Forest Restoration and Management in a Changing Climate: Implications for Northern Minnesota Forests

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Portland State UNIVERSITY

USDA
United States Department of Agriculture

Minnesota Forest Ecosystem Vulnerability Assessment and Synthesis:

A Report from the Northwoods Climate Change Response Framework Project

Forest Service | Northern Research Station | General Technical Report NRS-133 | May 2014

Minnesota Forest Ecosystem Vulnerability Assessment and Synthesis:

A Report from the Northwoods Climate Change Response Framework Project

Stephen Handler, Matthew J. Duveneck, Louis Iverson, Emily Peters, Robert M. Scheller, Kirk R. Wythers, Leslie Brandt, Patricia Butler, Maria Janowiak, P. Danielle Shannon, Chris Swanston, Kelly Barrett, Randy Kolka, Casey McQuiston, Brian Palik, Peter B. Reich, Clarence Turner, Mark White, Cheryl Adams, Anthony D'Amato, Suzanne Hagell, Patricia Johnson, Rosemary Johnson, Mike Larson, Stephen Matthews, Rebecca Montgomery, Steve Olson, Matthew Peters, Anantha Prasad, Jack Rajala, Jad Daley, Mae Davenport, Marla R. Emery, David Fehringer, Christopher L. Hoving, Gary Johnson, Lucinda Johnson, David Neitzel, Adena Rissman, Chadwick Rittenhouse, and Robert Ziel

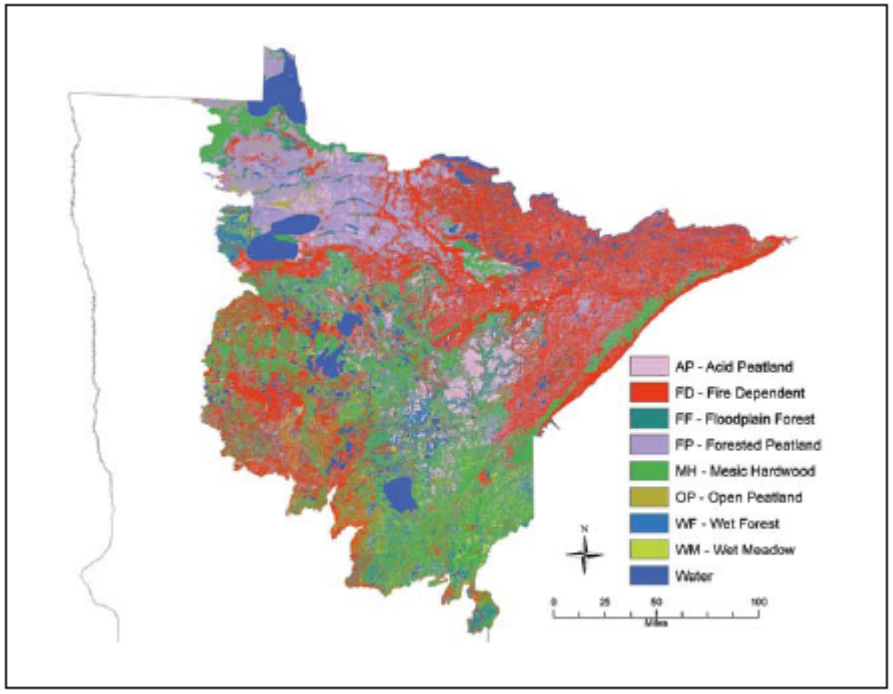
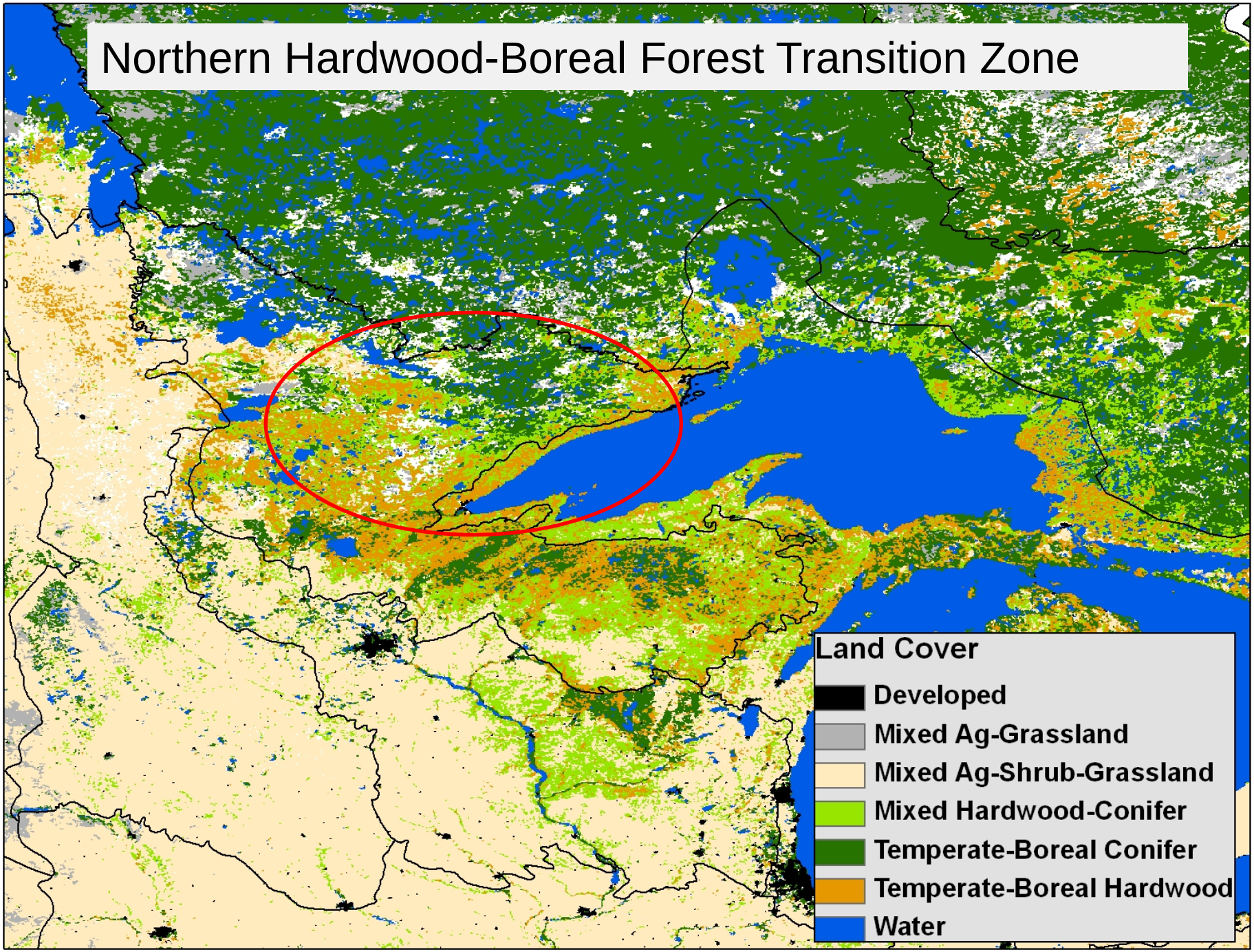


