ASCC
Adaptive Silviculture for Climate Change

Designing Forest Adaptation Treatments Across the Driftless Region Through Manager-Scientist Partnerships

Adaptive Silviculture for Climate Change (ASCC)
Driftless Region Workshop

December 2, 9, & 10, 2021

FOREST AND RANGELAND STEWARDSHIP
COLORADO STATE UNIVERSITY

NIACS
Northern Institute of Applied Climate Science

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

IOWA STATE UNIVERSITY

ASCC
Adaptive Silviculture for Climate Change

DEPARTMENT OF NATURAL RESOURCES

DNR IOWA DEPARTMENT OF NATURAL RESOURCES

WISCONSIN DEPT. OF NATURAL RESOURCES

Land Acknowledgement

Photo: Annamarie Rutledge, NIACS

Introductions

Alex Hoffman	David Ruff	Linda Nagel
Ann Calhoun	Greg Edge	Michelle Martin
Armund Bartz	Jeff Goerdnt	Mike Reinikainen
Brad Hutnik	Jessica Flatt	Miranda Curzon
Brandon Bleuer	John Pearson	Paul Dubuque
Brandon Schad	John Withers	Sascha Lodge
Brian Palik	Joe Brown	Scott Walter
Bruce Blair	Karen Kinkead	Stephen Handler
Colleen Matula	Kevin O'Brien	Tom Hill
Courtney Peterson	Lewis Wiechmann	Trent Stuchel
Dan Kaminski		

Ice breaker activity: Your name, organization, and one thing you are looking forward to in this workshop.

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 southern dry-mesic stands that will be part of a long-term study to be implemented across the Driftless Area in Iowa, Minnesota, and Wisconsin;
- Develop specific management, research, and monitoring questions that can be addressed through the ASCC project.

Adaptive Silviculture for Climate Change (ASCC) Network

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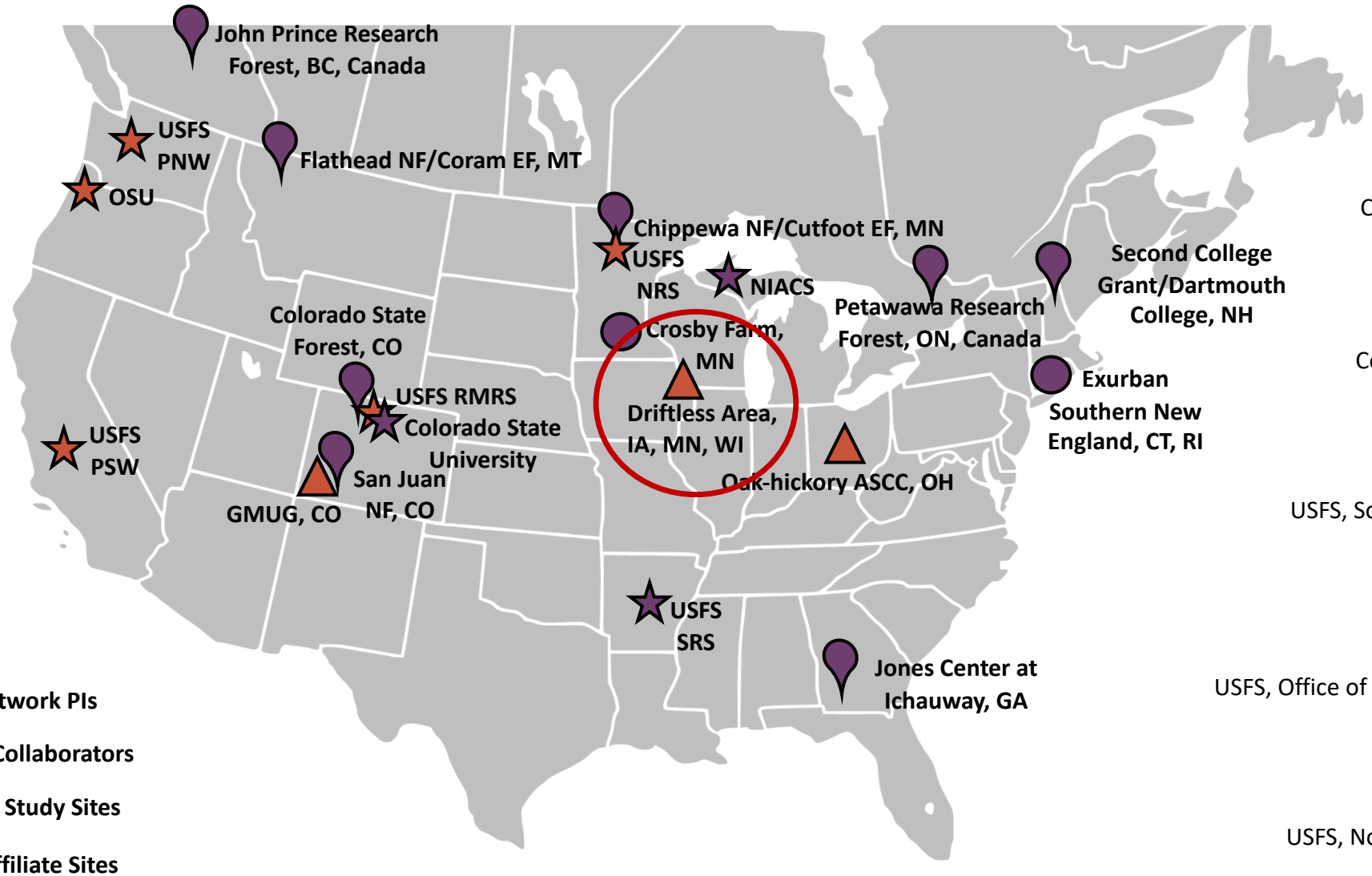
Adaptive Silviculture for Climate Change

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

Adaptive Silviculture for Climate Change Network

Adaptive Silviculture for Climate Change



ASCC Network PIs

Science Collaborators

Network Study Sites

Urban Affiliate Sites

Prospective Sites

Linda Nagel, Lead PI
Professor & Dept Head
Colorado State University

Courtney Peterson, ASCC Coordinator
Colorado State University
NIACS

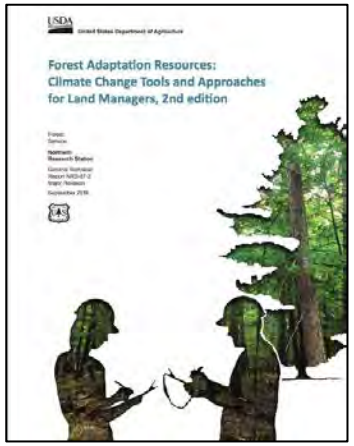
Jim Guldin, Lead FS PI
USFS, Southern Research Station
**retired*

Chris Swanston, Co-PI
USFS, Office of Sustainability & Climate

Maria Janowiak, Co-PI
USFS, Northern Research Station
Interim Director, NIACS

ASCC Network Website: www.adaptivesilviculture.org

ASCC Study Design and Collaborative Workshop



Common Design
Across All Forests

- **Treatment Themes:** ***Adaptation Options***
  - Resistance
  - Resilience
  - Transition
  - No Action
- **Minimum Study Design Elements**
  - Replication
  - Stand/EU Size
  - Monitoring Guidelines
  - Evaluation Window

Site Specifics
Unique to Individual Forests

- Forest Type or Ecosystem
- Study Sites/Layout
- Management Objectives
- Adaptation Approaches & Tactics
- Final Monitoring Plan

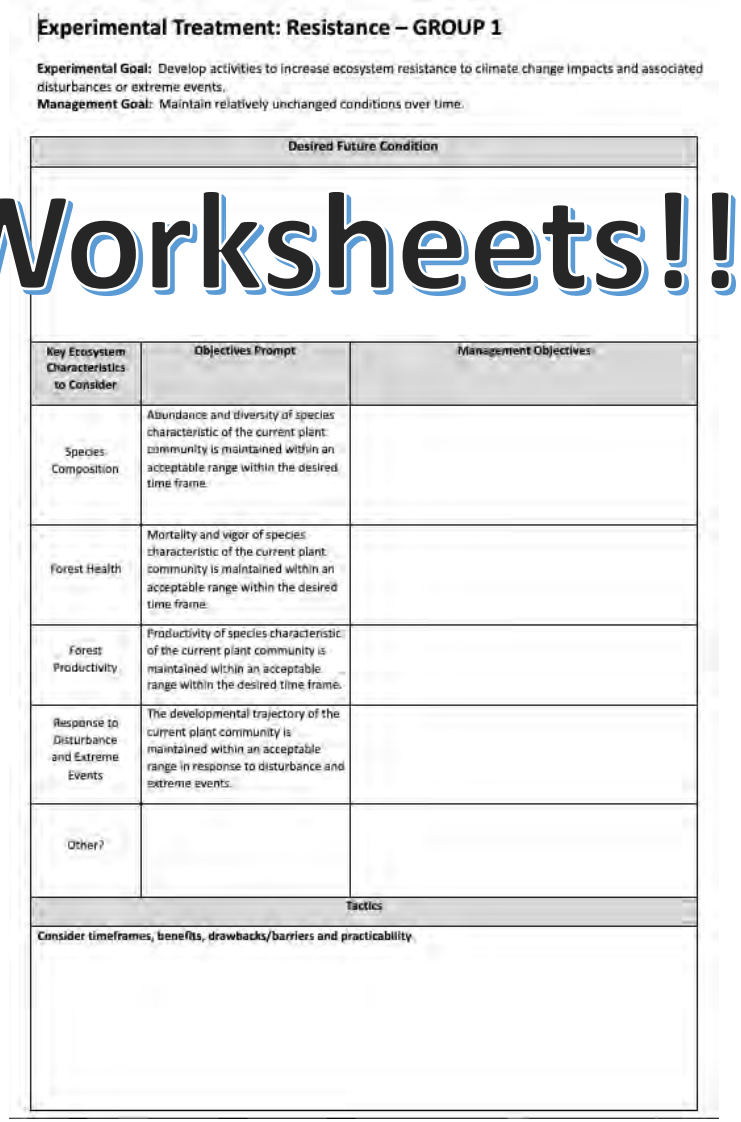
Workshop Agenda – Day 1, Thursday, Dec. 2

- **8:30** Introductions, ASCC Project Overview, Updates Since June
- **9:40** Silvics and Management of Driftless Region Forests
  - Overview of Disturbance Dynamics in Driftless Forests - Brad Hutnik (Wisconsin DNR)
  - Wisconsin Driftless Forests - Greg Edge (Wisconsin DNR)
  - Iowa Driftless Forests - Bruce Blair (Iowa DNR)
  - Minnesota Driftless Forests - Mike Reinikainen (Minnesota DNR)
- **10:20** Break
- **10:30** Ecosystem vulnerabilities of Driftless Area Forests to Climate Change - Stephen Handler (NIACS)
- **11:00** Climate Change Considerations for Driftless Forests
  - *What new or different considerations does climate change bring to making forest management decisions?*
- **12:00** Adjourn for the day

Workshop Agenda – Day 2, Thursday, Dec. 9

- **9:00** Quick recap of Day 1; Overview of day 2
- **9:05** Driftless Area Site Visit Recap & Overview – Miranda Curzon (Iowa State University)
- **9:35** Impacts of Climate Change on Management Goals for the Driftless Area ASCC Site – Linda Nagel, Courtney Peterson (Colorado State University), & Miranda Curzon (Iowa State University)
- **10:05** Break
- **10:20** Climate Adaptation Concepts & Developing an ASCC Study Site – Linda Nagel, Courtney Peterson (Colorado State University), & Brian Palik (USDA Forest Service Northern Research Station)
- **11:00 – 4:00** Develop ASCC study treatments at the CO State Forest – Work Time!

(We will take a 30-min break for lunch from 12:00 -12:30pm)



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 – Day 3, Friday, Dec. 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 about based on the ASCC treatments?
- **11:30** Large Group Adjourn
- **11:30** (*ASCC Site Leads*) Identify key implementation and monitoring next steps

Workshop 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
- We are recording the workshop

Virtual Workshop Expectations

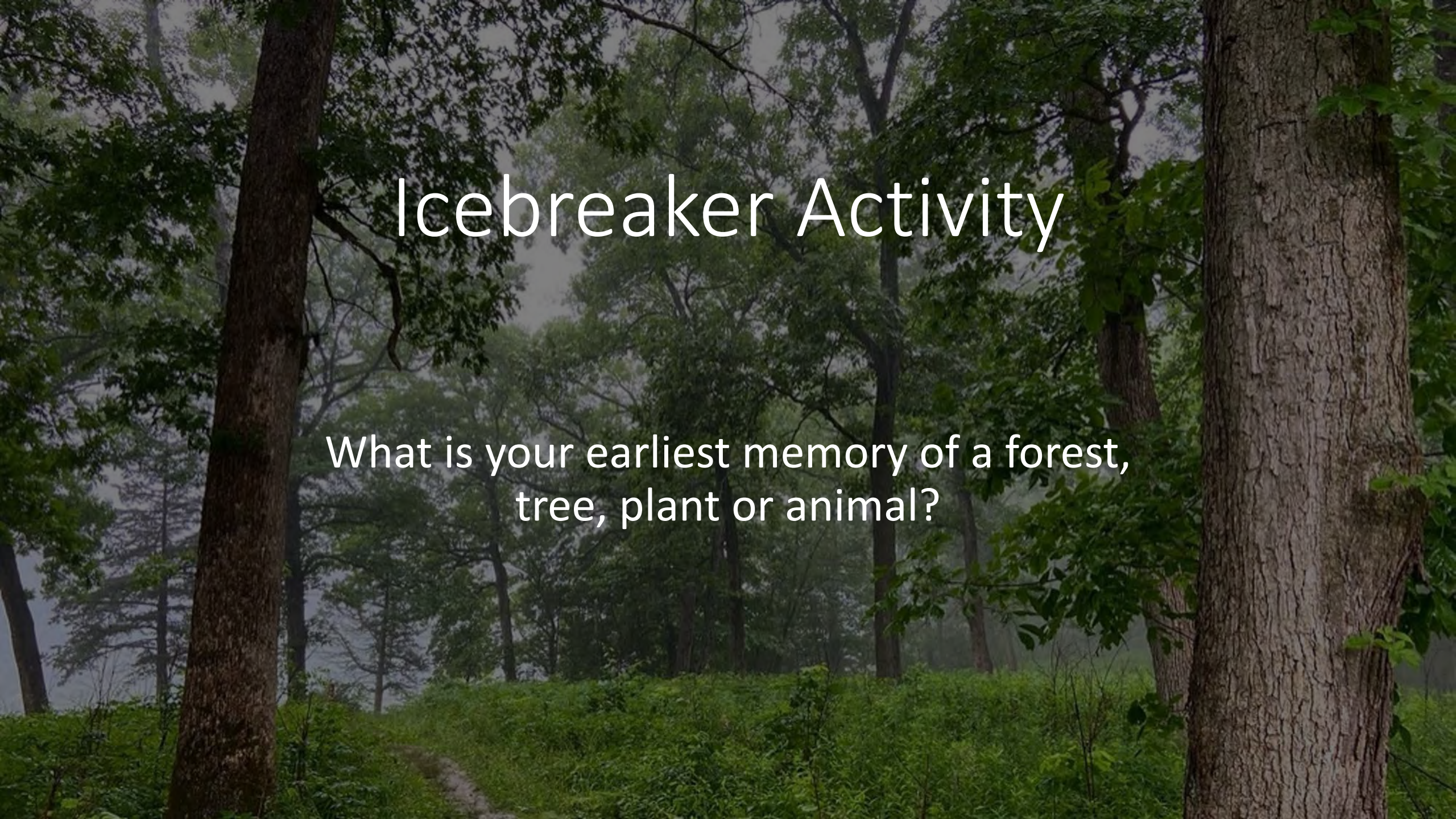
Please mute if not speaking

Add name 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



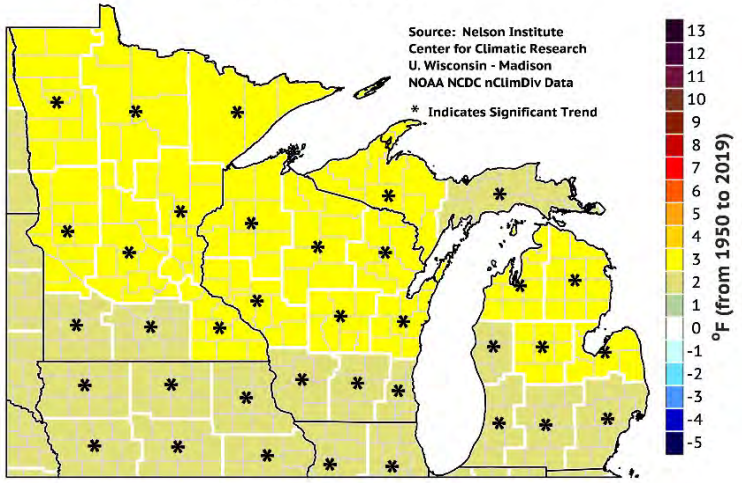
Icebreaker Activity

What is your earliest memory of a forest, tree, plant or animal?

