ASCC
Adaptive Silviculture for Climate Change

Designing Forest Adaptation Treatments at the John Prince Research Forest Through Scientist-Manager Partnerships

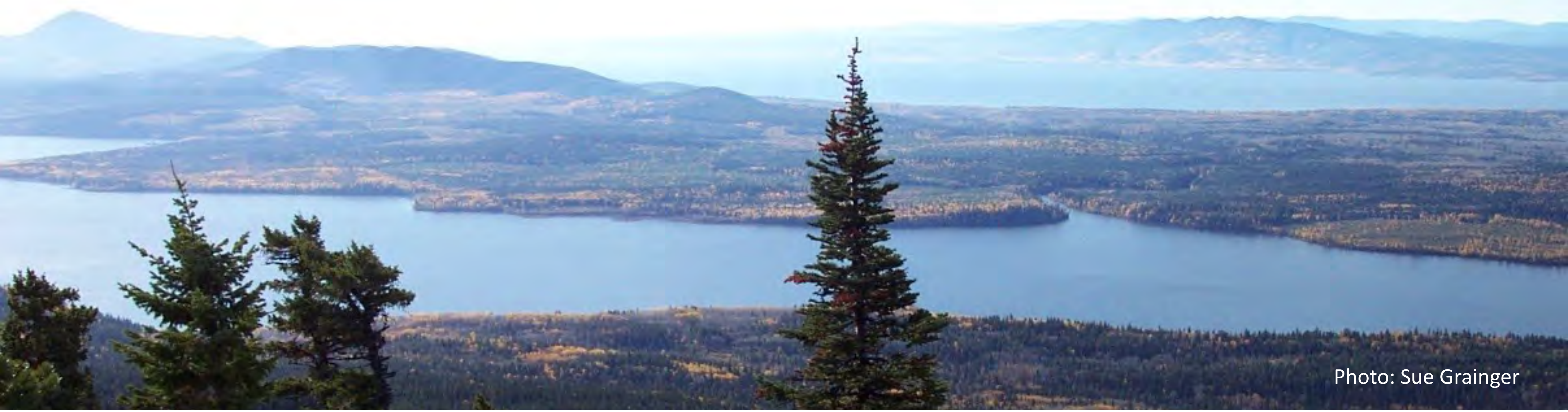


Photo: Sue Grainger

Adaptive Silviculture for Climate Change (ASCC)
at the John Prince Research Forest

June 9 & 10, 2021

John Prince Research Forest · UNBC · Tl'azt'en Nation
Natural Resources Canada / Ressources naturelles Canada
Canada
UNBC University of Northern British Columbia
ASCC Adaptive Silviculture for Climate Change
NAU Northern Arizona University
Forest and Rangeland Stewardship, Colorado State University
NIACS Northern Institute of Applied Climate Science

Welcome & Land Acknowledgement

Photo: Sue Grainger

Workshop Goals

- Introduce natural resource managers to conceptual tools and approaches that help integrate climate change into on-the-ground planning and decision-making processes;
- Use an adaptive planning process to design specific climate change adaptation experimental treatments for a set of sub-boreal spruce stands that will be part of a long-term study to be implemented across the John Prince Research Forest;
- Develop specific management, research, and monitoring questions that can be addressed through the ASCC project.

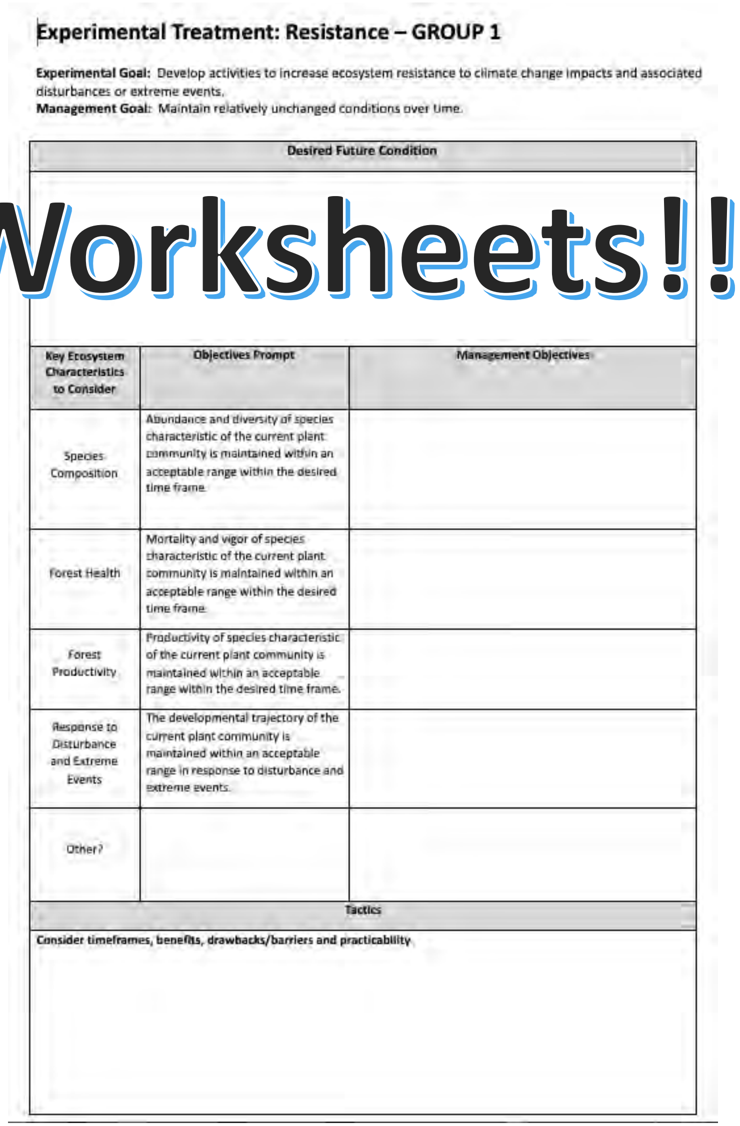
Photo: Sue Grainger

Workshop Agenda – June 9

- **8:00   Introductions, Recap of June 2, & Agenda Overview**
- **8:30   John Prince Research Forest Overview** – Sue Grainger (JPRF)
- **9:15   Discussion of Climate Change Impacts to the John Prince Research Forest**
- **9:45   Break**
- **10:00 Developing an ASCC Study Site at the John Prince Research Forest –** Linda Nagel (CSU)
- **10:30 – 4:00 Develop ASCC study treatments at the John Prince Research Forest – Work Time!**

(We will take a 40-min break for lunch from 11:30 am -12:10pm)

Worksheets!!!


Experimental Treatment: Resistance – GROUP 1

Experimental Goal: Develop activities to increase ecosystem resistance to climate change impacts and associated disturbances or extreme events.
Management Goal: Maintain relatively unchanged conditions over time.

Desired Future Condition

Key Ecosystem Characteristics to Consider	Objectives Prompt	Management Objectives
Species Composition	Abundance and diversity of species characteristic of the current plant community is maintained within an acceptable range within the desired time frame.	
Forest Health	Mortality and vigor of species characteristic of the current plant community is maintained within an acceptable range within the desired time frame.	
Forest Productivity	Productivity of species characteristic of the current plant community is maintained within an acceptable range within the desired time frame.	
Response to Disturbance and Extreme Events	The developmental trajectory of the current plant community is maintained within an acceptable range in response to disturbance and extreme events.	
Other?		

Tactics

Consider timeframes, benefits, drawbacks/barriers and practicability

Workshop Agenda – June 10

- **9:00 Recap of previous two days**
- **9:15 Review draft silvicultural treatments**
- **10:30 Break**
- **10:45 Next Steps, Evaluations, & Close-Out**
  - What research or management questions are you excited to ask based on the ASCC treatments?
- **11:30 Large Group Adjourn**
- **11:30am – 1:00pm (*ASCC Site Leads*)**
  - Identify key implementation and monitoring next steps

Community Guidelines

- Focus on what matters
- Contribute your thinking and experience
- Listen to understand
- Connect ideas
- Listen together for patterns, insights and deeper questions
- Honor everyone’s time
- Be present - mentally and physically
- Equal airtime - all participate, no one dominate

Virtual Workshop Expectations

- Please mute if not speaking
- Add name and organization to Zoom info and pronouns if desired
- If you need to turn off video, that is fine, please participate
- Speak up, Raise hand and use chat functions
- In small groups, create and maintain expectations

Introductions

Alicia Azpeleta-Tarancon	Jason Gordon	Linda Nagel
Jodi Axelson	Sue Grainger	Liam Parfitt
Ken Byrne	Hardy Griesbauer	Alex Pierre
Elizabeth Campbell	Sybille Haeussler	Courtney Peterson
Colin Chisholm	Dexter Hodder	Bruce Rogers
Shannon Crowley	Miriam Isaac-Renton	Paul Sewell
Pamela Dykstra	John Leidl/Johnny Tom	Phil Smith
Jason Edwards	Marie Lou Lefrancois	Keith Taite
Ché Elkin	Colin Mahony	Mihai Voicu
Vanessa Foord	Renel Mitchell	Kristen Waring
Erin Fraser-Reid	Brett Musa	Alex Woods

<u>Ice breaker activity</u>:
Your name, organization, and one highlight from June 2.

John Prince Research Forest Overview

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Sue Grainger

Principles to Guide Management of the JPRF:

- Support natural ecological conditions and cycles,
- Maintain biodiversity,
- Protect the productive capacity of the land-base and all resources,
- Ensure activities aim at protecting, restoring and maintaining existing productive capacity of all resources,
- Ensure that the level of resource extraction is secondary to the objectives for the sustainability of the natural resources,
- Manage for multiple uses, provide recreational opportunities,
- Achieve long-term sustainable yields from the natural resources.

Government Defined Goals & Objectives:

Resource	Objective (Non-timber values - without unduly reducing the supply of timber from British Columbia's forests)
Timber	• Maintain or enhance an economically valuable supply of commercial timber from British Columbia's forests, and ensure that delivered wood costs are competitive
Wildlife	• Conserve sufficient wildlife habitat and retain wildlife trees
Riparian Ecosystems	• Conserve, at the landscape level, the water quality, fish habitat, wildlife habitat and biodiversity associated with those riparian areas
Resilience to Disturbance	• Create ecosystem resilience to forest disturbances (i.e. wildfire, drought, insects and diseases, forest pests, etc.)
Soils	• Conserve the productivity and hydrologic function of soils
Fish & Riparian Values	• Prevent the cumulative hydrological effects of primary forest activities in the fisheries sensitive watershed from resulting in a material adverse impact on the habitat of the fish species
Community Watershed	• Prevent the cumulative hydrological effects of primary forest activities within the community watershed from resulting in: ○ (a) a material adverse impact on the quantity of water or the timing of the flow of the water to the waterworks, or ○ (b) the water from the waterworks having a material adverse impact on human health that cannot be addressed by water treatment
Biodiversity Landscape	• Design areas on which timber harvesting is to be carried out that resemble, both spatially and temporally, the patterns of natural disturbance that occur within the landscape
Cultural Heritage	• Conserve, or, if necessary, protect cultural heritage resources that are the focus of a traditional use by an aboriginal people that is of continuing importance to that people
Plant Communities	• Conserve forage and associated plant communities

Climate Change Impacts Brainstorming on June 2

"Since we clearcut and plant pine and spruce it would appear as if the practices on the ground are not reflecting actions. Need to leave more retention when harvesting and plant more species."

