ASCC
Adaptive Silviculture for Climate Change

Designing Forest Adaptation Treatments At the Mohegan State Forest Through Scientist-Manager Partnerships

UCONN
NATURAL RESOURCES AND THE ENVIRONMENT

Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

Adaptive Silviculture for Climate Change (ASCC) on the CT Urban/Exurban Landscape

October 19, 20, & 21, 2020

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Land Acknowledgement

Introductions

Amanda Bunce	Eric Hansen
Anita Morzillo	Jill Humphreys
Audrey Barker-Plotkin	Lisa Hayden
Beth Bernard	Malcolm Itter
Brett Butler	Maria Janowiak
Carla Fenner	Max Piana
Christopher Pryor	Richard Hallett
Christopher Riely	Robert Fahey
Courtney Peterson	Tony D'Amato
Dan Evans	Tom Worthley
Doug Emmerthal	Will Hochholzer

Tell us your name, organization, and one activity you have taken up during quarantine

Workshop Goals

- Engage local managers and scientists in the Adaptive Silviculture for Climate Change (ASCC) co-development framework through the co-creation of locally-relevant climate change adaptation strategies;
- Use an adaptive planning process to design specific climate change adaptation experimental treatments for a set of exurban oak-hickory forest stands that will be part of a long-term study to be implemented at the Mohegan State Forest;
- 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

Overall project goals: Forest managers need robust, operational examples of **how to integrate climate change adaptation into silvicultural planning and on-the-ground actions** that can…

- Foster resilience to the impacts of climate change and/or
- Enable adaptation to uncertain futures

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Project Goals:

1) 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
2) Introduce managers to tools and approaches to integrate climate change into silvicultural decision making that meets management goals and objectives

The ASCC Network

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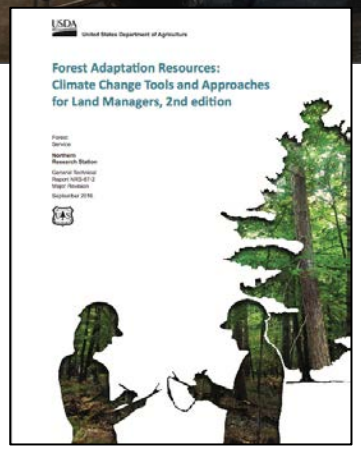
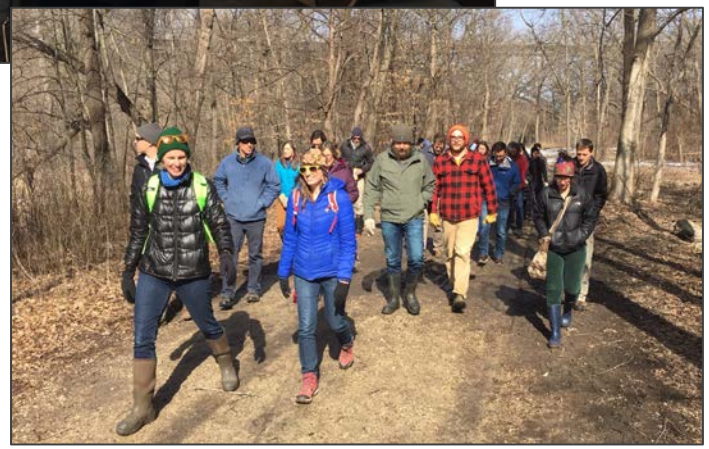
Adaptive Silviculture for Climate Change

ASCC Study Design and Collaborative Workshop





Common Design
Across All Forests

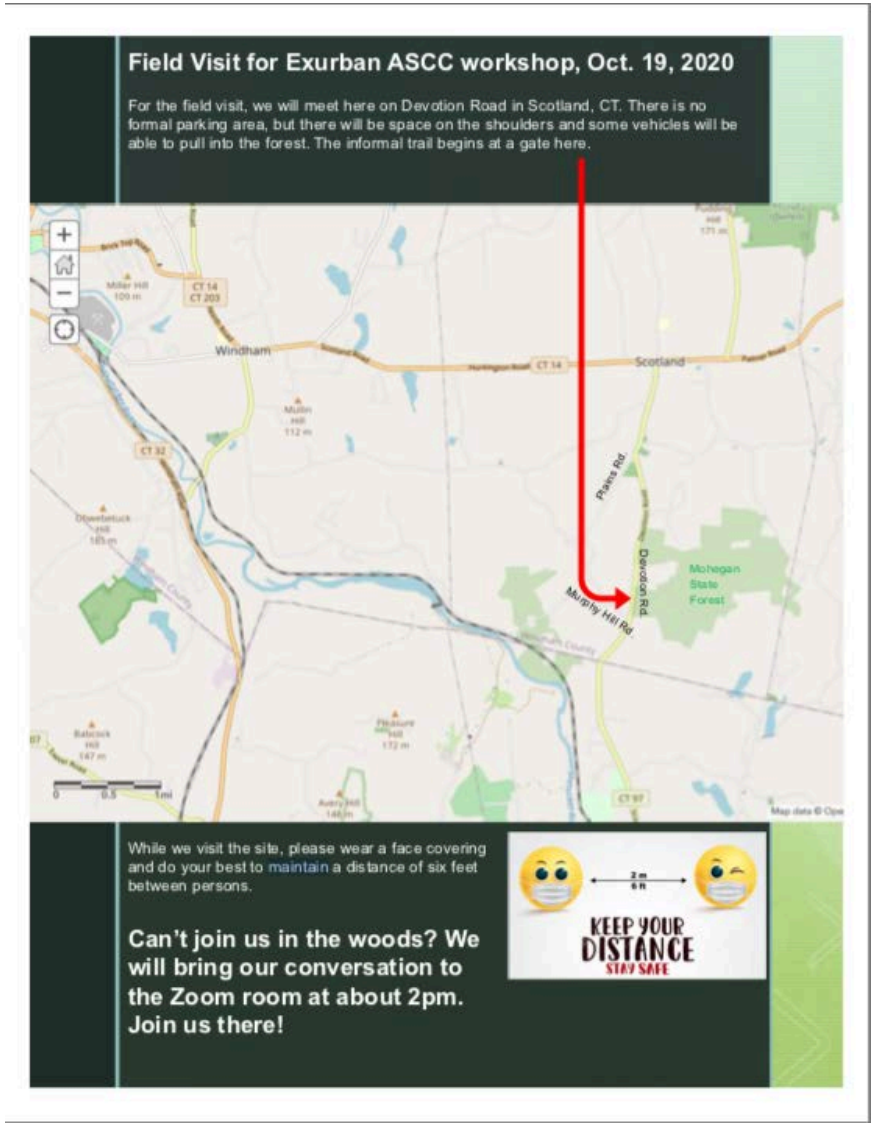
- **Treatment Themes:** ***Adaptation Options***
  - Resistance
  - Resilience
  - Transition
  - No Action
- **Minimum Study Design Elements**
  - Replication
  - Stand/EU Size
  - Monitoring Guidelines
  - Evaluation Window

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, October 19

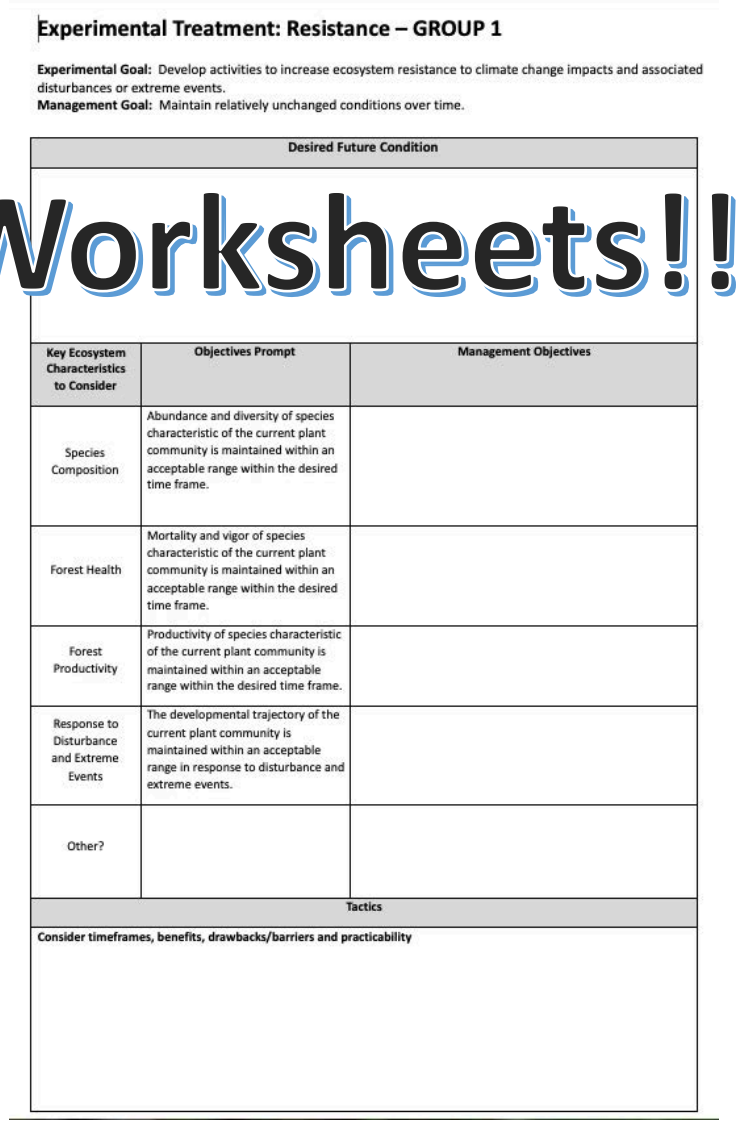
- **9 – 12:** Presentations & Activities on Southern New England Oak-Hickory Forests & Climate Change Considerations to prep for ASCC treatment development at Mohegan State Forest
- **12:00 – 1:00:** Lunch Break
- **1:00:** Meet at Mohegan State Forest for a field tour of the site
- **2:00:** *Virtual option available for folks who cannot attend in-person*
- **4:00:** Adjourn for the day



Workshop Agenda – Day 2, October 20

- **9 – 10:15:** Mohegan State Forest overview, goals, objectives, and climate change considerations
- **10:15 – 11:00:** ASCC Experimental Design
- **11:00 – 12:00:** Identify adaptation approaches and tactics for Resistance
- **12:00-12:30: Break for lunch**
- **12:30 – 2:30: :** Identify adaptation approaches and tactics for Resilience
- **2:30-3:45:** Identify adaptation approaches and tactics for Transition
- **3:45 – 4:00:** Finalize any lingering parking lot items

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 – Day 3, October 21

- **10:00 – 10:15:** Recap of previous two days
- **10:15 – 11:00:** Review and finalize adaptation treatments for Mohegan State Forest
- **11:00 – 11:30:** Evaluations
- **11:30 – 12:00:** Broad Next Steps & Close-Out with Larger Group
- **12:00 – 1:00:** Lunch Break
- **1:00-2:00:** Identify Key Monitoring Items and Metrics (*DEEP STAFF AND UCONN ONLY)*
- **2:00 – 3:00:** Discuss Next Steps, Roles, & Responsibilities
- **3:00 Adjourn**

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

Amanda's PhD Research – We need your help!