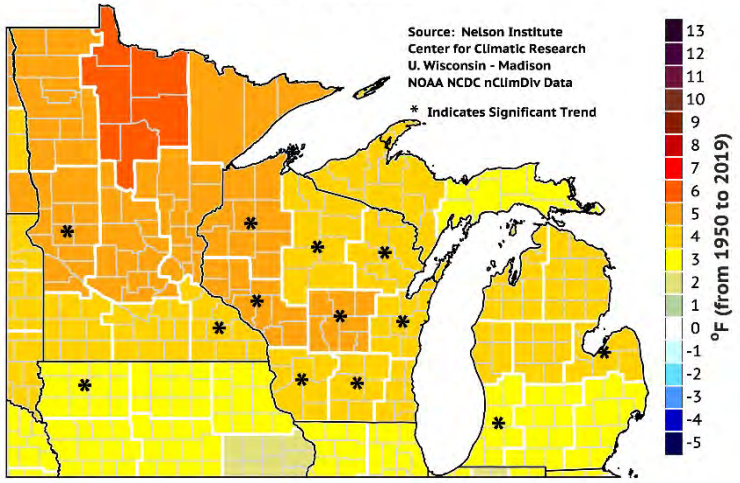
Silvics & Management of Driftless Region Forests

Ecosystem Vulnerabilities of Driftless Area Forests to Climate Change

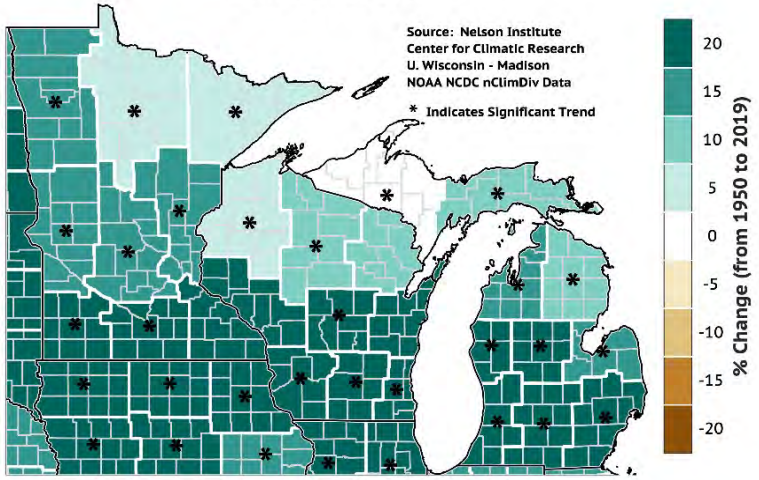
Historical Change in Annual TMEAN from 1950 to 2019



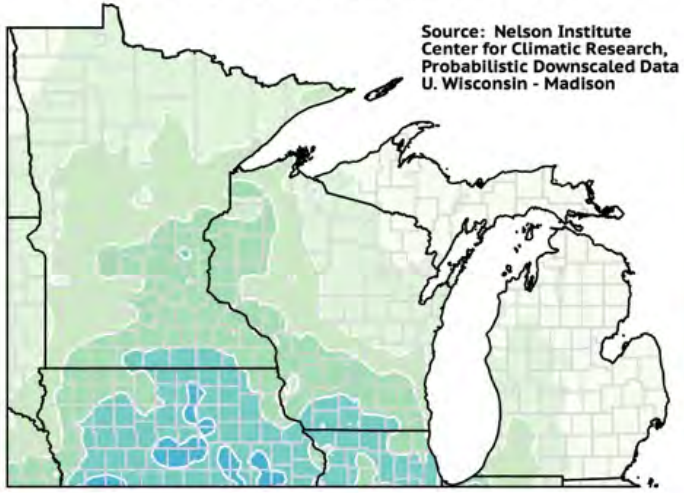
Historical Change in DJF TMEAN from 1950 to 2019



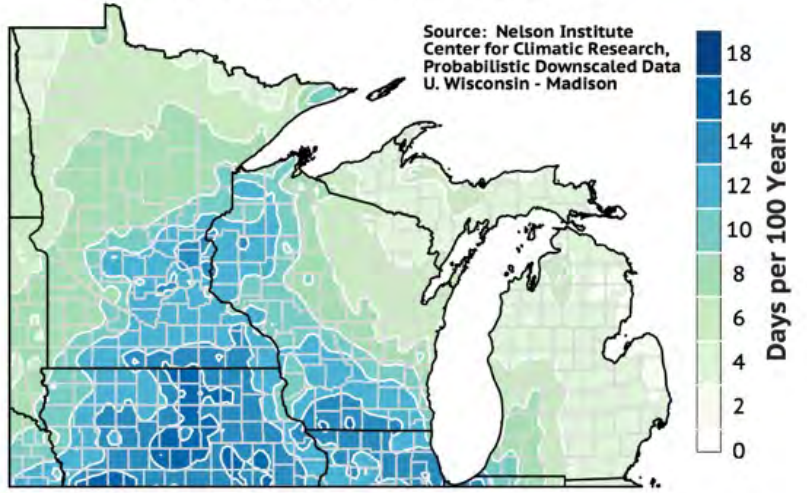
Historical Change in Annual PRECIP (%) from 1950 to 2019



Days per 100 Years with PRCP > 4in 1981-2010 Conditions (HISTORICAL)



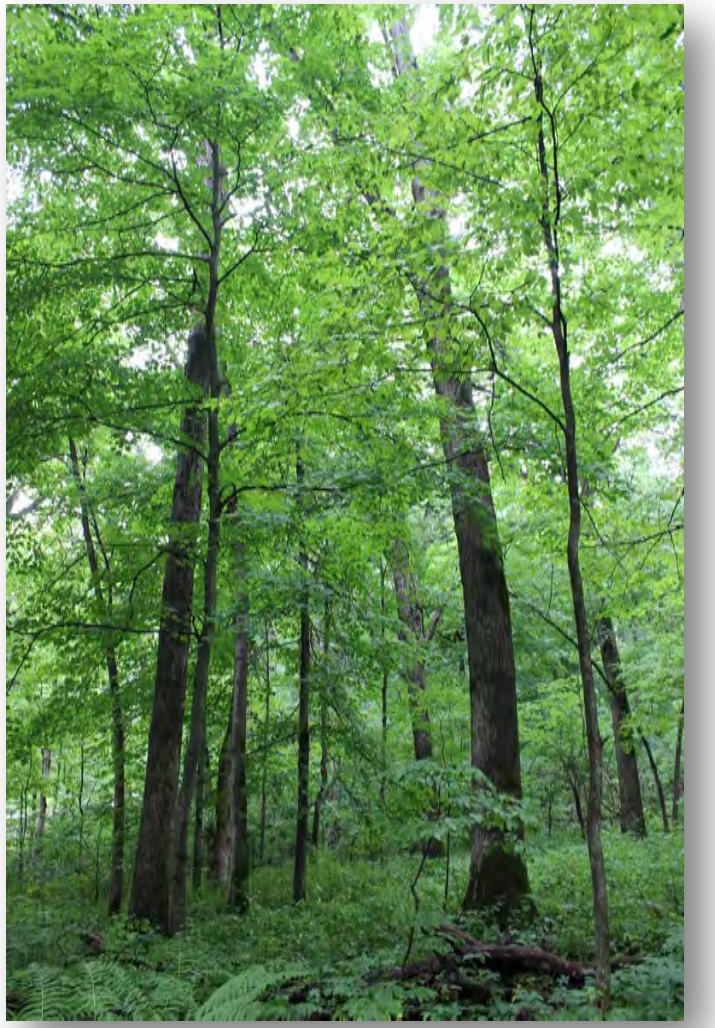
Days per 100 Years with PRCP > 4in 2041-2060 Conditions (HISTORICAL)



Activity: Climate Change Considerations for Forest Management

What new or different considerations do we need to think about when managing forests in the face of climate change?

GroupMaps!



Brainstorm → Group → Vote → Results Climate Change Impacts Brainstorming CHAT PARTICIPANTS 1/51 INVITE

Tap to add

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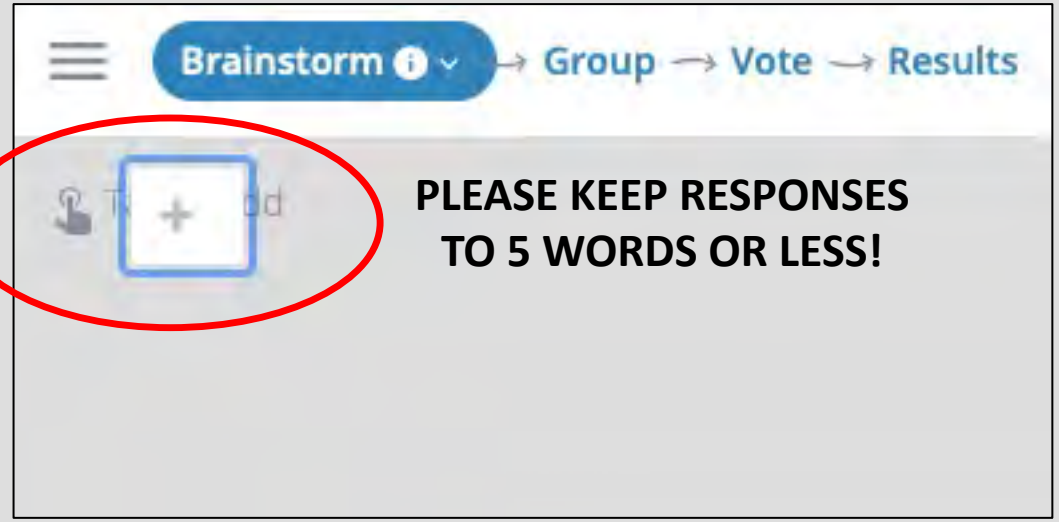

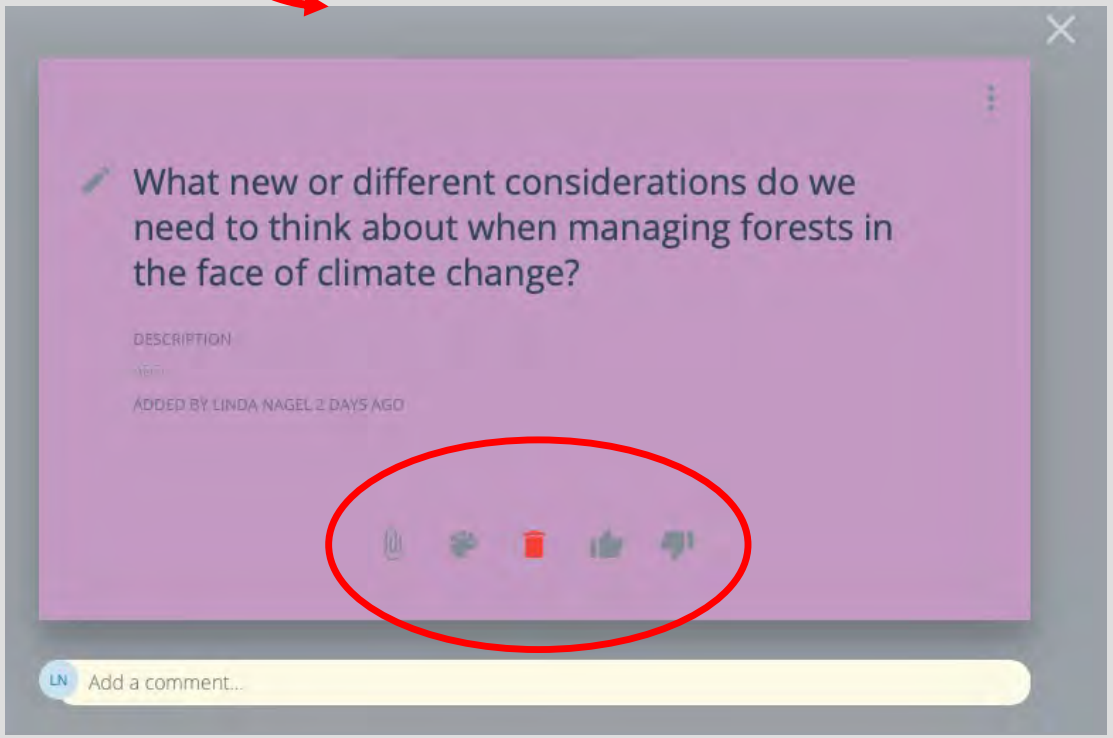

Homework for Next Week

Think about the climate change impacts that are likely to affect the Driftless Region, and what management challenges and opportunities this creates.

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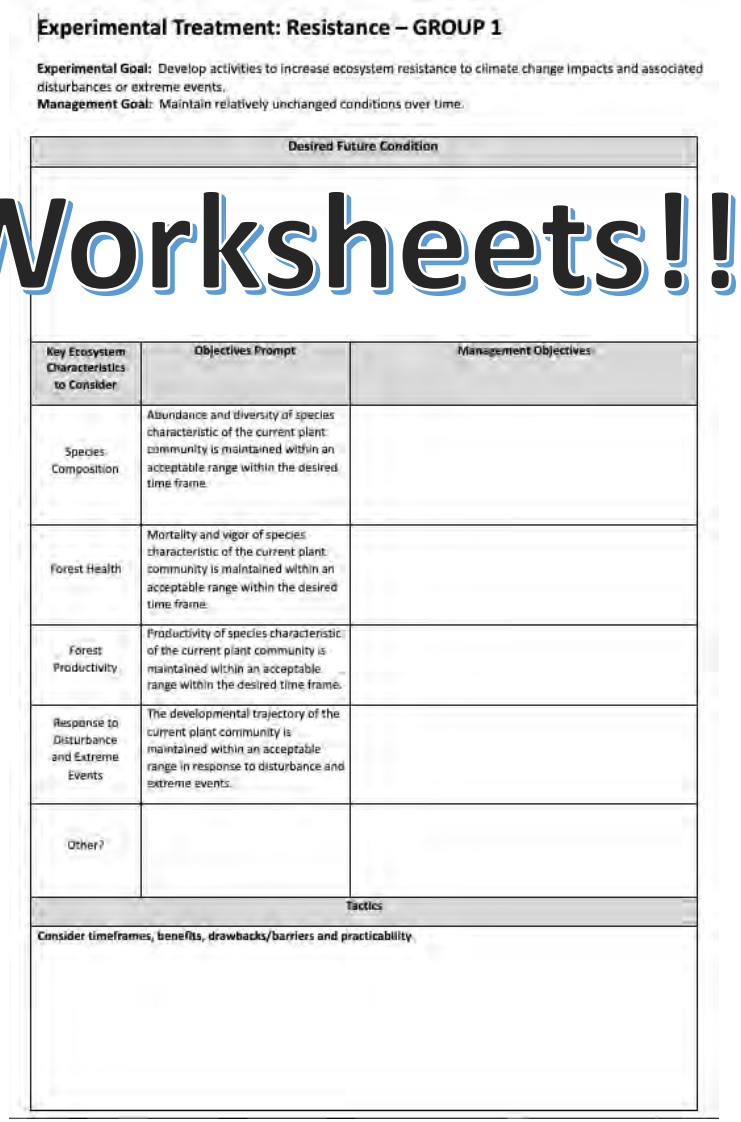

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Consider timeframes, benefits, drawbacks/barriers and practicability		

GROUPMAP ACTIVITY RESULTS

What new or different considerations do we need to think about when managing forests in the face of climate change?