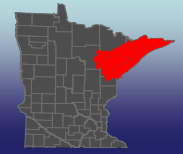
Figure 6.—Map of Native Plant Community Systems within the assessment area (version 2.6, prepared by T. Brown and G. Host, Natural Resources Research Institute).

Northern Hardwood-Boreal Forest Transition Zone



Introduction

- TNC Forest restoration program
- Climate adaptive management
- Vulnerability Assessment



MN, USA

Natural Variability and Biodiversity Conservation

Source: Wh
Host 2000

[redacted]

ectives:

/ Historical reference onditions

Species Diversity

Structural Complexity

Age Structure

Spatial Pattern

Maintain Biodiversity + Forest Function

Climate Change?

NE MN Landscape Plan

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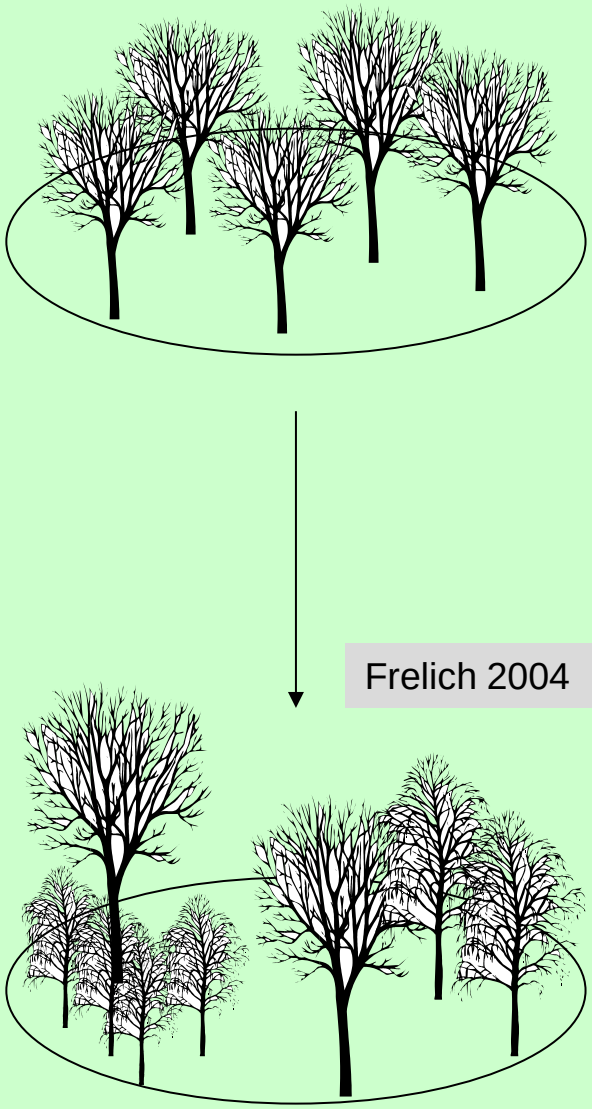
Land Use History: The legacy of settlement era logging + fire

Current Simplified Forests: Loss of long-lived conifers and structural diversity

Conservation Objectives : Restore species diversity- Long-Lived Conifers, Structural complexity



Conifer Restoration Sites
Chris Dunham-TNC Northeast Minnesota

- Plant 200,000 – 300,000 trees/ year
- Browse protection on 2500 ac/ year (40-80% cost)
- Release 500 acres per year
- Spend $250,000 per year

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Conifer Restoration Projects

Post Harvest: Introduce conifers soon after harvest

Riparian: Post Harvest, Enrichment

Enrichment: Restore conifers to aspen-birch stands

Treatments: Shelterwood, seed tree, gaps, clearcut

Native Plant Communities: Reference Conditions for Forest Ecosystems

↑ Map units based physical variables (soil, topography).

↑ Understanding of ecosystem response to disturbance

↑ Best available information for developing strategies to maintain habitat diversity.

↓ Rapid rates of climate change?

Key Questions

- **RNV restoration strategies and objectives under climate change**
- **Influence of forest management on composition under climate change**
- **Can forest management increase resilience/adaptive capacity?**

Approach: Use spatially dynamic model that incorporates climate, disturbance and seed dispersal

Ecological Applications, 20(2), 2010, pp. 327–346
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Forest restoration in a mixed-ownership landscape under climate change

CATHERINE RAVENSCROFT,[1,3] ROBERT M. SCHELLER,[1,4] DAVID J. MLADENOFF,[1] AND MARK A. WHITE[2]

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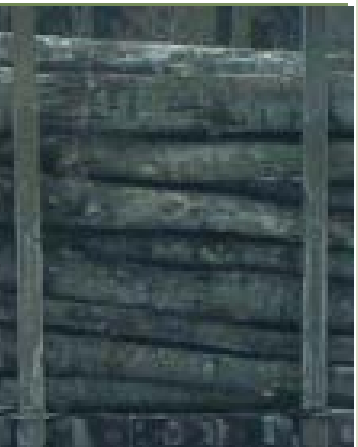
Uncertainty: Modeling Forests under Climate Change