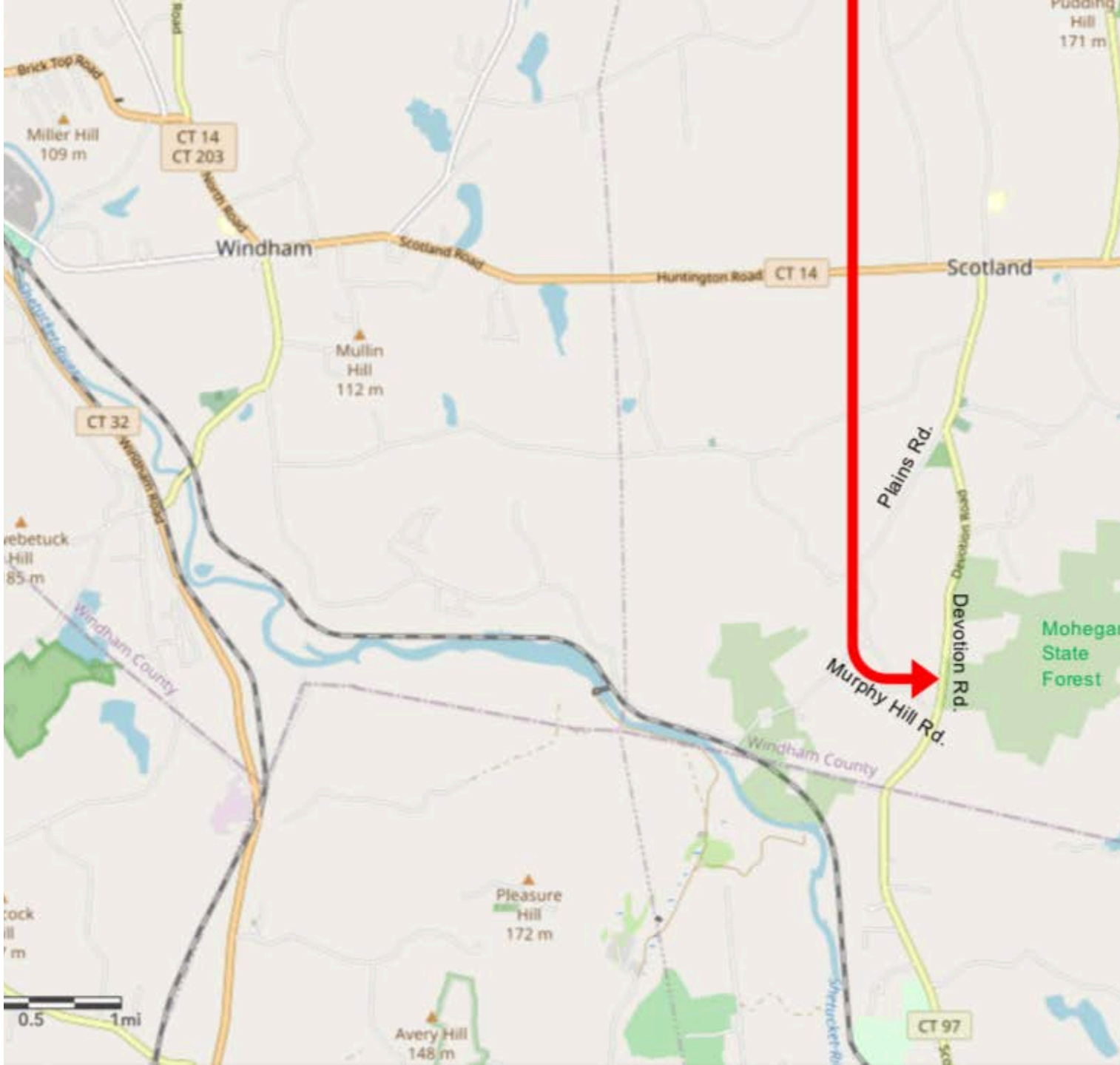
Activity A: Climate Change Considerations for Forest Management

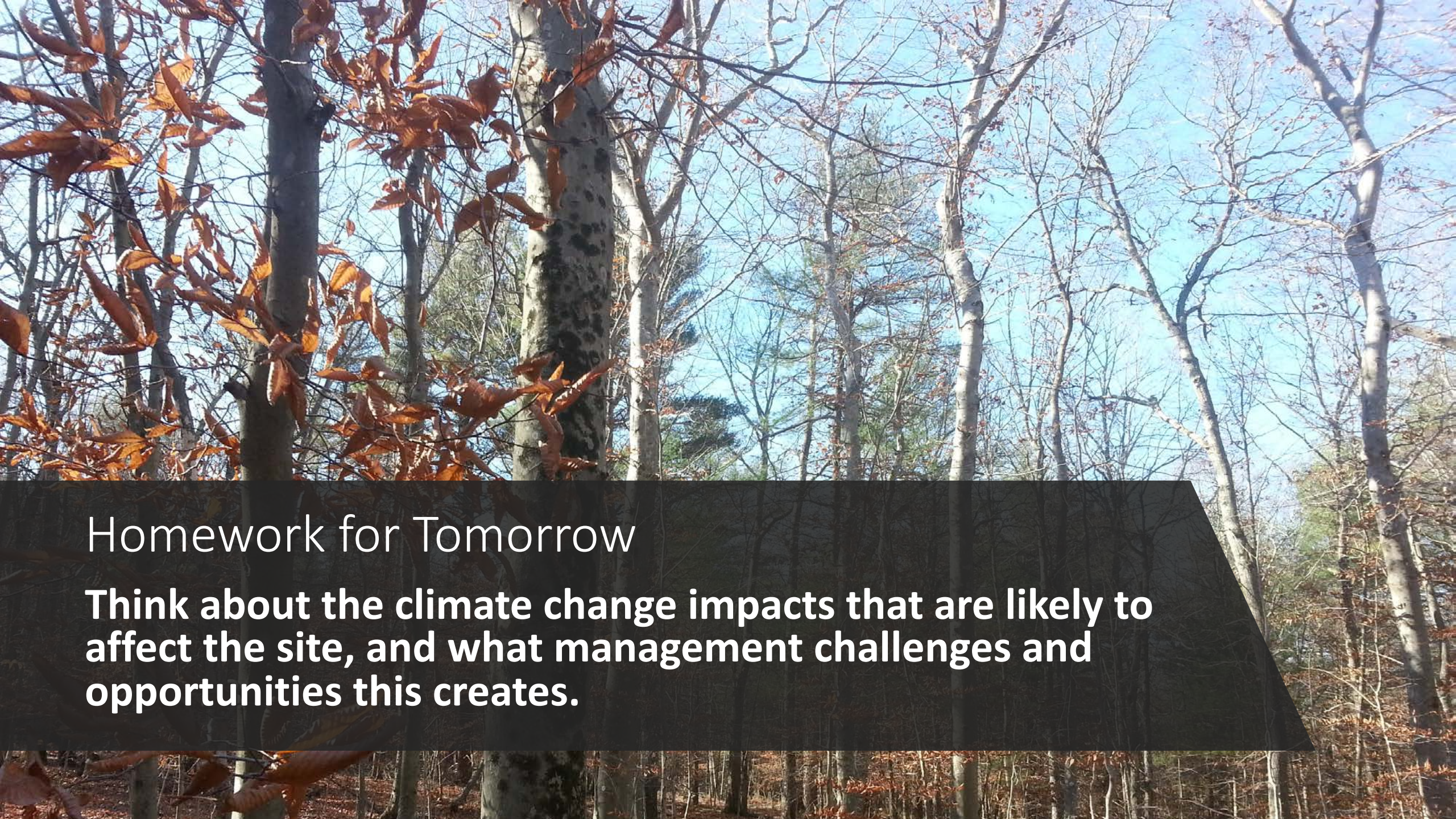
What new or different considerations do we need to think about when managing forests in the face of a changing climate?

Google Jamboard!

Field Tour Logistics

- Meet on Devotion Road at 1:00 p.m.
- Please wear a face covering and do your best to maintain a distance of 6 ft.
- Virtual discussion at 2:00 p.m.
- Check-out the StoryMap





Homework for Tomorrow

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

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Workshop Agenda – Day 2, October 20