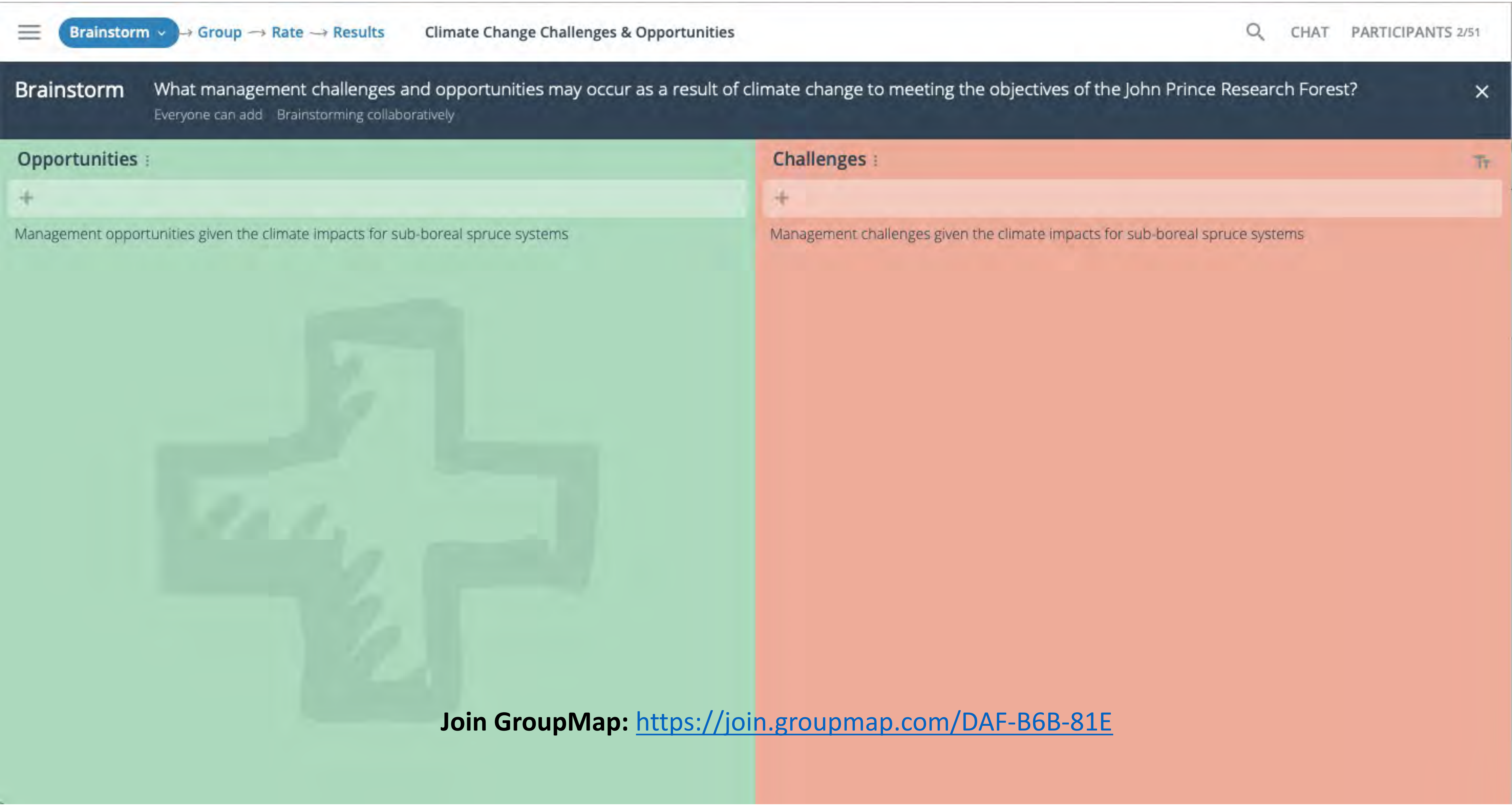
- Diversifying harvest practices
- Diversifying regeneration plantings
- Novel insect and pathogen issues coupled with different species
- Complex interactions (e.g. more 'open' forests might be good for tree vigor, and appear to reduce fuel loading, but wind can increase through these stands, exacerbating fire severity)
- Weather extremes drive disturbances
- How are threatened species like caribou going to be impacted?
- Incorporation of traditional ecological knowledge
- Monitoring
- Considerations at landscape level vs. site conditions

Activity: EVALUATE management objectives given projected impacts and vulnerabilities

Challenges to Meeting Management Objective with Climate Change: Things that will make it harder to achieve the management objective due to climate change.

Opportunities to Meeting Management Objective with Climate Change: Things that will make it easier to achieve the management objective due to climate change.

***Focus on challenges within control of your management (not global markets, policies, etc.)*



Join GroupMap: https://join.groupmap.com/DAF-B6B-81E

Adaptive Silviculture for Climate Change (ASCC) Network

ASCC
Adaptive Silviculture for Climate Change

Project Goals:

1) Introduce managers to tools and approaches to integrate climate change into silvicultural decision making that meets management goals and objectives
2) Co-develop robust, operational examples of how to integrate climate change adaptation into silvicultural planning and on-the-ground actions to foster resilience to the impacts of climate change and enable adaptation to uncertain futures

ASCC is testing a spectrum of adaptation options

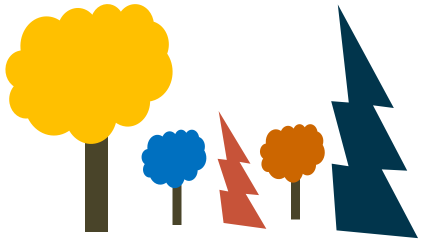
RESISTANCE

- Improve defenses of forest against change and disturbance
- Maintain relatively unchanged conditions

RESILIENCE

- Accommodate some degree of change
- Return to prior reference condition following disturbance

TRANSITION

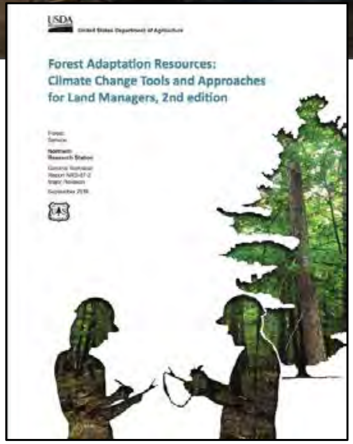


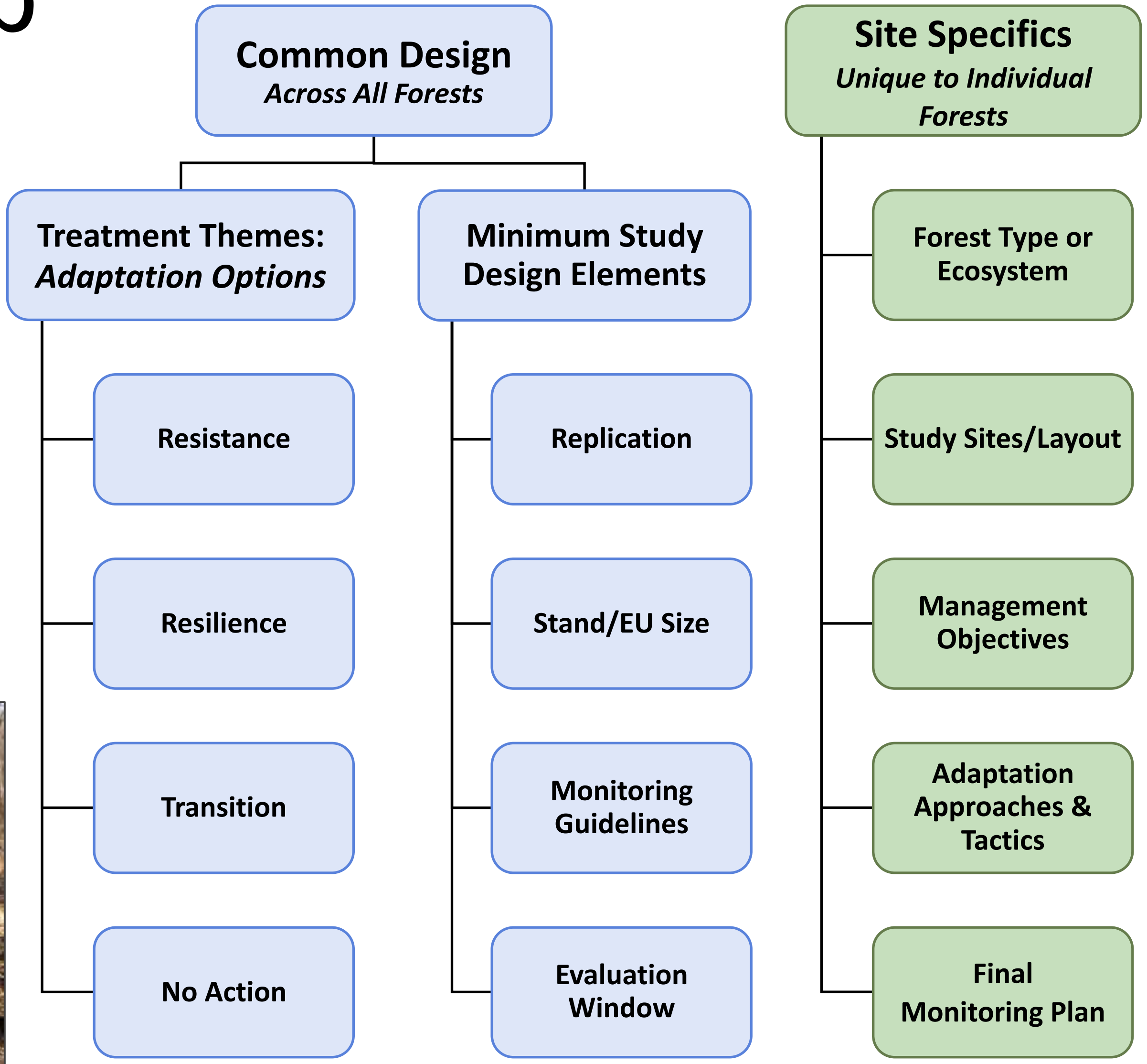
- Intentionally facilitate change
- Enable ecosystem to respond to changing and new conditions

Reduce impacts/maintain current conditions ⟷ **Forward-looking/promote change**

Millar et al. 2007, Swanston et al. 2016, Nagel et al. 2017

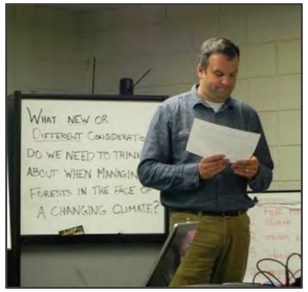
ASCC Study Design and Collaborative Workshop





Collaborative Workshop

Developing the Experimental Treatments



First workshop: MN, June 2013

Most recent workshop: CO, Dec 2020

For each experimental treatment (Resistance, Resilience, Transition):

DFC → **Management objectives** → **Silvicultural practices (tactics)**

DFC: **What is the desired structure and function (*desired future condition*)?**

Keep in mind key variables/outcomes:
- **Species composition**
- **Forest health**
- **Forest productivity**
- **Response to disturbance**

For each silvicultural practice (tactic):
- **Timeframes**
- **Benefits**
- **Drawbacks and Barriers**
- **Practicality**

Experimental Treatment Definitions

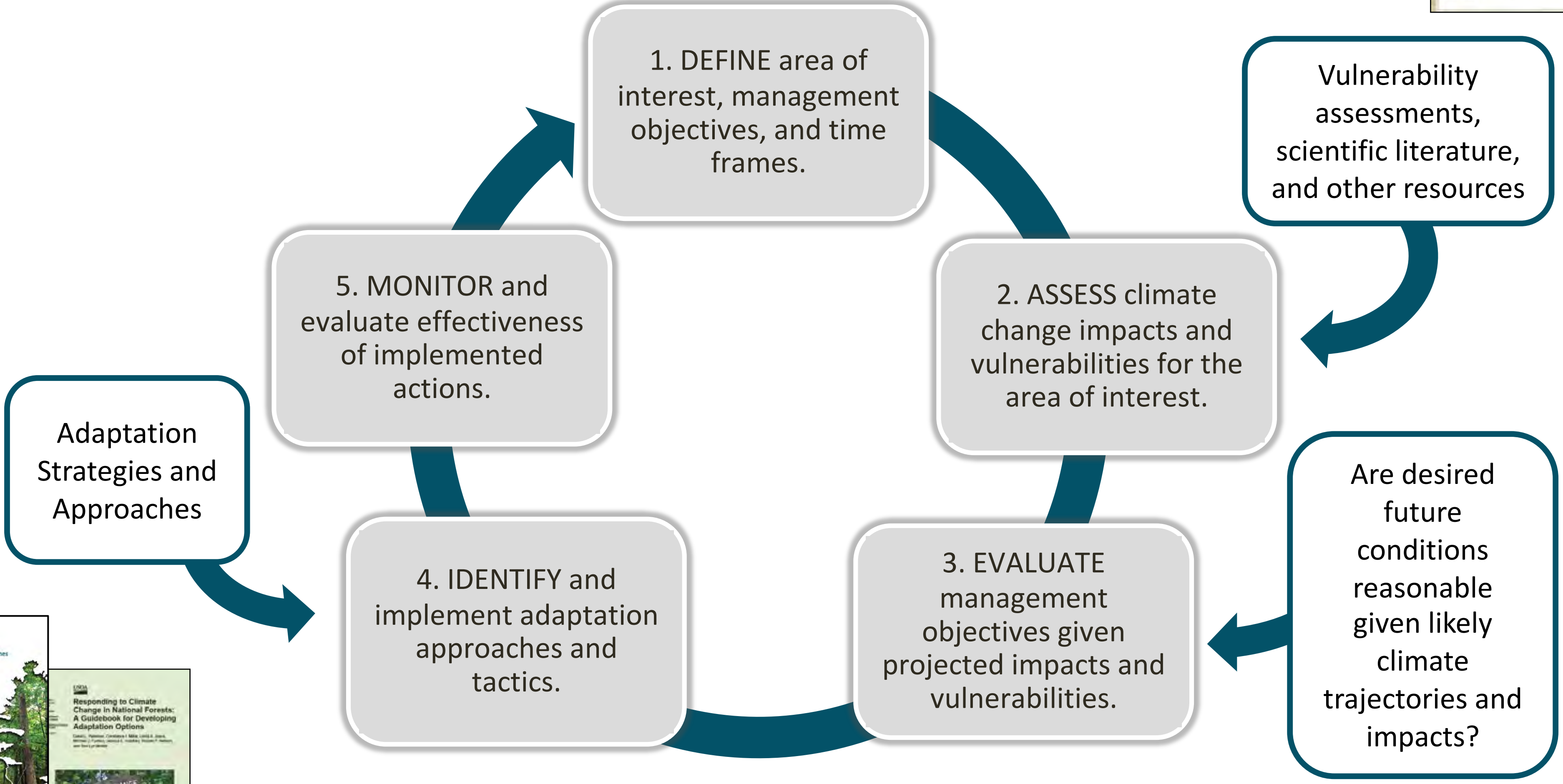
Treatment Name	**Experimental Treatment Definition**
RESISTANCE	Actions that improve the defenses of the forest against anticipated change or directly defend the forest against disturbance in order to maintain relatively unchanged conditions.
RESILIENCE	Actions that accommodate some degree of change, but encourage a return to a prior condition or desired reference conditions following disturbance.
TRANSITION	Actions that intentionally accommodate change and enable ecosystems to adaptively respond to changing and new conditions.
NO ACTION	Since climate change impacts all forests globally, we cannot maintain a true "control". With this in mind, we consider an approach in which forests are allowed to respond to climate change in the absence of direct silvicultural intervention as an appropriate baseline for many questions.