- Changing natural disturbance patterns
  - Increasing fire frequency and intensity
  - Extreme rain and greater erosion (especially with Driftless Area topography)
  - Impacts of freezing temps on introduced southern species
  - Drought
  - Invasive species
  - Interacting disturbances and feedbacks
- Understory dynamics
  - Impacts of native and non-native herbaceous understory species on oak regeneration
  - future species richness, composition, and diversity in understory (response to treatments + change w/changing conditions)
  - Changes in natural regeneration potential
- Is adaptive capacity limited by past management and land use influences?
  - Grazing
  - High-grading
  - Fire

- Function > specific species?
  - How to embrace novel forest types?
  - Welcome or resist migrant trees?
- Impacts of declining markets on ability to adapt
- Implementation
  - Consistent funding sources for treatment implementation
  - Operability
  - Consider unconventional approaches
  - Think of treatments/approach as a process
  - Consider needs of private landowners ("easy and affordable")
- Ecosystem Services:
  - Carbon sequestration as a forest product
  - Wetter weather impacts on oak pollination
  - Changed resources for wildlife habitat
- Educating private landowners
- Landscape-scale considerations
  - Fragmentation
  - Changing ownership
  - Wildlife habitat considerations
  - Cross-agency (political) collaboration and support

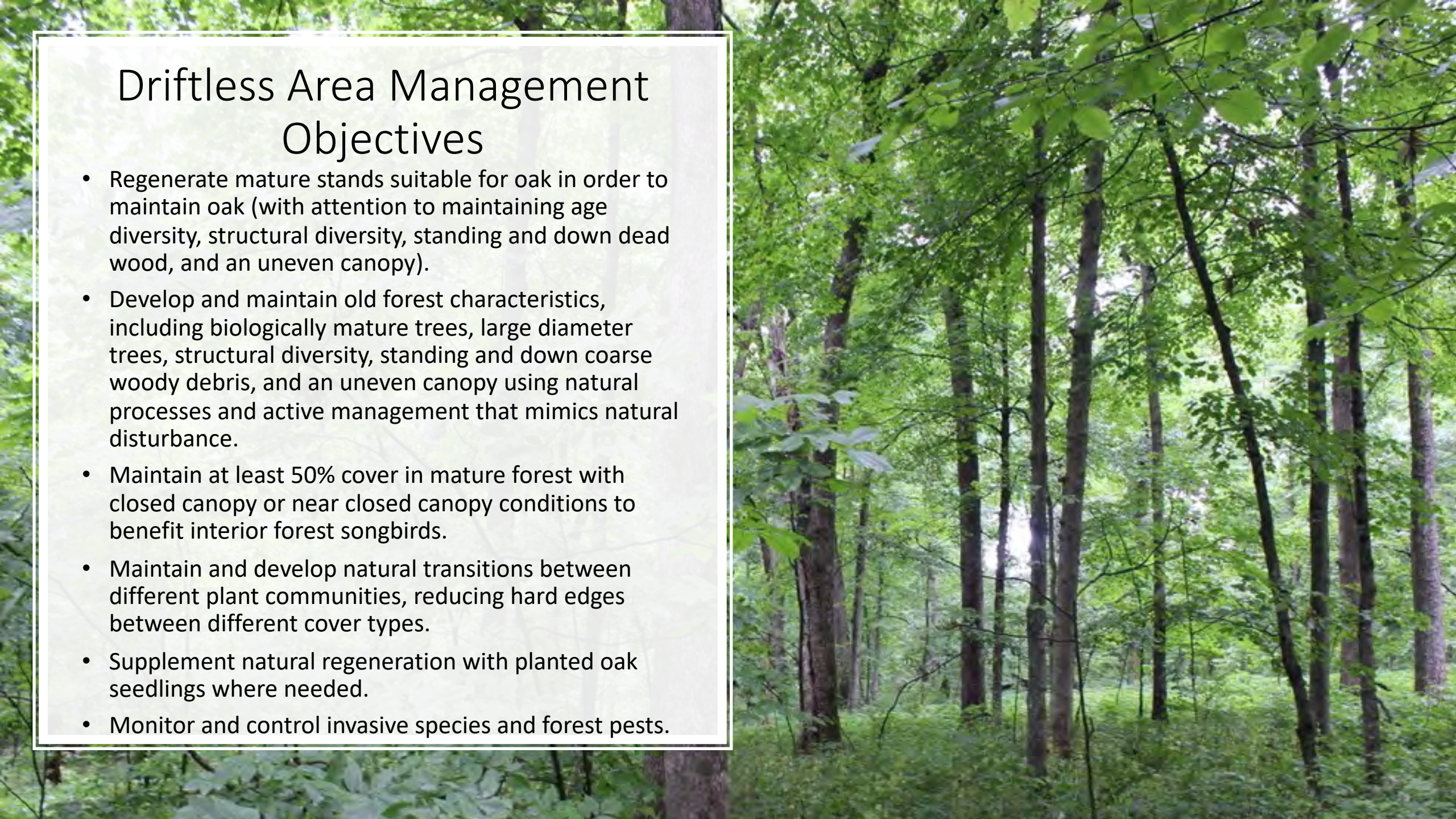
Driftless Area Site Visit Recap & Overview

Driftless Area Management Goals

- Manage for healthy, sustainable forests with an emphasis on maintaining oak cover types.
- Produce high-quality oak saw logs efficiently, encouraging other compatible, merchantable species (e.g. walnut) whenever possible.
- Demonstrate sustainable forest management and support research.
- Maintain or improve habitat for game and non-game wildlife species. Protect known endangered and threatened species as well as species of concern and their habitats.
- Manage to protect cultural resources and to provide opportunities for high-quality, nature-based open-space recreational uses that are compatible with the properties' capabilities and the ecological and habitat management goals.

Driftless Area Management Objectives

- Regenerate mature stands suitable for oak in order to maintain oak (with attention to maintaining age diversity, structural diversity, standing and down dead wood, and an uneven canopy).
- Develop and maintain old forest characteristics, including biologically mature trees, large diameter trees, structural diversity, standing and down coarse woody debris, and an uneven canopy using natural processes and active management that mimics natural disturbance.
- Maintain at least 50% cover in mature forest with closed canopy or near closed canopy conditions to benefit interior forest songbirds.
- Maintain and develop natural transitions between different plant communities, reducing hard edges between different cover types.
- Supplement natural regeneration with planted oak seedlings where needed.
- Monitor and control invasive species and forest pests.



Activity: Impacts of Climate Change on Management Goals for the Driftless Area ASCC Site

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.)*

Brainstorm → Group → Rate → Results Climate Change Challenges & Opportunities CHAT PARTICIPANTS 1/51 INVITE

Brainstorm What management challenges and opportunities may occur as a result of climate change to meeting the objectives of the Driftless Area ASCC sites?

Everyone can add Brainstorming collaboratively

Opportunities

Management opportunities given the climate impacts southern dry-mesic forest systems

Challenges

Management challenges given the climate impacts for southern dry-mesic forest systems

Join GroupMap: https://join.groupmap.com/729-E28-328

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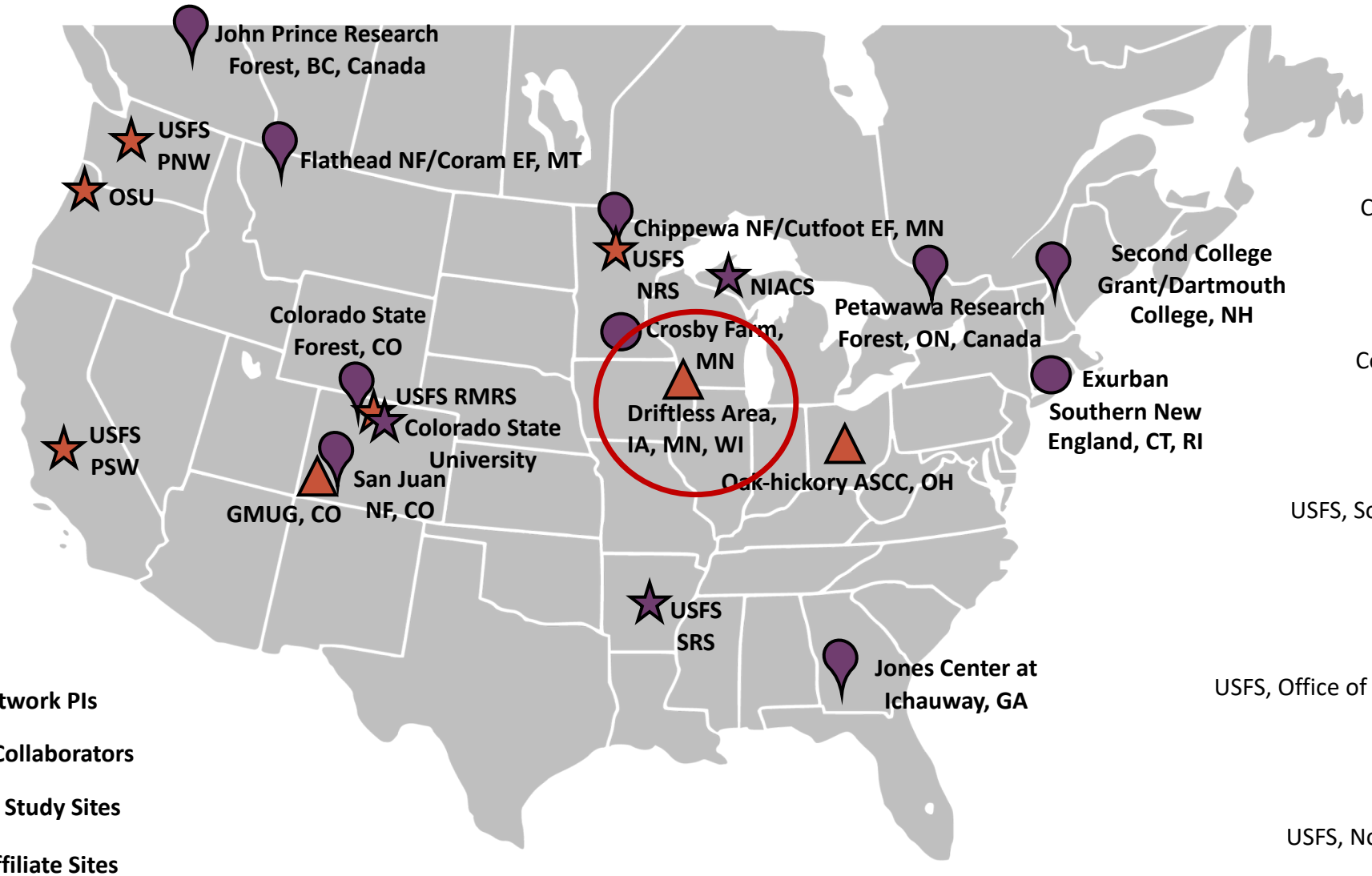

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Chippewa National Forest/Cutfoot Experimental Forest, MN
- Brian Palik, USFS Northern Research Station
- Tony D'Amato, University of Vermont

San Juan National Forest, CO
- Mike Battaglia, USFS Rocky Mountain Research Station
- Matt Tuten, San Juan National Forest

Second College Grant, NH
- Tony D'Amato, University of Vermont
- Chris Woodall, USFS Northern Research Station
- Kevin Evans, Dartmouth University

The Jones Center at Ichauway , GA
- Steven Brantley, The Jones Center at Ichauway
- Jeff Cannon, The Jones Center at Ichauway
- Andy Whelan, The Jones Center at Ichauway

Flathead National Forest/Coram Experimental Forest, MT
- Justin Crotteau, USFS Rocky Mountain Research Station
- Terrie Jain, USFS Rocky Mountain Research Station
- Amanda Rollwage, Flathead National Forest

Mississippi National River and Recreation Area, Saint Paul, MN
- Mary Hammes, Mississippi Park Connection
- Marcella Windmuller-Campione, University of Minnesota
- Leslie Brandt, USFS Northern Research Station

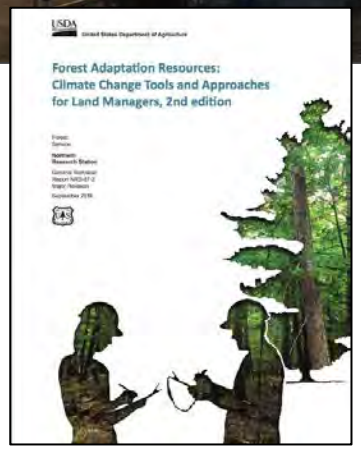
Petawawa Research Forest, ON, Canada
- Michael Hoepting, Natural Resources Canada
- Jeff Fera, Natural Resources Canada
- Trevor Jones, Natural Resources Canada

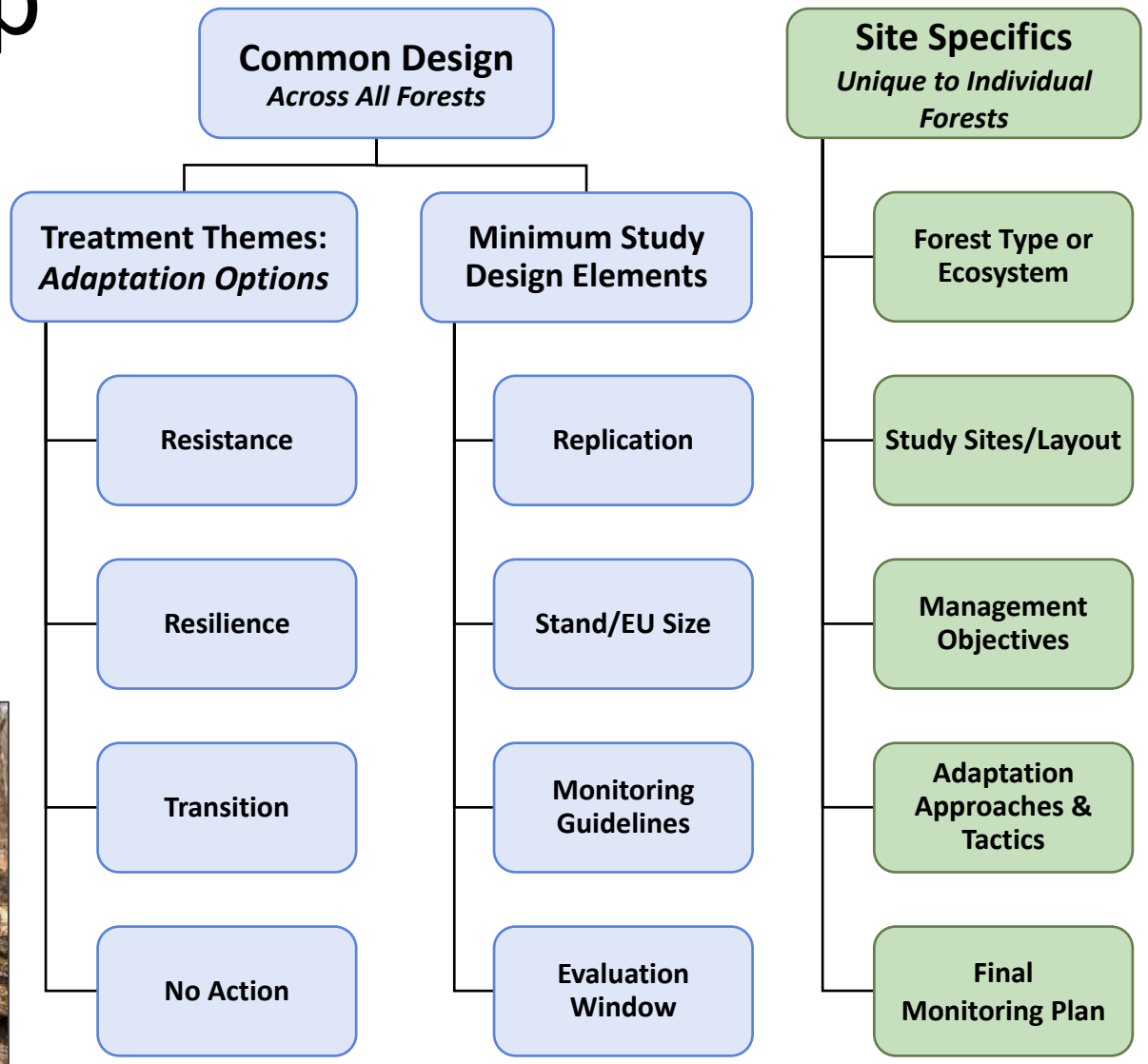
Southern New England Exurban Affiliate, CT
- Tom Worthley, University of Connecticut
- Bob Fahey, University of Connecticut
- Will Hochholzer, Mohegan State Forest
- Daniel Evans, Mohegan State Forest

Colorado State Forest, CO
- Mike Battaglia, USFS Rocky Mountain Research Station
- Blair Rynearson, Colorado State Forest Service
- Ethan Bucholz, Colorado State Forest Service

John Prince Research Forest, BC, Canada
- Che Elkin, University of Northern British Columbia
- Kristen Waring, University of Northern Arizona
- Sue Grainger, John Prince Research Forest

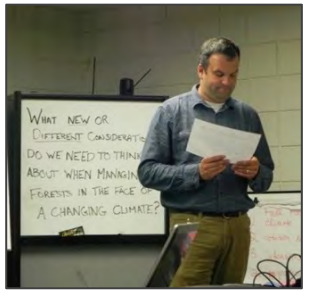
ASCC Study Design and Collaborative Workshop





Collaborative Workshop

Developing the Experimental Treatments



First workshop: MN, June 2013

Most recent workshop: CO, Dec 2020

For <u>each</u> experimental treatment (Resistance, Resilience, Transition):

DFC

↓

Management objectives

↓

Silvicultural practices (tactics)

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

<u>Keep in mind key variables/outcomes</u>:

- **Species composition**
- **Forest health**
- **Forest productivity**
- **Response to disturbance**

<u>For each silvicultural practice (tactic)</u>:

- **Timeframes**
- **Benefits**
- **Drawbacks and Barriers**
- **Practicality**

Identifying Adaptation Tactics

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

1. DEFINE area of interest, management objectives, and time frames.

Vulnerability assessments, scientific literature, and other resources

2. ASSESS climate change impacts and vulnerabilities for the area of interest.

Are desired future conditions reasonable given likely climate trajectories and impacts?