- Co2 fertilization
- **Deer**, earthworms
- Insect + disease
- Land-use change
- Climate models
- Ozone

- Understand **relative** influence of climate and disturbance on regional species composition trends

Uncertainty



Very warm & dry

Warm & dry

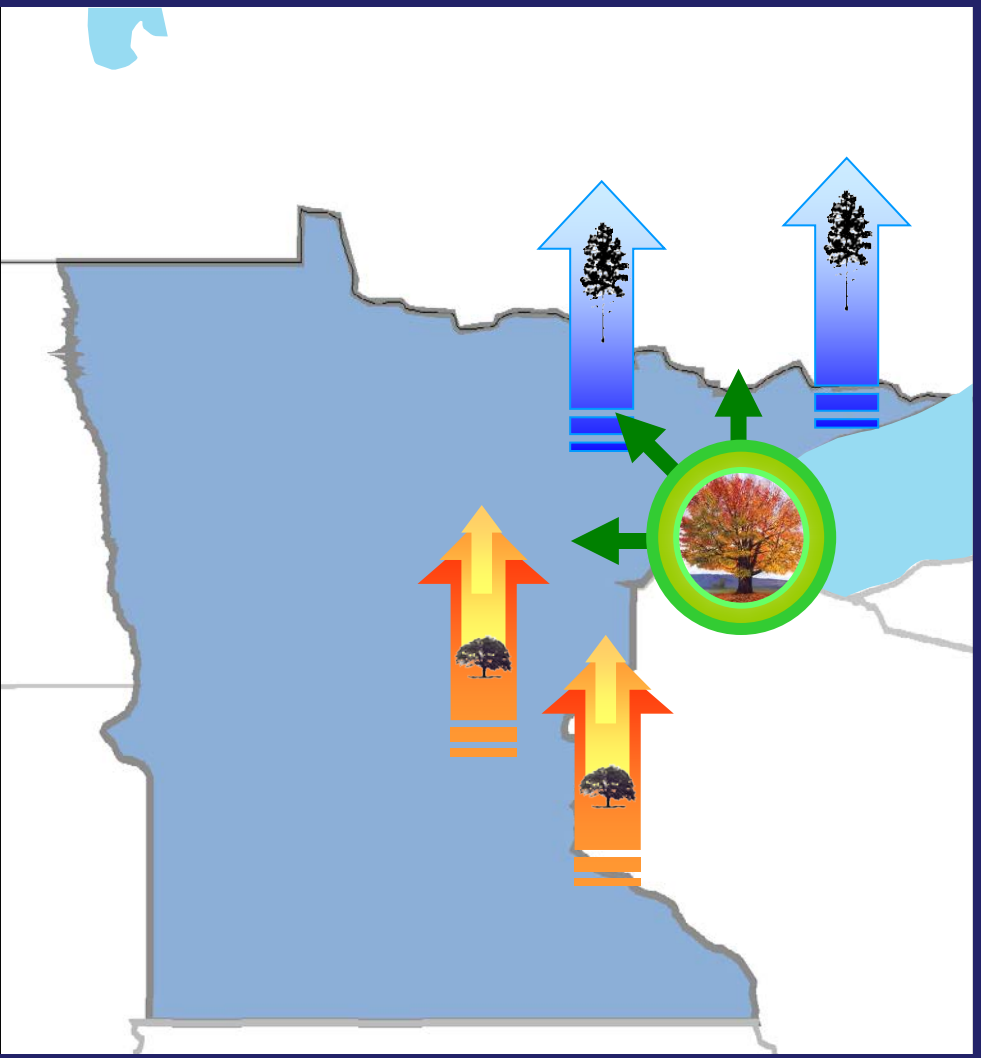
Very warm & wet

Warm & wet

Frelich and Reich 2009 NAJ

Potential Climatic Changes

(Ravenscroft et al. 2010)



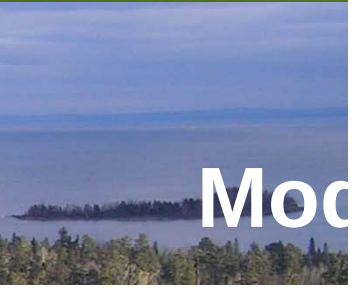
Low Emissions: Restoration can maintain boreal species-increase in *Acer spp*.

High Emissions: Loss of boreal spp. regardless of management

Loss of forest-mismatch between climate & management

Large increase in red maple

Oak/hickory-dispersal limited



Modeling: Phase 2
Model Climate-Adaptive Management

Can we increase <u>adaptive capacity</u> through management?

Robert Scheller &
Matthew Duveneck

Portland State University

Mark White

The Nature Conservancy

Chris Swanston &
Stephen Handler

Forest Service U.S. Department of Agriculture

Upper Midwest/ Great Lakes Landscape Conservation Cooperative

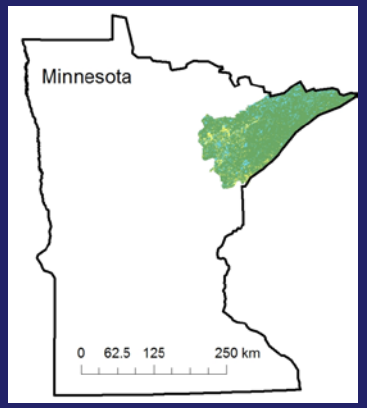
Model Climate Adaptive Management

Resilience-Increase Adaptive Capacity

- Mix-uneven-even-aged, higher retention
- Manage for species tolerant of future climate-overcome migration limits
- Red oak, bur oak, yellow birch, basswood, white pine-
- Response diversity-life history traits
- Favorable response-environmental change

Resistance:

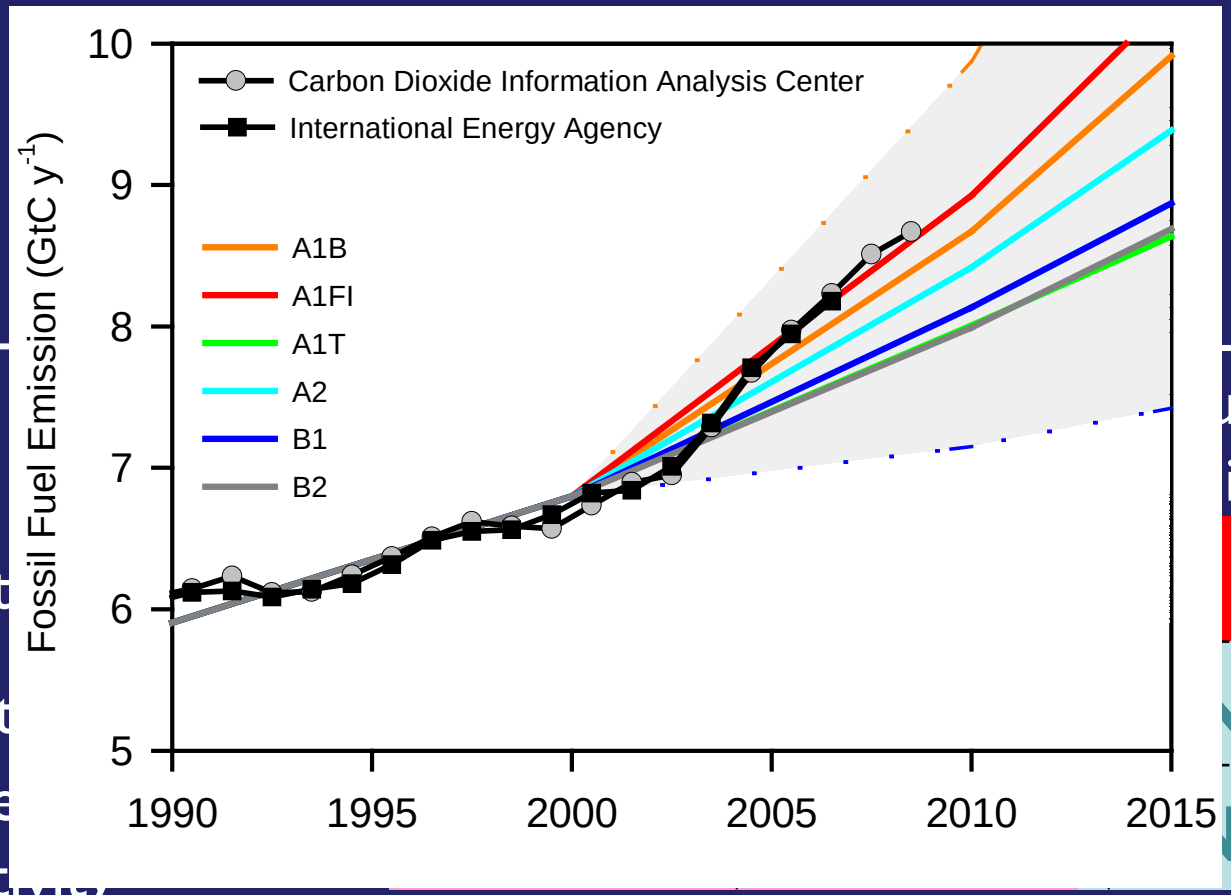
- Increase area of forest reserves-buffer riparian corridors- 1500 m



Measure resilience: the ability to maintain diverse forest communities and structural components.

…

Scenarios



MANAGEMENT

Current

Alternat

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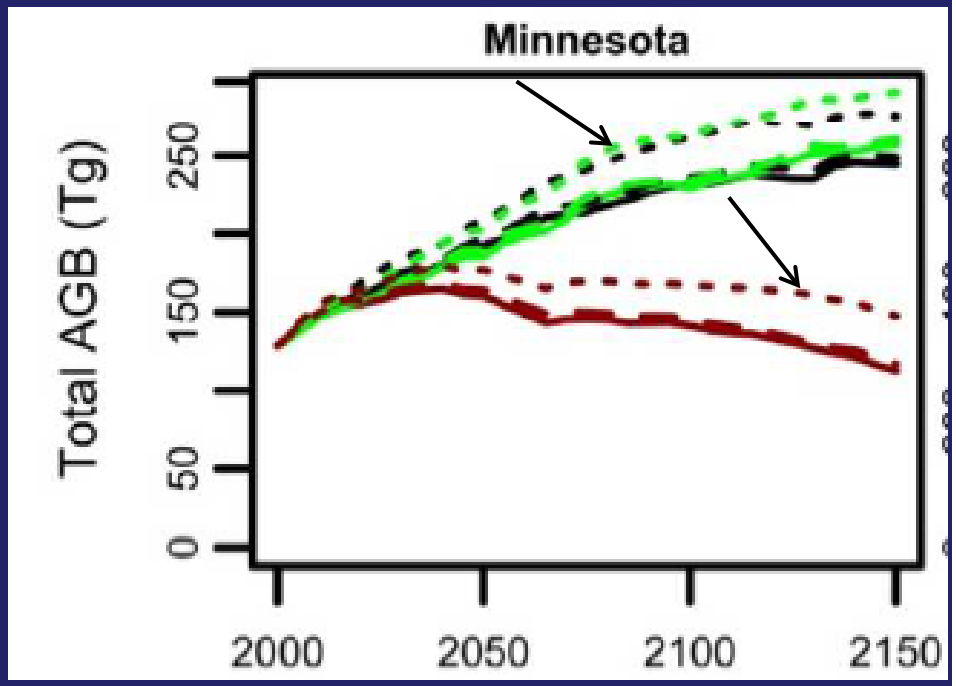
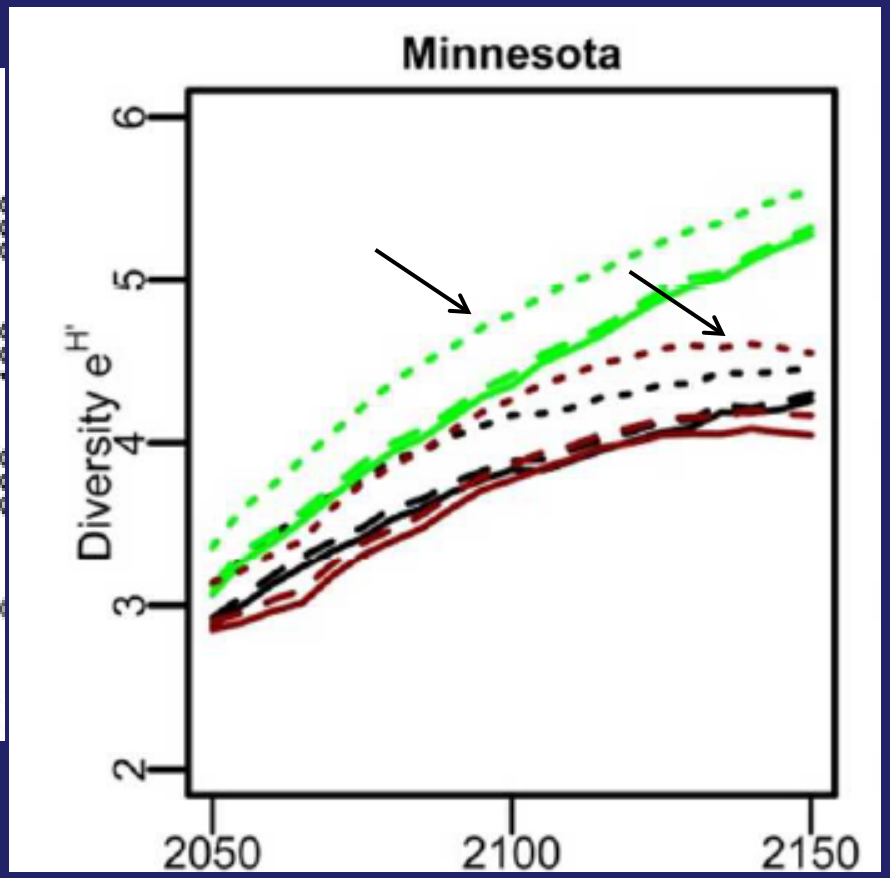
NA

