Looking back to inform the future

Climate change adaptation lessons from long-term silviculture studies on USFS experimental forests

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Objectives:

Highlight the important role of long-term silvicultural studies on FS-Experimental Forests for developing response strategies in the face of an uncertain climate future

-Context: what we do and don't know and what will we need to do (as silviculturist)?

-Considerations: for silviculture in the face of climate change and uncertainty

-Silvicultural strategies: to create more resilient forests (lessons from EF research)

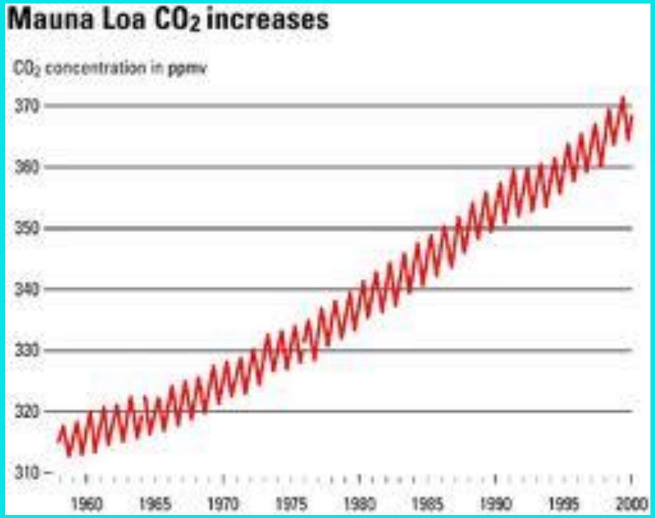
What do we know?:

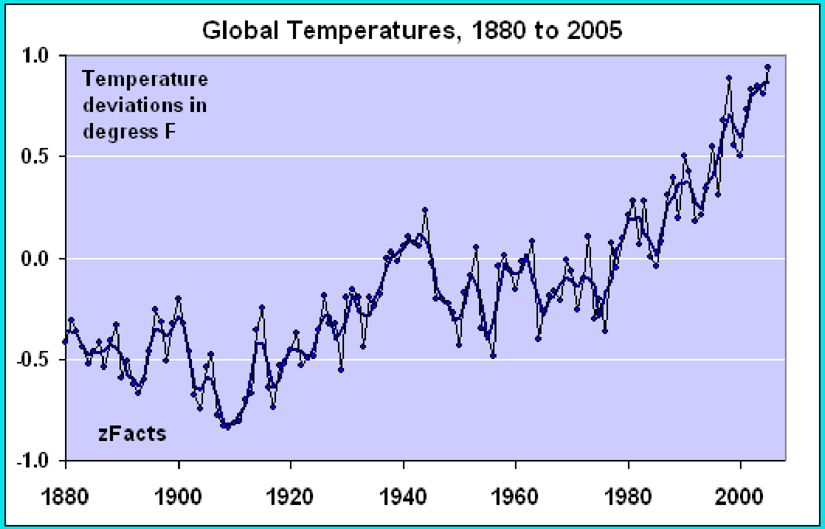
CO_2 is increasing, temperature is increasing; precipitation patterns will change; storm patterns will be different

What we don't know:

Exact magnitude of temperature increases; magnitude and timing of precipitation changes; degree of change in storm events