- **9 – 10:15:** Mohegan State Forest overview, goals, objectives, and climate change considerations
- **10:15 – 11:00:** ASCC Experimental Design
- **11:00 – 12:00:** Identify adaptation approaches and tactics for Resistance
- **12:00-12:30: Break for lunch**
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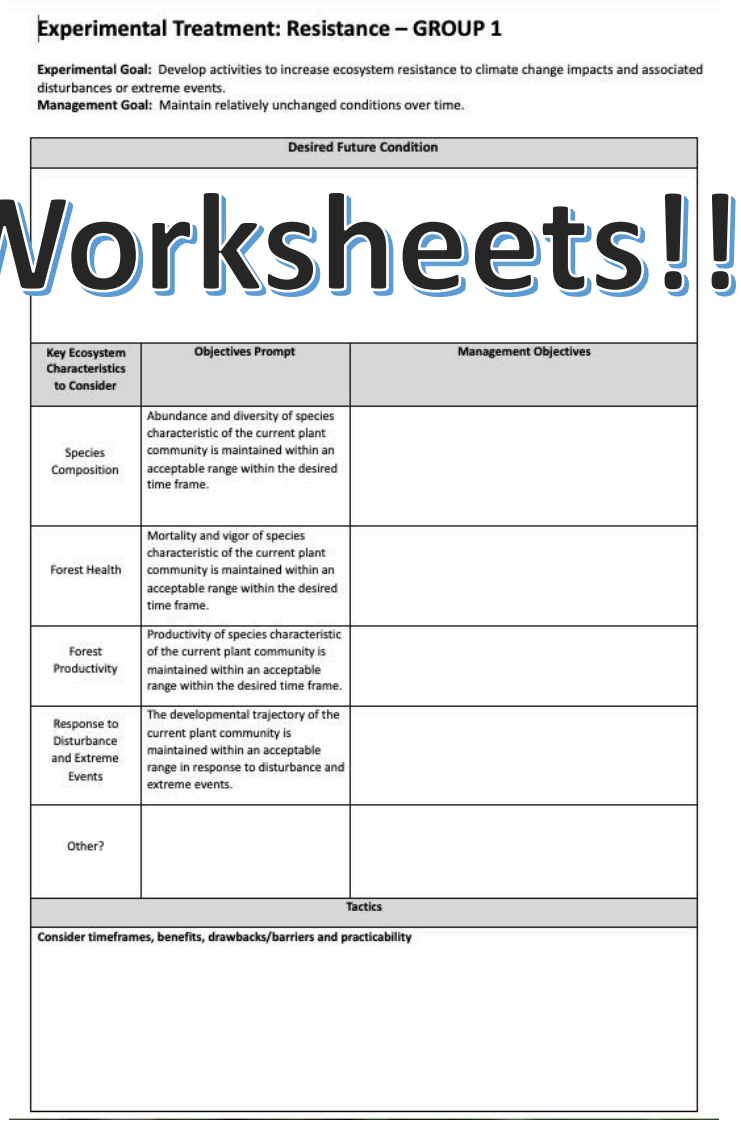
Worksheets!!!



Experimental Treatment: Resistance – GROUP 1

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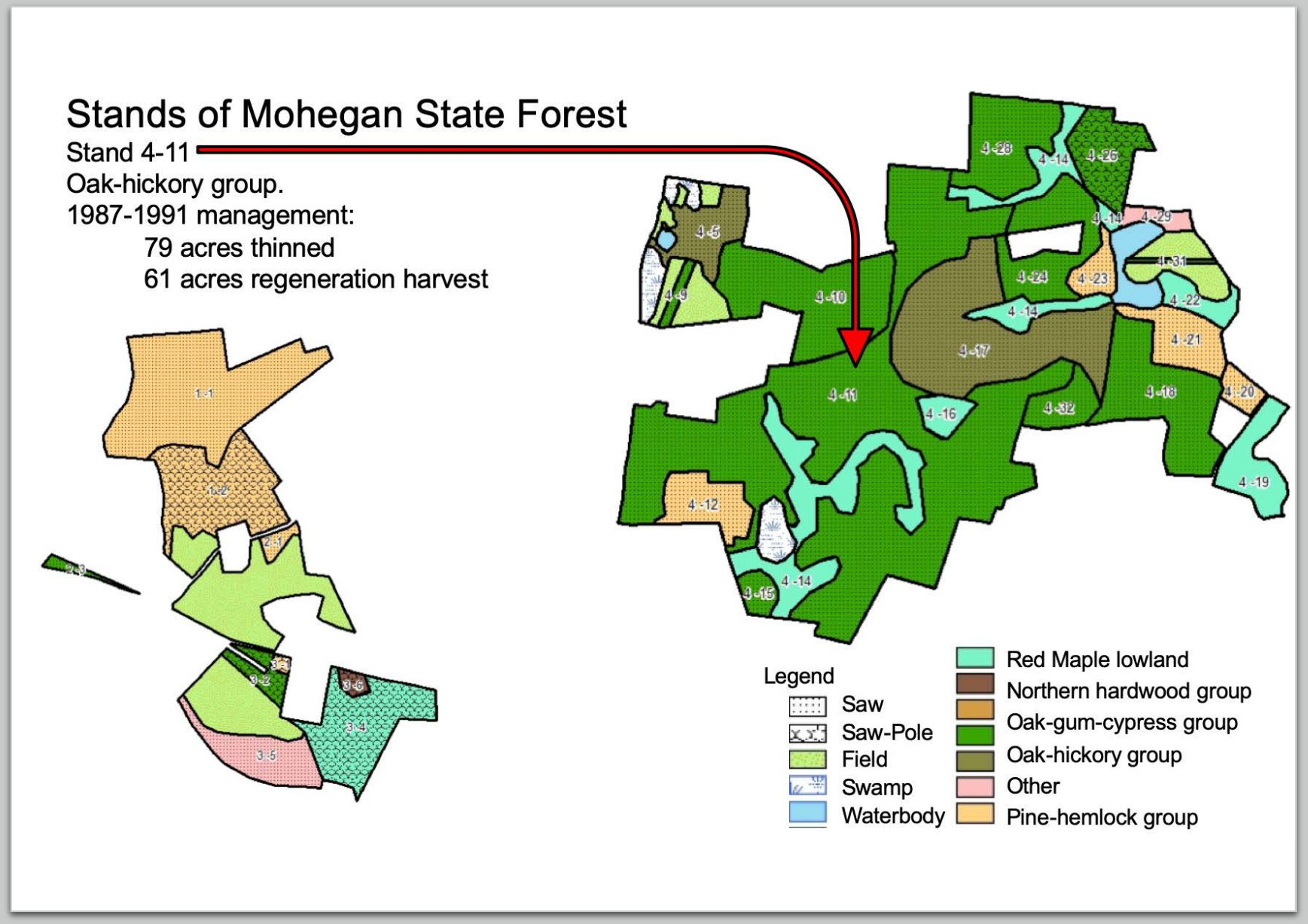
Response to Disturbance and Extreme Events	The developmental trajectory of the current plant community is maintained within an acceptable range in response to disturbance and extreme events.	
Other?		
Tactics		
Consider timeframes, benefits, drawbacks/barriers and practicability		

Mohegan State Forest Overview – Dan Evans



Activity B: Climate Change Impacts on the Mohegan State Forest ASCC Site

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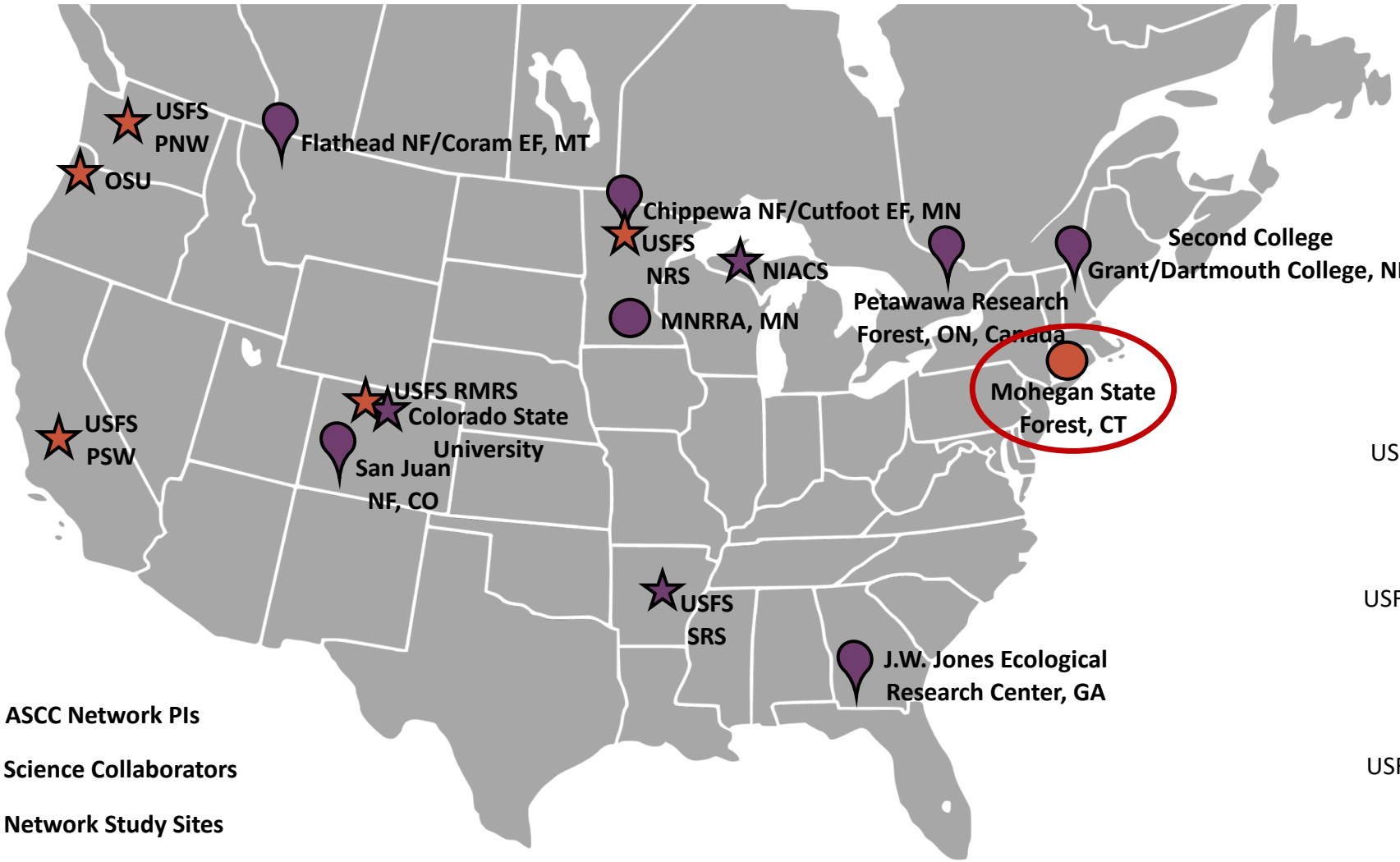

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Colorado State University

Courtney Peterson, Coordinator
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NIACS

Jim Guldin, Lead FS PI
USFS, Southern Research Station

Chris Swanston, Co-PI
USFS, Northern Research Station
Director, NIACS

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

Adaptive Silviculture for Climate Change Network

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USFS, Rocky Mountain Research Station

Matt Tuten, CO
San Juan National Forest

Tony D'Amato, NH, MN
University of Vermont

Chris Woodall, NH
USFS, Northern Research Station

Kevin Evans, NH
Dartmouth University

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USFS, Northern Research Station

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USFS, Rocky Mountain Research Station