3. EVALUATE management objectives given projected impacts and vulnerabilities.

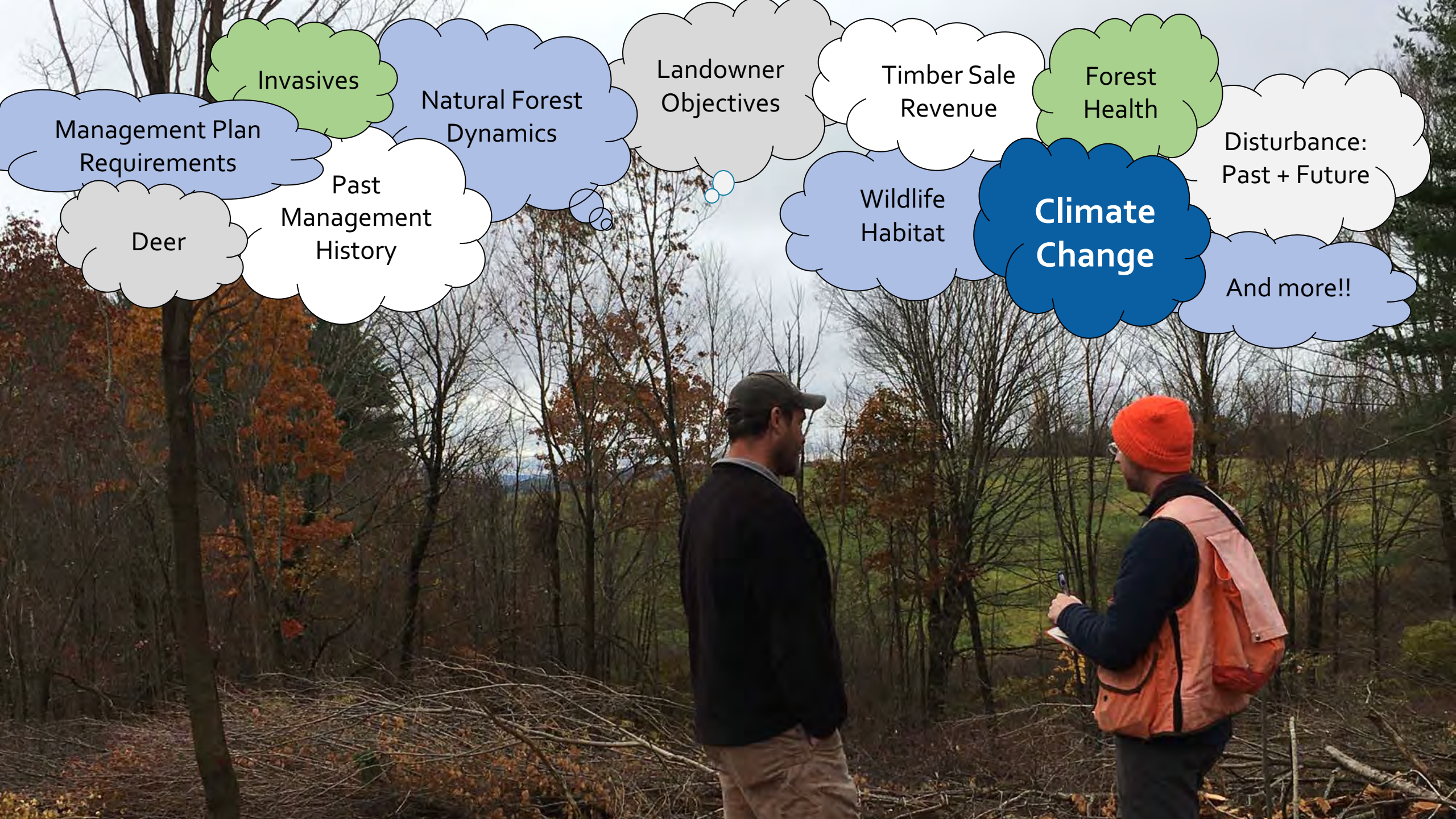
4. IDENTIFY and implement adaptation approaches and tactics.

Adaptation Strategies and Approaches

5. MONITOR and evaluate effectiveness of implemented actions.

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

Adapting to Climate Change


Invasives
Natural Forest Dynamics
Landowner Objectives
Timber Sale Revenue
Forest Health
Management Plan Requirements
Disturbance: Past + Future
Deer
Past Management History
Wildlife Habitat
Climate Change
And more!!

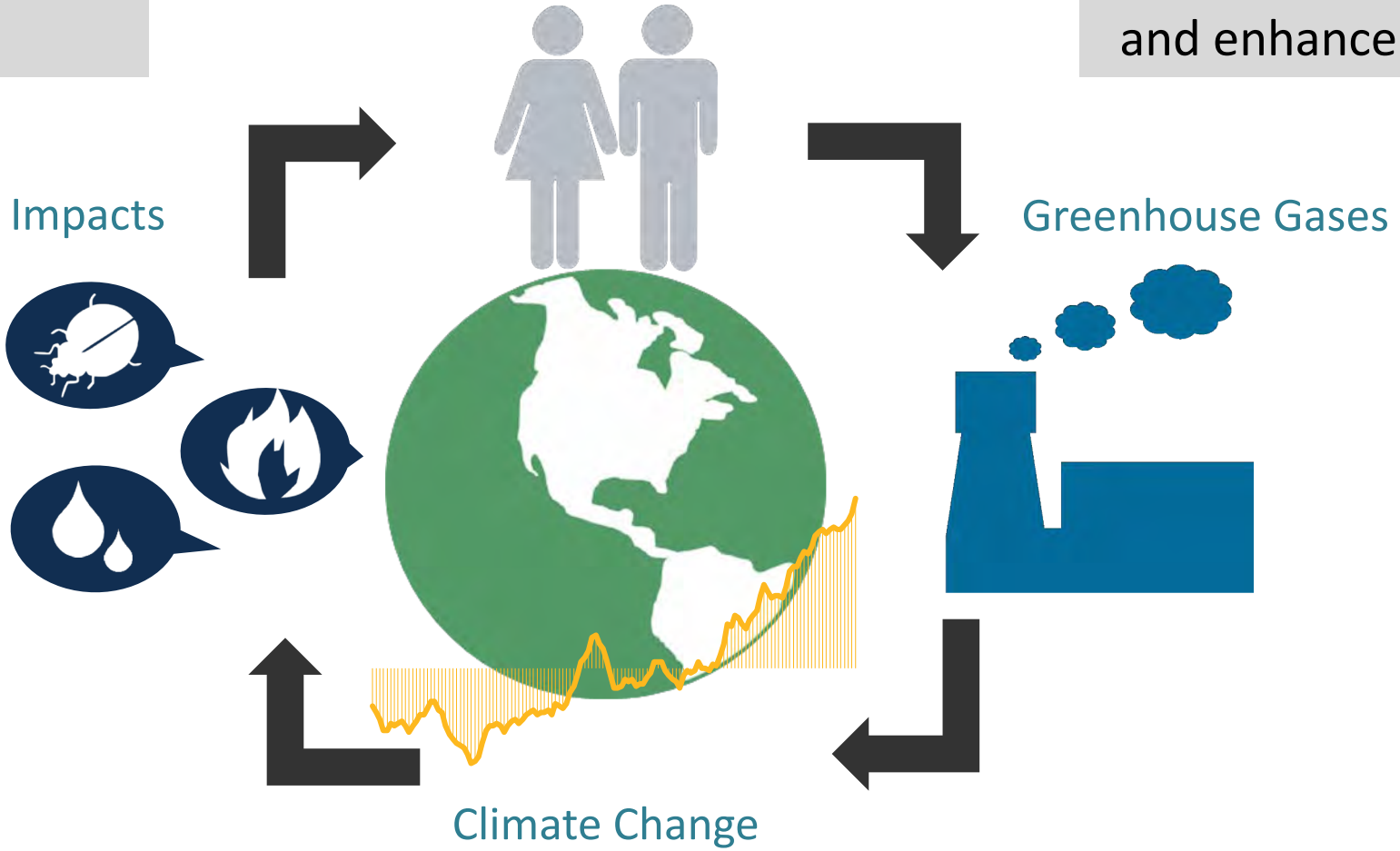
How can we respond to climate change?

Adaptation

Actions to reduce the vulnerability of systems to climate change effects.

Mitigation

Actions that reduce greenhouse gas emissions and enhance carbon sinks.



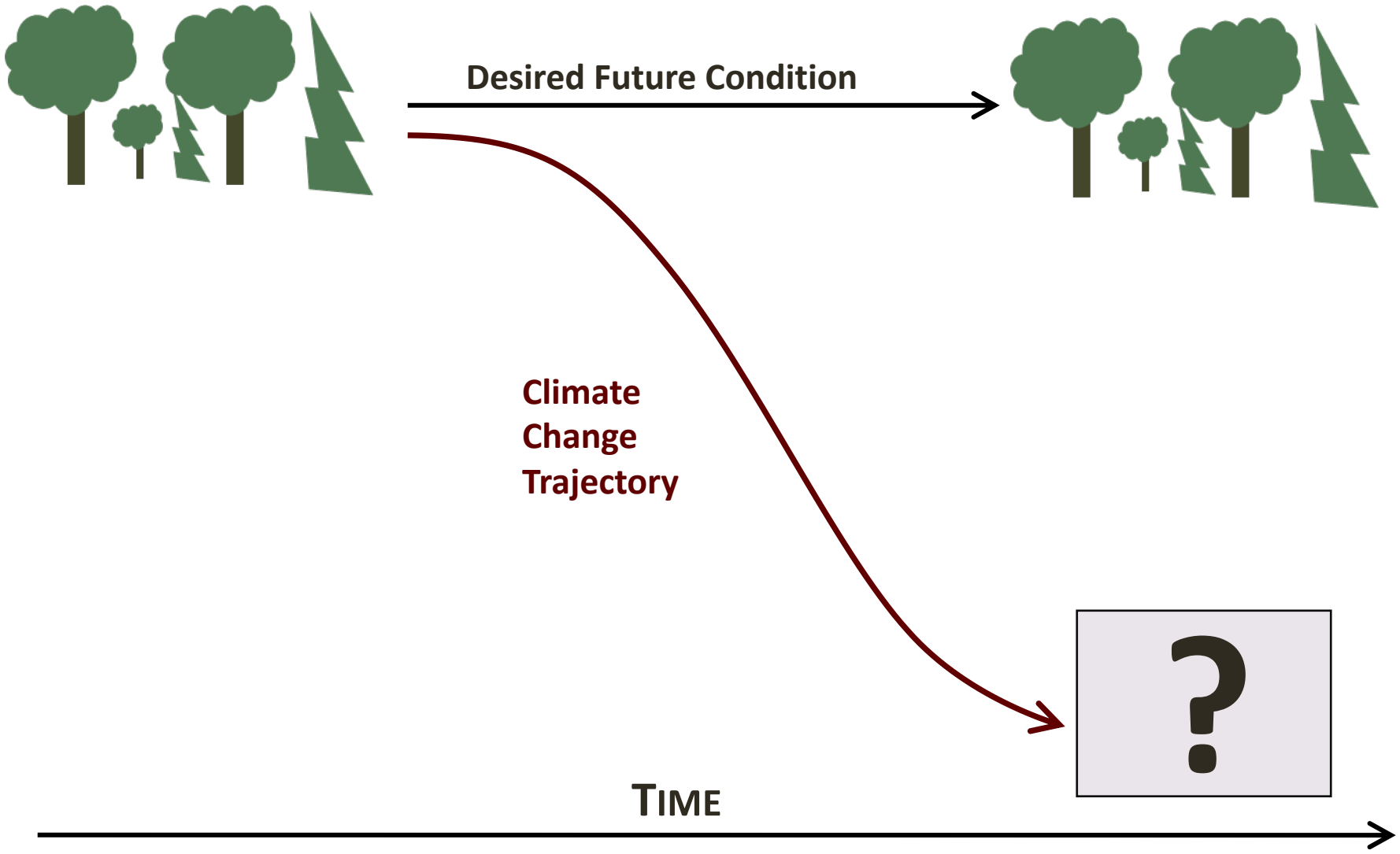
Adaptation - the adjustment of systems in response to climate change.

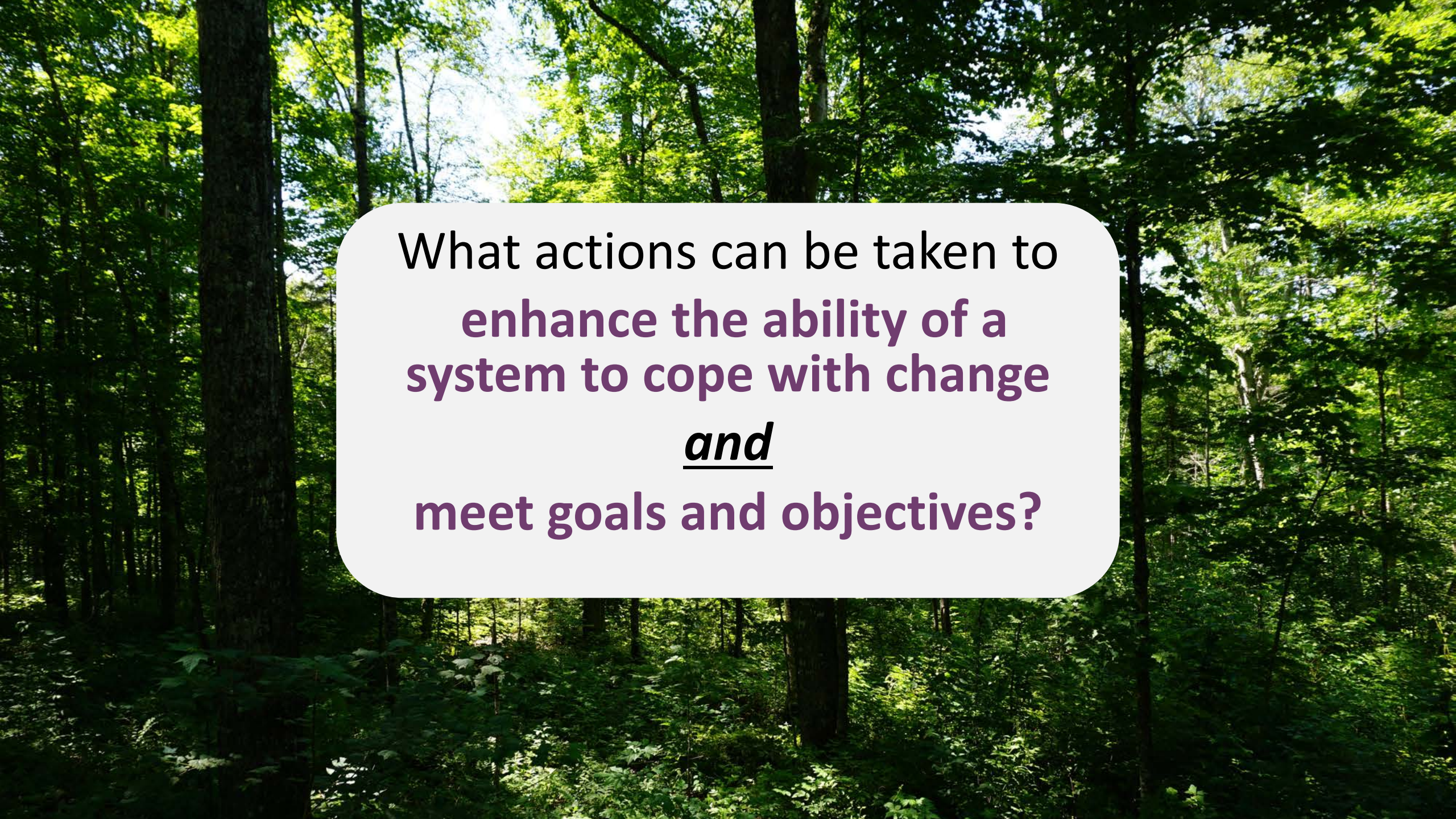



Ecosystem-based adaptation activities build on sustainable management, conservation, and restoration.

- What do you value?
- How much risk are you willing to tolerate?

Climate-Driven Changes



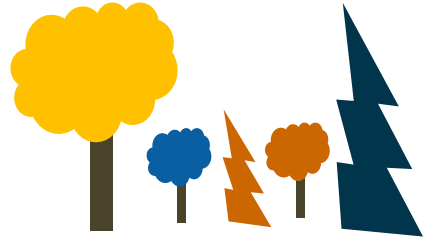

What actions can be taken to
enhance the ability of a system to cope with change
and
meet goals and objectives?