Uncertainty is High



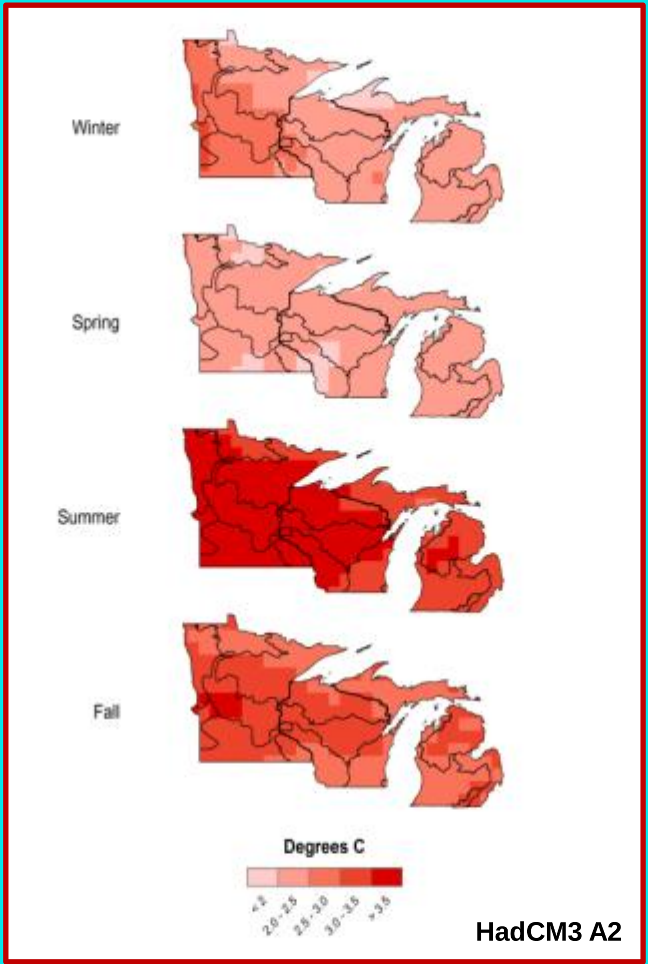


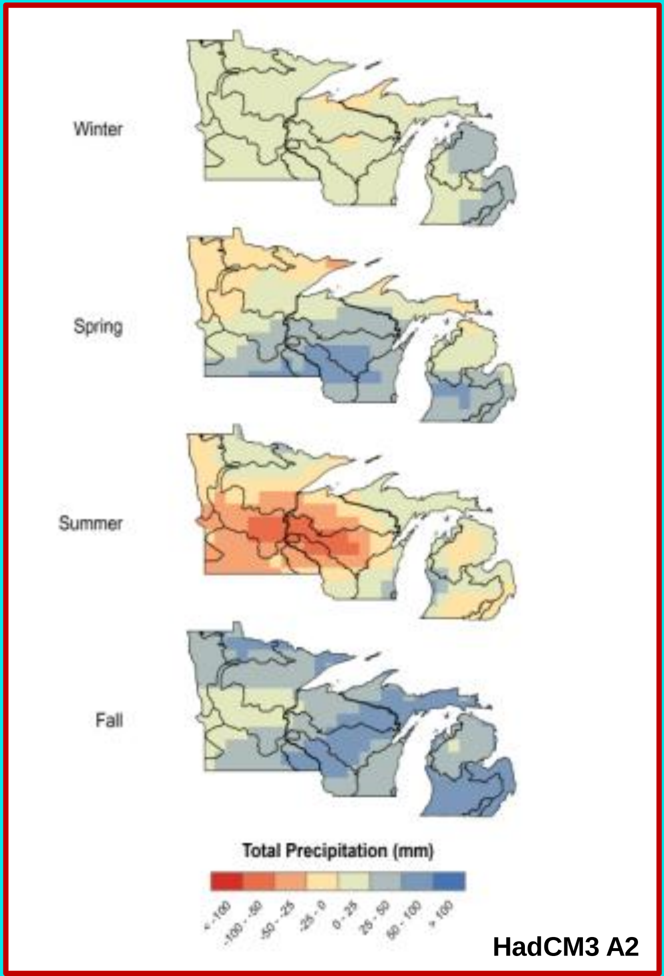
What do we know?

e.g., Northern Lake States: warmer temperatures; increased precipitation, except in summer

Potentially: -greater growing season moisture deficit and plant stress
-shorter and less severe spring and fall fire seasons
-greater potential for severe wildfire in summer

Still, there is uncertainty





Source: 2013 National Climate Assessment (In prep)

What we need to recognize:

Silviculture will need to adapt to changing and *uncertain* climate conditions

Silvicultural objectives will include managing for adaptation to climate change, but within a framework of *uncertainty*

But is managing in the face of uncertainty all that new?

Uncertainty of:

- **-markets**
- **-natural disturbance**
- **-pests & pathogens**
- **-social demands**

There is always uncertainty; So what is new?

Silvicultural planning *(in the face of an uncertain climate future)*:

1. As usual: develop objectives, strategies, and prescriptions in the context of landscape, Forest, and project goals

2. And bring climate change considerations into the discussion now

This is what is new

Silvicultural considerations: *in the face of an uncertain climate future*

1. **Projected future habitat suitability of component species** ★

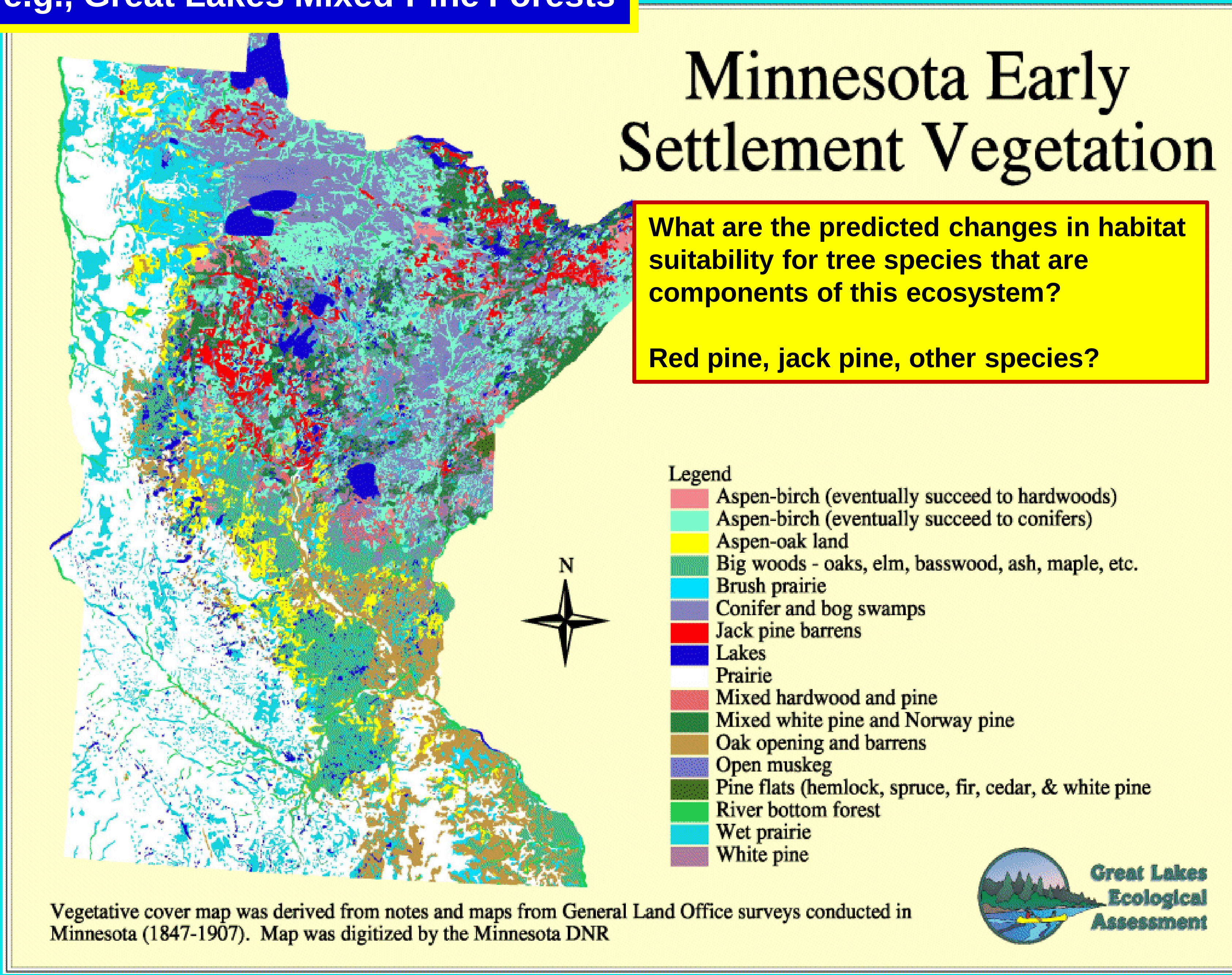
   -warmer temperatures; dryer growing season conditions

