


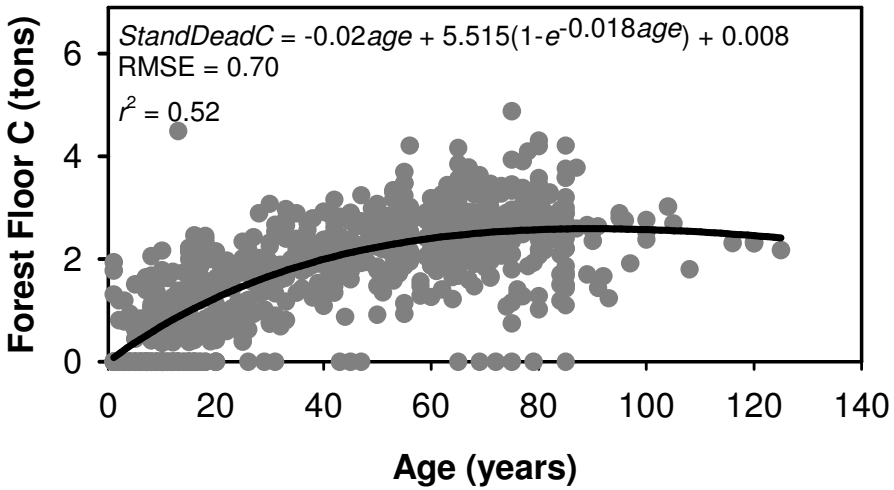
Carbon storage model

- Incorporate carbon accumulation rates specific to this region

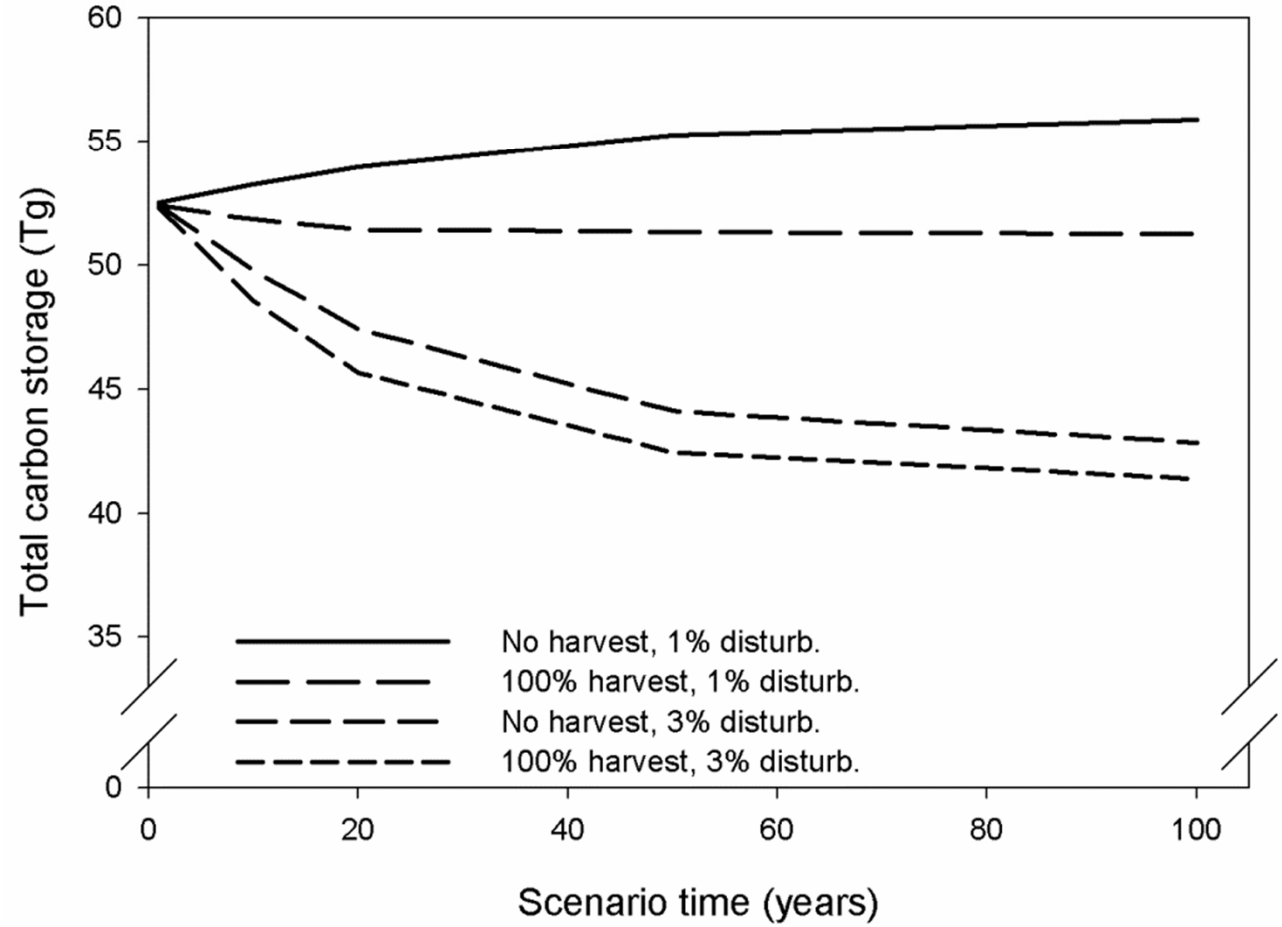
Aspen example:







Carbon storage model



Low disturbance:

- +6% w/o harvest
- -2% with harvest

High disturbance:

- -18% w/o harvest
- -21% with harvest

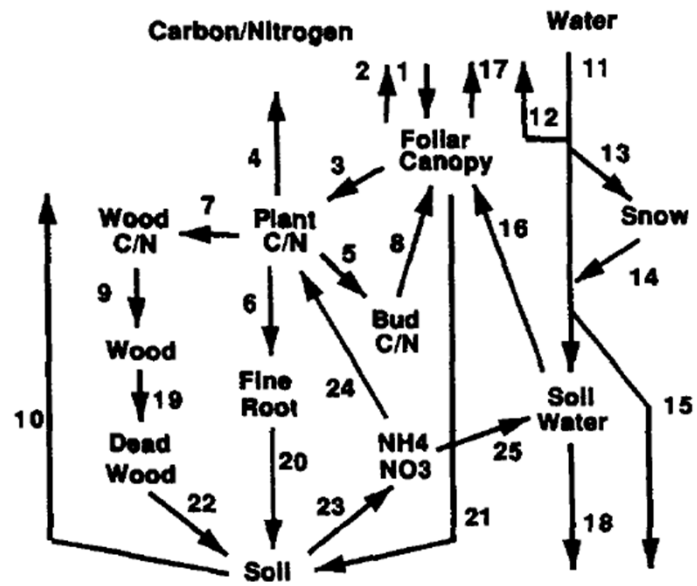
1. Increasing disturbance rates have the potential to overwhelm management impacts on forest carbon.
2. Increasing or maintaining forest-wide stocks may be difficult.

Forest productivity

- Work in progress with John Bradford, Peter Reich, Kirk Wythers, and Emily Peters

Modeling Approach (PnET-CN)