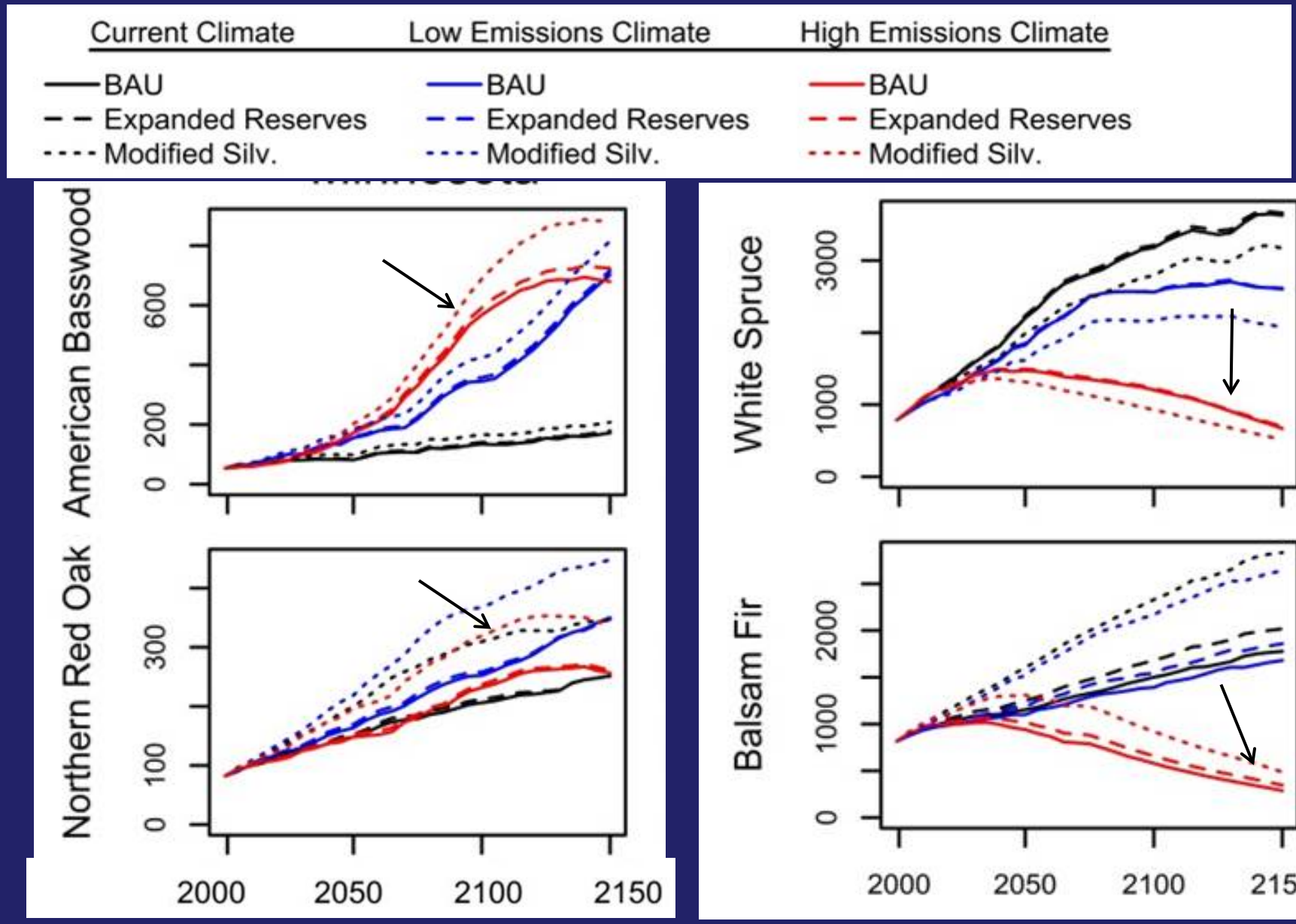
NA



Above ground biomass



Species Diversity



Temperate

Boreal

Summary

Low Emissions

- Resistance and resilience-maintain boreal species
- Both maintain or increase species diversity

esa ECOSPHERE

Climate change effects on northern Great Lake (USA) forests: A case for preserving diversity