2. **Changing threats with changing climate**

   -dryer growing season conditions; greater plant stress; altered pest behavior; more storms

What does long-term silviculture research on EF's tells us about adaptation strategies, relative to these new considerations?

e.g., Great Lakes Mixed-Pine Forests



Vegetative cover map was derived from notes and maps from General Land Office surveys conducted in Minnesota (1847-1907). Map was digitized by the Minnesota DNR

What are the predicted changes in habitat suitability for tree species that are components of this ecosystem?

Red pine, jack pine, other species?

Great Lakes Pine Forest: *component* species

Source: NRS Tree Atlas

Declining: red pine, jack pine, trembling aspen, balsam fir, eastern white pine, paper birch, northern red oak,

Staying the same: bur oak

Increasing: red maple

Consideration of potential changes should be part of the discussion now--- but with uncertainty in mind!

Consideration: ***changing (but uncertain) habitat suitability***

How to incorporate this into silviculture

Silvicultural Strategy: Manage for complexity

Restore structure and composition by reducing disparities from reference conditions

Start with all the parts!

Silvicultural strategy: Restore structure and composition (complexity) by reducing disparities from reference conditions

Brian Palik &
Shawn Fraver
NFP Funding

e.g., Great Lakes Pine Forests

Managed: 62 year-old Growing Stock Experiment , Cutfoot EF, Chippewa NF

1. Mostly red pine
2. Even-aged (one cohort)
3. Narrow range of tree sizes
4. Higher stocking
5. Minimal dead wood
6. Dense understories

Reference: Sunken Lake Old Growth Cutfoot EF, Chippewa NF

1. Mixed-species
2. Uneven-aged (three cohorts)
3. Wide dia. range w/ large trees
4. Lower stocking
5. Large dead wood
6. Open/dense understories

Complex Forests:

-are more resistant to invasion
-store more carbon
-provide habitat variety
-have greater product diversity
-provide options with uncertainty

Additional considerations:

1. **Projected future habitat suitability of component species**

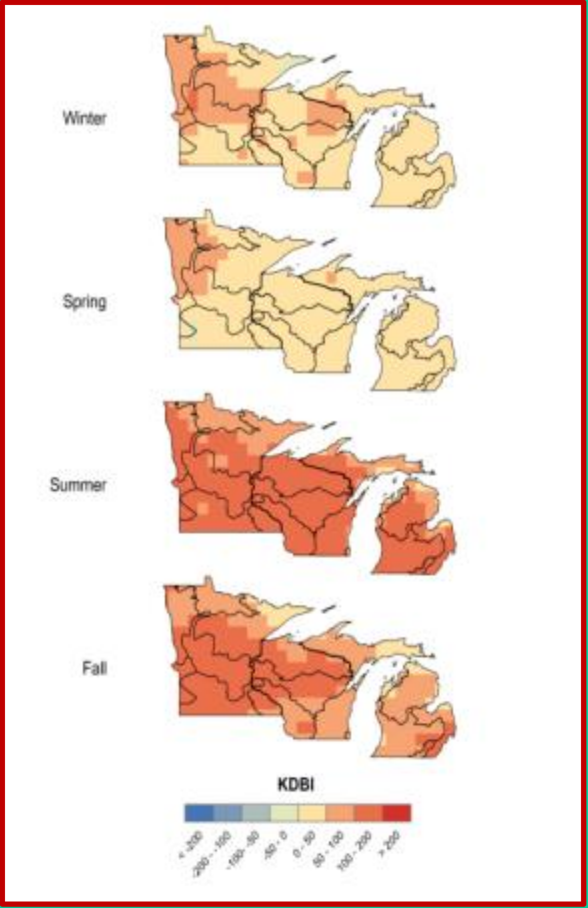
   -due to warmer conditions; dryer growing season conditions

