# THE ADAPTIVE SILVICULTURE FOR CLIMATE CHANGE (ASCC) PROJECT

## A SCIENTIST-MANAGER NATIONAL NETWORK

**Climate Learning Network**
**Webinar Series**
**March 1, 2018**


Courtney Peterson
Courtney.Peterson@colostate.edu
Research Associate II
Forest and Rangeland Stewardship Department
Colorado State University
Northern Institute of Applied Climate Science

Linda Nagel
Linda.Nagel@colostate.edu
Professor and Department Head
Forest and Rangeland Stewardship Department
Colorado State University


Colorado State University · USFS · NIACS Northern Institute of Applied Climate Science · Dartmouth · The University of Vermont · University of Minnesota · Michigan Technological University 1885 · The Joseph W. Jones Ecological Research Center at Ichauway

# Adaptive Silviculture for Climate Change National Network

**Linda Nagel, Lead PI**
Colorado State University

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

**Courtney Peterson, Coordinator**
Colorado State University
NIACS

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

**Maria Janowiak, Co-PI**
USFS, Northern Research Station
NIACS

**Mike Battaglia, CO**
USFS, Rocky Mountain Research Station

**Matt Tuten, CO**
San Juan National Forest

**Brian Palik, MN**
USFS, Northern Research Station

**Seth Bigelow, GA**
J.W. Jones Ecological Research Center

**Steve Jack, GA**
J.W. Jones Ecological Research Center

**Elaine Kennedy-Sutherland, MT**
USFS, Rocky Mountain Research Station

**Terrie Jain, MT**
USFS, Rocky Mountain Research Station

**Melissa Jenkins, MT**
Flathead National Forest

**Tony D'Amato, NH, MN**
University of Vermont

**Chris Woodall, NH**
USFS, Northern Research Station

**Kevin Evans, NH**
Dartmouth University

# Adaptive Silviculture for Climate Change (ASCC)

*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

# Adaptive Silviculture for Climate Change (ASCC)

## PROJECT GOALS (1):

Populate a multi-region study design with ecosystem-specific climate change adaptation treatments using input from an expert panel of regional scientists and local managers

Treatments
Resistance
Resilience
Transition
No Action
*Sensu* Millar et al 2007

# Adaptive Silviculture for Climate Change (ASCC)

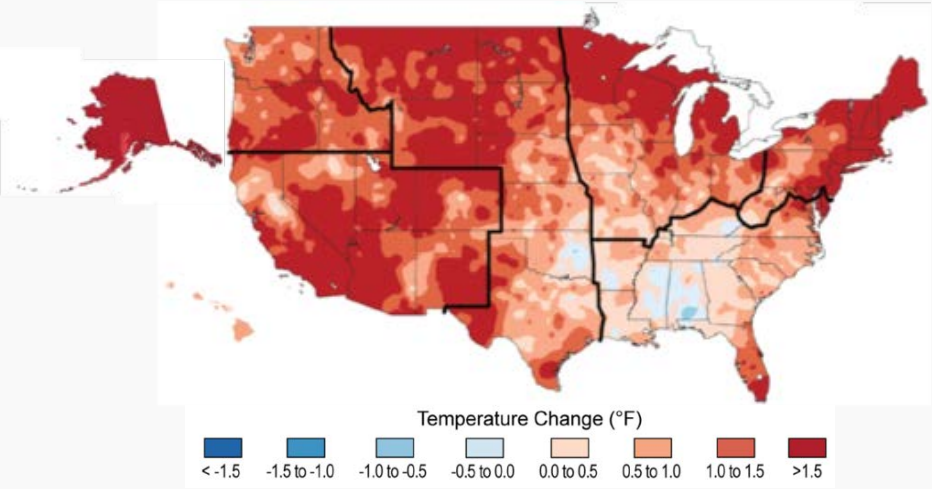
PROJECT GOALS (2):

Introduce natural resource managers to conceptual tools and approaches that help integrate climate change into natural resource management and silvicultural decision making