Experimental Treatment Goals

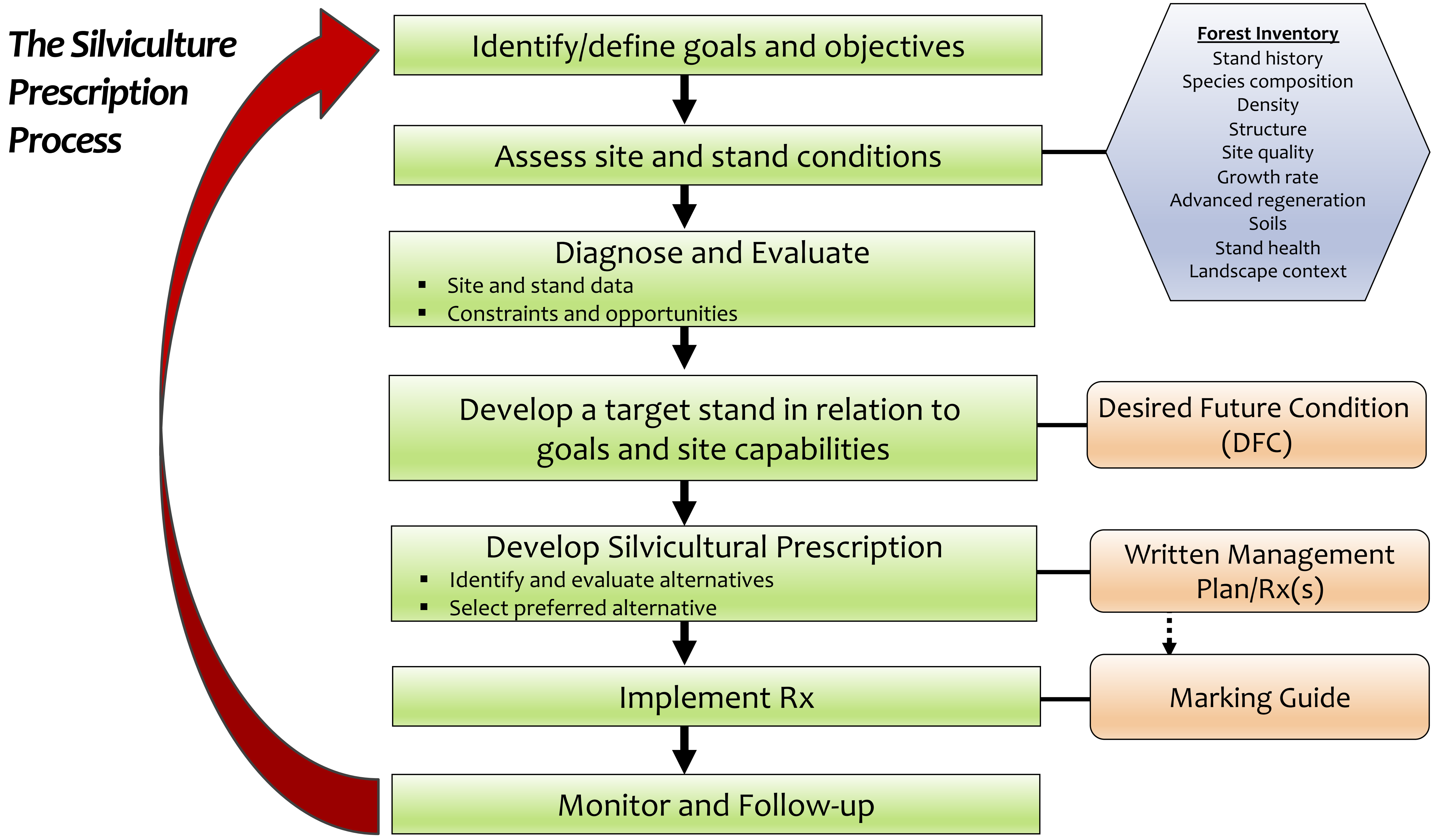
Treatment Name	**Experimental Treatment Goals**
RESISTANCE	Maintain relatively unchanged conditions over time
RESILIENCE	Allow some change in current conditions, but encourage an eventual return to reference conditions
TRANSITION	Actively facilitate change to encourage adaptive responses
NO ACTION	Allow forests to respond to climate change without direct management intervention

Identifying Adaptation Tactics

Forest Adaptation Resources: Climate Change Tools & Approaches for Land Managers



Swanston et al. 2016 https://www.nrs.fs.fed.us/pubs/52760; Janowiak et al. 2014


The Silviculture Prescription Process
Identify/define goals and objectives
Assess site and stand conditions
Forest Inventory
Stand history
Species composition
Density
Structure
Site quality
Growth rate
Advanced regeneration
Soils
Stand health
Landscape context
Diagnose and Evaluate
Site and stand data
Constraints and opportunities
Develop a target stand in relation to goals and site capabilities
Desired Future Condition (DFC)
Develop Silvicultural Prescription
Identify and evaluate alternatives
Select preferred alternative
Written Management Plan/Rx(s)
Implement Rx
Marking Guide
Monitor and Follow-up

Key Definitions (SAF Dictionary of Forestry, 2018)

- **Goal** = A broad, general statement, usually not quantifiable, that describes the desired outcomes of each adaptation treatment (*resistance, resilience, transition, no action*).
  - *note* – normally, a management ***goal*** is stated in terms of purpose, often not attainable in the short term, and provides the context for more specific ***objectives***
- **Objective** = A concise, time-specific statement of measurable planned results that correspond to pre-established ***goals*** in achieving a desired outcome
  - *note* – an ***objective*** commonly includes information on resources to be used, forms the basis for further planning to define the precise steps to be taken and the resources to be used and assigned responsibly in achieving the identified ***goals***

Key Definitions (SAF Dictionary of Forestry, 2018)

- **Desired Future Condition (DFC)** = a description of the land or resource conditions that are believed necessary to fully meet the ***goals*** and ***objectives*** of each adaptation treatment
- **Prescription** = a set of management ***practices*** and intensities scheduled for application on a specific area to satisfy ***multiple uses*** or other ***goals*** and ***objectives***
- **Practice** = a specific activity, measure, course of action, or treatment undertaken on a forest ownership
- **Practice** = **Tactic**

Goals vs. Objectives

Goals

- The “what”
- General
- Intangible
- Broad
- Abstract
- Strategic

- Example:

Objectives

- The “how”
- Specific
- Measurable
- Narrow
- Concrete
- Tactical

- Example:

Goals vs. Objectives

Goals

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- Example: Manage for resilient forests

Objectives

- The "how"
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- Narrow
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- Tactical

- Example:

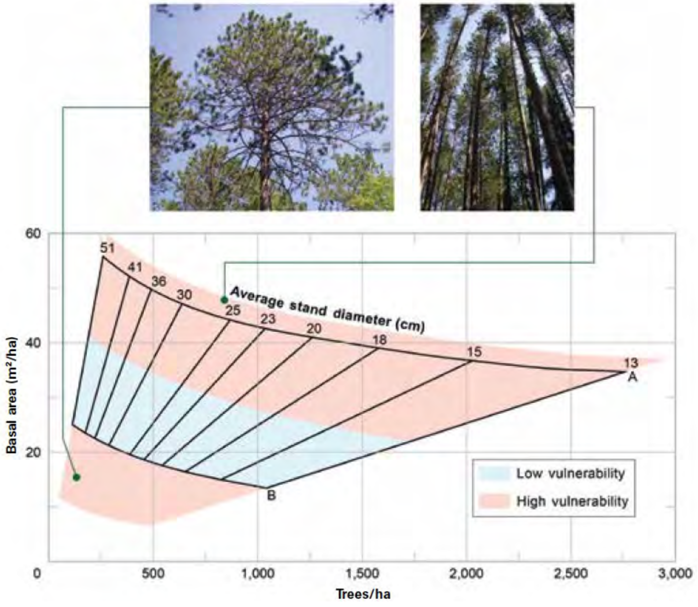
Goals vs. Objectives

Goals

- The "what"
- General
- Intangible
- Broad
- Abstract
- Strategic

- Example: Manage for resilient forests

Objectives



- The "how"
- Specific
- Measurable
- Narrow
- Concrete
- Tactical

- Example: Reduce stand density to reduce competition and drought stress

Developing the Experimental Treatments

For each experimental treatment (Resistance, Resilience, Transition):

DFC

↓

Management objectives

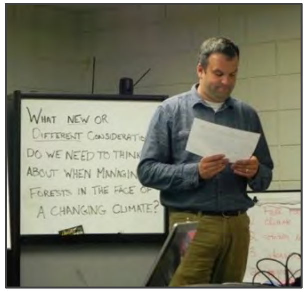
↓

Silvicultural practices (tactics)

What do you want the stand to be and look like?

Keep in mind key variables/outcomes:
- **Species composition**
- **Forest health**
- **Forest productivity**
- **Response to disturbance**

For each silvicultural practice (tactic):
- **Timeframes**
- **Benefits**
- **Drawbacks and Barriers**
- **Practicality**
- **Recommend tactic?**