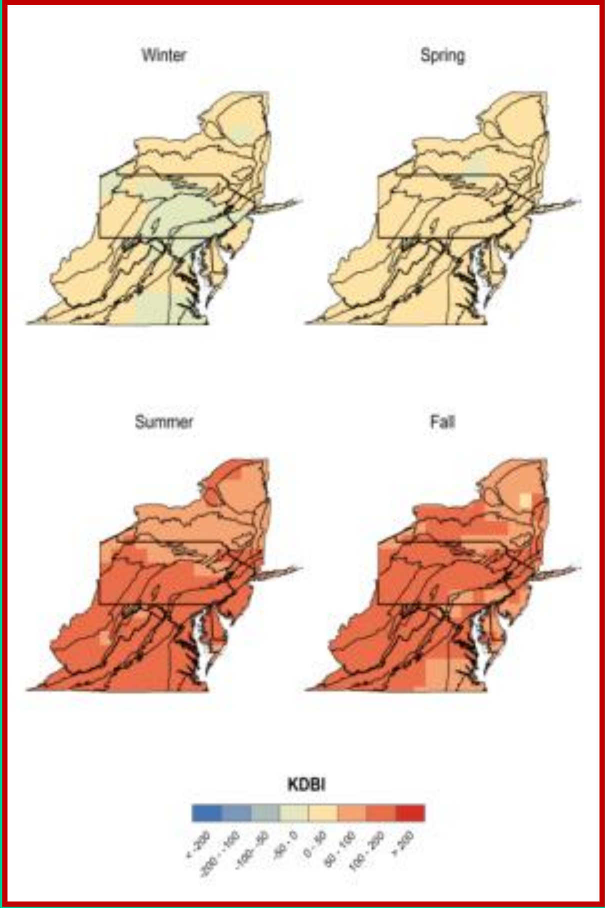
2. **Changing threats with changing climate** ★

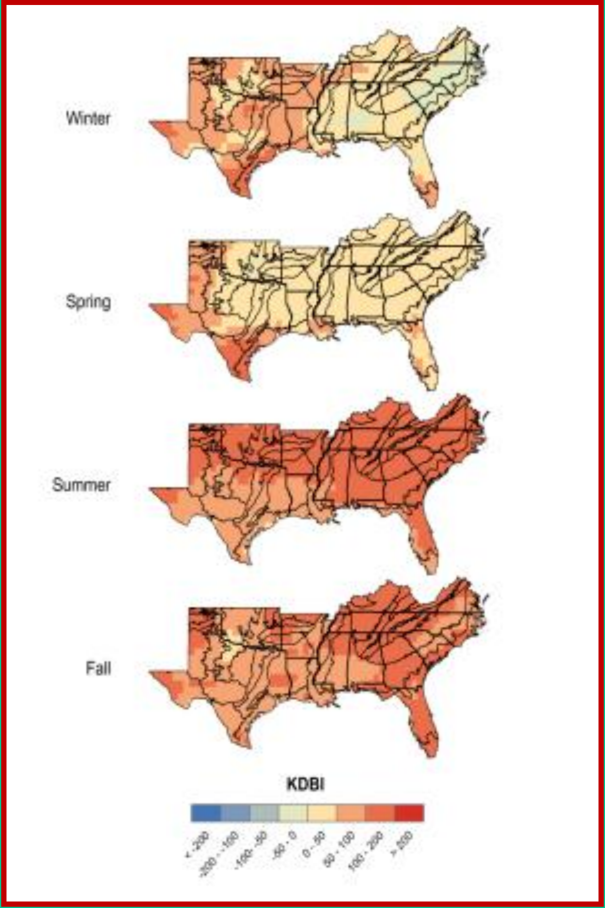
   -dryer growing season conditions; greater moisture stress; altered pest behavior; more storms, great fire risk

Changing threats: Increased plant stress

Source: 2013 National Climate Assessment (In prep)







Warmer temperatures; similar or reduced precipitation:

drier soils, greater moisture stress, decreased tree vigor

Consideration: *changing threats (moisture stress) with climate change*

Silvicultural strategy: stand-scale treatments to reduce tree stress

Life boating species at risk in the near to mid-term: ***to facilitate transition to new species***

1.How do *at-risk species* respond to temp., precip., drought?

- **-growth**
- **-mortality**
- **-establishment**

2. Can silvicultural treatments be used to alter the response?

The Need:

-A long-term record of growth, mortality, establishment

-A diversity of conditions (forest type,soil, etc.)

-Know history of treatments

USFS Experimental Forest Network (silviculture EF's particularly)!