Melissa Jenkins, MT
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Seth Bigelow, GA
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Mary Hammes, Urban MN
Mississippi National River and Recreation Area

Marcella Windmuller-Campione, Urban MN
University of Minnesota

Leslie Brandt, Urban MN
USFS, Northern Research Station
NIACS

Michael Hoepting, ON, Canada
Petawawa Research Forest

Jeff Fera, ON, Canada
Petawawa Research Forest

Trevor Jones, ON, Canada
Petawawa Research Forest

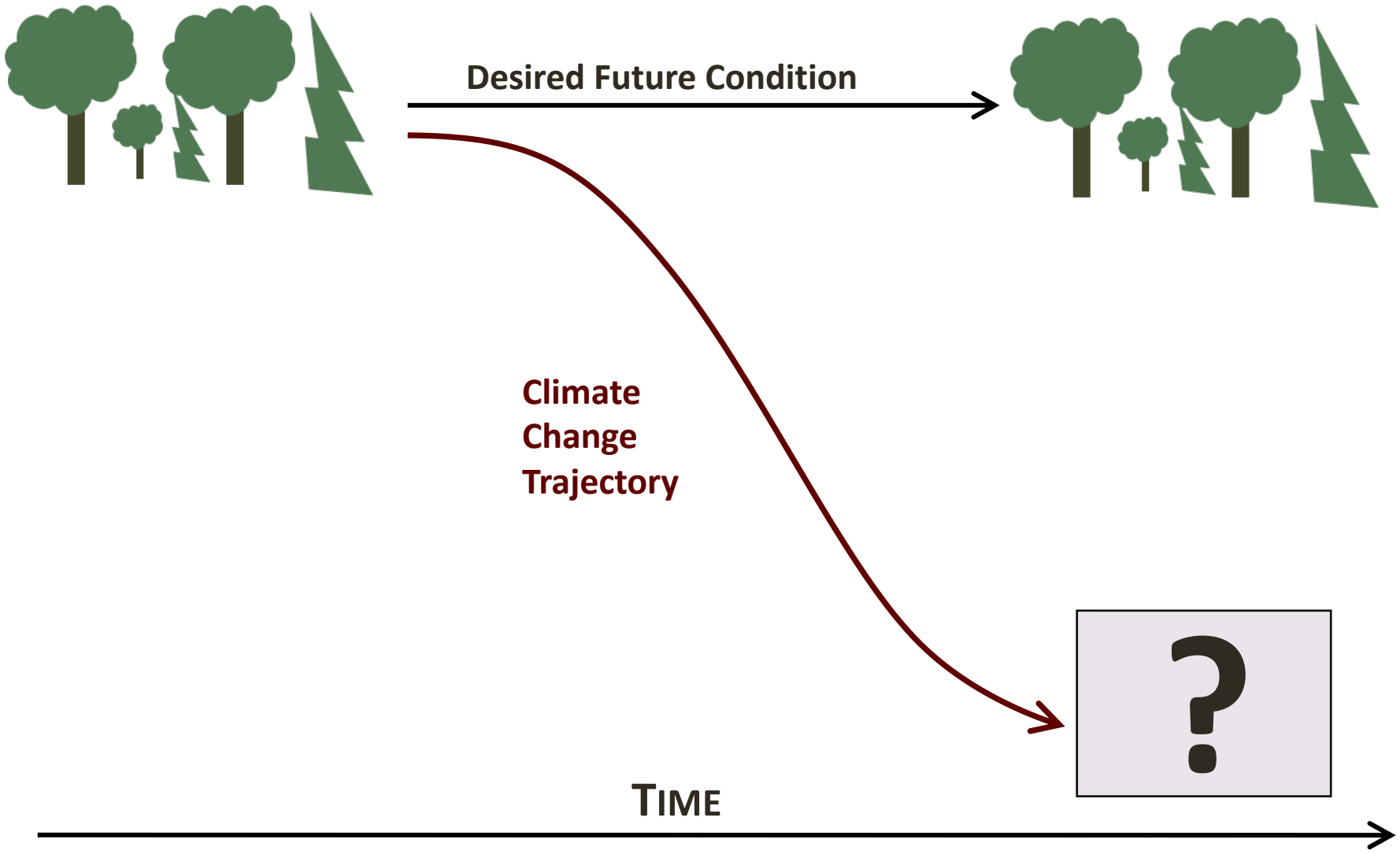
Adaptation - the adjustment of systems in response to climate change.

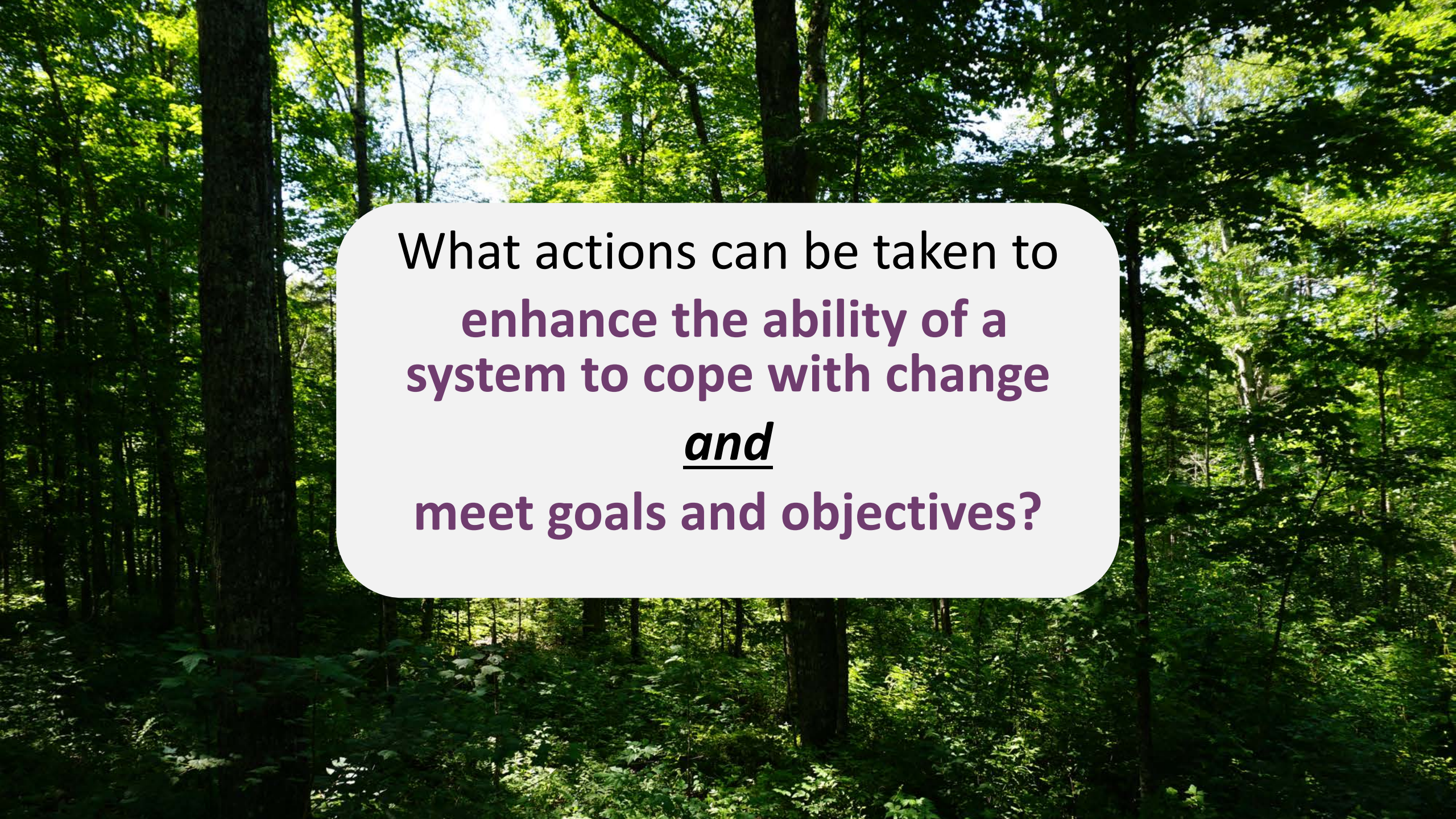



Ecosystem-based adaptation activities build on sustainable management, conservation, and restoration.

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

Climate-Driven Changes



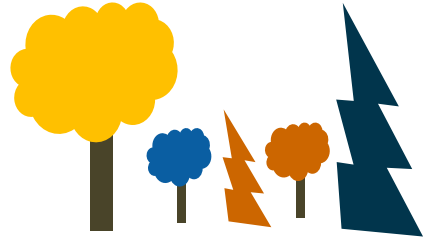

What actions can be taken to
enhance the ability of a system to cope with change
and
meet goals and objectives?

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 forest against anticipated change or directly defend the forest against disturbance in order to maintain relatively unchanged conditions.