Matthew J. Duveneck,[1,†] Robert M. Scheller,[1] Mark A. White,[2] Stephen D. Handler,[3] and Catherine Ravenscroft[4]

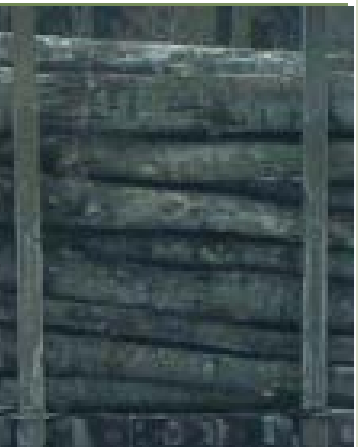
ecosystem services

- Resilienc ... ersity
- Tempera ... diversity
- Adaptatio ...

Canadian Journal of Forest Research

Effects of alternative forest management to biomass and species diversity in the face of climate change in the northern Great Lake region (USA)

Matthew Joshua Duveneck, Robert M Scheller, Mark A. White



Adaptation Frameworks

Resistance to Change

Resilience of Current System

Facilitation to New Sustainable State

Millar et al. 2007, *Ecological Applications*
Heller and Zavaleta 2009, *Biological Conservation*

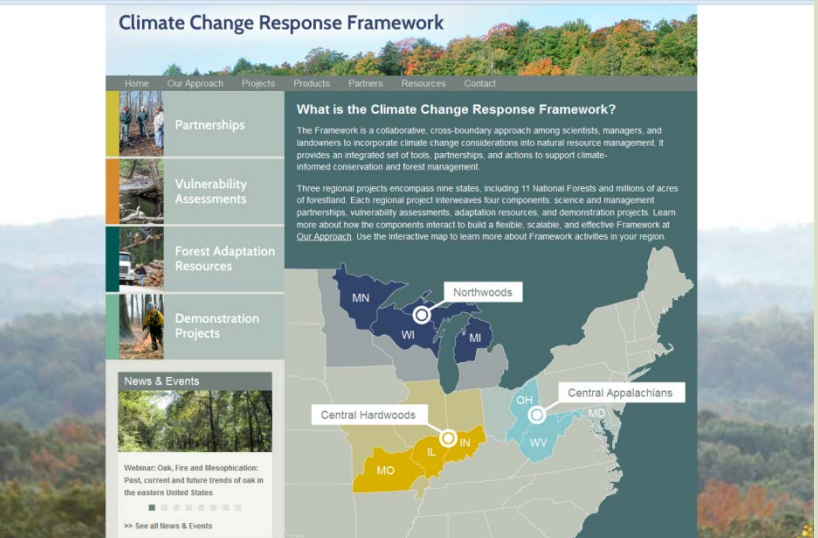
Regional Scale Adaptation Framework

1. Sustain ecological functions.

2. Reduce impact of existing stressors.

3. Protect forests from severe disturbances.

4. Maintain or create refugia.



*5. Maintain and enhance species & structural diversity

6. Increase ecosystem redundancy.

7. Promote landscape connectivity.

*8. Enhance genetic diversity.

*9. Facilitate community adjustments through species transitions.

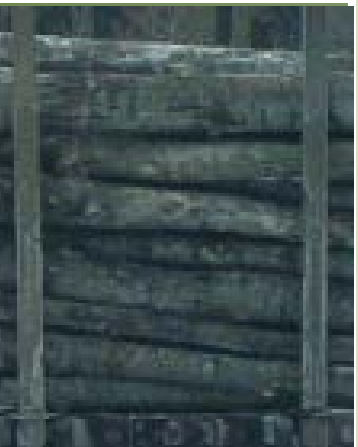
10. Plan for and respond to disturbance.