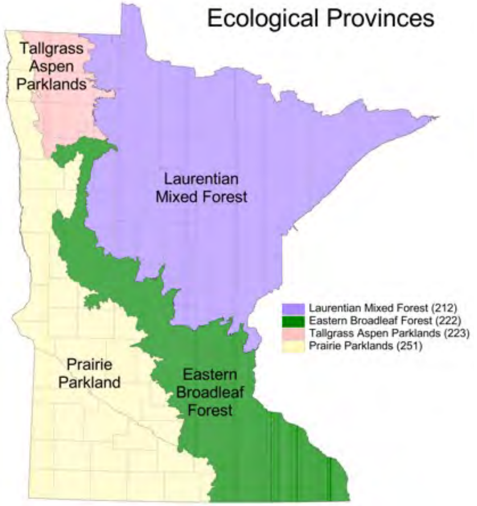


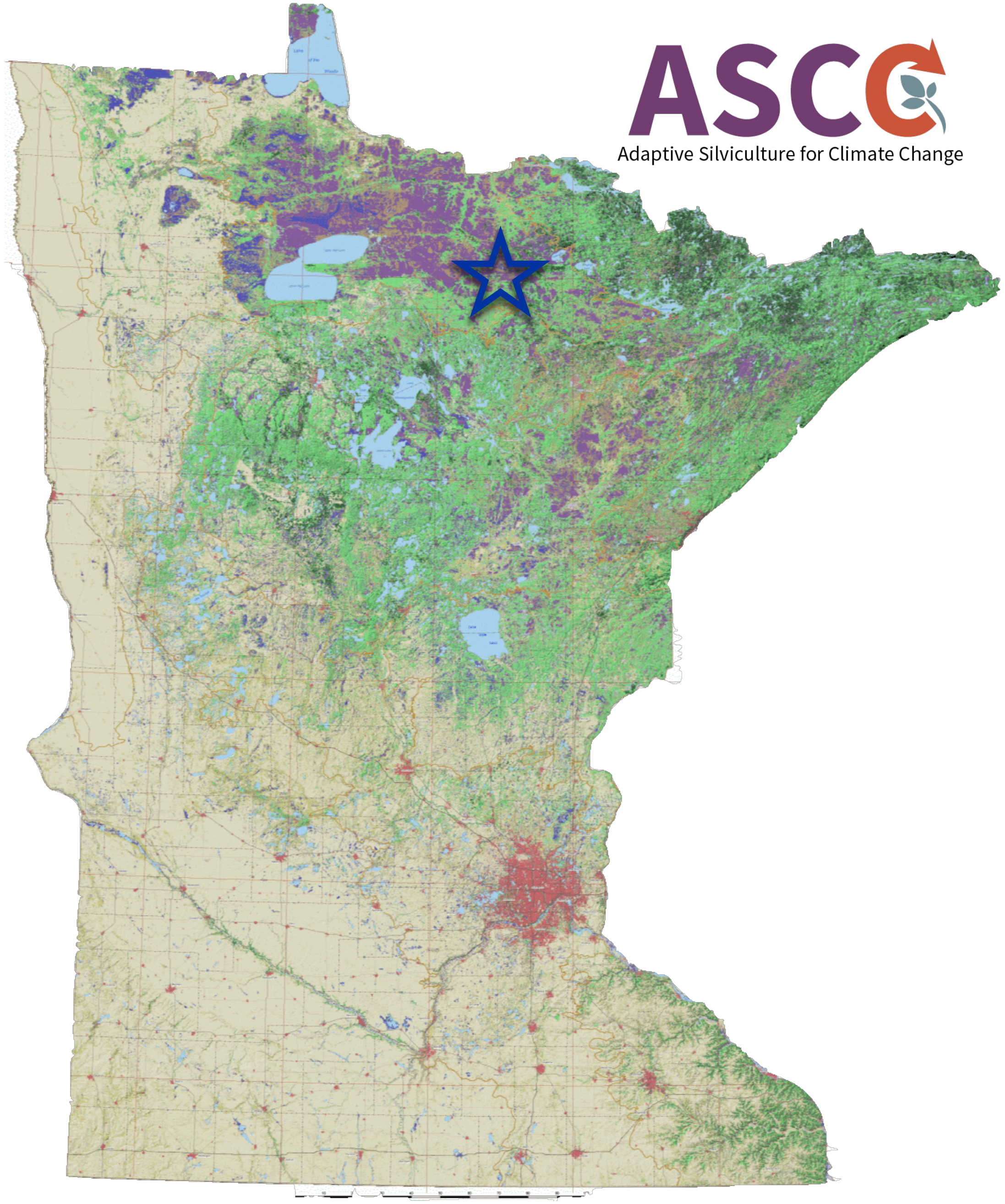
First workshop: MN, June 2013

Most recent workshop: CO, Dec 2020

Cutfoot Experimental Forest

- Chippewa National Forest, MN
- Workshop: June 25-27, 2013
- First ASCC site implemented





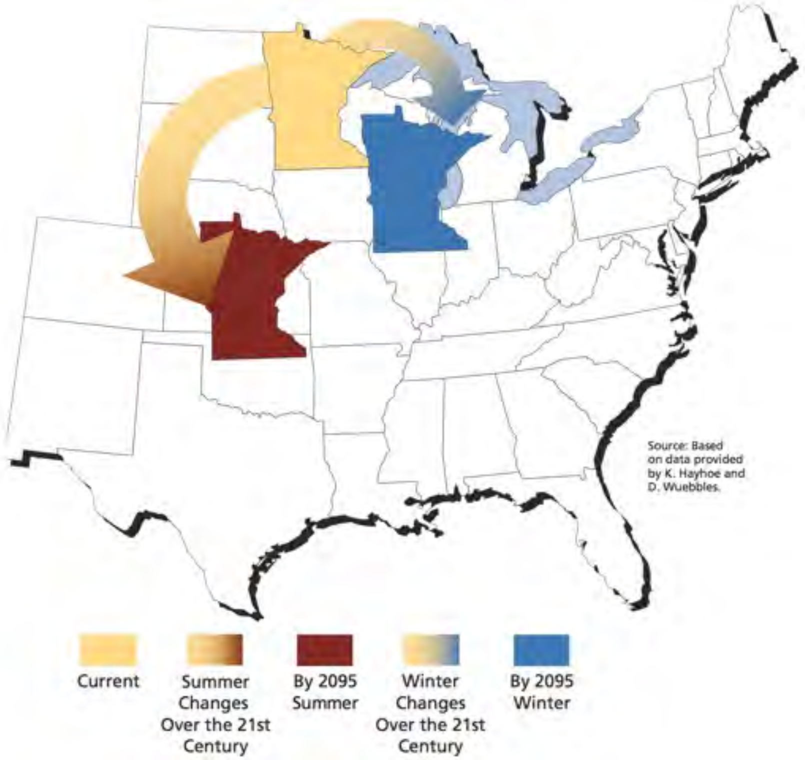
ASCC
Adaptive Silviculture for Climate Change

Cutfoot Experimental Forest, MN

- FDn33: Northern Dry-Mesic Mixed Woodland
  - Fire dependent, mixed-species, dry woodland
  - Overstory: red pine dominated mixed with white and jack pine
  - Minor species: paper birch, northern red oak, red maple, white spruce, and aspen
- Dense understory of *Corylus* (hazel)
- Average basal area 41 m^2/ha (180 ft^2/ac) (*over-stocked*)
- Fire-origin 1918; fire exclusion since
- Largely single cohort
- Current condition: vulnerable to environmental and climatic changes and associated forest health issues

Climate Change Impacts

- Increased severity and frequency of drought during growing season
- Warmer, wetter winters
- Reduced habitat suitability for most northern tree species
- Increased threat from new pests (e.g., mountain pine beetle)

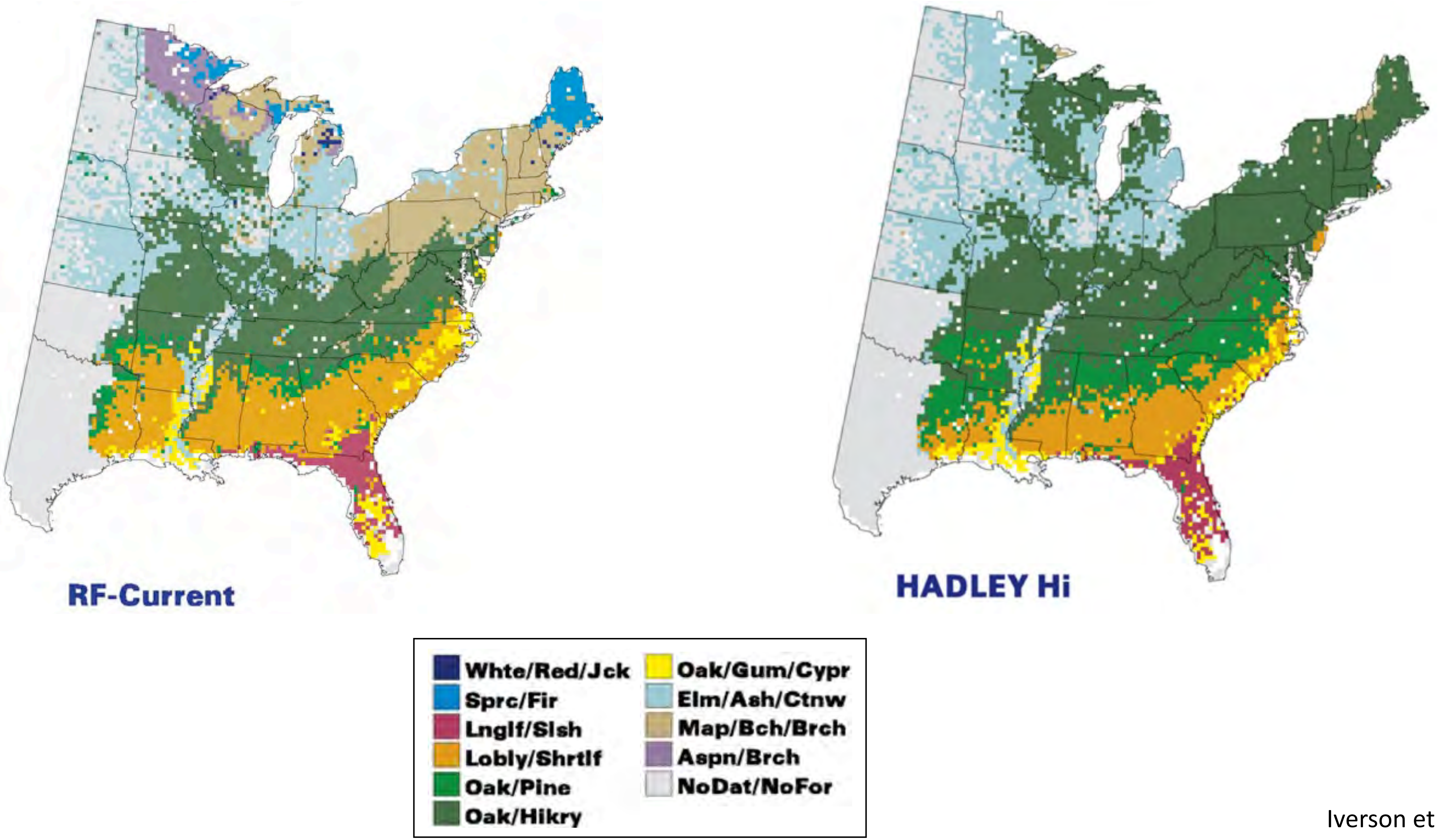


http://www.ucsusa.org/greatlakes/glchallengereport.html

Cutfoot Experimental Forest, MN

Tree Atlas

Climate-induced changes in biophysical conditions will likely lead to shifts in species range distributions

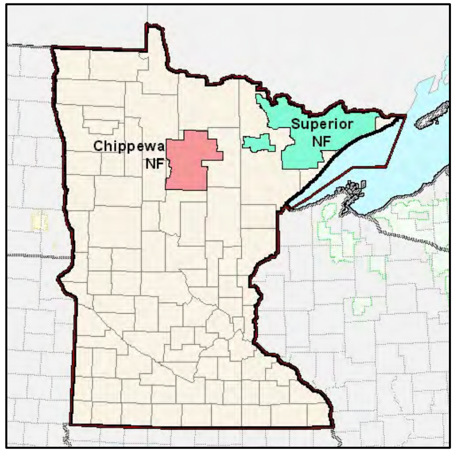


Iverson et al. 2008; http://www.fs.fed.us/nrs/atlas

Cutfoot Experimental Forest, MN

Species Predictions

Chippewa NF – Tree Atlas (change in IV)



Reduced Habitat Suitability

Species	Current	HadHiDif
Quaking aspen	21.80	-17.41
Balsam fir	7.24	-7.24
Black spruce	5.34	-5.27
Paper birch	6.65	-5.22
Jack pine	**3.36**	**-1.46**
Bigtooth aspen	1.44	-0.93
White spruce	1.19	-0.73
Red pine*	2.35	-0.70
Northern red oak	**2.44**	**-0.26**

**Potential for increasing issues with native pine beetles and root diseases affecting red pine*

Increased Habitat Suitability

Species	Current	HadHiDif
Bur oak	**2.95**	**2.67**
Green ash	2.06	2.31
Red maple	**2.57**	**1.91**
Eastern white pine	**1.03**	**0.22**
White oak	**0.00**	**2.30**
Black cherry*	**0.30**	**1.60**
Bitternut hickory*	**0.00**	**0.75**

**Choices tempered by "Suitability of Tree Species by Native Plant Community (NPC)", MN DNR*

Cutfoot Experimental Forest, MN

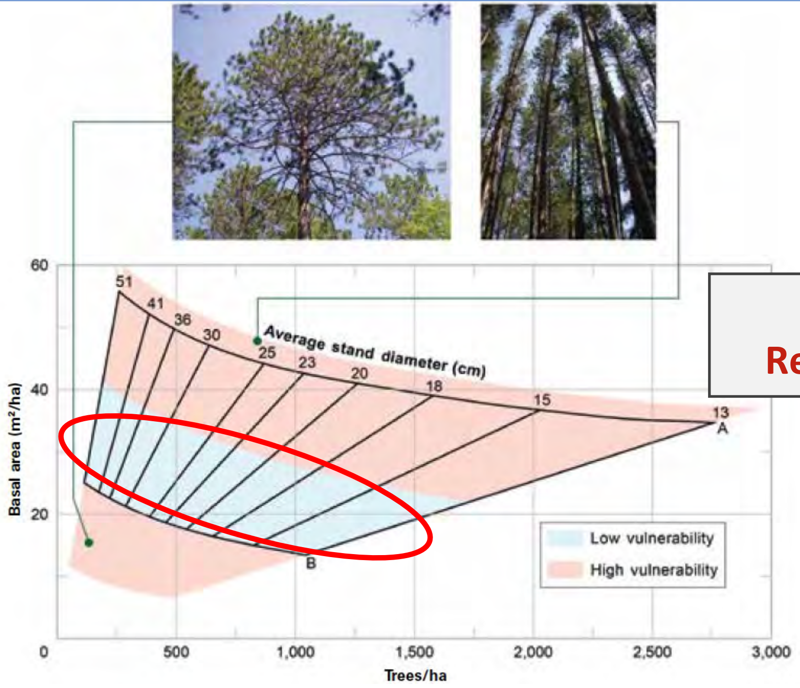
RESISTANCE maintain relatively unchanged conditions

DFC/Goal

- Homogeneous, RP dominated (90% BA)
- Single cohort
- Reduced stocking closer to historic

Tactics

- Free thin to 100-120 ft^2/ac
- Remove RP and JP to maintain diversity
- Reserve large-diameter trees



Vose et al. 2016

Reduced Stocking = Reduced Moisture Stress ?