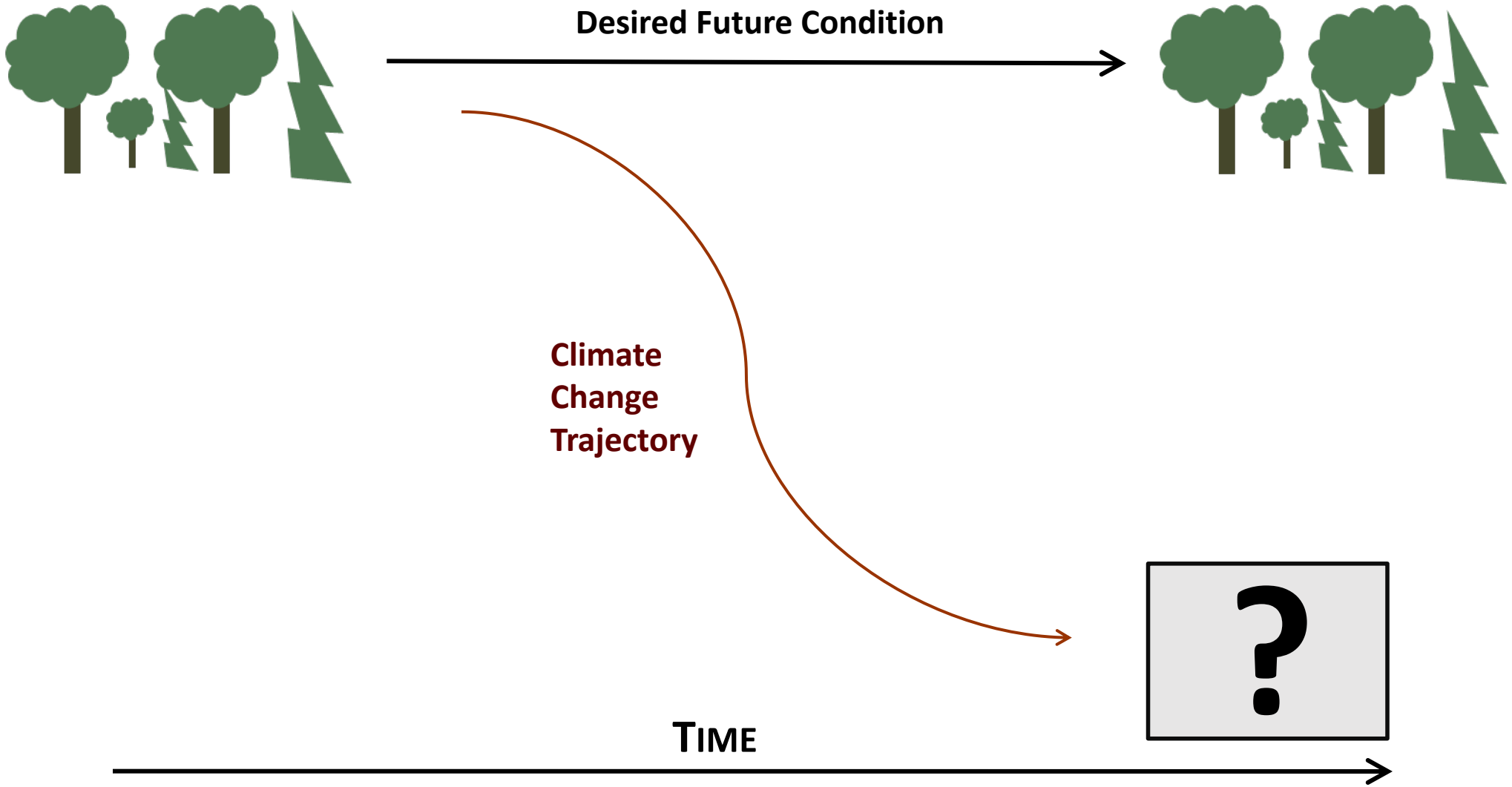
Road crossings that can withstand flood events (USFS, Monongahela NF)

Threatened Dwarf lake iris (FWS)

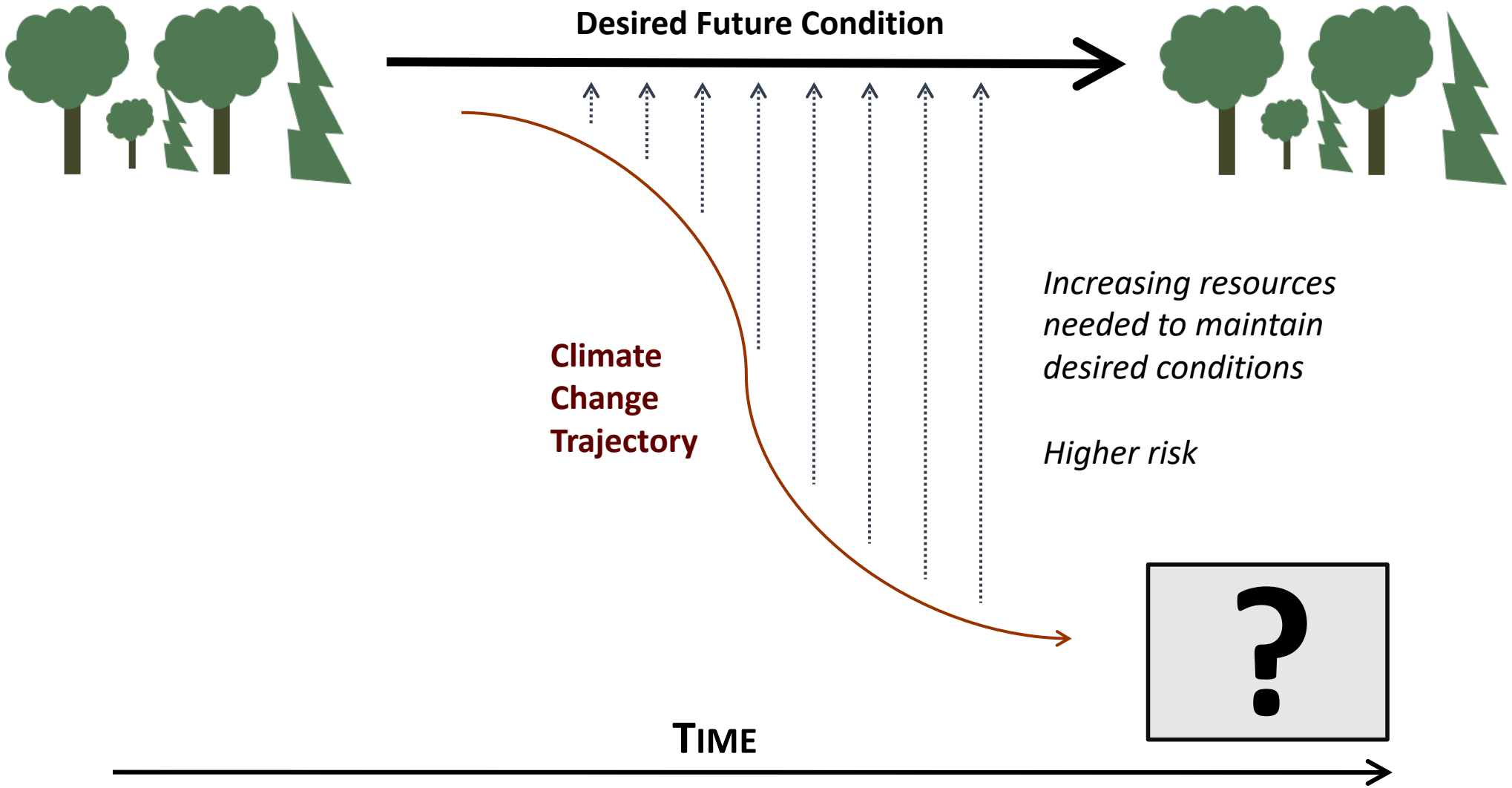
Invasive species management (USFS)

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, but encourage a return to a prior condition or desired reference conditions following disturbance

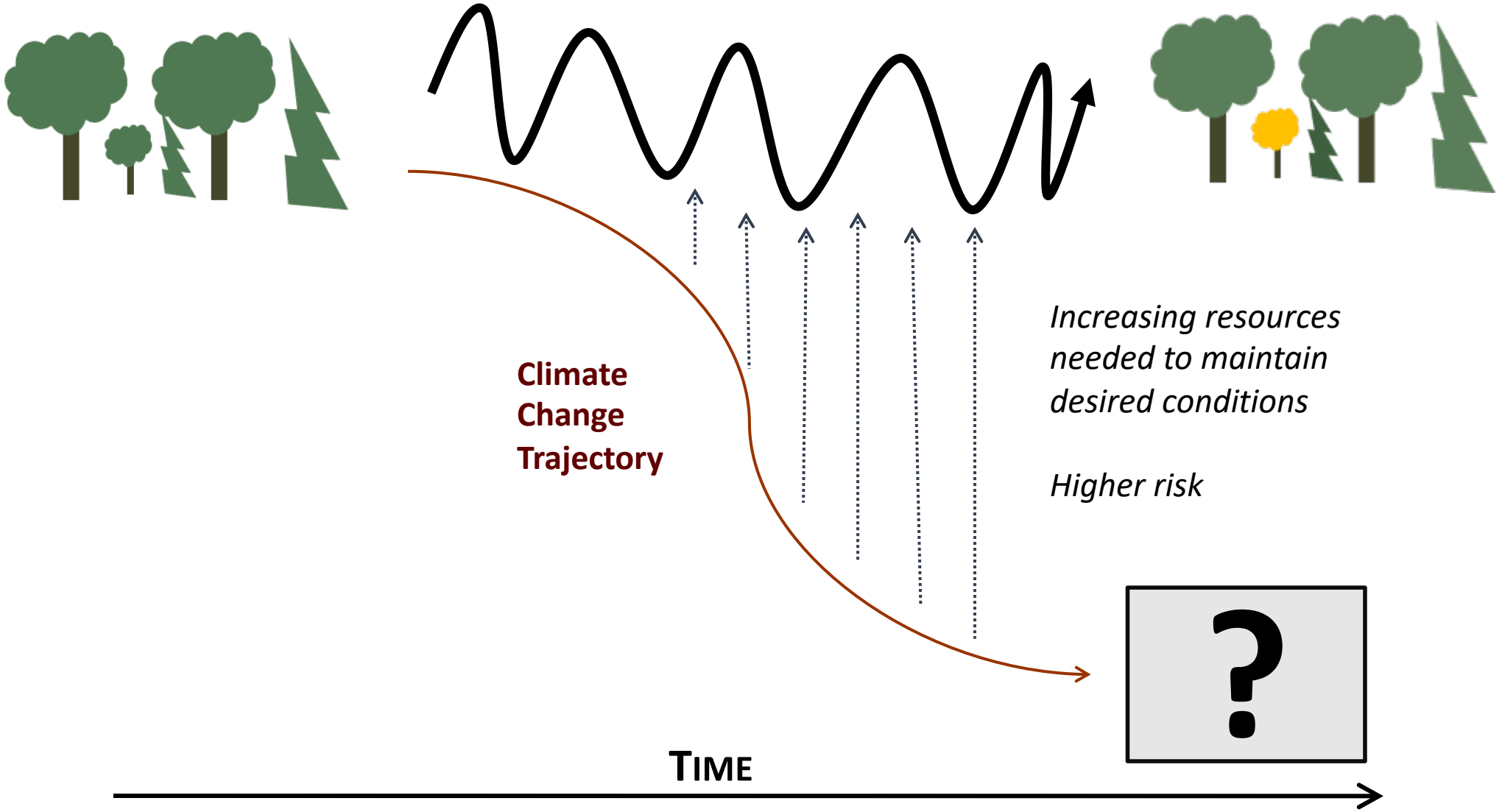
Prescribed burning to regenerate fire-adapted species