http://www.climateframework.org/northwoods

Adaptation Forestry in Minnesota's North Woods

- Plant climate tolerant species in NSU with stock from different seed zones

- Tree Species
  White pine, Bur oak, Red oak, Basswood, Yellow birch

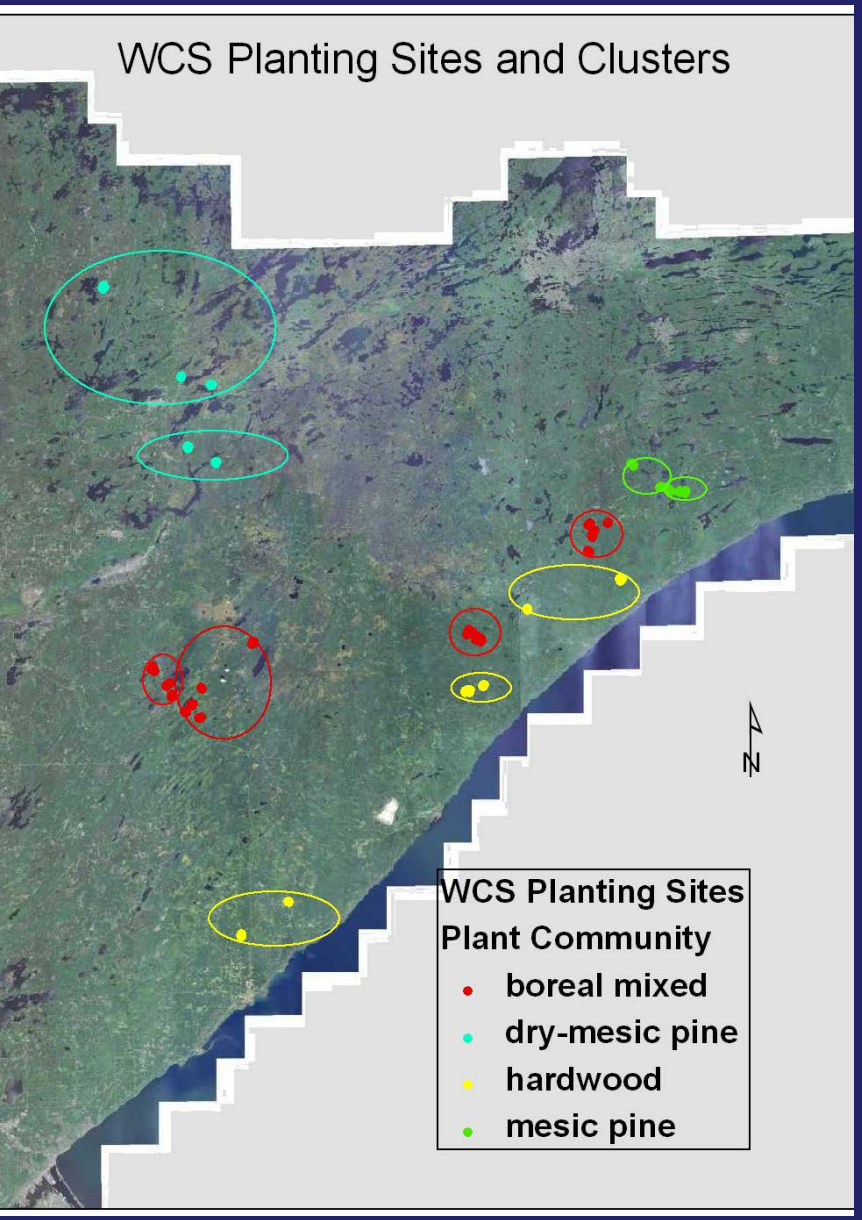


- **Structural Treatments**
  Gap, shelterwood w/reserves, thinning, clearcut w/reserves

Adaptation Forestry Assumptions

- Significant climate change during the life span of current trees in the forest
- Warmer-drier climate will select for tolerant species
- Models: species tolerant of warmer-drier conditions may be dispersal limited
- Manage for these species to reduce the risks to forest function under warmer-drier conditions

Adaptation Forestry



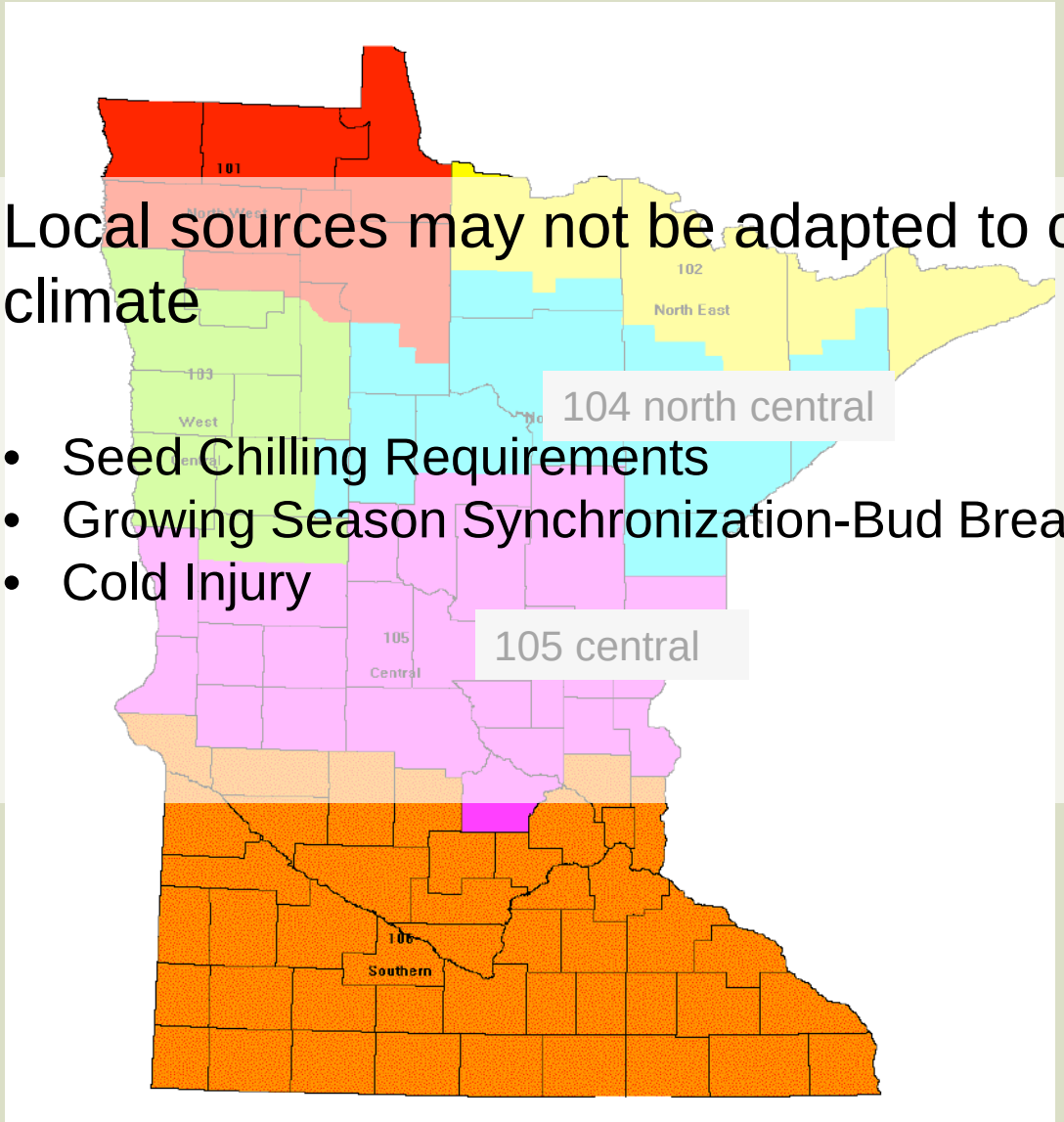
100,000 seedlings-2013-2014
bur oak, red oak, white pine, basswood, yellow birch-northern and southern seed zones