Cutfoot Experimental Forest, MN

RESILIENCE allow some change, eventual return to reference

DFC/Goal

- RP dominated (50-75% BA)
- Increase heterogeneity and complexity
- Increase future-adapted ***native*** species

Tactics

- Variable density thinning (skips & gaps)
  - 20% unthinned in ½ ac skips
  - 20% in ½ ac gaps, retain large diameter
  - Disperse thin matrix to 100-120 ft^2/ac
- Plant future-adapted ***native*** species in gaps

Change in Habitat Suitability

Species	Current	HadHiDif
Bur oak	2.95	+2.67
Red maple	2.57	+1.91
Eastern white pine	1.03	+0.22

Eastern white pine is tolerant of a range of canopy conditions and shrub competition, is native, versatile, and future adapted

Plant seed from next southern climate zone, except local jack pine

Resilience Treatment: change, but within the natural range of variability, which includes increasing eastern white pine

Cutfoot Experimental Forest, MN

TRANSITION enable ecosystems to respond to changing conditions

DFC/Goal

- Reduce pine to 20-50%, multi-cohort
- Increase future-adapted species
- High species diversity and complexity

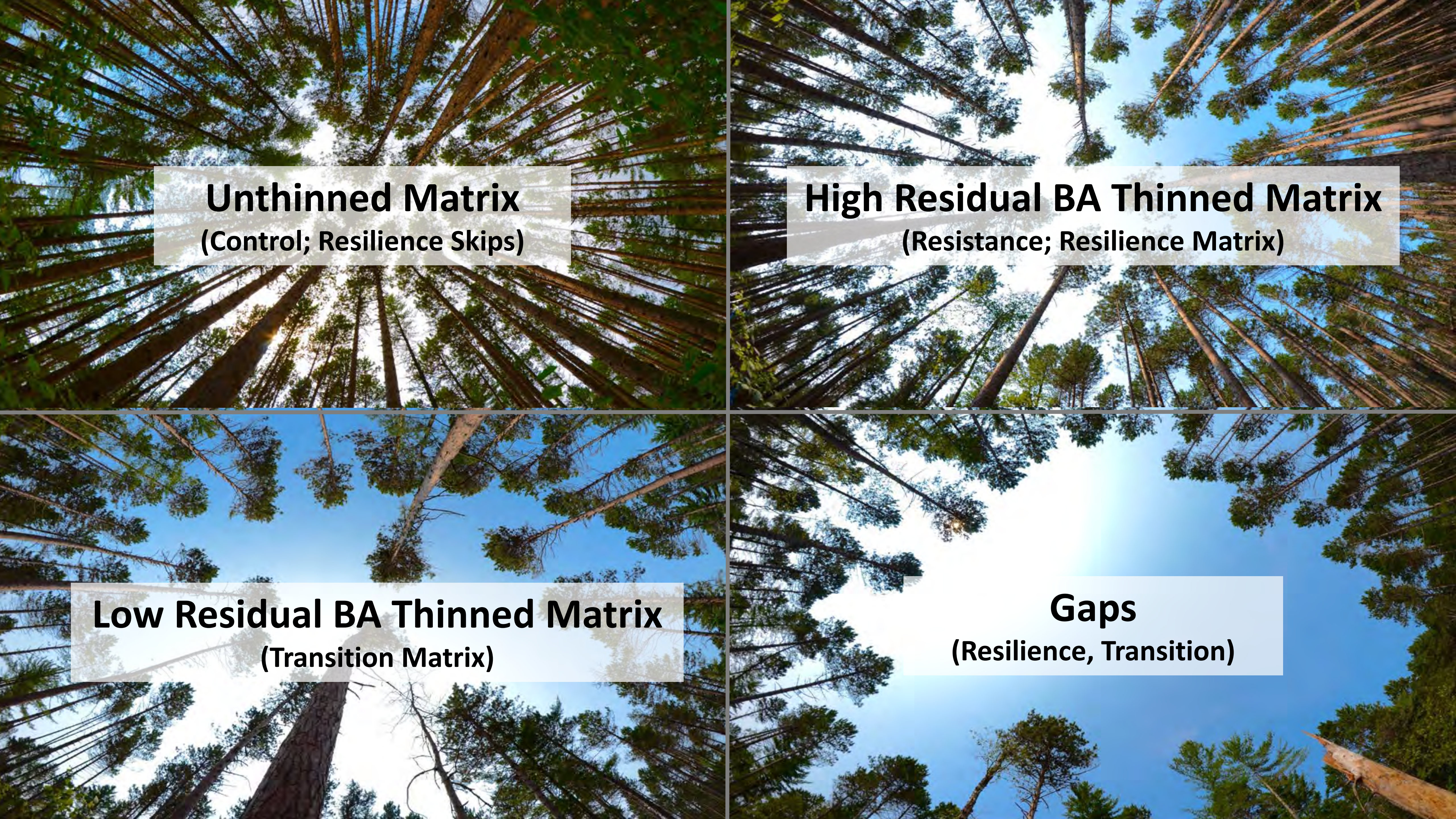
Tactics

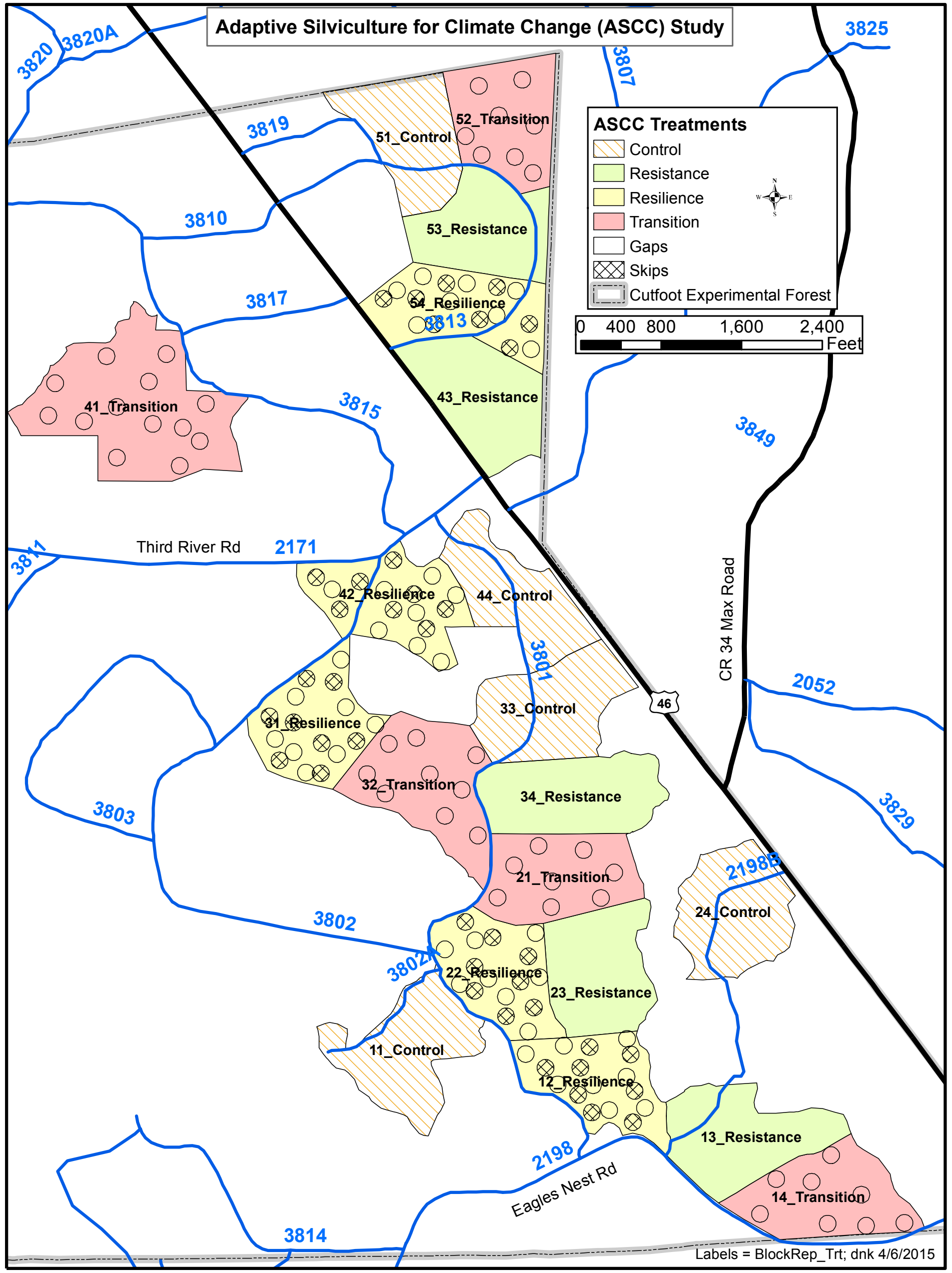
- Irregular shelterwood with expanding gaps
  - 20% in ½ ac gaps, retain large diameter
  - Thin matrix to 60-80 ft^2/ac
- Regenerate/plant future-adapted species in gaps *and* matrix (***native*** and ***novel*** species)

Species choices based on Tree Atlas modeling and local experience

Cutfoot EF Layout

- 4 Treatments (~10 ha each)
  - Resistance, Resilience, Transition, No Action
- 5 replicated blocks
- 170 vegetation plots
- 40 microclimate plots
- 4 predominant overstory conditions
  - Skips, High residual BA thinned, Low residual BA thinned, Gaps
- 9 species planted (resilience gaps and throughout entire transition treatment)


Unthinned Matrix
(Control; Resilience Skips)
High Residual BA Thinned Matrix
(Resistance; Resilience Matrix)
Low Residual BA Thinned Matrix
(Transition Matrix)
Gaps
(Resilience, Transition)



Cutfoot EF Layout

- 4 Treatments (R, R, T, Control)
- 5 replicated blocks
- 170 vegetation plots
- Control / Resistance
  - 7 plots
- Resilience
  - 3 in gaps
  - 3 in skips
  - 5 in matrix
- Transition
  - 3 in gaps
  - 6 in matrix

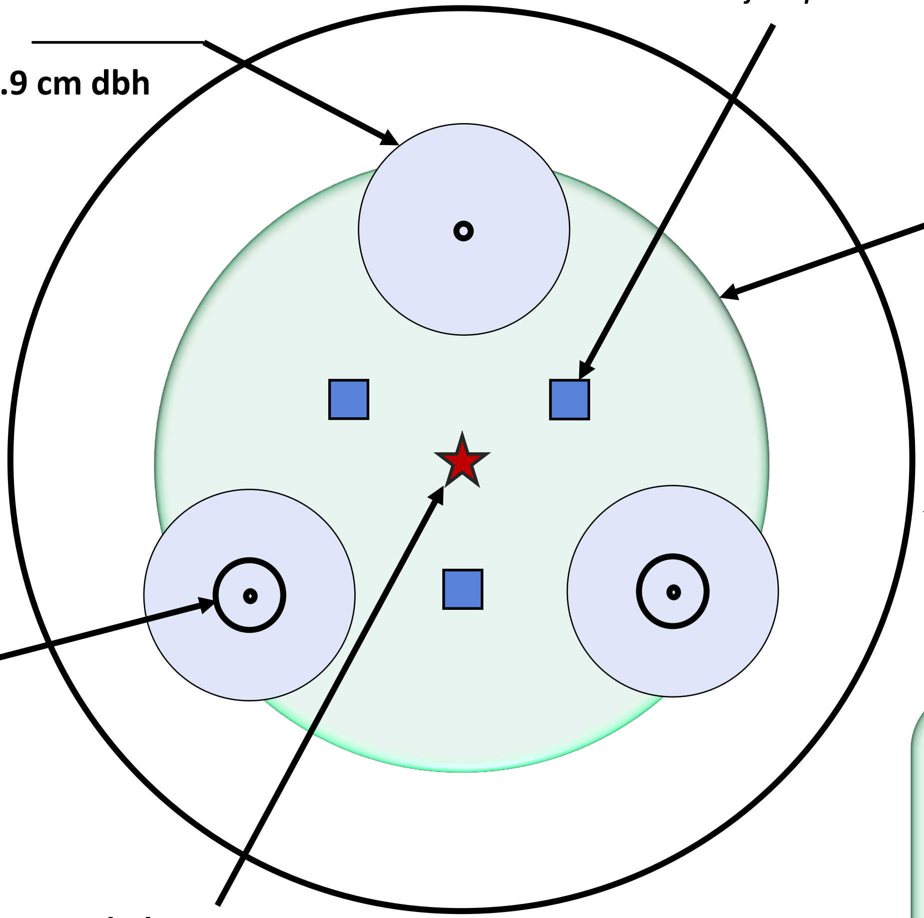
ASCC Plot Design

Small Tree Plot (Adv Regen) (3)
0.004 ha (1/100th ac)
Radius 3.59 m (11.8 ft)
Measuring ≥ 30cm tall to ≤ 8.9 cm dbh
(≥ 1 ft tall to ≤ 3.5 in dbh)
8m from plot center at 0, 120 and 240°