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

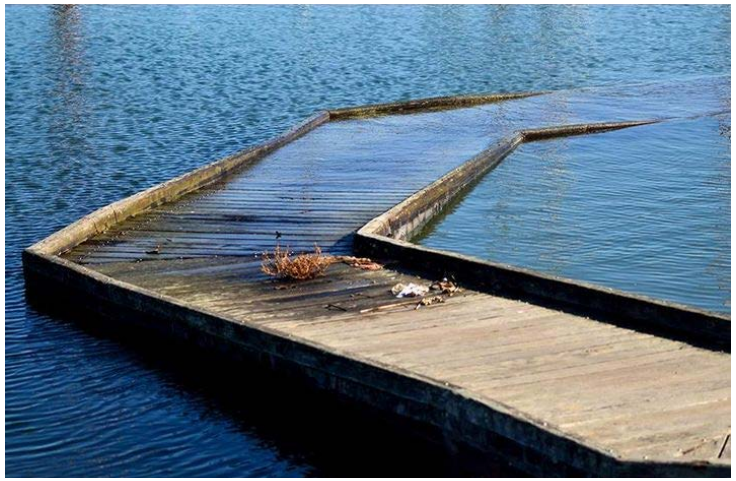
Resilience


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

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

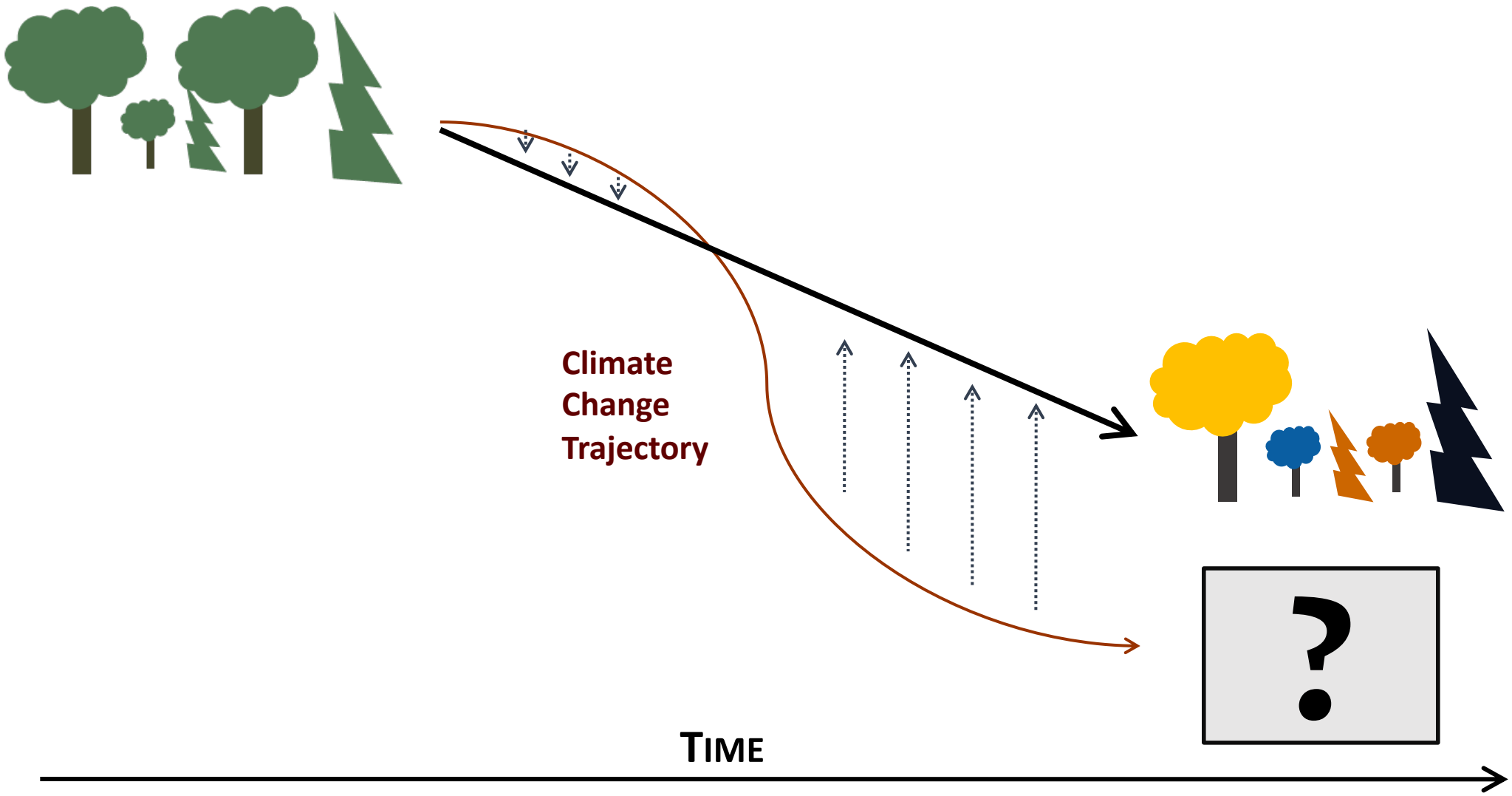


Relocate existing infrastructure to areas with less risk (P:Tom Hilton)

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

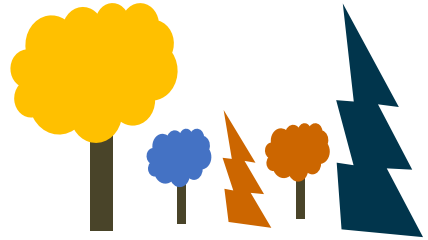
RESISTANCE

- 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

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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

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

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

3. EVALUATE management objectives given projected impacts and vulnerabilities.

4. IDENTIFY and implement adaptation approaches and tactics.

5. MONITOR and evaluate effectiveness of implemented actions.

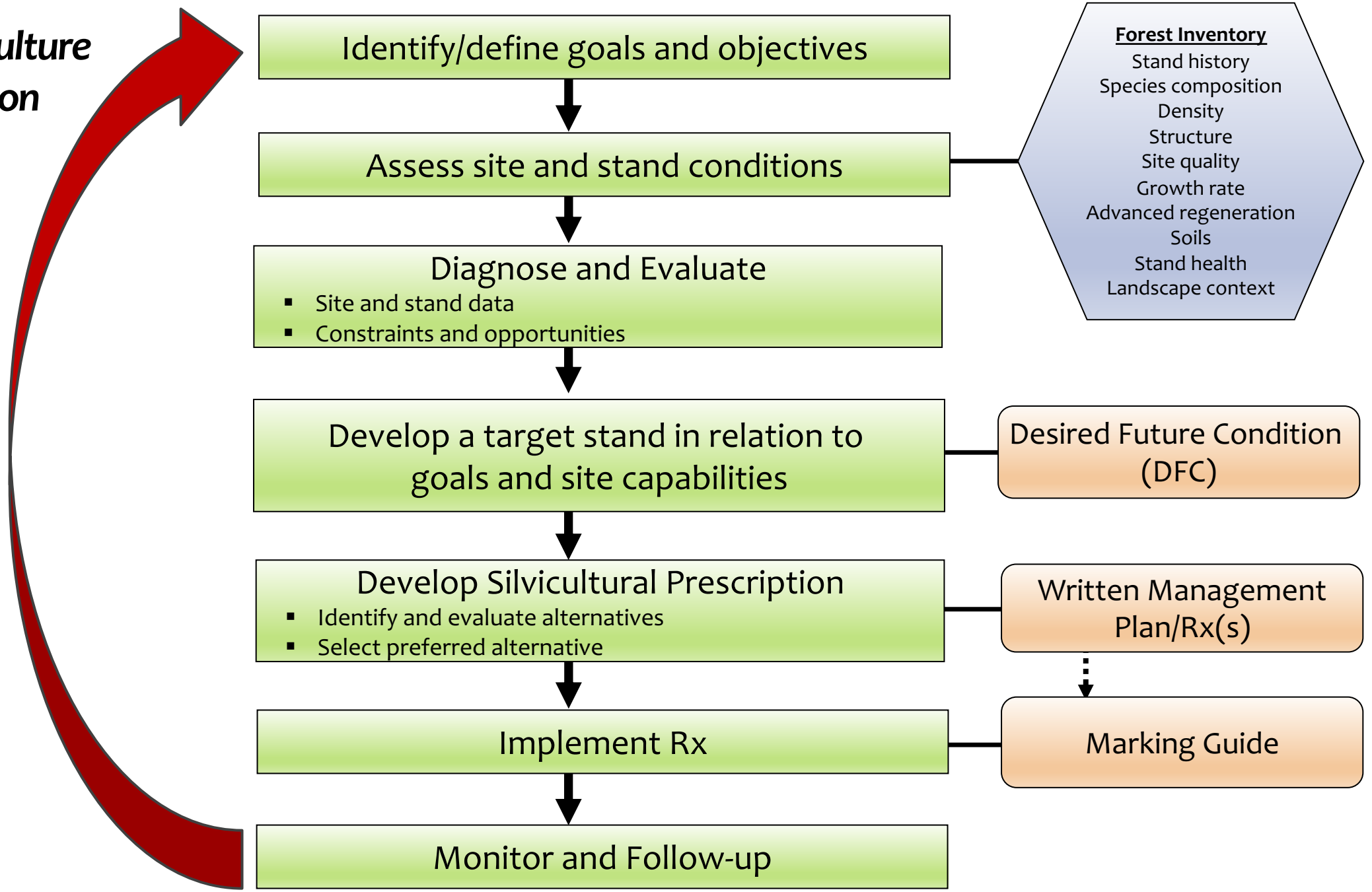
Vulnerability assessments, scientific literature, and other resources