Toward annual monitoring of climate change impacts on Experimental Forests

Funding: NRS Climate Change Program

Brian Palik NRS
Shawn Fraver NRS
John Brissette NRS
Tony D'Amato U of Minnesota
John Bradford USGS

Objectives:

-Establish a network of long-term monitoring plots on EF's

-Stratify within various silvicultural experiments, to examine adaptation potential

-Move towards *near-annual* measurement of key demographic variables

-Relate responses to climate fluctuation

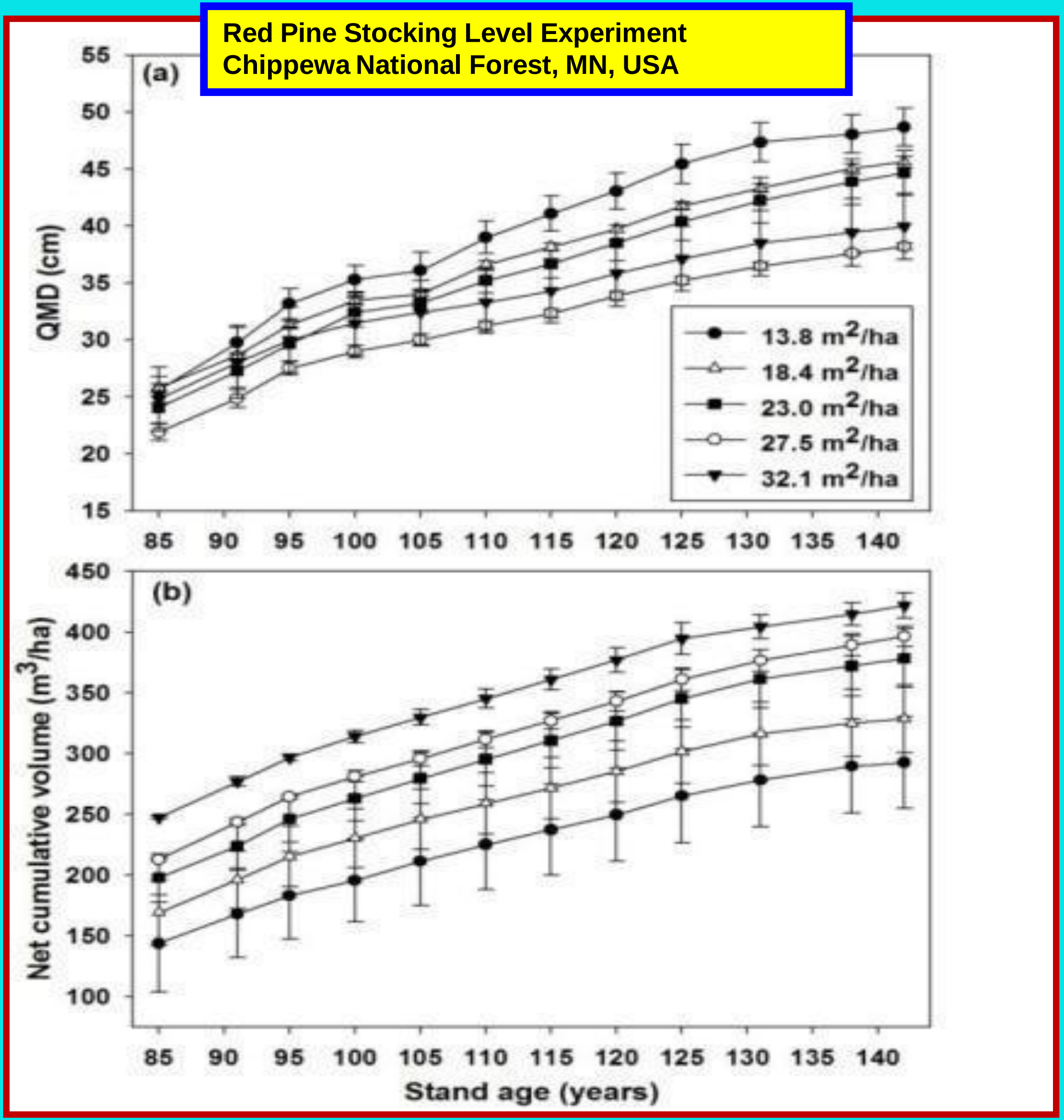
Future payoff

-Examine past response using long-term records and dendroecological methods
-in known silvicultural treatments

e.g., Density management as an adaptation approach

Density Management

Traditional use: influencing growth and yield



Density Management

But what about thinning to control moisture stress?