Class I	1 – 4.5 ft in ht
Class II	> 4.5 ft ht – 0.5 in DBH
Class III	0.6 – 1.5 in DBH
Class IV	1.6 – 2.5 in DBH
Class V	2.6 – 3.5 in DBH

Ground Layer Plot (3)
1 m²
Measuring herbaceous and woody spp
< 30 cm (1 ft) tall
4m from plot center at 60, 180, and 300°

Mid-Tree Plot (Sapling) (1)
0.04 ha (1/10th ac)
Radius 11.34 m / 37.2 ft
Measuring 8.9 to 12.6 cm dbh
(3.5 to 7.4 in dbh)



Annular Plot (1)
0.08 ha (1/5th ac)
Radius 16.1 m / 52.7 ft
Measuring ≥ 12.7 cm / 7.5 in dbh
Species, Ht, DBH, snags + decay class, forest health metrics

Shrub Plot (2)
5 m²
Radius 1.26 m (4.13 ft)
Tally by species

LAI and Photos

Key Response Variables Monitored Across All Sites (Overstory and Understory):

- Species composition, density, diversity, etc.
- Forest health (mortality, local indices)
- Productivity (increment, biomass)

Transition Treatment

Facilitate change, encourage adaptive response

Desired Future Condition/Goal

- Increase future-adapted species, diversity
- Increase structural heterogeneity
- Non-red pine dominated

Tactics

- Irregular shelterwood: 0.2-ha expanding gaps
- Reduce matrix 40 m^2 ha^{-1} to 14-18 m^2 ha^{-1}
- Plant future-adapted species

Planted Species

Native to the CEF

- Red maple
- Northern red oak
- Bur oak
- Eastern white pine

Novel to the CEF

- White oak
- Bitternut hickory
- Black cherry
- Ponderosa pine (4 seed sources)

Muller, J.J., L.M. Nagel and B.J. Palik. 2019. Forest adaptation strategies aimed at climate change: Assessing the performance of future climate-adapted tree species in a northern Minnesota pine ecosystem. Forest Ecology and Management 451: 12 pgs. https://doi.org/10.1016/j.foreco.2019.117539

Research Questions

1) How does survival and growth of planted future-adapted tree seedlings vary among species under current climate conditions?
2) How does performance differ between overstory condition and among different levels of shrub and herbaceous density?
3) How does the initial performance of novel species compare to native species?

Study Design

- 2016-2018 measurements (3 growing seasons)
- 45 plots (30 Matrix, 15 Gaps)
- 10 seedlings tagged per species per plot
- 4950 total seedlings being monitored
    - Survival and basal diameter (RGR)
    - Shrub/herb density

Native vs. Novel Species on the Cutfoot EF

Eastern white pine

Ponderosa pine

Northern red oak

White oak

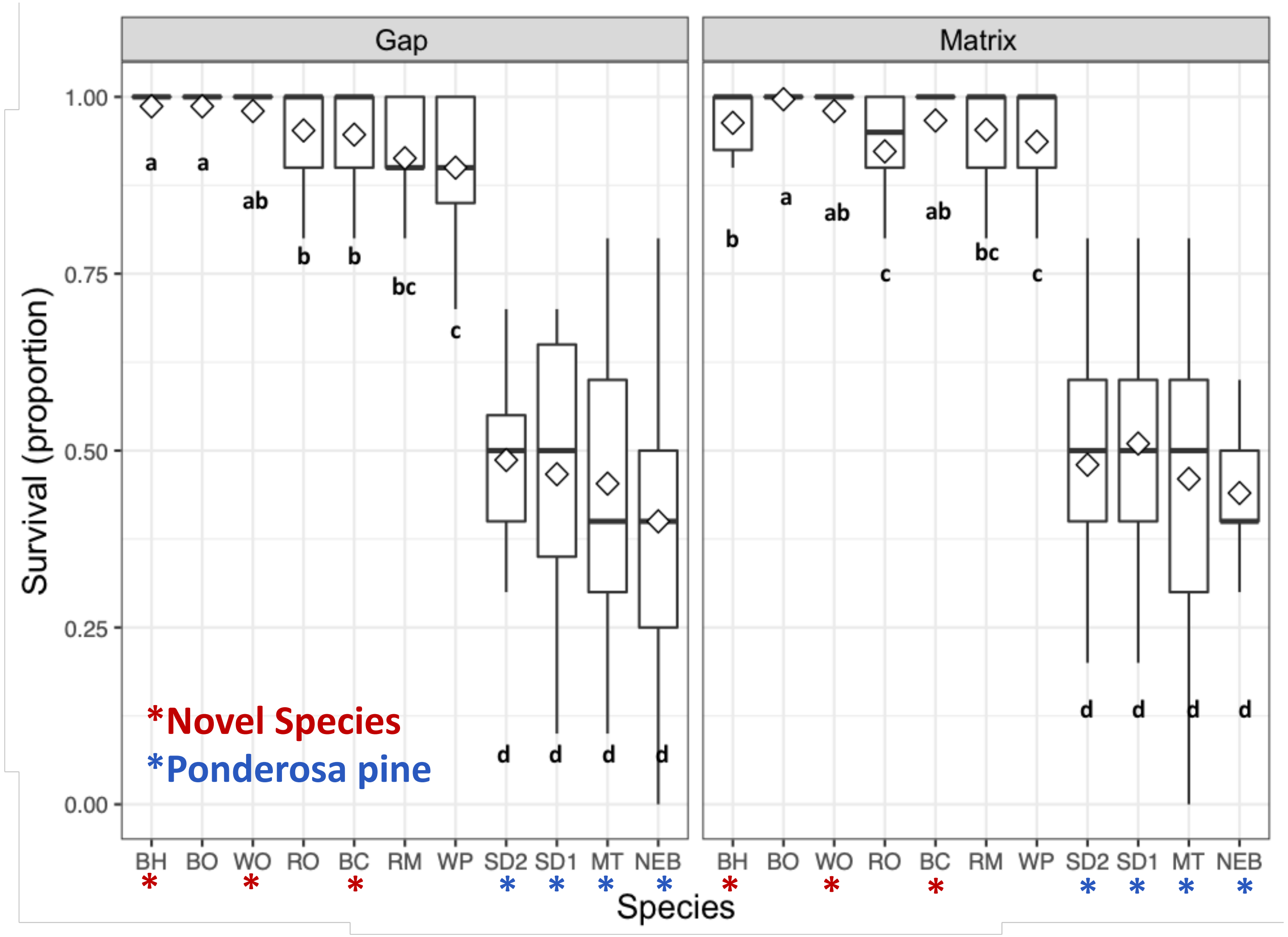
3-year Seedling Survival

BC – Black Cherry*
BH – Bitternut Hickory*
BO – Bur Oak
RM – Red Maple
RO – Northern Red Oak
WO – White Oak*

SD1 – South Dakota 1 Ponderosa Pine*
SD2 – South Dakota 2 Ponderosa Pine*
MT – Montana Ponderosa Pine*
NEB – Nebraska Ponderosa Pine*
WP – Eastern White Pine

Key Findings

- **Novel species were among those species with highest levels of survival**
- **Ponderosa pine had significantly lower levels of survival than other species**
- **Understory shrub cover was a strong predictor of seedling survival**
- **No real impact of overstory (gap vs. matrix) on survival**

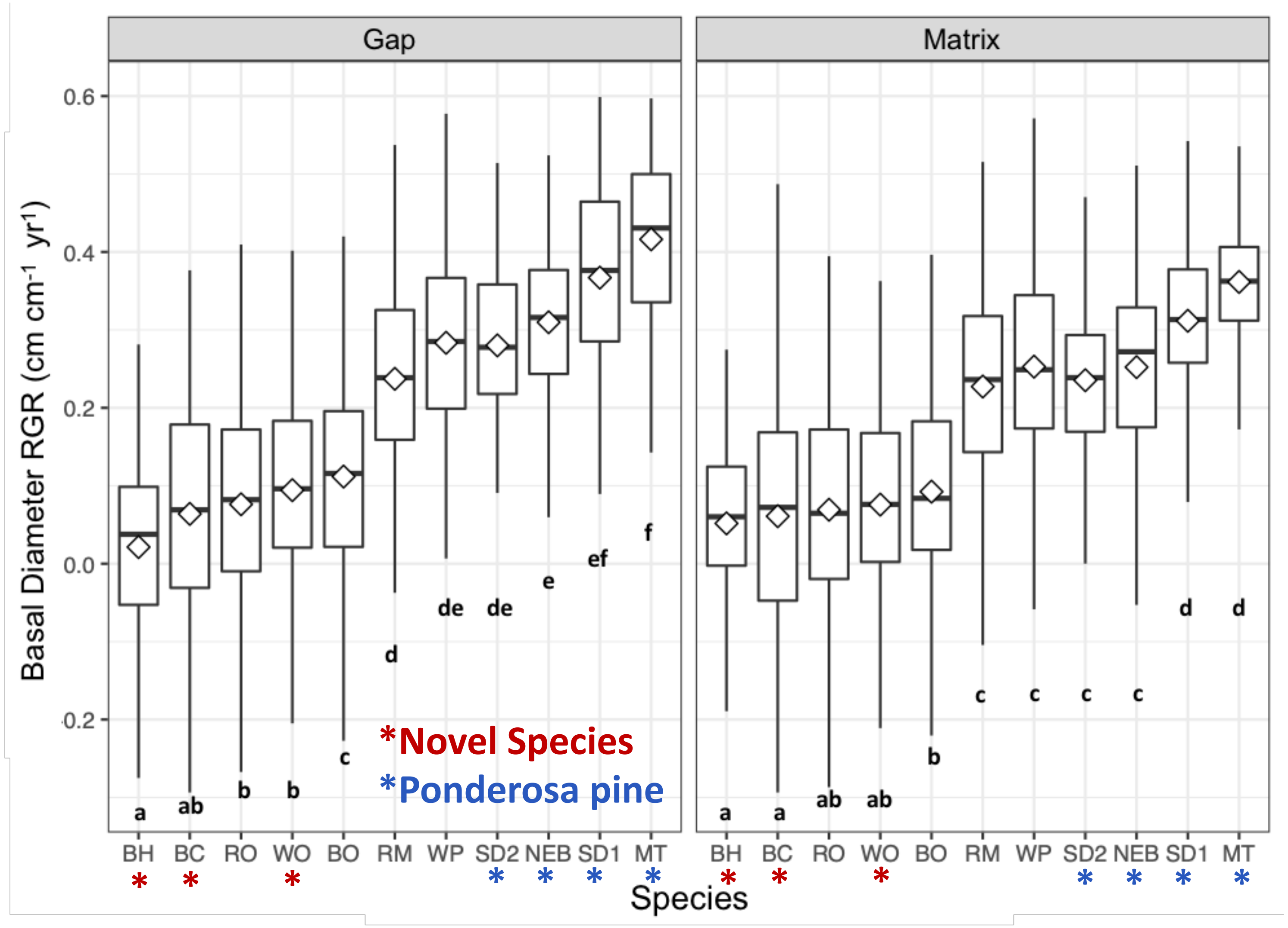


Muller et al. 2019

3-year Seedling Growth

BC – Black Cherry*
BH – Bitternut Hickory*
BO – Bur Oak
RM – Red Maple
RO – Northern Red Oak
WO – White Oak*

SD1 – South Dakota 1 Ponderosa Pine*
SD2 – South Dakota 2 Ponderosa Pine*
MT – Montana Ponderosa Pine*
NEB – Nebraska Ponderosa Pine*
WP – Eastern White Pine



Muller et al. 2019

Key Findings

- **Native species significantly outgrew novel species (*sans* Ponderosa)**
- **Ponderosa pine significantly outgrew other species**
- **Understory vegetation was not a predictor of RGR**
- **Species with a high to moderate shade tolerance grew more in gaps vs. matrix**

Conclusions and Implications for Seedlings

It may be reasonable for managers to consider unconventional species compositions under climate change, and begin planting novel future-adapted species (e.g., in this study, bitternut hickory, black cherry, and white oak)