Adaptation Options

RESISTANCE

RESILIENCE

TRANSITION



Identify and implement actions that are

robust across a range of potential future conditions

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

Resistance

Improve the defenses of the system against anticipated changes or directly defending against disturbance in order to maintain relatively unchanged conditions.

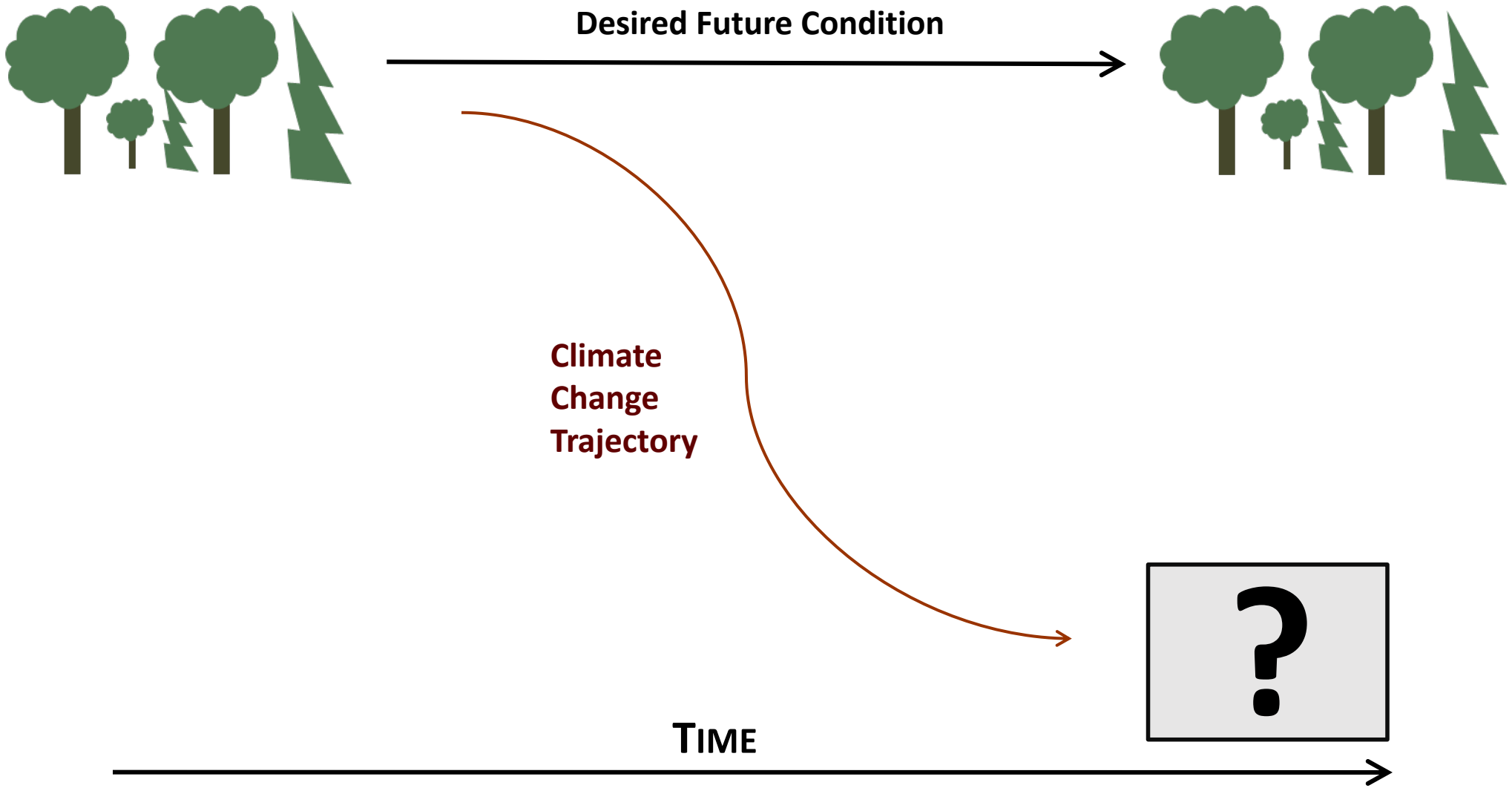
Road crossings that can withstand flood events (USFS, Monongahela NF)

Threatened Dwarf lake iris (FWS)

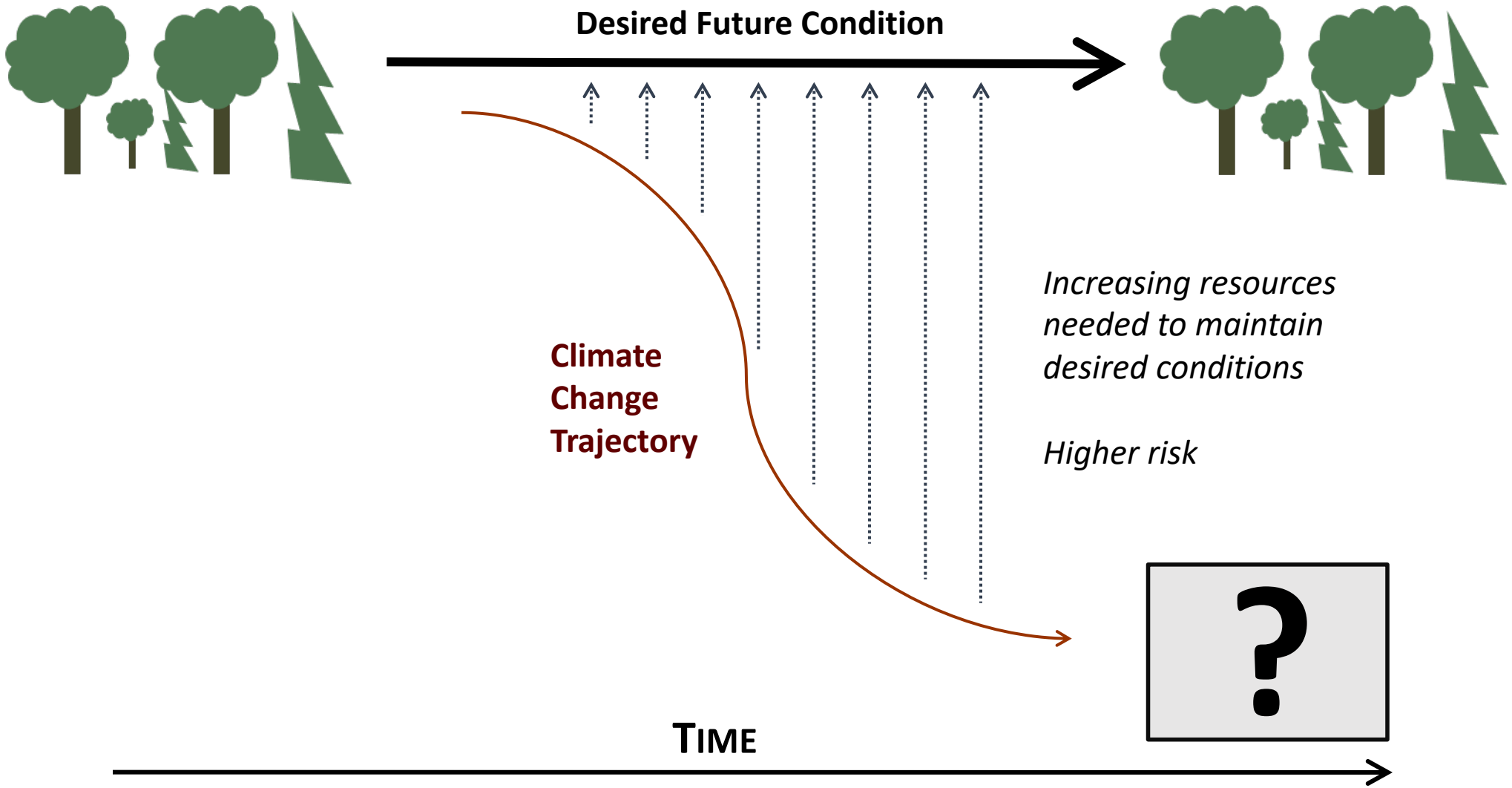
Invasive species management (USFS)

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

Resistance



Resistance


Desired Future Condition
Climate Change Trajectory
Increasing resources needed to maintain desired conditions
Higher risk
?
TIME

Resilience

Accommodate some degree of change or disruption, but be able to return to a similar condition after disturbance.

- Improve overall health & vigor
- Management of vegetation following disturbance

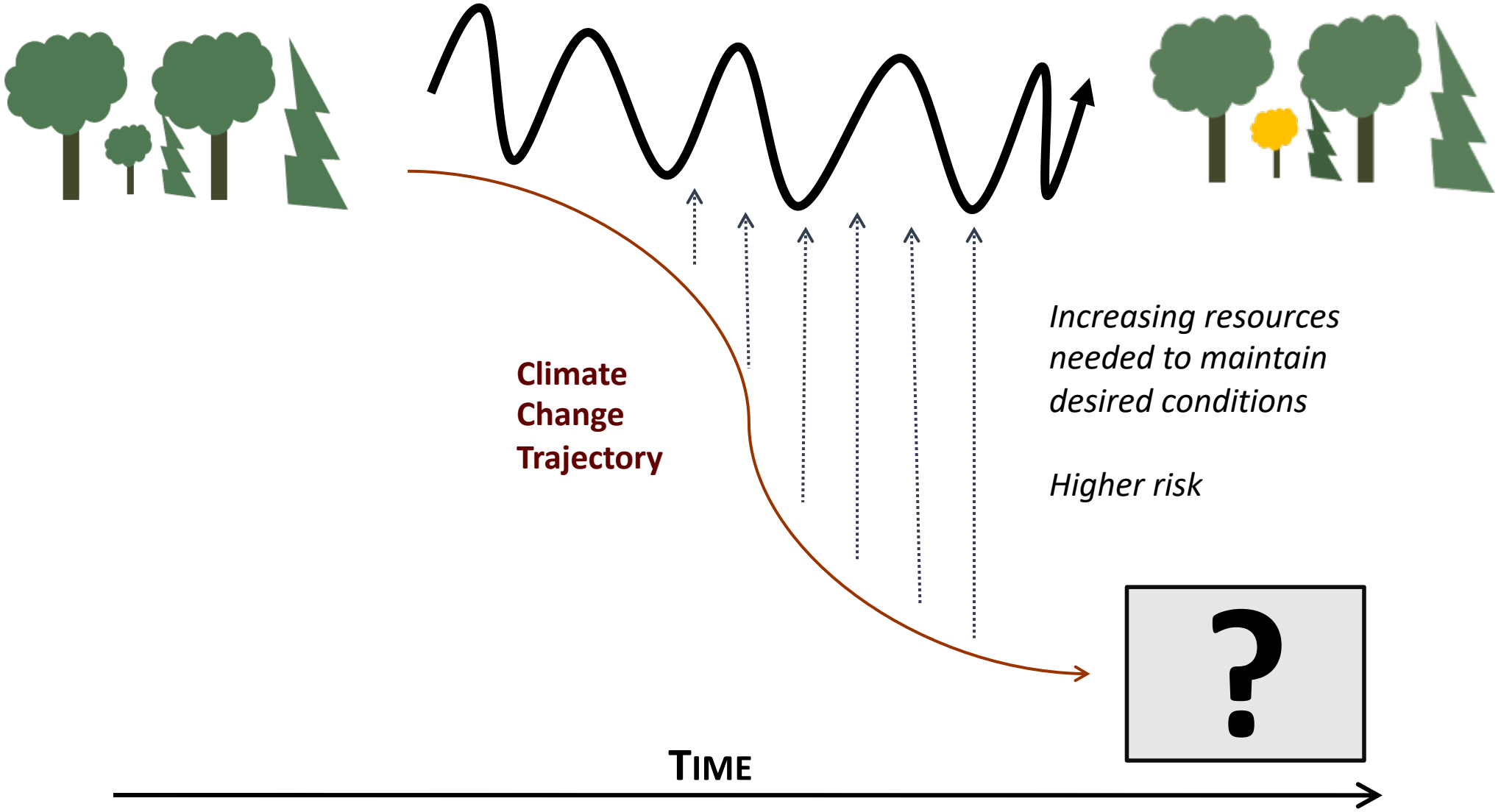
Prescribed burning to regenerate fire-adapted species

Reducing overstocked stands (Tahoe NF)

Increasing setbacks to allow for fluctuating water levels.

Holling 1973, Millar et al. 2007, Swanston et al. 2016
See also – Moser et al. 2019

Resilience

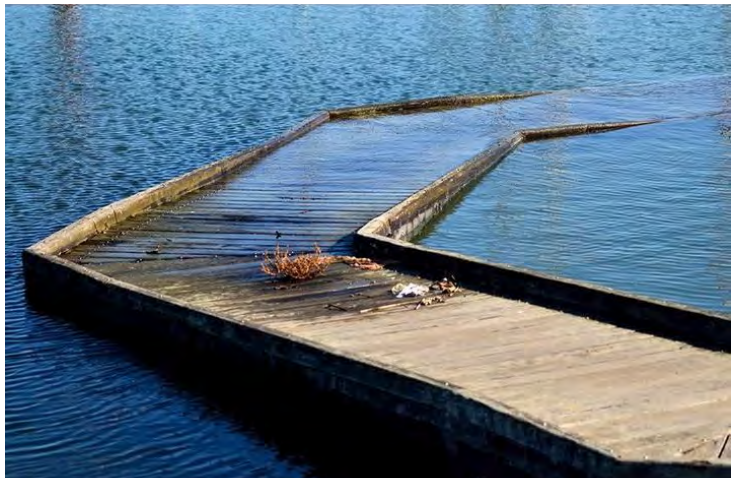

Climate
Change
Trajectory
Increasing resources
needed to maintain
desired conditions
Higher risk
?
TIME

Transition

Intentionally accommodate change and enable ecosystems to adaptively respond to changing and new conditions

- Foster well-adapted native species
- Relocate visitor and recreation infrastructure
- Accommodate new & altered hydrologic processes

Favoring native species that are expected to be adapted to future conditions.

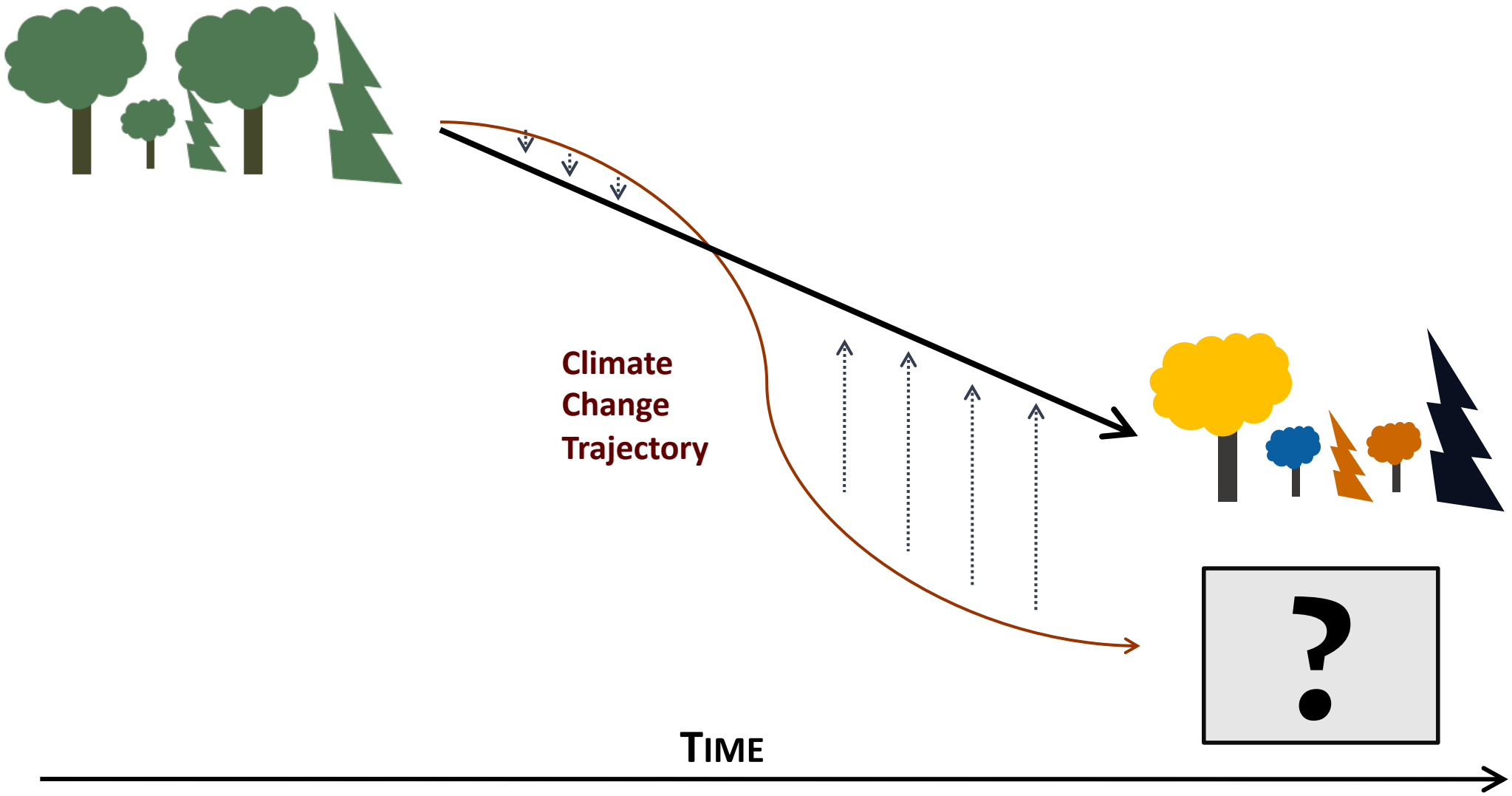


Relocate existing infrastructure to areas with less risk (P:Tom Hilton)