-Thinning increases resource availability, including soil moisture

-Improves tree vigor

-Greater pest resistance

-Maintain stands at optimal stocking to confer drought resistance and resilience

Quantifying drought response

1. Drought resistance: ability to experience drought without change in stand-level growth

$$\text{Resistance} = BAI_{\text{drought period}}/BAI_{\text{pre-drought}}$$

2. Drought resilience: ability to return to pre-drought levels of growth

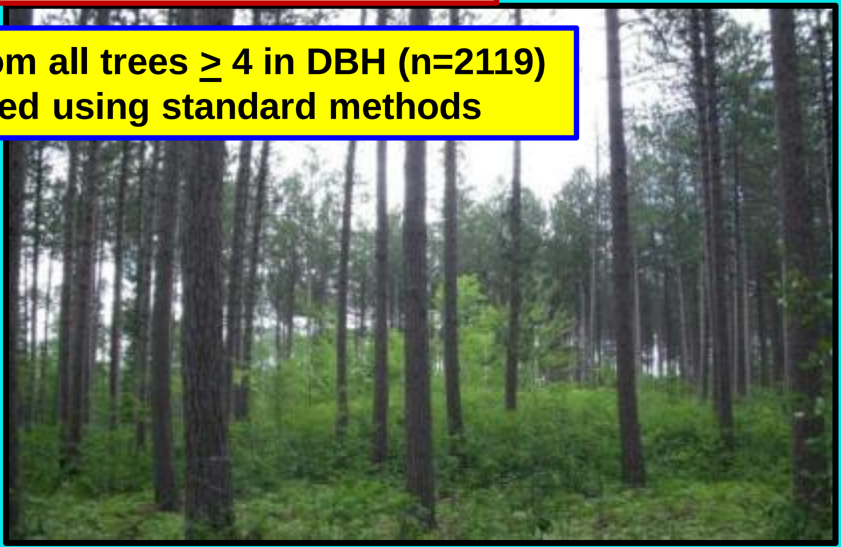
$$\text{Resilience} = BAI_{\text{post-drought}}/BAI_{\text{pre-drought}}$$

BAI=Basal area increment

Long-Term Red Pine Thinning Experiment (55 yrs)

Increment core samples collected from all trees ≥ 4 in DBH (n=2119)
Ring widths measured and cross-dated using standard methods