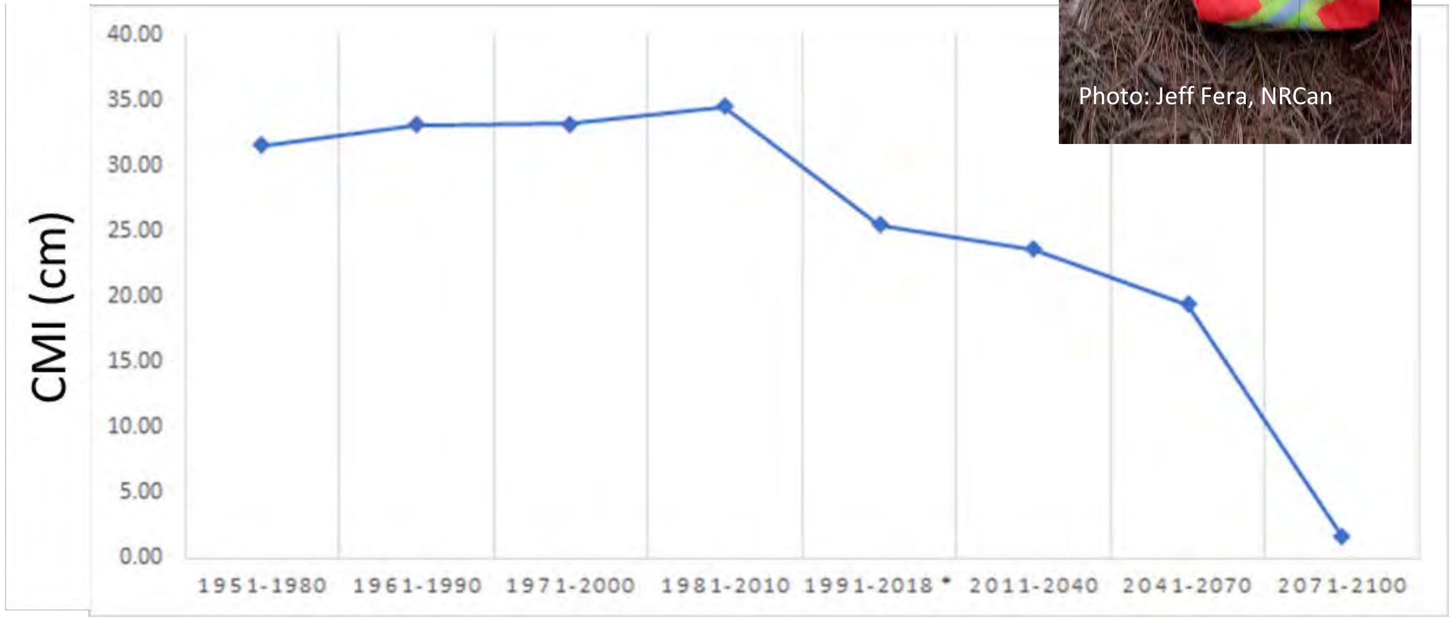
Petawawa Research Forest, Ontario, Canada

- Great Lakes-St. Lawrence forest region
- White pine, red pine, red oak, yellow birch, sugar maple, and red maple
- 40 m^2/ha (174 ft^2/acre)
- Workshop in July 2019
- Site Leads:
  - Dr. Trevor Jones
  - Dr. Nelson Thiffault
  - Michael Hoepting
  - Jeff Fera
  - Liz Cobb

ASCC
Adaptive Silviculture for Climate Change

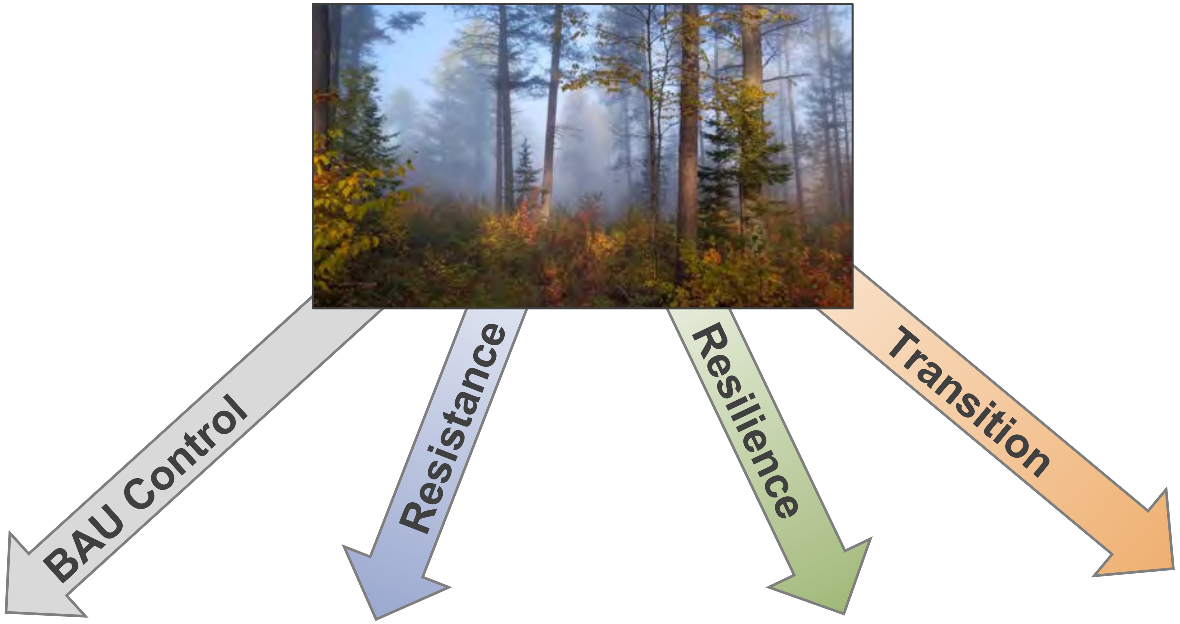
Climate Changes Impacts at the PRF

- Continued snow and ice storms leading to crown damage and snow loading on seedlings
- Warmer winter temperatures and increased evapotranspiration
- Rain on snow events leading to rapid snow melt and fluctuating water tables
- Increasing summer moisture stress due to drought and the increased potential for wildfire concerns



Historic and projected Climate Moisture Index for the Petawawa Research Forest (source: CFS, McKenney et al.)

Petawawa Research Forest, Chalk River, Ontario, Canada



BAU Control

Two-cut shelterwood

Seed cut 12-14 m²/ha (129-151 ft²/acre) BA

Final cut when height of white pine regeneration is 6 meters (20 ft)

One year after site prep, plant WP from local seed zones

Resistance

Two-cut shelterwood

Seed cut, 12-14 m²/ha residual (129-151 ft²/acre) BA

Final cut when height of white pine regeneration is 6 meters

One year after site prep, plant WP & RP from local & WP from southern seed zones

Resilience

Irregular shelterwood with expanding gaps

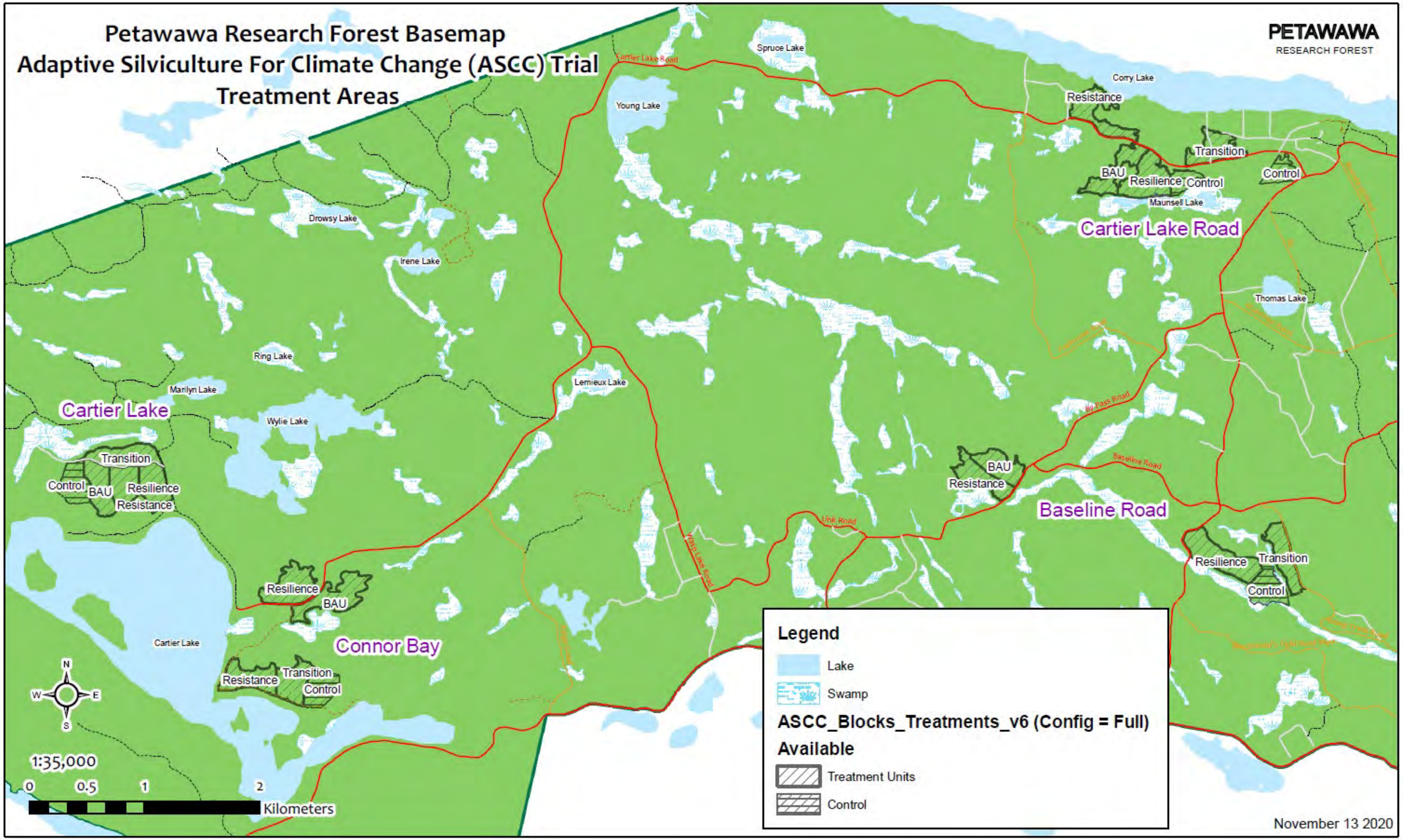
Gaps should be 1 to 2 tree heights in diameter (1/4 ha to 1/2 ha) (1/2 acre – 1 acre) with 20-25% of the area in gaps with feathered edges to promote WP regeneration

Plant species from seed zones to reflect changing climatic conditions

Transition

Clearcut with aggregate retention in variable sizes focused on existing white pine and red oak

Plant pines and oaks with local and novel future-adapted species



Blocks and treatment areas of the Adaptive Silviculture for Climate Change trial at the Petawawa Research Forest.

Developing the Experimental Treatments

For each experimental treatment (Resistance, Resilience, Transition):

DFC

↓

Management objectives

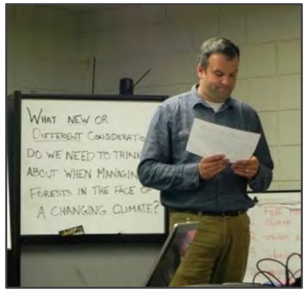
↓

Silvicultural practices (tactics)

What do you want the stand to be and look like?