River & riparian area restoration in agricultural fields (P:Joann Kline)

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

Transition



ASCC is testing a spectrum of adaptation options

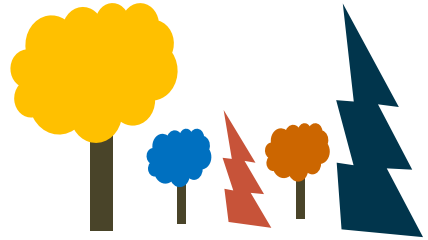
RESISTANCE

- 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

Intentionality

- Explicitly consider and address climate change
- Sure we might get lucky…
- Intentionally assessing risk and vulnerabilities **makes our plans more robust!**

Experimental Treatment Definitions

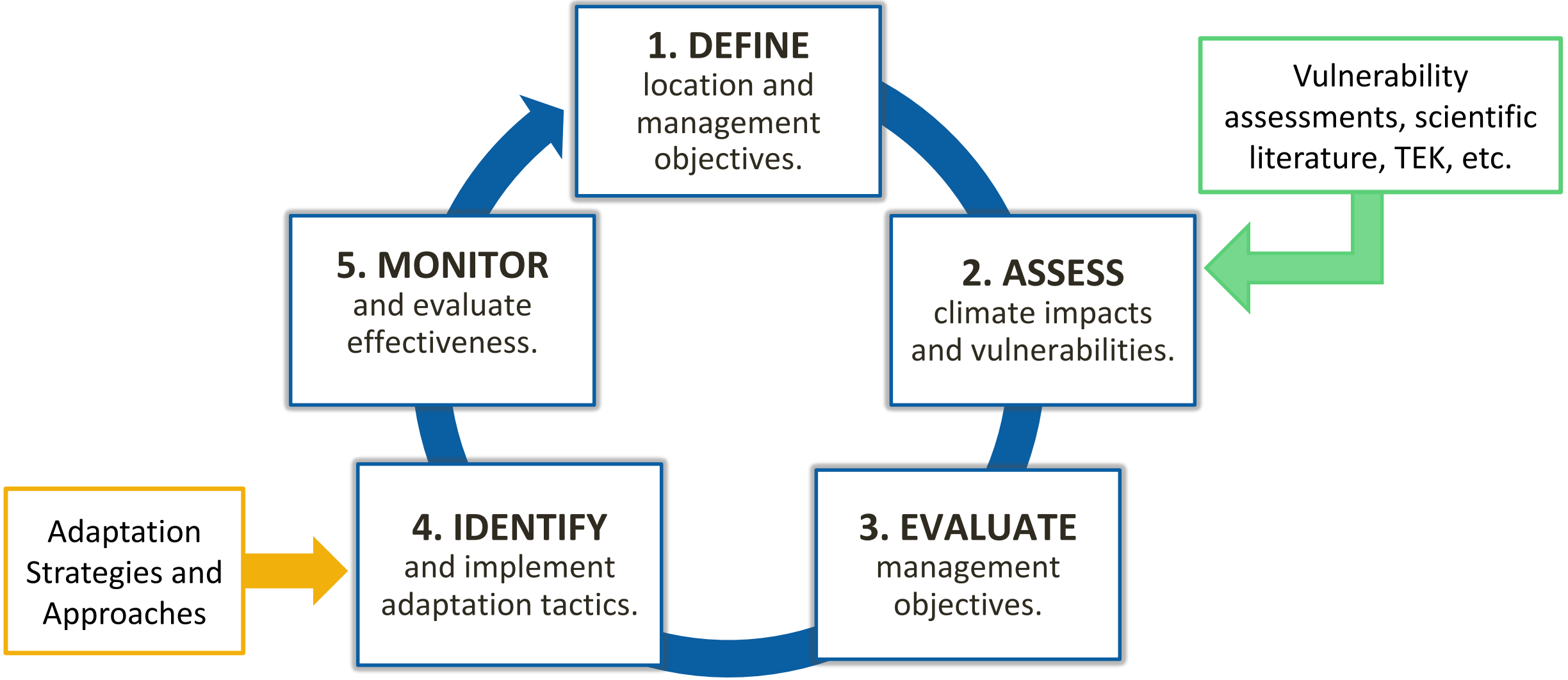
Treatment Name	Experimental Treatment Definition
RESISTANCE	Actions that improve the defenses of the forest against anticipated change or directly defend the forest against disturbance in order to maintain relatively unchanged conditions.
RESILIENCE	Actions that accommodate some degree of change, but 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

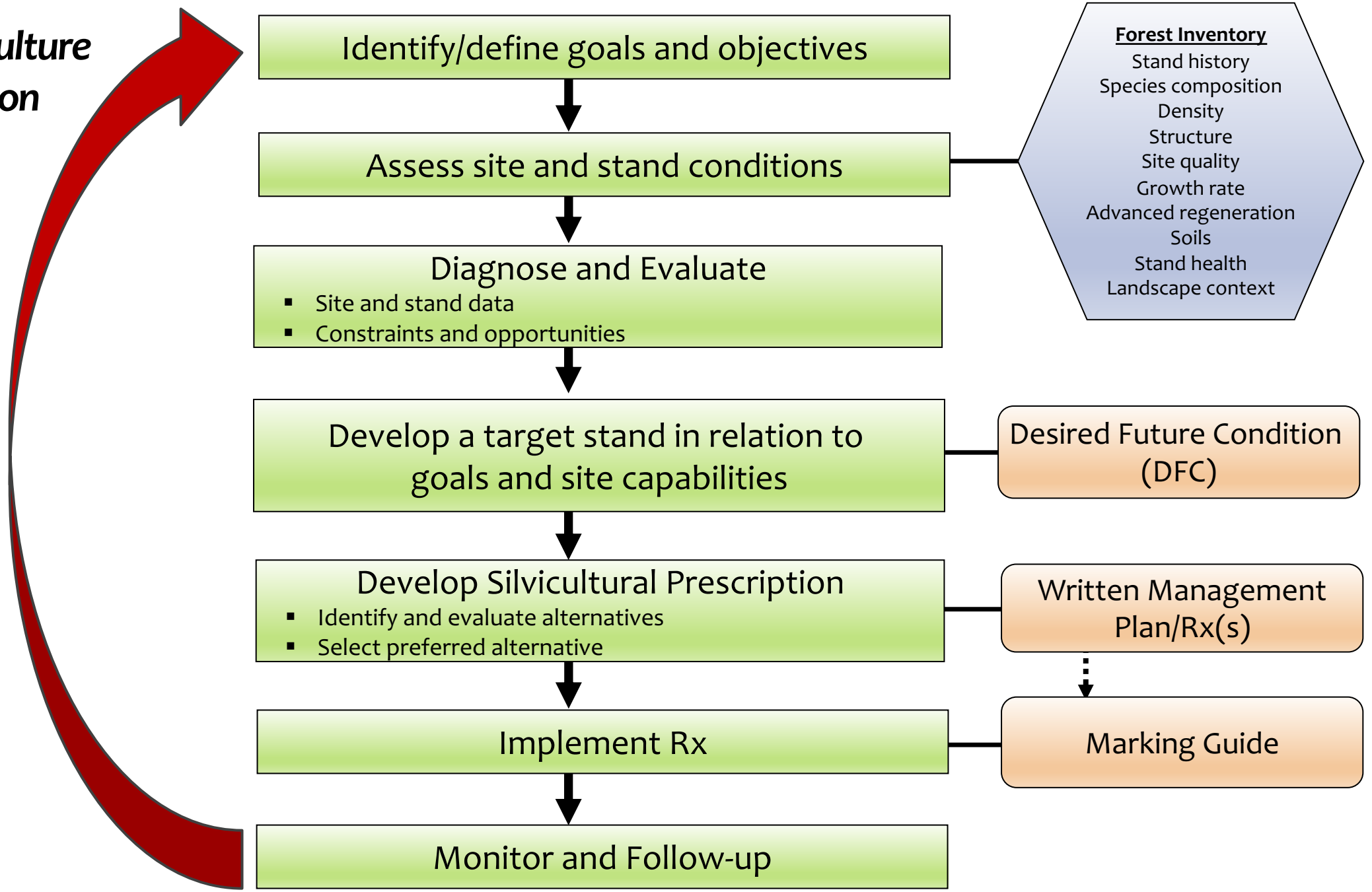
Identifying Adaptation Tactics

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



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

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

- Example: Manage for resilient forests

Objectives

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

- Example:

Goals vs. Objectives

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- Example: Manage for resilient forests

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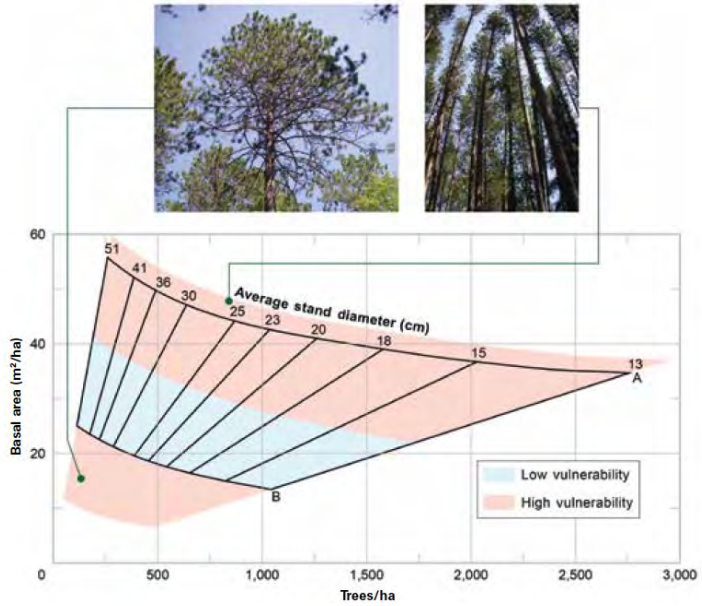
- Tactical



- 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)

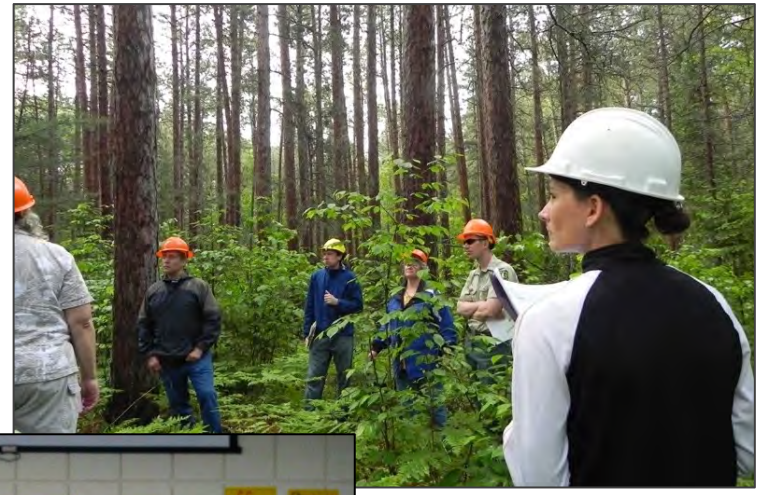
What do you want the stand to be and look like?

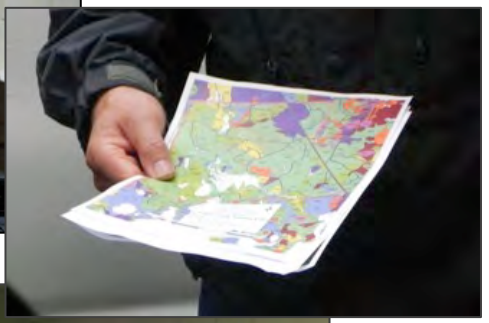
Keep in mind key variables/outcomes:

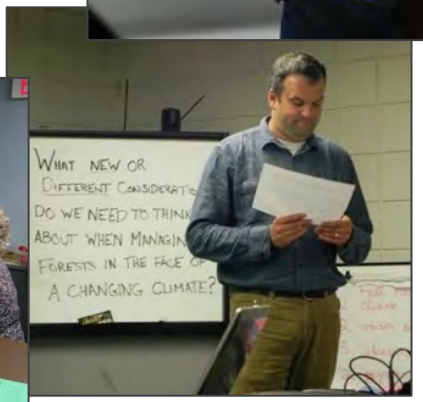
- **Species composition**
- **Forest health**
- **Forest productivity**
- **Response to disturbance**

For each silvicultural practice (tactic):

- **Timeframes**
- **Benefits**
- **Drawbacks and Barriers**
- **Practicality**
- **Recommend tactic?**

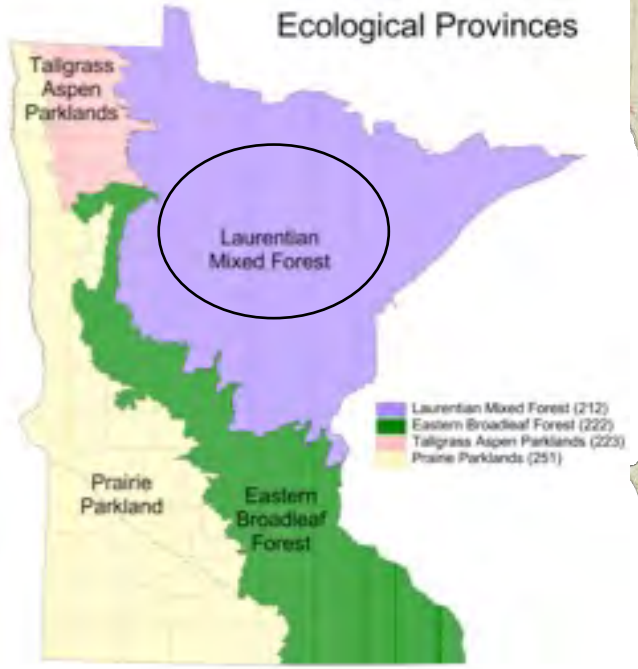


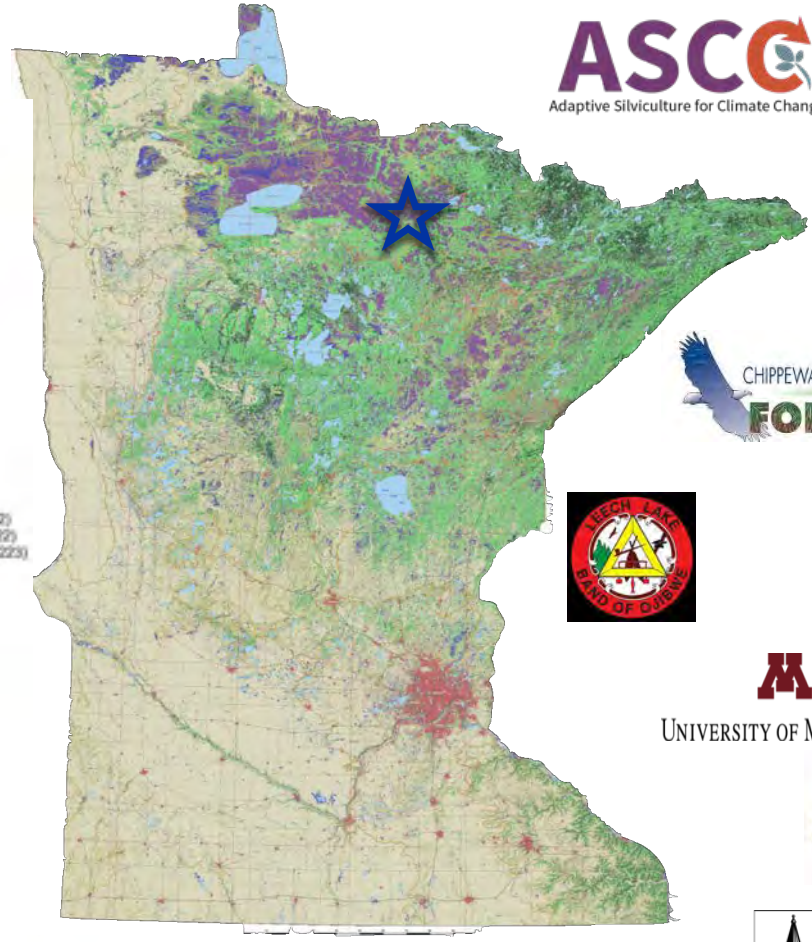




Red Pine ASCC

- Chippewa National Forest, MN
- Cutfoot Experimental Forest
- Workshop: June 25-27, 2013
- Follow-up@Climate Change Summit
- First ASCC site implemented (2014)