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

Adaptation Strategies and Approaches

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**

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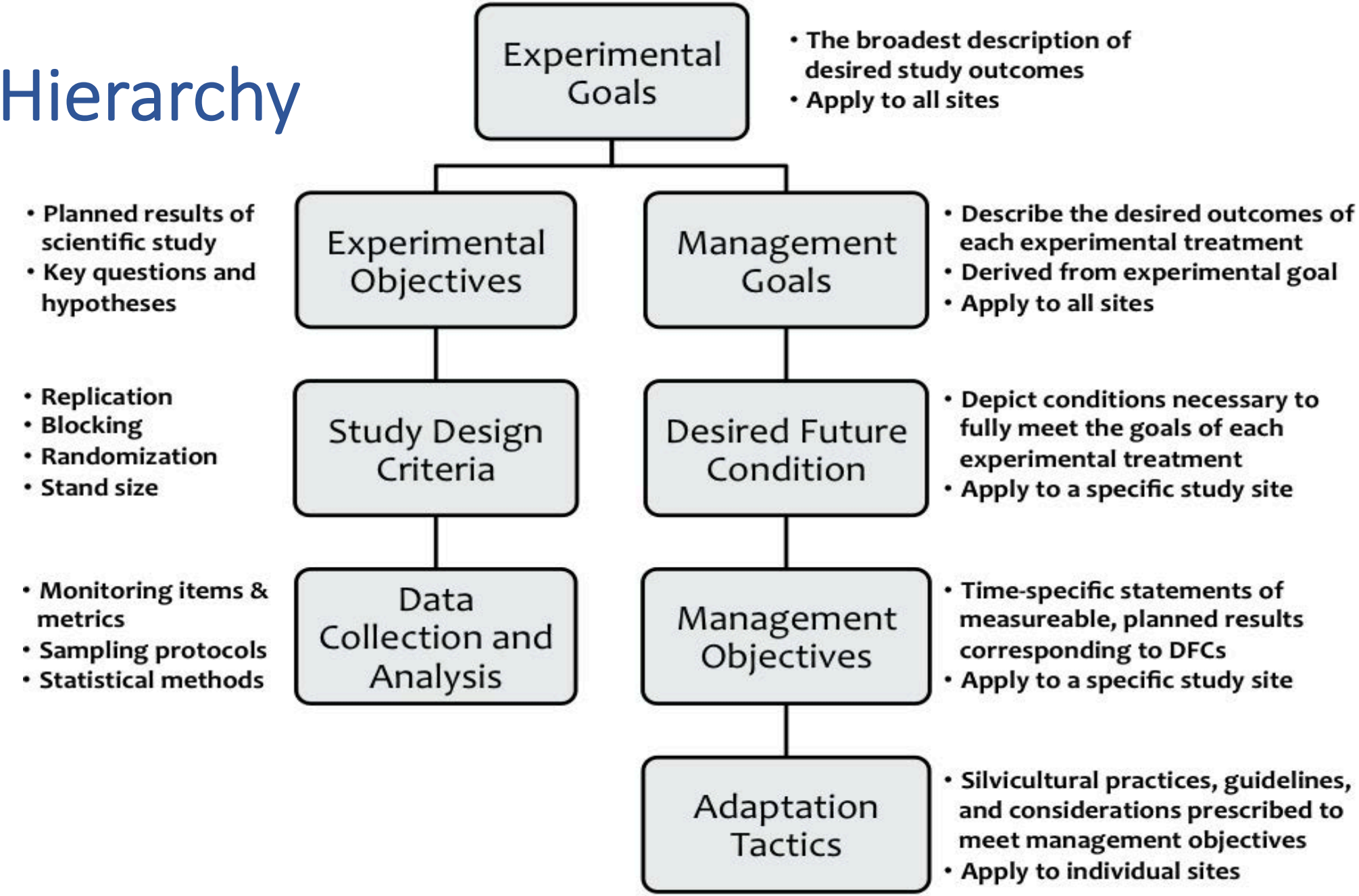
Hierarchy



Developing the Experimental Treatments

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

DFC

Management objectives

Silvicultural practices (tactics)

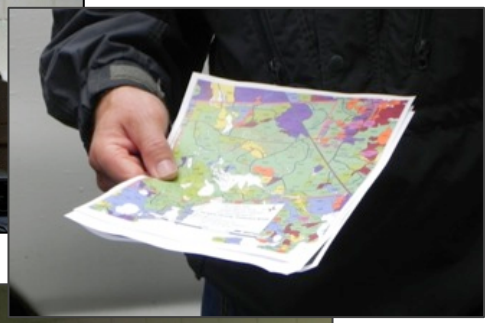
What do you want the stand to be and look like?

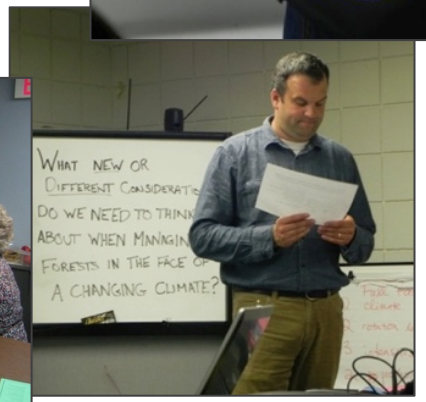
<u>Keep in mind key variables/outcomes</u>:

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

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

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





ASCC Plot Design

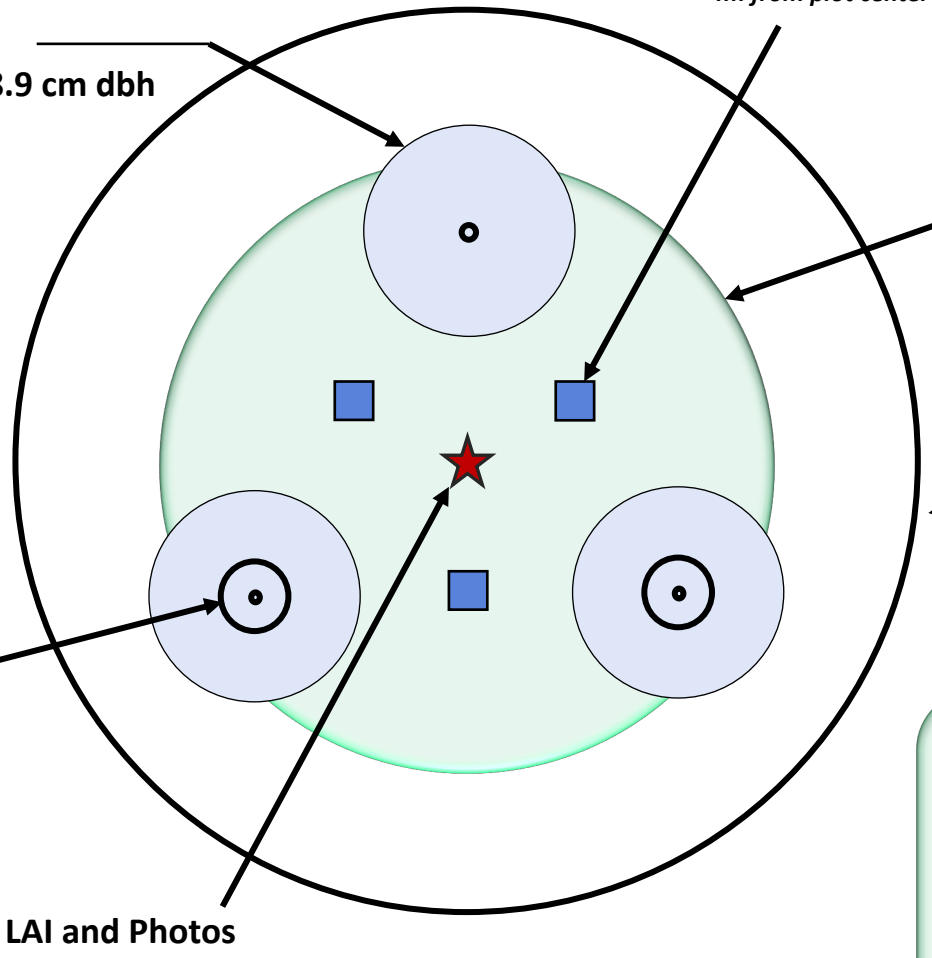
Adaptive Silviculture for Climate Change

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°

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

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)

ASCC
Adaptive Silviculture for Climate Change

Designing Forest Adaptation Treatments At the Mohegan State Forest Through Scientist-Manager Partnerships

UCONN
NATURAL RESOURCES AND THE ENVIRONMENT

Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

Adaptive Silviculture for Climate Change (ASCC) on the CT Urban/Exurban Landscape

October 19, 20, & 21, 2020

NIACS
Northern Institute of Applied Climate Science

FOREST AND RANGELAND STEWARDSHIP
COLORADO STATE UNIVERSITY

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FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

Dartmouth

The University of Vermont

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MISSISSIPPI PARK CONNECTION
Discover your river

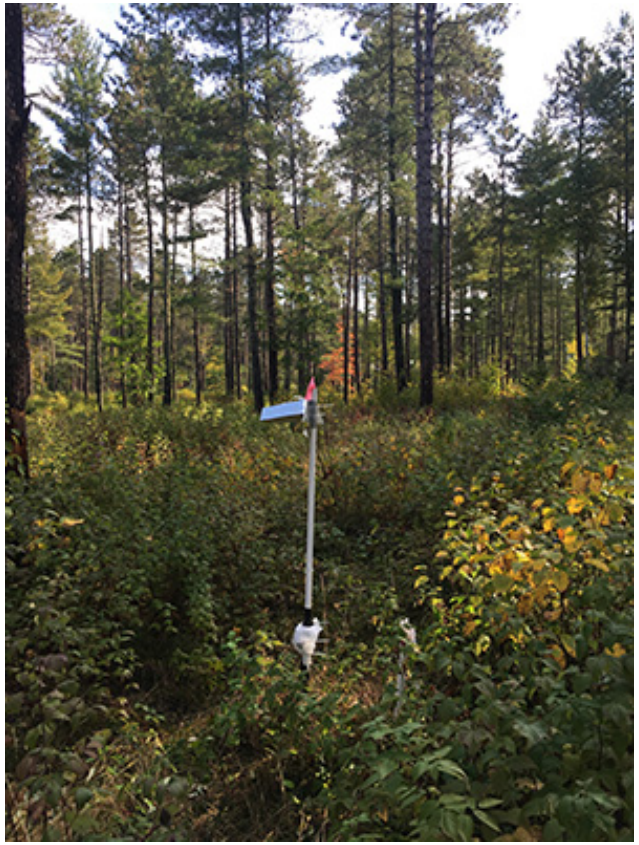
Canada
Natural Resources Canada
Canadian Forest Service

Workshop Agenda – Day 3, October 21

- **10:00 – 10:15:** Recap of previous two days
- **10:15 – 11:00:** Review and finalize adaptation treatments for Mohegan State Forest
- **11:00 – 11:30:** Evaluations
- **11:30 – 12:00:** Broad Next Steps & Close-Out with Larger Group
- **12:00 – 1:00:** Lunch Break
- **1:00-2:00:** Identify Key Monitoring Items and Metrics (*DEEP STAFF AND UCONN ONLY)*
- **2:00 – 3:00:** Discuss Next Steps, Roles, & Responsibilities
- **3:00 Adjourn**