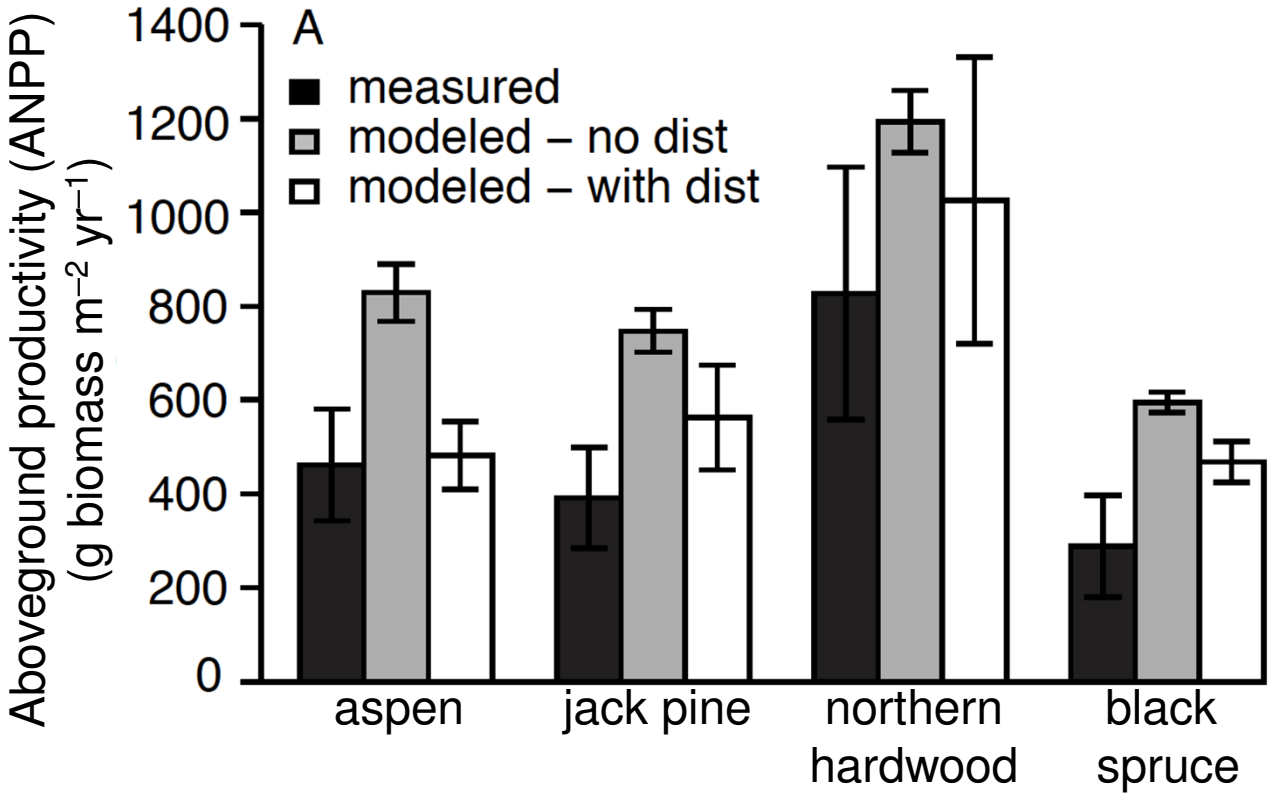
- Simulates C, H_2O & N cycling in forests
- Accounts for changes in disturbance, climate, CO_2, N deposition, & ozone
- Spatial scale: Forest stand to region
- Input data: climate, site & forest type info
- Outputs include productivity, evapotranspiration, and N mineralization



1. Gross Photosynthesis
2. Foliar Respiration
3. Transfer to Mobile C
4. Growth and Maint. Resp.
5. Allocation to Buds
6. Allocation to Fine Roots
7. Allocation to Wood
8. Foliar Production
9. Wood Production
10. Soil Respiration
11. Precipitation
12. Interception
13. Snow-Rain Partition
14. Snowmelt
15. Fast Flow
16. Water Uptake
17. Transpiration
18. Drainage
19. Wood Litter
20. Root Litter
21. Foliar Litter
22. Wood Decay
23. Mineralization
24. N Uptake
25. To Soil Solution