USDA Forest Service
Northern Research Station

ASCC
Adaptive Silviculture for Climate Change

CHIPPEWA NATIONAL FOREST

LEECH LAKE BAND OF OJIBWE

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

UNIVERSITY OF MINNESOTA

STATE

NH

NECASC
Northeast Climate Adaptation Science Center

The University of Vermont

FOREST AND RANGELAND STEWARDSHIP
COLORADO STATE UNIVERSITY

USGS
science for a changing world

NIACS
Northern Institute of Applied Climate Science

Laurentian-Acadian Northern Pine/Oak Woodlands

-1.4 million ha pre-European settlement

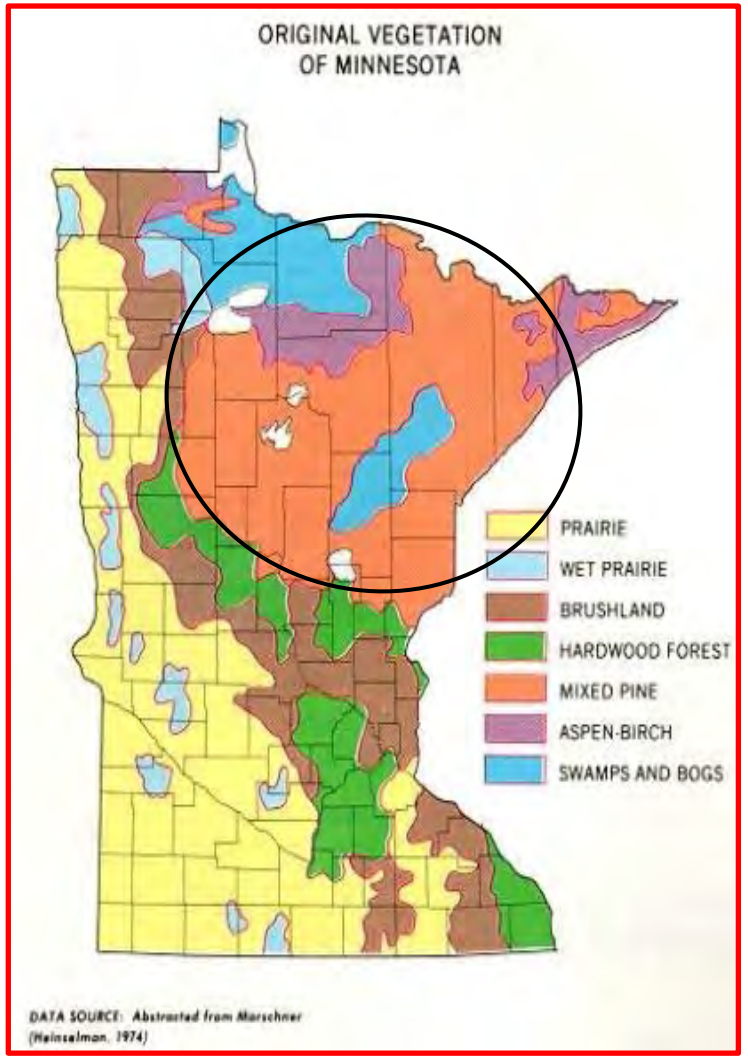
-Mixed-species: *red pine, eastern white pine, balsam fir, white spruce, jack pine, trembling and bigtooth aspens, red maple, northern red oak, bur oak, paper birch*

-Northern Dry-Mesic Mixed Woodland (FDn33a)

-Fire dependent (mixed-severity fire regime)

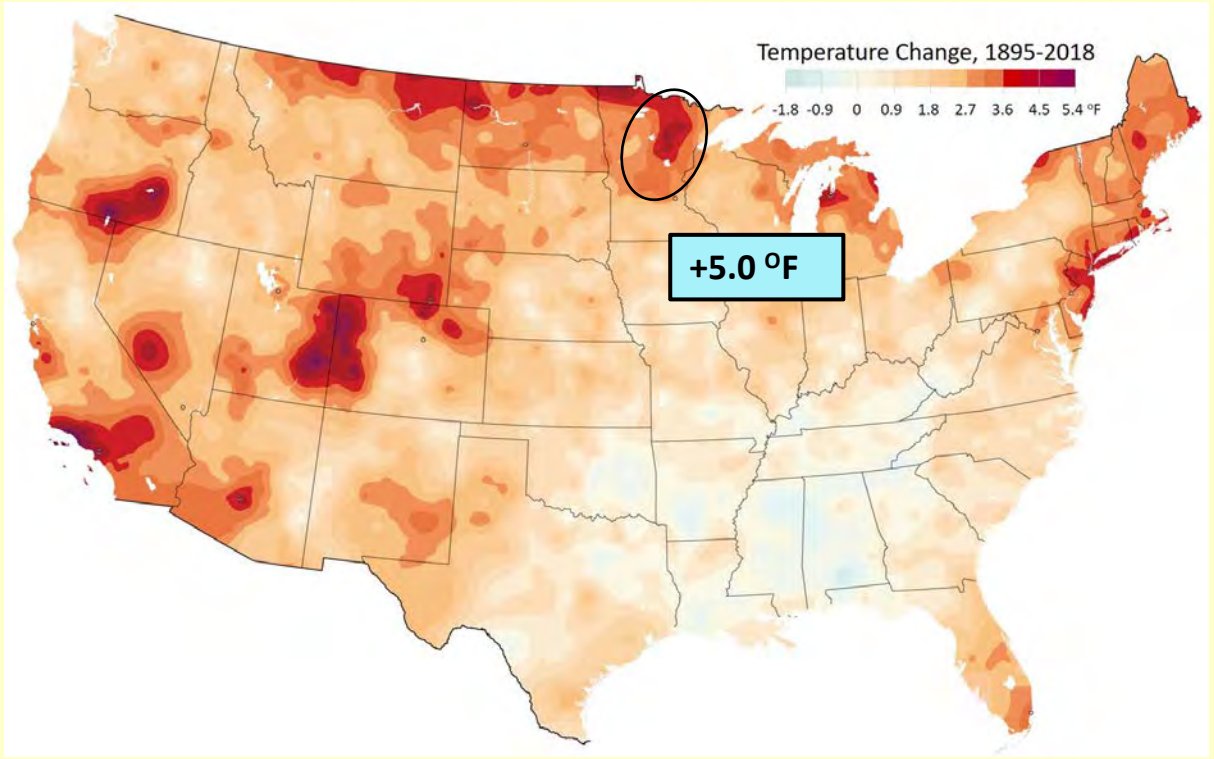
-Variably open tree canopy

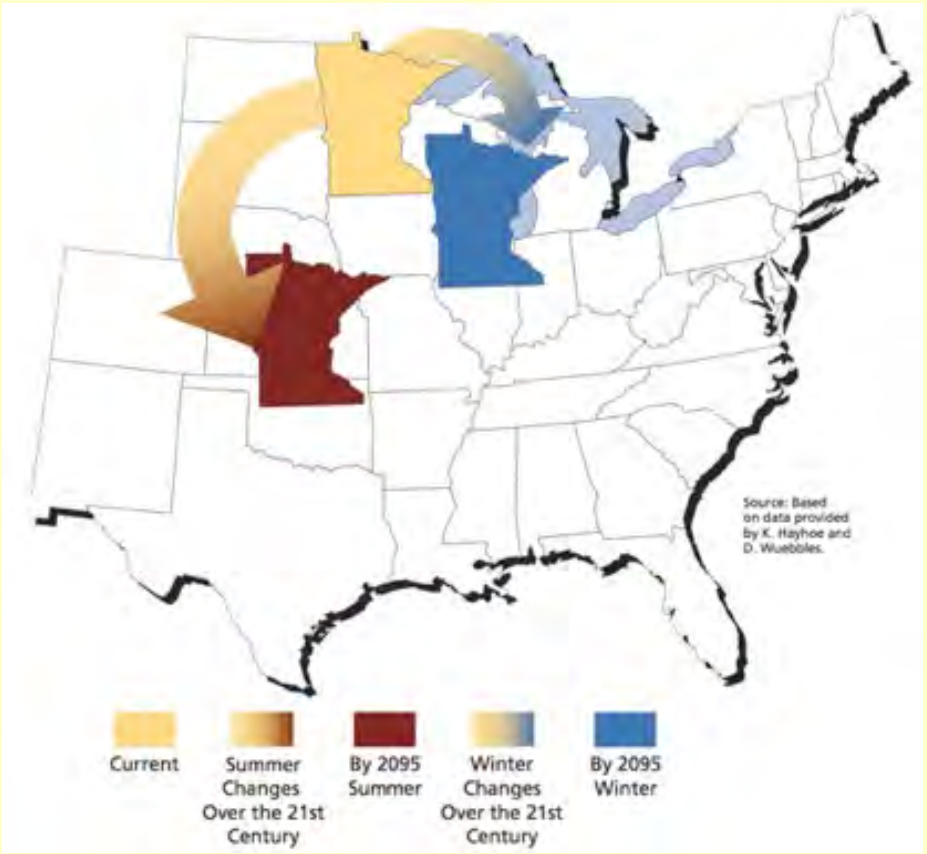
-Occupy sandy, drought prone soils



Climate Change

- Increased growing season drought
- Warmer, wetter winters
- Increased threat from new pests (e.g., mountain pine beetle)

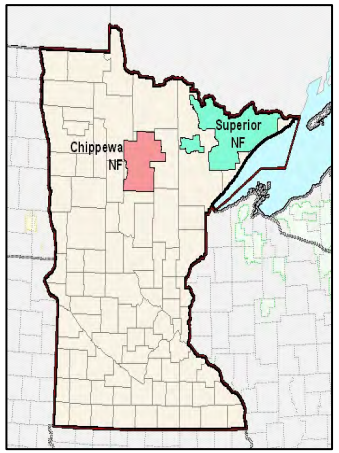


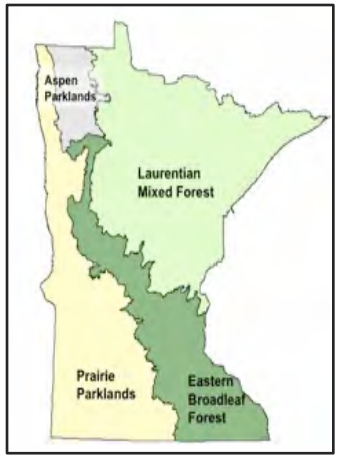


http://www.ucsusa.org/greatlakes/glchallengereport.html

Changes in habitat suitability for most northern tree species

Chippewa NF – Tree Atlas Version 4





Change in Habitat Suitability

Species	RCP45	RCP85
Quaking aspen	Sm Dec	Sm Dec
Balsam fir	Sm Dec	NC
Black spruce	Sm Dec	Sm Dec
Paper birch	NC	NC
Jack pine	Sm Dec	NC
Bigtooth aspen	Sm Inc	NC
White spruce	NC	Sm Inc
Red pine*	**Sm Dec**	**Sm Dec**
Northern red oak	Lg Inc	Lg Inc

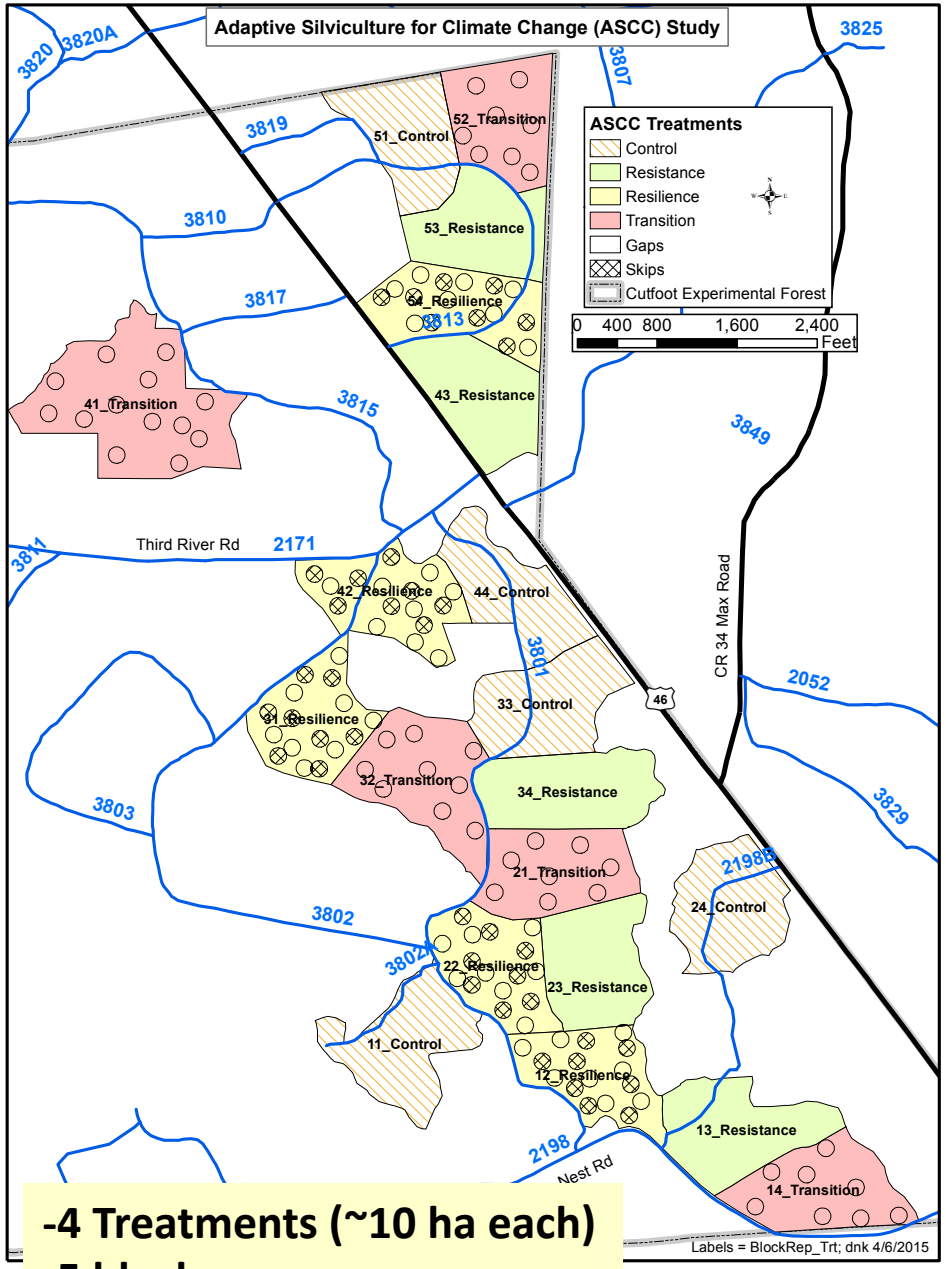
Potential for increasing issues from insects and diseases; Red pine growth is very sensitive to drought

Change in Habitat Suitability

Species	RCP45	RCP85
Bur oak	**Lg Inc**	**Lg Inc**
Red maple	**Lg Inc**	**Lg Inc**
Eastern white pine	**Lg Inc**	**Lg Inc**
White oak	**Lg Inc**	**Lg Inc**
Black cherry	**Lg Inc**	**Lg Inc**
Bitternut hickory	**New**	**New**

Red Pine-ASCC

Red Pine-ASCC



-4 Treatments (~10 ha each)
-5 blocks

- **Strongly red pine dominated**
- **Dense understory of *Corylus* (hazel)**
- **Average basal area 41 m²/ha (180 ft²/ac)**
- **Fire-origin 1918; fire exclusion since**
- **Largely even-aged**