Keep in mind key variables/outcomes:
- **Species composition**
- **Forest health**
- **Forest productivity**
- **Response to disturbance**

For each silvicultural practice (tactic):
- **Timeframes**
- **Benefits**
- **Drawbacks and Barriers**
- **Practicality**
- **Recommend tactic?**



First workshop: MN, June 2013

Most recent workshop: CO, Dec 2020

Community Guidelines

- Focus on what matters
- Contribute your thinking and experience
- Listen to understand
- Connect ideas
- Listen together for patterns, insights and deeper questions
- Honor everyone’s time
- Be present - mentally and physically
- Equal airtime - all participate, no one dominate

Adaptive Silviculture for Climate Change

Designing Forest Adaptation Treatments at the John Prince Research Forest Through Scientist-Manager Partnerships

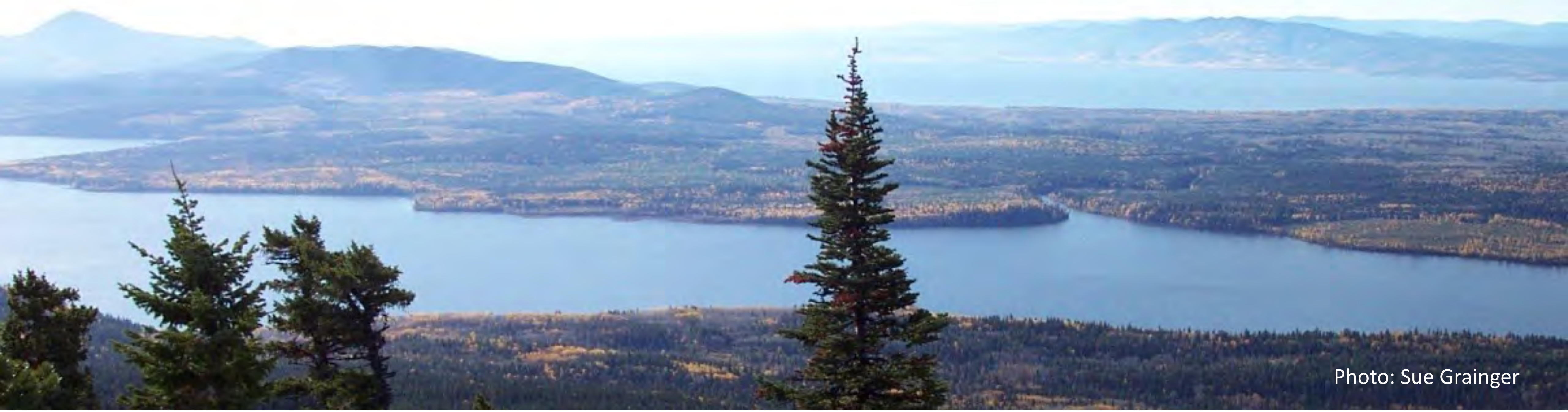


Photo: Sue Grainger

Adaptive Silviculture for Climate Change (ASCC)
at the John Prince Research Forest

June 9 & 10, 2021

John Prince Research Forest • Tl'azt'en Nation • UNBC
Natural Resources Canada / Ressources naturelles Canada
Canada
UNBC University of Northern British Columbia
ASCC Adaptive Silviculture for Climate Change
NAU Northern Arizona University
Forest and Rangeland Stewardship, Colorado State University
NIACS Northern Institute of Applied Climate Science

What research or management questions are you excited to ask based on the ASCC treatments?

Photos: Sue Grainger

ASCC Data Collection and Implementation Timeline – John Prince Research Forest

Photo Credit: Sue Grainger

Photo Credit: Sue Grainger

GUIDING PRINCIPLES

- ASCC is a multi-site project
- ASCC's primary experimental objectives and core study questions apply to every site
  - Some level of standardization is required for basic sampling
- Additional, system-specific or regionally-specific experimental objectives and questions are encouraged at individual sites
  - Some relevant data may be collected to address primary experimental objectives
  - Additional data may be needed to answer secondary questions
- The core study design has some flexibility, but general principles should be maintained across all sites

Core Management Questions

Concept-Driven

Will adaptation approaches and treatments work in a real-world context to **meet local management goals** and objectives?

How **feasible** are the treatments silviculturally, as well as in terms of financial, social, or other management constraints?

How does our **idea of desired future conditions** (DFCs) **change with each treatment type**?

What does it mean to deliberately create a future-adapted ecosystem, and **why would a manager choose to do this**?

What tradeoffs exist between achievement of adaptation objectives and other common objectives for a given region and ecosystem type?

Nagel et al. 2017

Core Scientific Questions

Hypothesis-Driven

- Do the treatments create significant changes to forest conditions over time at a particular site, and **how do treatments compare across sites**?
- How do hypothesized treatment responses (DFCs) compare with actual **responses observed in the future**?
- Do these treatments achieve what they were designed for?
- What **criteria** emerge to enable managers to identify which treatments perform best?
- Does one type of treatment (resistance, resilience, transition, or no action) consistently **perform better across all sites**?

Nagel et al. 2017

KEY MONITORING VARIABLES ACROSS THE NETWORK

Key Response Variables to be collected at each ASCC site

	Species Composition	**Forest Health**	**Productivity**
Overstory	Species richness Species diversity Relative density Relative dominance	Mortality Crown density Crown dieback Live crown ratio Tree damage (DSI)	Biomass increment Basal area increment
Midstory	Species richness Species diversity Relative density Relative biomass	Relative density or biomass of invasive species	Biomass increment
Ground Layer	Species richness Species diversity Percent cover by species	Percent cover of invasive species	Biomass increment

Other Suggested Variables for Monitoring:

- Leaf area index (plot center)
- Down woody debris
- Archived soil cores
- Forest floor samples
- Wildlife

Photo Credit: Chris Woodall

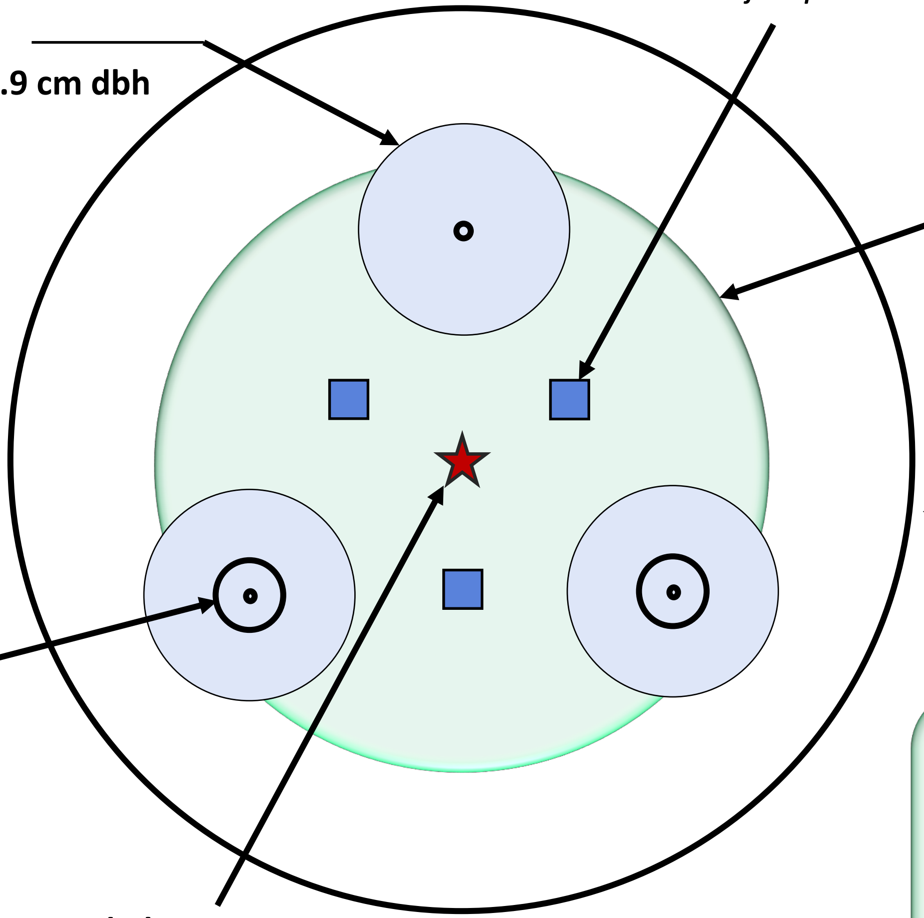
ASCC Plot Design

Small Tree Plot (Adv Regen) (3)
0.004 ha (1/100th ac)
Radius 3.59 m (11.8 ft)
Measuring ≥ 30cm tall to ≤ 8.9 cm dbh
(≥ 1 ft tall to ≤ 3.5 in dbh)
8m from plot center at 0, 120 and 240°

Class I	1 – 4.5 ft in ht
Class II	> 4.5 ft ht – 0.5 in DBH
Class III	0.6 – 1.5 in DBH
Class IV	1.6 – 2.5 in DBH
Class V	2.6 – 3.5 in DBH

Ground Layer Plot (3)
1 m²
Measuring herbaceous and woody spp
< 30 cm (1 ft) tall
4m from plot center at 60, 180, and 300°

Mid-Tree Plot (Sapling) (1)
0.04 ha (1/10th ac)
Radius 11.34 m / 37.2 ft
Measuring 8.9 to 12.6 cm dbh
(3.5 to 7.4 in dbh)



Annular Plot (1)
0.08 ha (1/5th ac)
Radius 16.1 m / 52.7 ft
Measuring ≥ 12.7 cm / 7.5 in dbh
Species, Ht, DBH, snags + decay class, forest health metrics

Shrub Plot (2)
5 m²
Radius 1.26 m (4.13 ft)
Tally by species

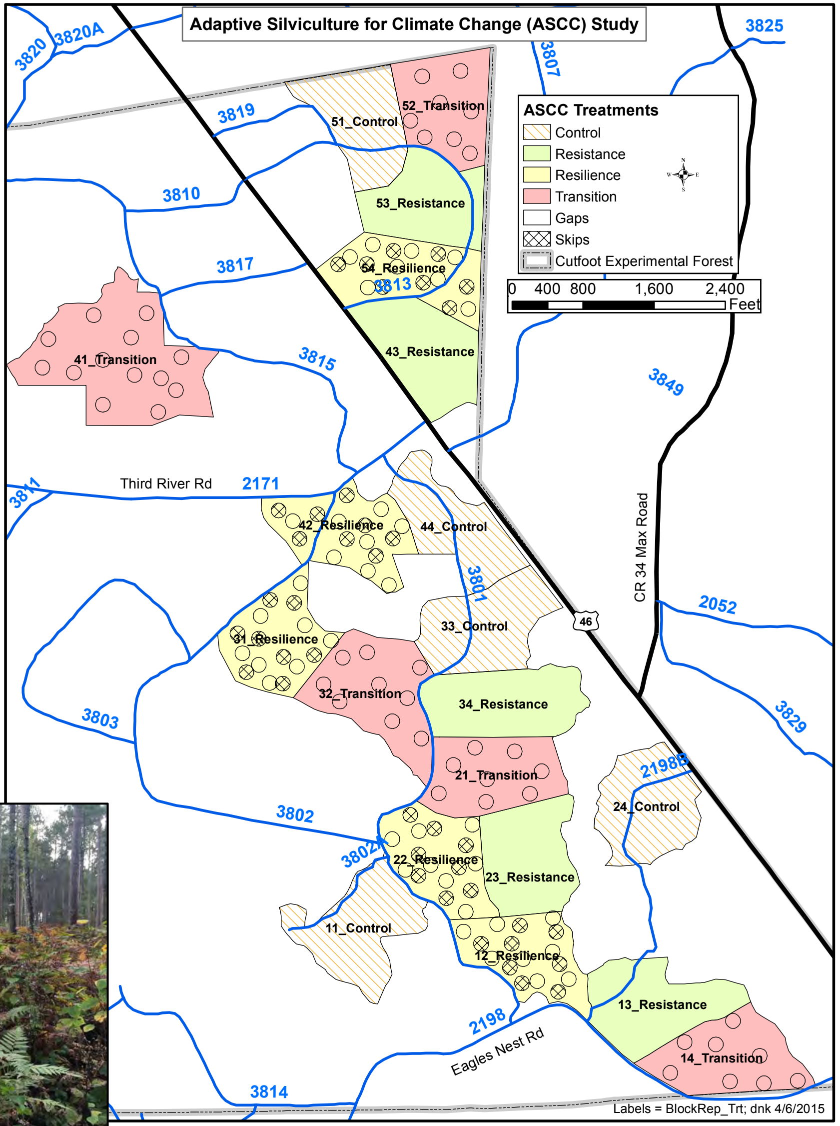
LAI and Photos

Key Response Variables Monitored Across All Sites (Overstory and Understory):

- Species composition, density, diversity, etc.
- Forest health (mortality, local indices)
- Productivity (increment, biomass)

Cutfoot Experimental Forest, MN

- 4 treatments
  - ~10 ha each, 202 ha total (500 ac)
- 5 replicated blocks
- 170 vegetation plots
  - No Action and Resistance: 7 each
  - Resilience: 3 gaps, 3 skips, 5 matrix
  - Transition: 3 gaps, 6 matrix
- 40 microclimate plots
- 4 predominant overstory conditions
  - Skips, High residual BA thinned, Low residual BA thinned, Gaps
- 9 species planted (resilience gaps and throughout entire transition treatment)



MEASUREMENT FREQUENCY

Variable	ASCC Suggestion	Group Ideas
Overstory Layer	1, 3, 5, 10, 15, 20, etc.	
Sapling Layer	1, 3, 5, 10, 15, 20, etc	
Shrub & Seedling Layers	1, 3, 5, 10, 15, 20, etc	
Ground Layer	1, 2, 3, 5, 10, 15, 20, etc	
Forest Health Indicators	1, 2, 3, 5, 10, 15, 20, etc	
LAI	1, 5, 10, 15, 20, etc	

Note: Times listed indicate post-treatment measurements.
A pre-treatment measurement may also be required for many variables.

ASCC Project Timeline – Key Events

Event	Timeframe
Finalize ASCC treatment details	
Is pre-treatment data needed at this stage?	
Select final treatment locations	
Assign treatments to locations	
Develop formal prescriptions	
Environmental assessments	
Order tree seedlings	
Finalize monitoring details	
Pre-treatment sampling (research focus)	
Implement silvicultural treatments (detail steps)	
Year 1 post-treatment sampling	