21 sites, 4 native plant communities

46 research plots, 120 seedlings: red oak, bur oak, and white pine
2 seed zones

Compare suitability: growth, mortality, phenology

Minnesota Seed Zones



Local sources may not be adapted to changing climate

- Seed Chilling Requirements
- Growing Season Synchronization-Bud Break, Bud-Set
- Cold Injury

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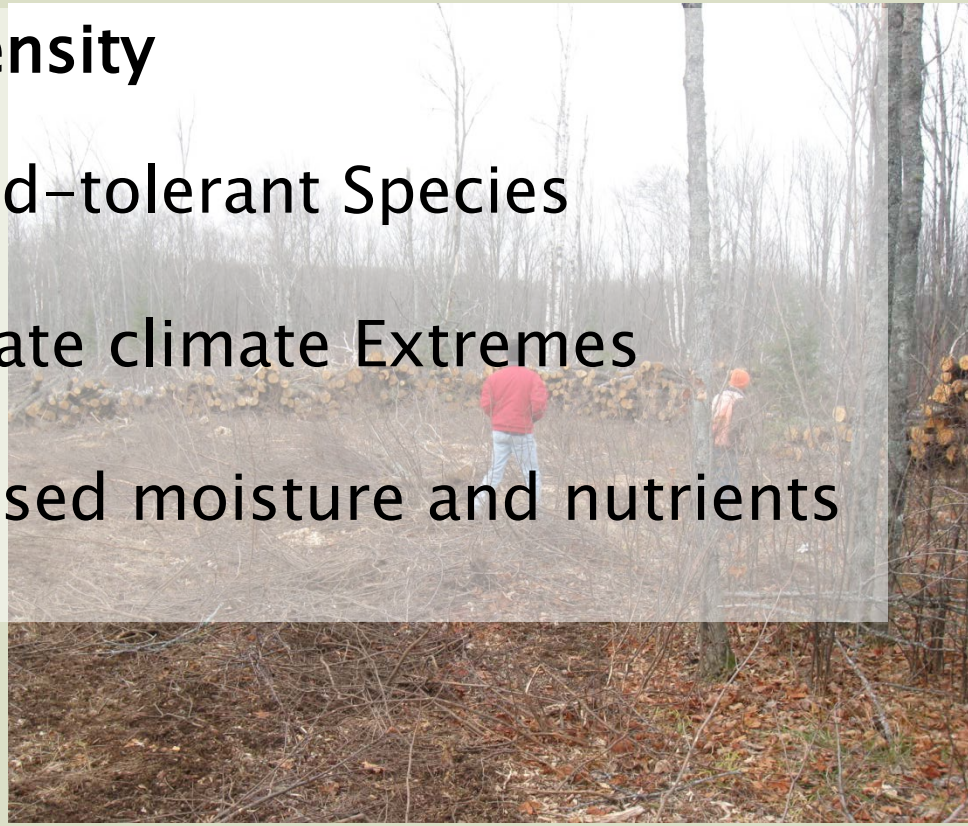
Adaptation Forestry: Plantings in Structural Treatments
Hardwoods Example

Gap

Shelterwood



Manage Overstory Density

Growing Space for Mid-tolerant Species

Higher Density-Mitigate climate Extremes

Lower Density-Increased moisture and nutrients

Measures

Compare Suitability: 4 Tree Species,2 Seed Zones, Structural Treatments 3-Year Period

- Phenology: Bud Burst, Bud Set Maturation Stage
- Height, Diameter
- Survival
- Leaf damage

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Collaborators

TNC

Meredith Cornett, Director of Science
Chris Dunham, NEMN Forest Manager
Kim Hall, Climate Change Ecologist
Mark White, Forest Ecologist

University of MN – Duluth

Julie Etterson, Associate Professor
Laura Kavajecz, MS Candidate

Northern Institute of Applied Climate

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Conservation Partners Legacy-MN
National Science Foundation
Cox Family Fund for Science and Research
University of Minnesota-Duluth

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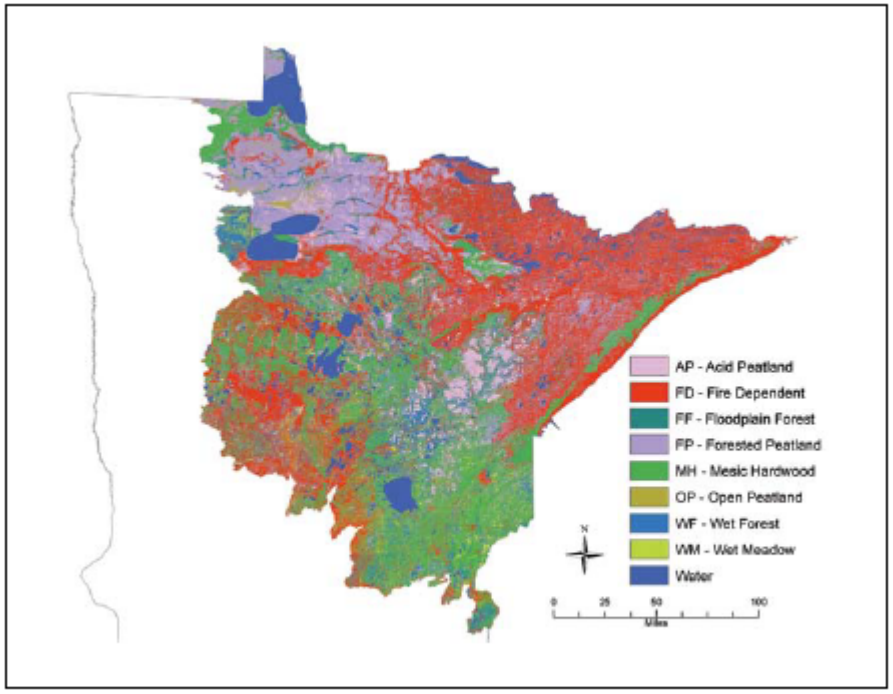

Figure 6.—Map of Native Plant Community Systems within the assessment area (version 2.6, prepared by T. Brown and G. Host, Natural Resources Research Institute).

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Questions?

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