Red Pine-ASCC

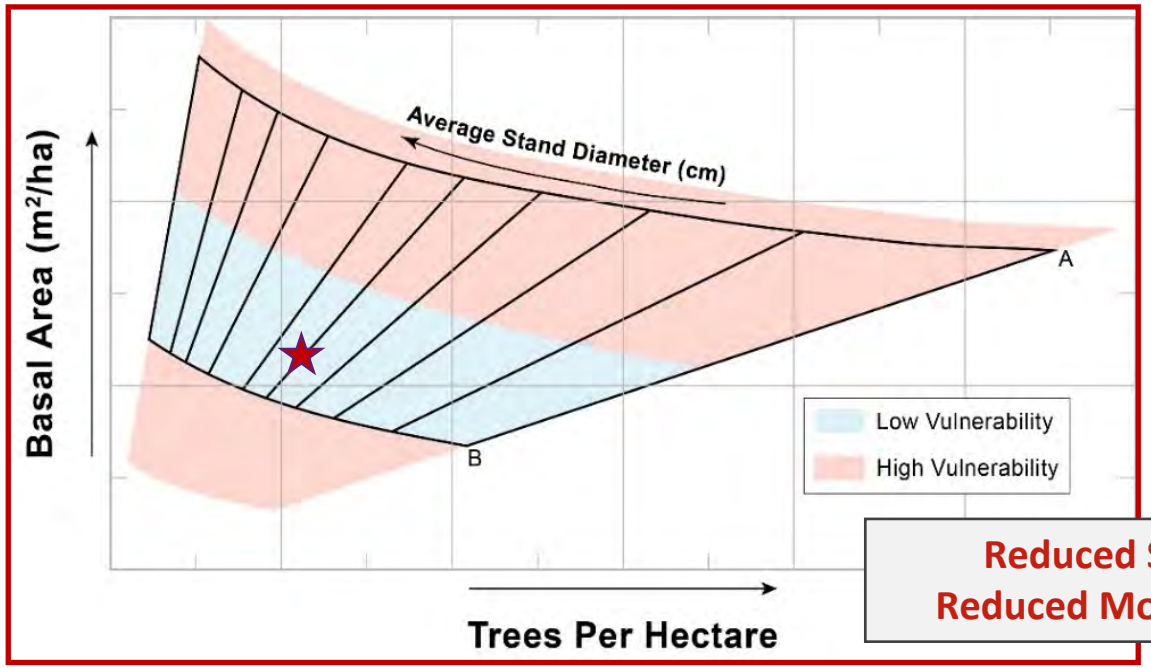
RESISTANCE maintain relatively unchanged composition

DFC/Goal (near-term)

- Maintain RP dominance (90% BA)
- Reduced stocking closer to historical condition

Tactics

- Free thin to 100-120 ft^2/ac (closer to B-line)
- Harvest RP largely
- Reserve large-diameter trees



Reduced Stocking =
Reduced Moisture Stress

Red Pine-ASCC

Change in Habitat Suitability

Species	RCP45	RCP85
Bur oak	Lg Inc	Lg Inc
Red maple	Lg Inc	Lg Inc
Northern red oak	Lg Inc	Lg Inc
Eastern white pine	Lg Inc	Lg Inc
Jack pine	Sm Dec	NC

RESILIENCE allow some change within range of natural variability

DFC/Goal (mid-term)

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

Tactics

- Variable density thinning (skips & gaps)
  - 20% unthinned in ½ ac skips
  - 20% in ½ ac gaps, retain 2-3 large diameter trees
  - Disperse thin matrix to 100-120 ft^2/ac
- Site preparation and planting future-adapted ***native*** species in gaps

Seed from next southern climate zone, except local jack pine

Red Pine-ASCC

TRANSITION enable ecosystems to respond to changing conditions

DFC/Goal (longer-term)

- Reduce red pine to 20-50%, multi-cohort structure
- Increase future-adapted species

Tactics

- Expanding gap irregular shelterwood
  - 20% in ½ ac gaps, retain 2-3 large diameter trees
  - Thin matrix to 60-80 ft^2/ac
- Site preparation entire stand
- Regenerate/plant future-adapted species in gaps *and* matrix (***native*** and ***novel*** species)

Species choices based on Tree Atlas modeling and expert experience

Species	RCP45	RCP85
Bur oak	Lg Inc	Lg Inc
Red maple	Lg Inc	Lg Inc
Eastern white pine	Lg Inc	Lg Inc
Northern red oak	Lg Inc	Lg Inc
White oak	Lg Inc	Lg Inc
Black cherry	Lg Inc	Lg Inc
Bitternut hickory	New	New
Ponderosa pine	?	?

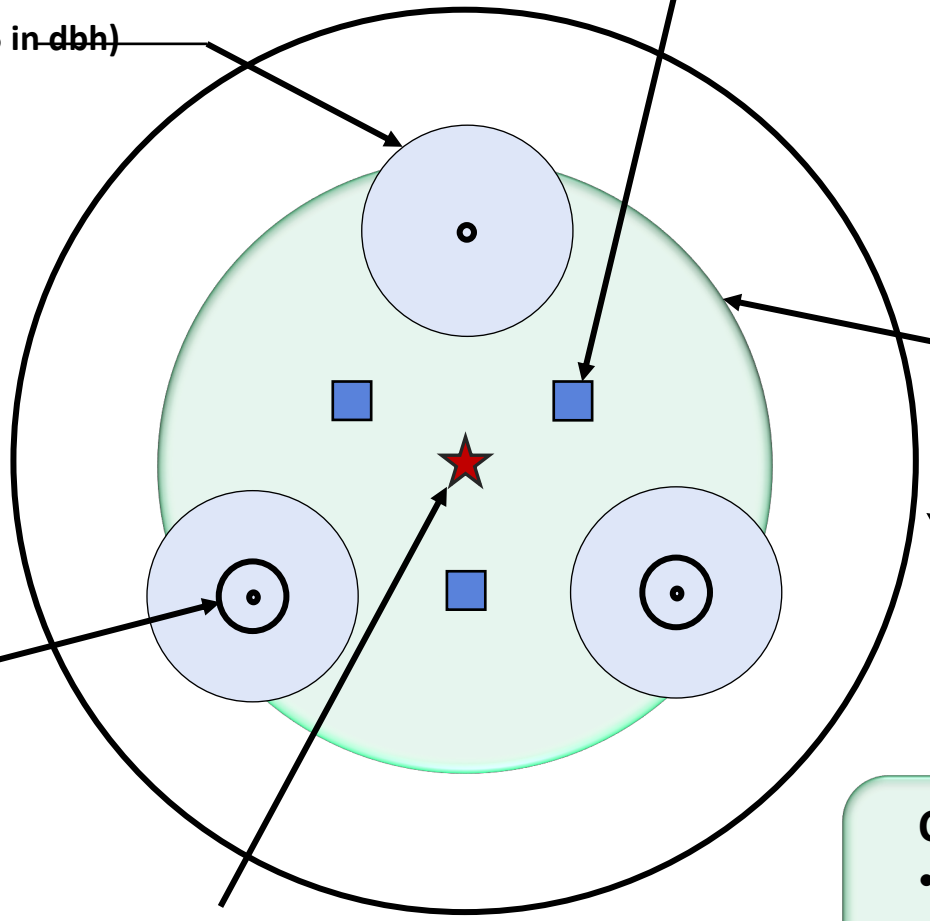
ASCC Plot Design

170 vegetation plots

- **Passive / Resistance 7 plots (per rep)**
- **Resilience (per rep)**
  - **3 in gaps**
  - **3 in skips**
  - **5 in matrix**
- **Transition (per rep)**
  - **3 in gaps**
  - **6 in matrix**

Ground Layer Plot (3)
1 m^2
Herbaceous/woody spp

Small Tree Plot (Adv Regen) (3)
0.004 ha (1/100th ac)
Measuring (≥ 1 ft tall to ≤ 3.5 in dbh)



Sapling Sub-Plot
0.04 ha (1/10th ac)
Measuring 3.5 to 7.4 in dbh

Annular Plot
0.08 ha (1/5th ac)
Measuring ≥ 7.5 in dbh

Shrub Plot (2)
5 m^2
Tally by species

LAI and Photos
Microclimate stations

Commone Response Variables:

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

What Are We Studying?

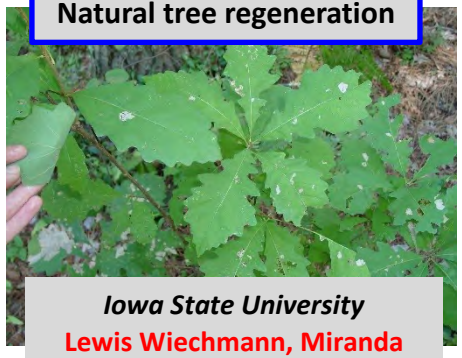
Planted tree regeneration

University of Minnesota, Colorado State University
Jacob Muller, Linda Nagel, Lucia Fitz Vargas

Small mammals

USGS NECSAC
Toni Lyn Morelli, Alexej Siren
Jamie Mosel

Natural tree regeneration

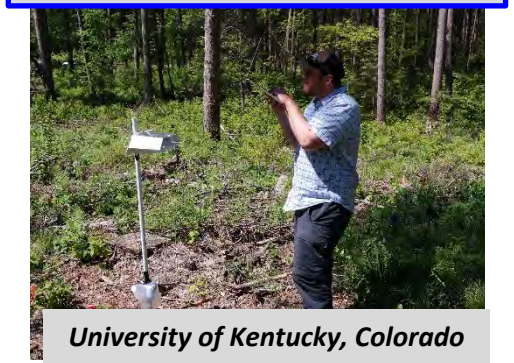


Iowa State University
Lewis Wiechmann, Miranda Curzon

Blueberry response

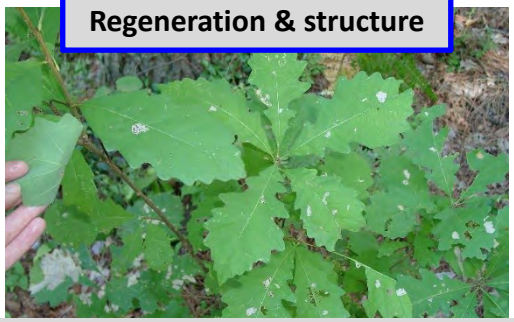
University of Minnesota
Sara de Sobrino, Jamie Mosel, Rebecca Montgomery

Microclimate



University of Kentucky, Colorado State University
Jacob Muller, Linda Nagel

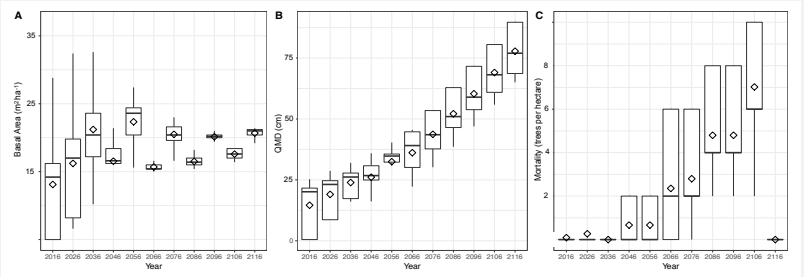
Regeneration & structure



University of Vermont
Tony D'Amato

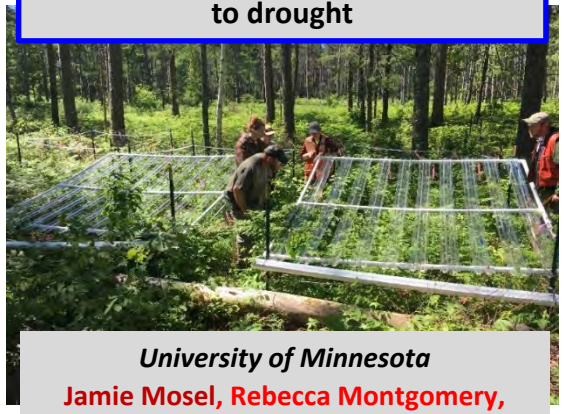
Bird responses to forest structure

FVS modeling



University of Kentucky, Colorado State University
Jacob Muller, Linda Nagel

Physiological responses of seedlings to drought



University of Minnesota
Jamie Mosel, Rebecca Montgomery, Matt Russel

Ojibwe Interpretation

University of Minnesota, Leech Lake Tribal College
Jamie Mosel, Rebecca Montgomery

Also:
Ground layer plant communities,
Forest productivity

Developing the Experimental Treatments

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

DFC

Management objectives

Silvicultural practices (tactics)

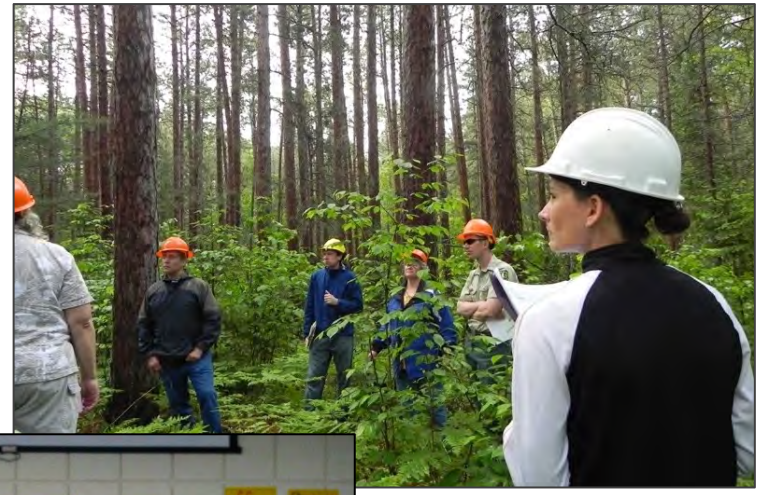
What do you want the stand to be and look like?

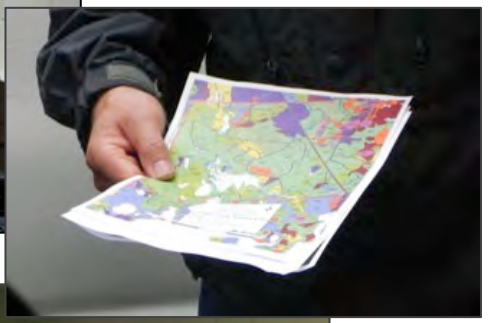
Keep in mind key variables/outcomes:

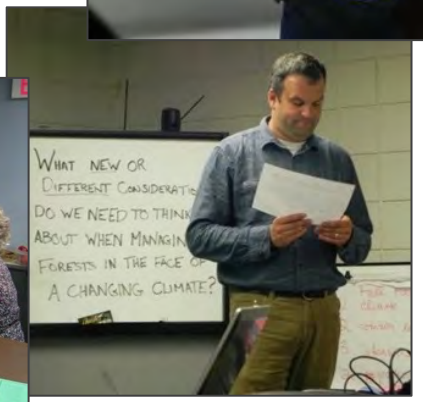
- **Species composition**
- **Forest health**
- **Forest productivity**
- **Response to disturbance**

For each silvicultural practice (tactic):

- **Timeframes**
- **Benefits**
- **Drawbacks and Barriers**
- **Practicality**
- **Recommend tactic?**







Workshop 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
- We are recording the workshop

Breakout Groups

Group 1	Group 2	Group 3	Group 4
Facilitator – Stephen Handler	Facilitator – Brian Palik	Facilitator – Courtney Peterson	Facilitator – Miranda Curzon
Greg Edge	Brad Hutnik	Ann Calhoun*	Mike Reinikainen
Alex Hoffman*	Brandon Bleur	John Pearson	David Ruff*
Armund Bartz	Jess Flatt*	Kevin O'Brien	Scott Walter
John Withers	Dan Kaminski	Trent Stuchel	Karen Kinkeade
Joe Brown	Michelle Martin	Brandon Schad	Colleen Matula
Sascha Lodge	Paul Dubuque	Bruce Blair	Lewis Wiechmann
Jeff Goerndt			

ASCC
Adaptive Silviculture for Climate Change

Designing Forest Adaptation Treatments Across the Driftless Region Through Manager-Scientist Partnerships

Adaptive Silviculture for Climate Change (ASCC)
Driftless Region Workshop

December 2, 9, & 10, 2021

FOREST AND RANGELAND STEWARDSHIP
COLORADO STATE UNIVERSITY

NIACS
Northern Institute of Applied Climate Science

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

IOWA STATE UNIVERSITY

ASCC
Adaptive Silviculture for Climate Change

DEPARTMENT OF NATURAL RESOURCES

DNR IOWA DEPARTMENT OF NATURAL RESOURCES

WISCONSIN DEPT. OF NATURAL RESOURCES

Workshop Agenda – Day 3, Friday, Dec. 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 about based on the ASCC treatments?
- **11:30** Large Group Adjourn
- **11:30** (*ASCC Site Leads*) Identify key implementation and monitoring next steps

https://www.audubon.org/field-guide/bird/cerulean-warbler

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