ASCC Data Collection and Implementation Timeline – Mohegan State Forest

Photo Credit: Tony D'Amato



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

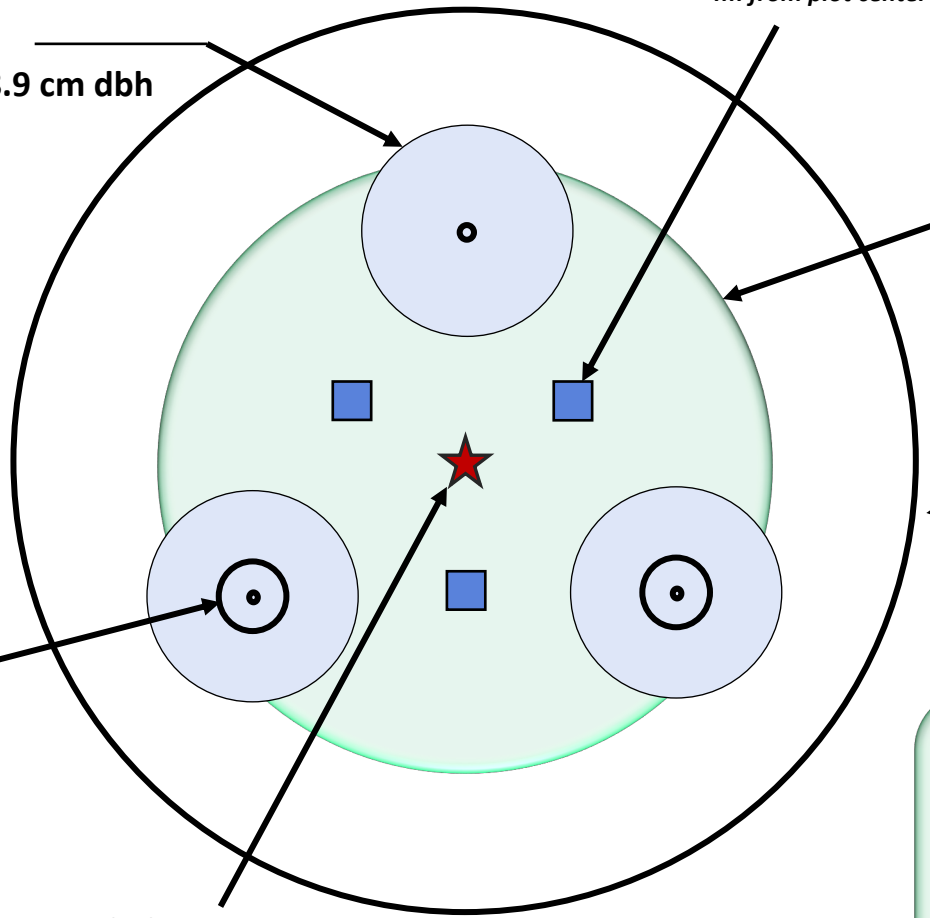
Ground Layer Plot (3)
1 m²
Measuring herbaceous and woody spp
< 30 cm (1 ft) tall
4m from plot center at 60, 180, and 300°

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

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

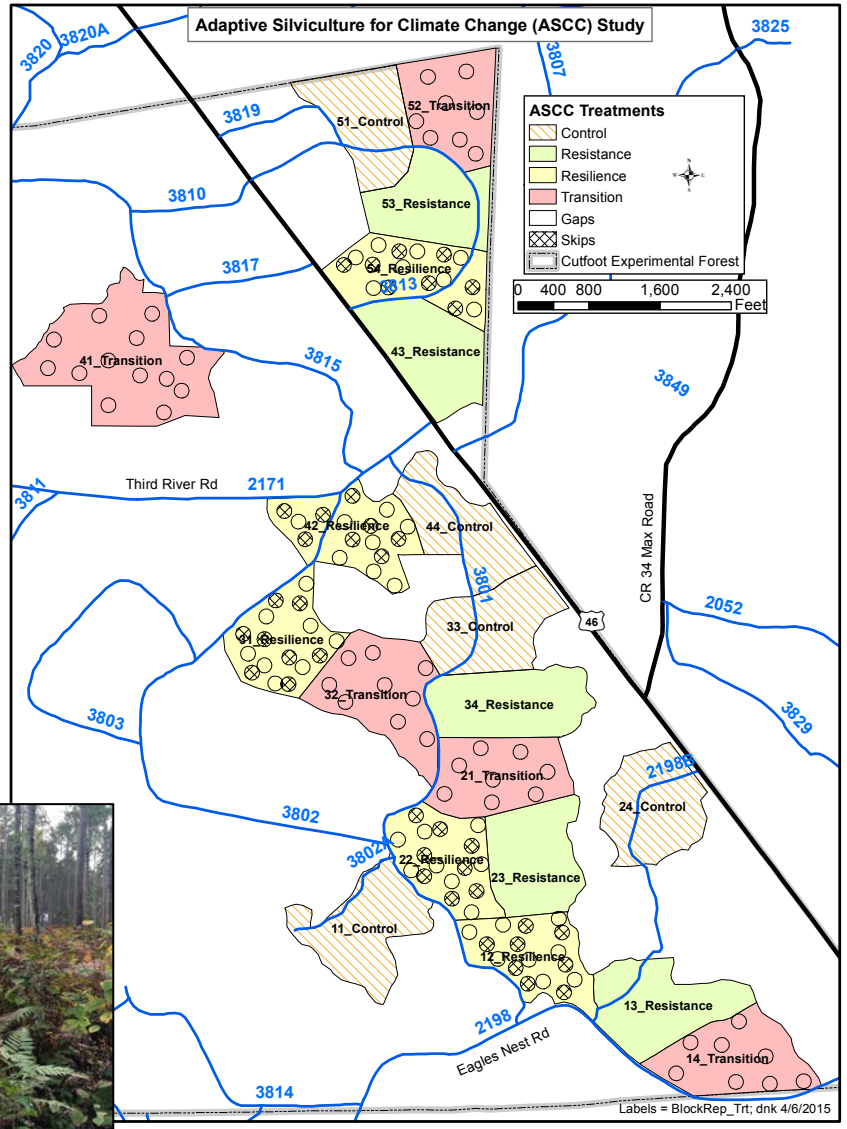
LAI and Photos

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

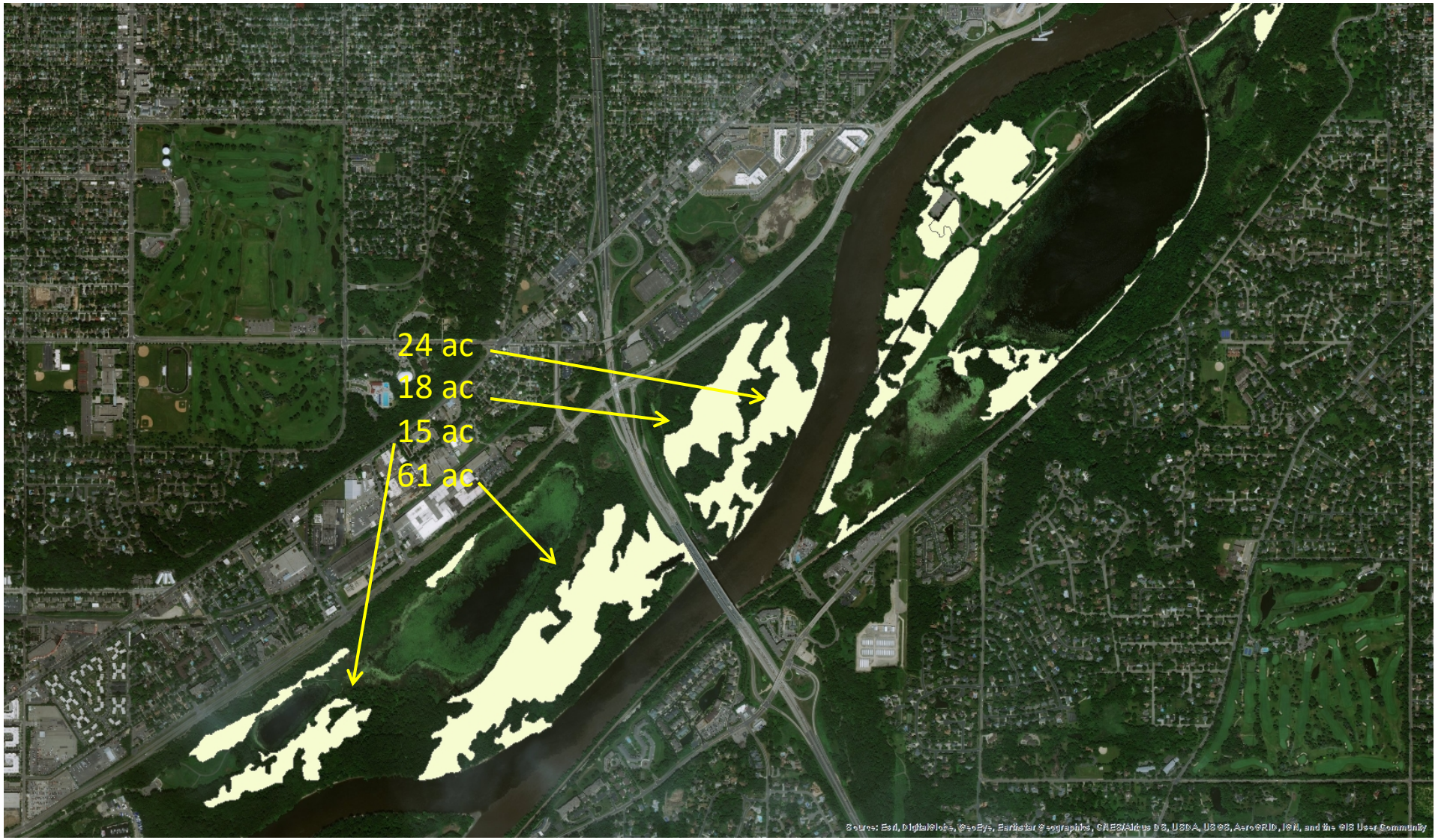
- Species composition, density, diversity, etc.
- Forest health (mortality, local indices)
- Productivity (increment, biomass)

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)



Ash-Elm Mixed Hardwood Forest Phase I Sites: Crosby Farm Regional Park



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	