30 ft^2 ac^{-1}



60 ft^2 ac^{-1}

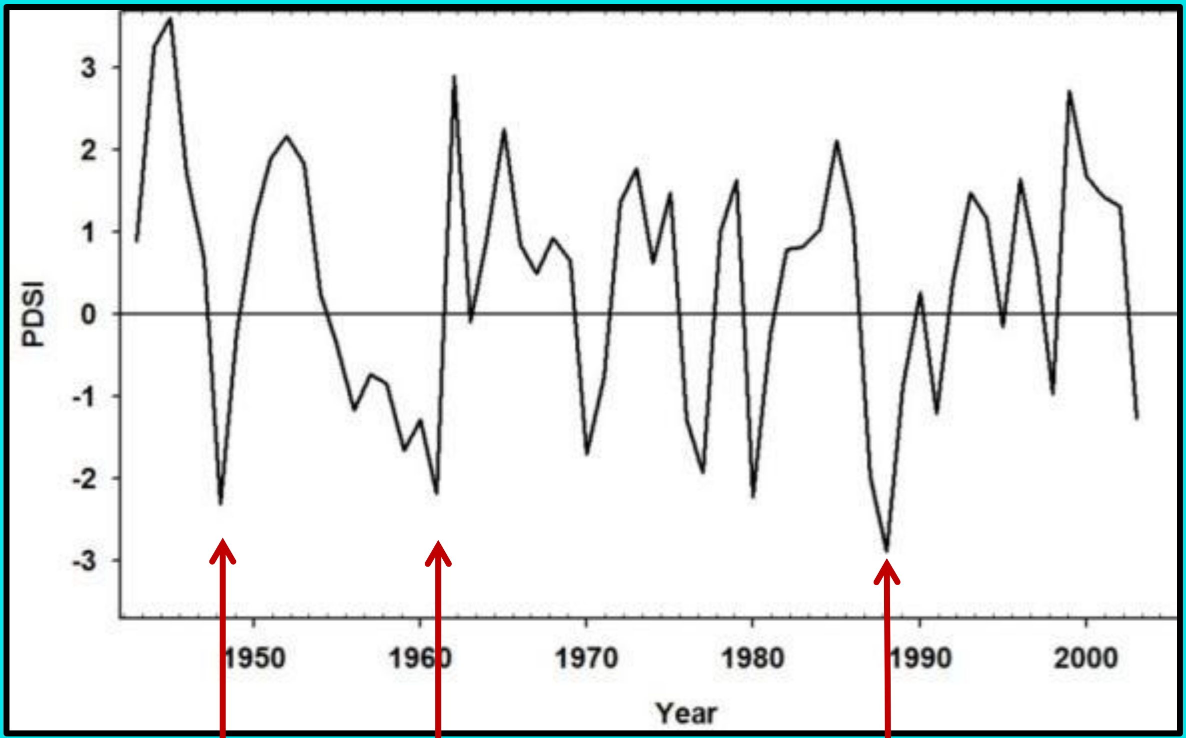
150 ft^2 ac^{-1}

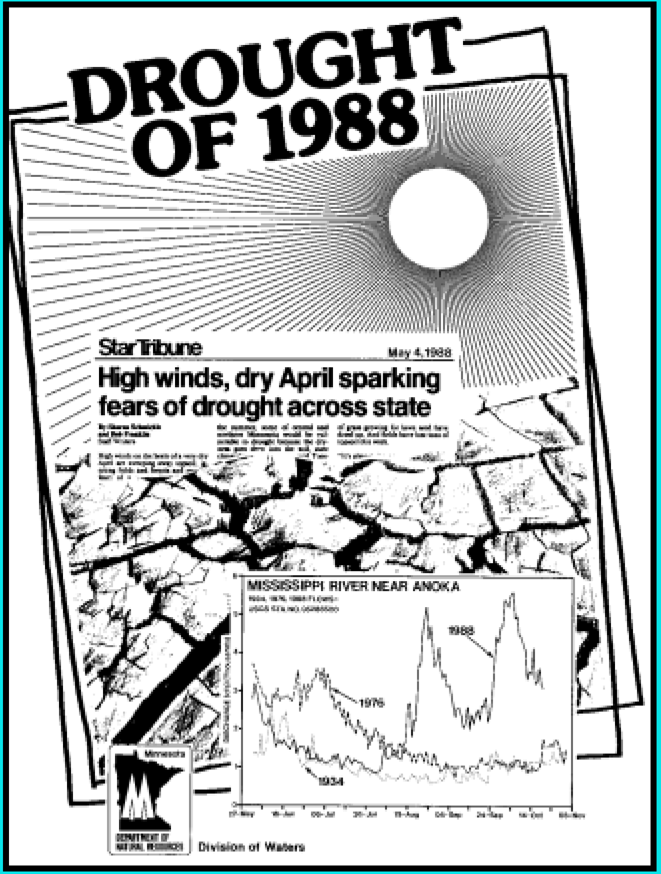
Control

Quantifying drought response

Examine known drought periods

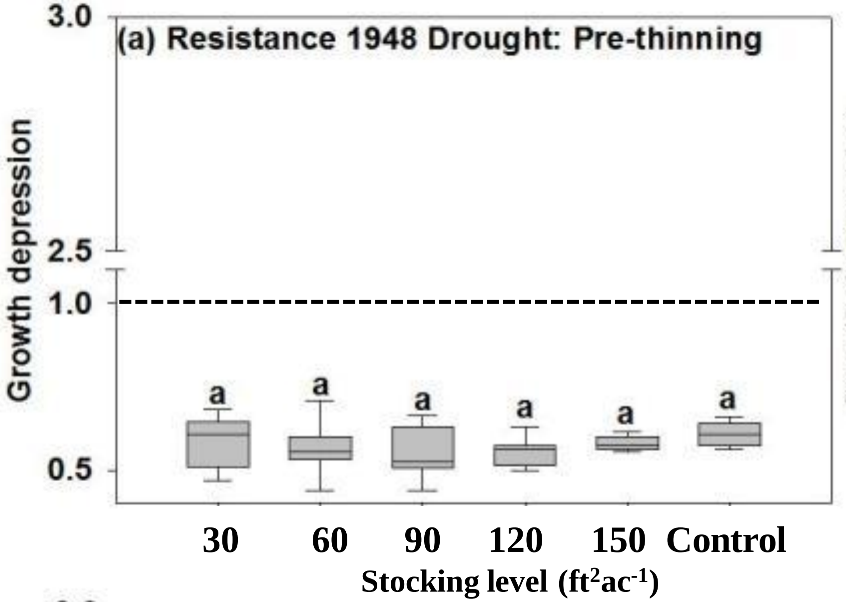
– 1948, 1961, 1988

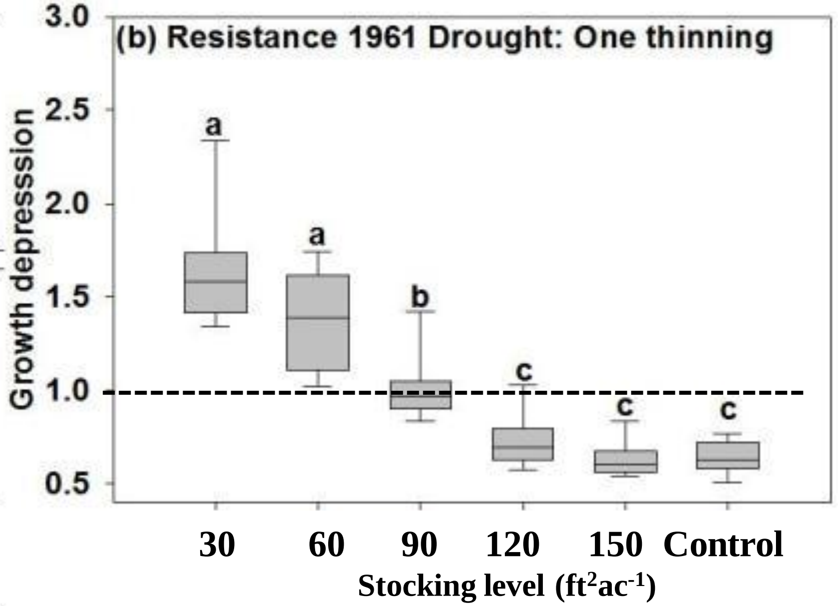


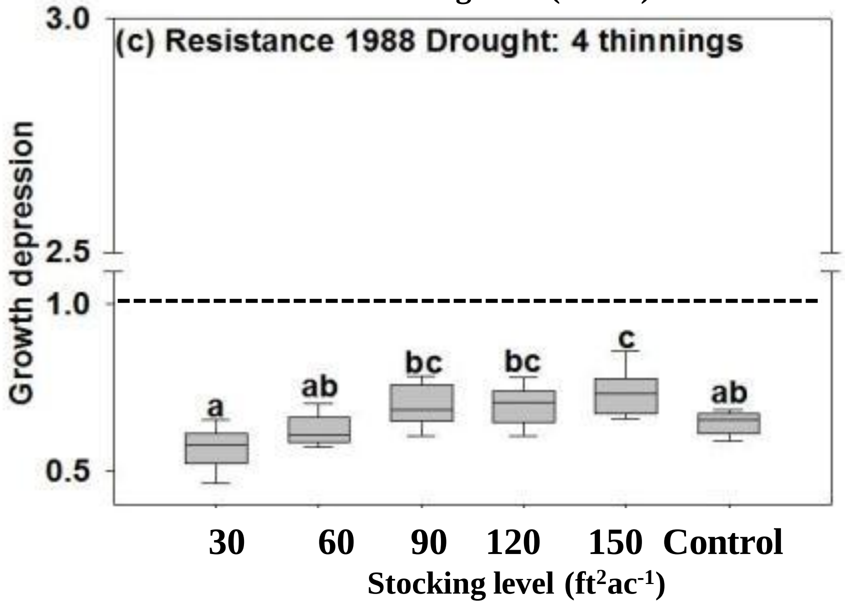


Drought Drought Drought

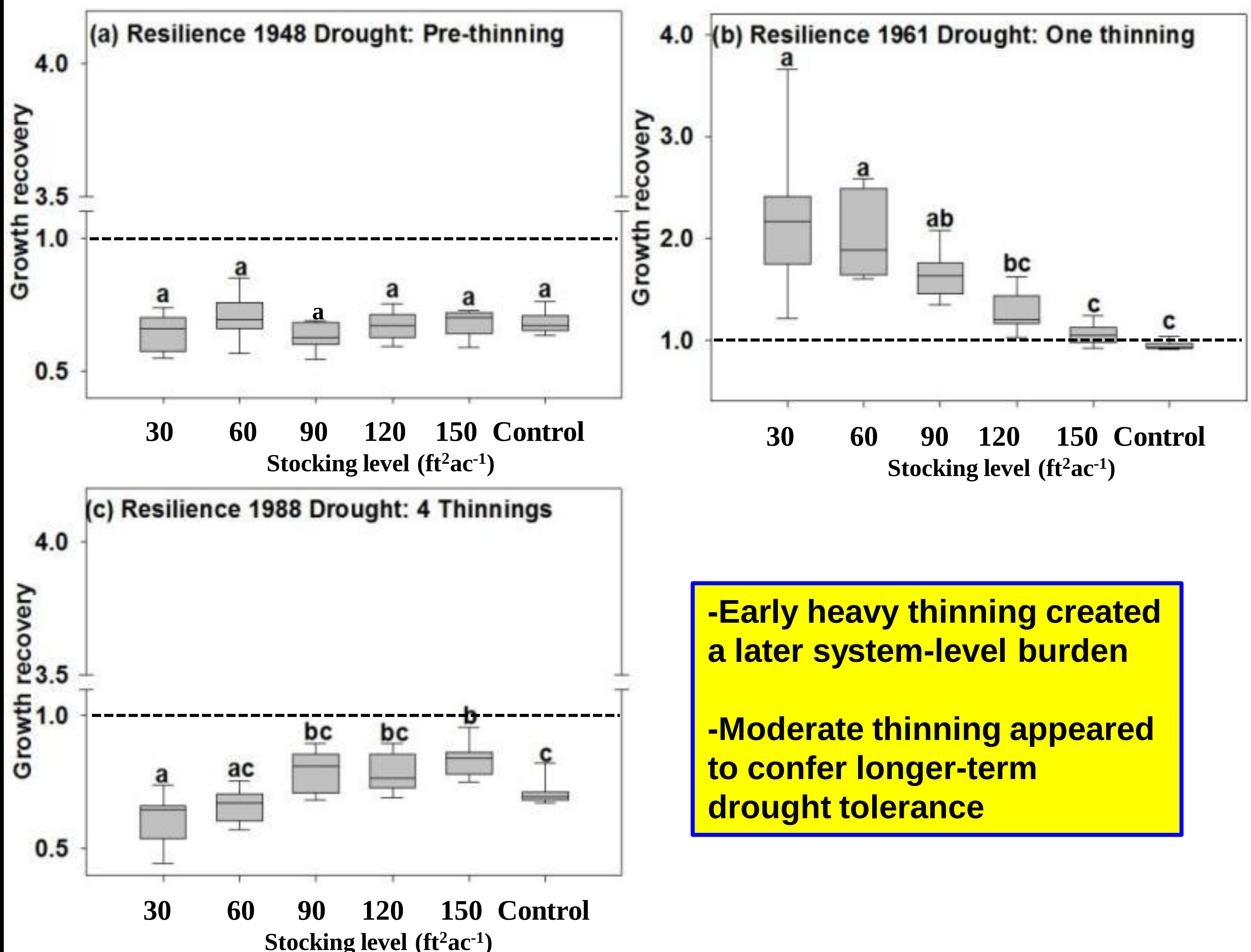
Drought response: resistance







Drought response: resilience



-Early heavy thinning created a later system-level burden

-Moderate thinning appeared to confer longer-term drought tolerance

Take Home Messages

The specifics of climate change are uncertain; managers must incorporate uncertainty into their planning

Start with the normal planning process (nothing new there) and add additional considerations specific to climate uncertainty: changing habitat suitability and changing threats (e.g., moisture stress)

A key to planning for uncertainty is to develop conditions that provide options: stands containing all native species and a diversity of age structures provide more options…..restoration of complex stands is the first line of defense

Potential exists to manage stands with silvicultural to reduce threats (e.g., soil moisture stress): life boating at-risk species in the near- to mid-term

FS-R & D, through long-term experiments on EF's, is the undisputed leader in efforts to develop adaptation strategies

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