Forest productivity

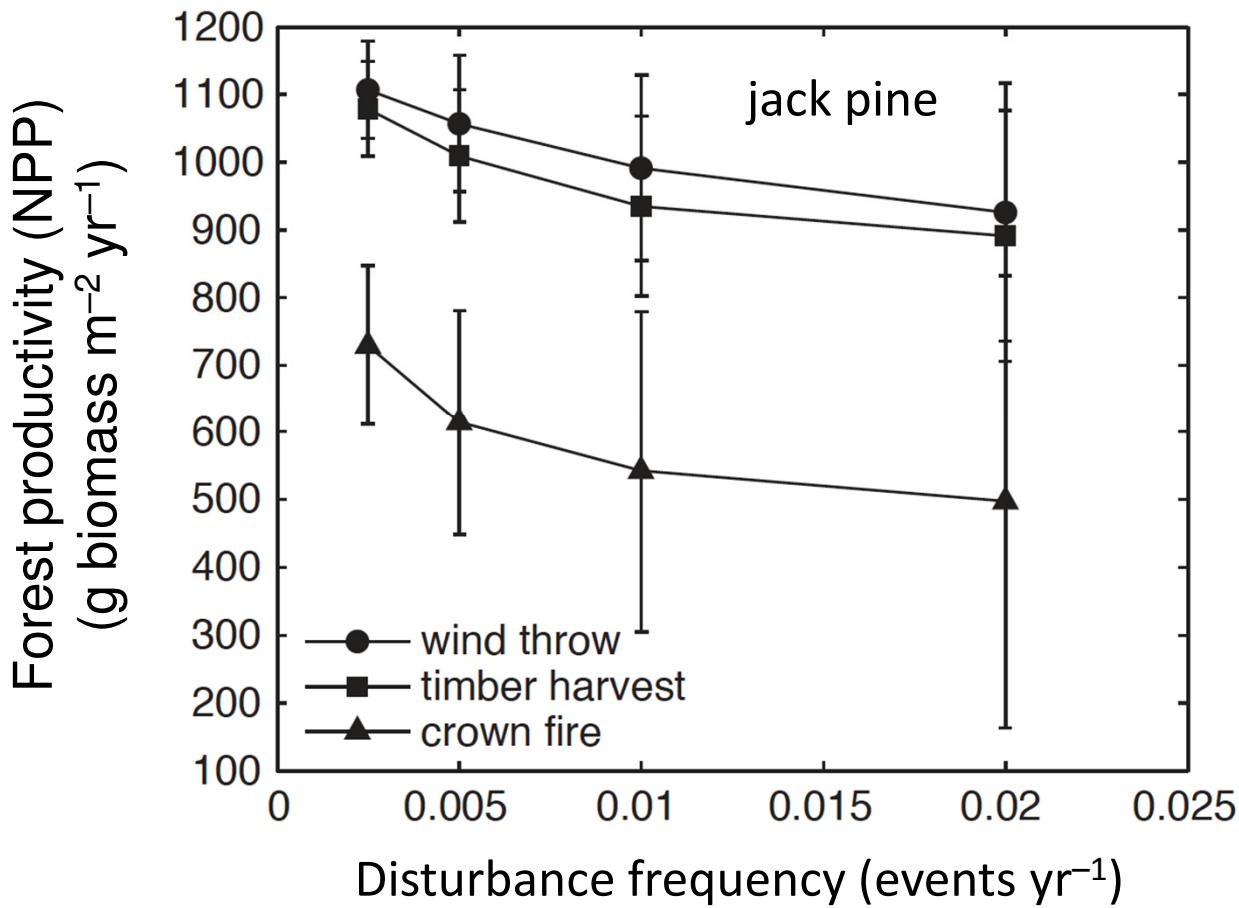
Effects of past disturbances (fire & harvest) on productivity of 108 forest stands in MN & WI



1. Model with disturbance better predicts ANPP.
2. Current productivity is lowered by past disturbances.

Forest productivity

Effects of disturbance type and frequency on productivity.



1. NPP declines with increasing disturbance frequency.
2. Fires reduce NPP more than wind or harvest events.

Summary

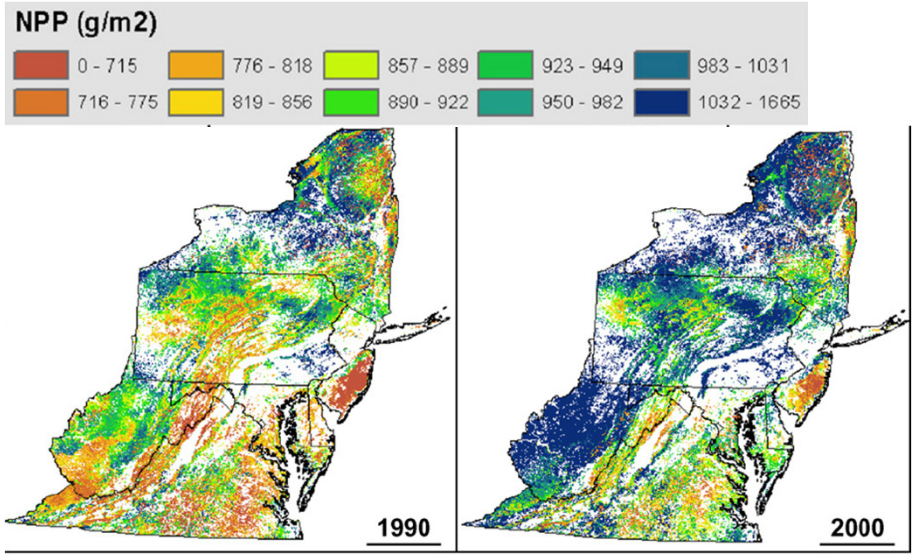
- Long-term monitoring network in place
- Data being processed to understand impacts of weather and other stressors on specific forest types
- Carbon storage results suggest minimal impact of harvesting, challenges ahead with increasing disturbance
- PnET model providing information on forest productivity responses to changing environmental conditions

Forest productivity

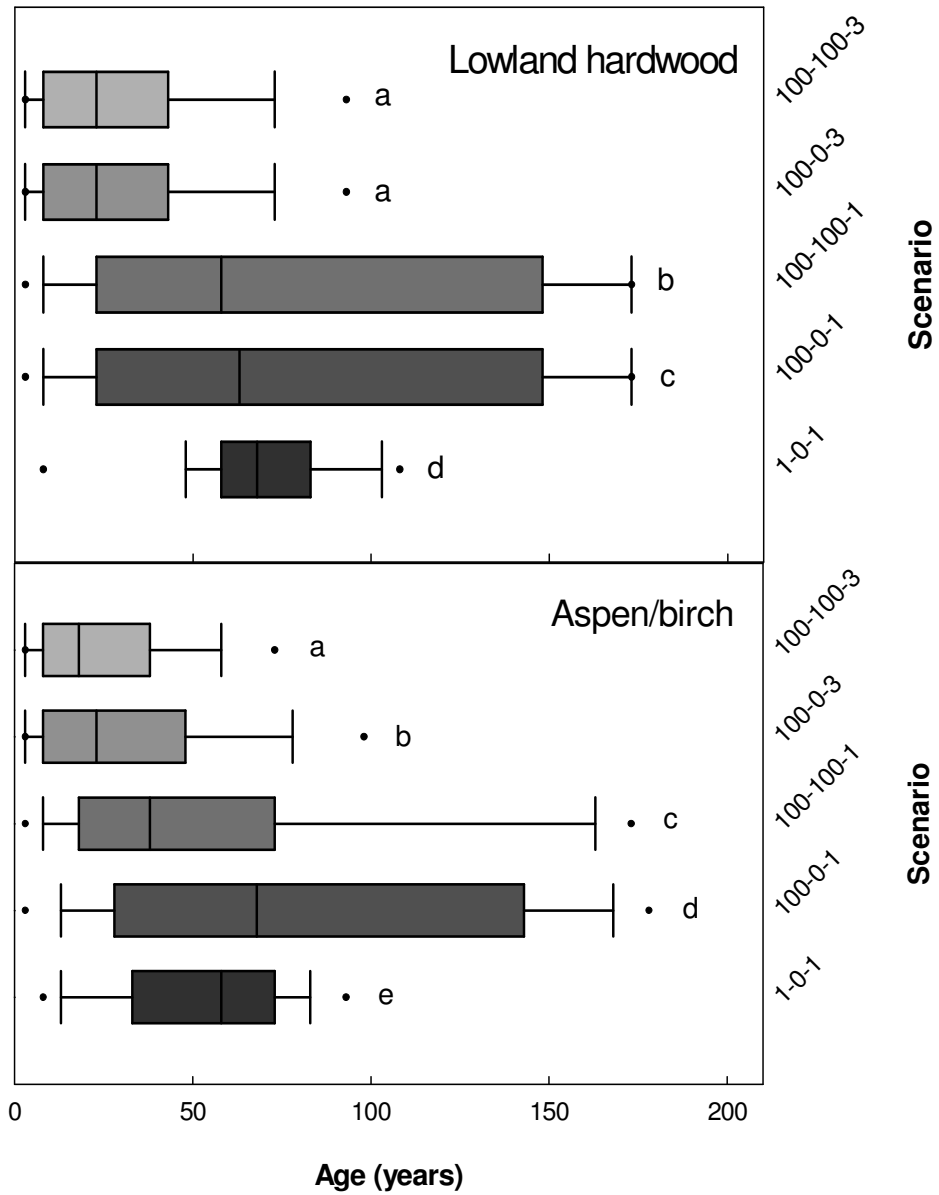
MN Climate Change Response Framework

In progress

- 2 emissions scenarios (B1 & A1fi)
- 5 forest types (spruce, pine, northern hwd, aspen-birch, oak)
- Expected output summer 2012
  1. NPP maps of MN for 1960-2100
  2. Percent change in NPP by forest type/climate scenario
  3. Relative importance of different global change factors (climate, N deposition, ozone, CO_2) on NPP



Pan et al. 2009 For. Eco. Mgmt

Carbon storage model

- Large age distribution shifts
- Driver of carbon storage potential