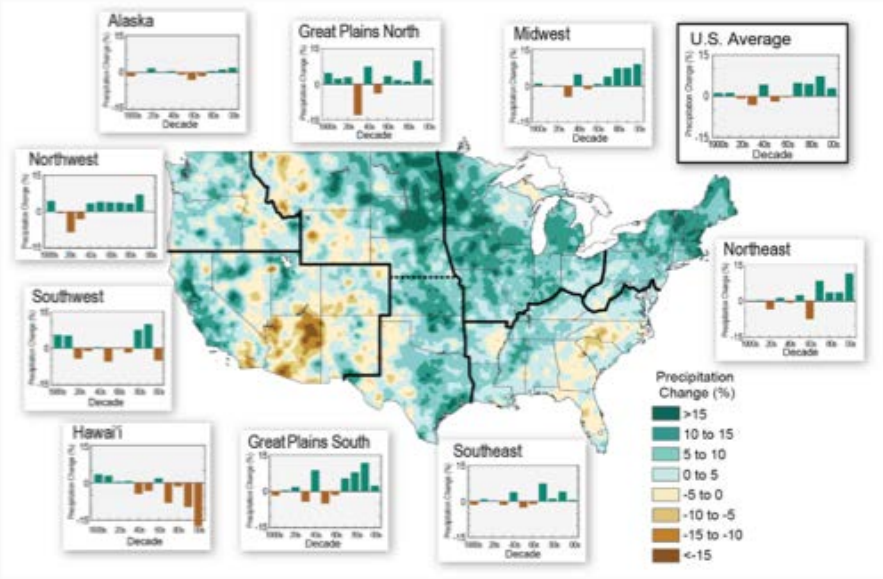
- Through training sessions at participating forests for an audience of local managers and scientists

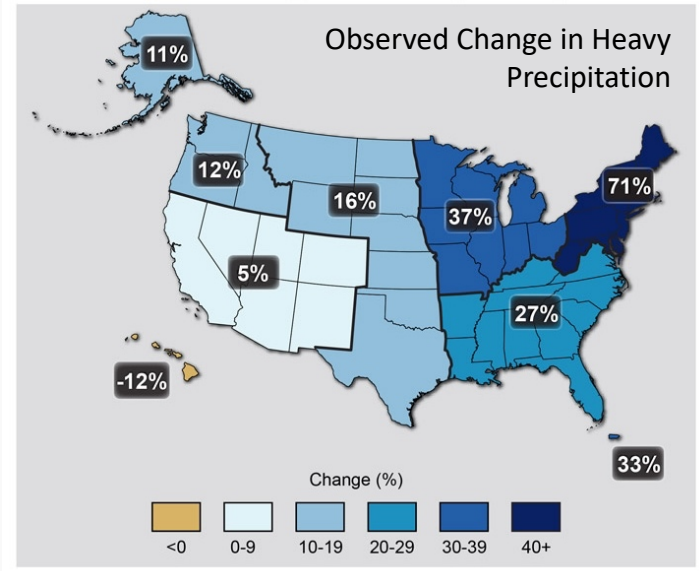
# Our Changing Climate

Observed Changes in Temperature
1991-2012 departure from 1901-1960 average

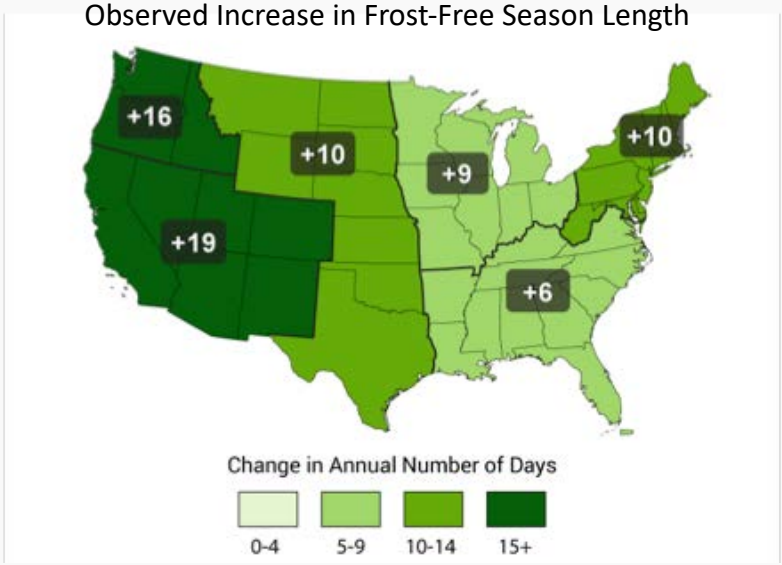



Observed US Precipitation Change



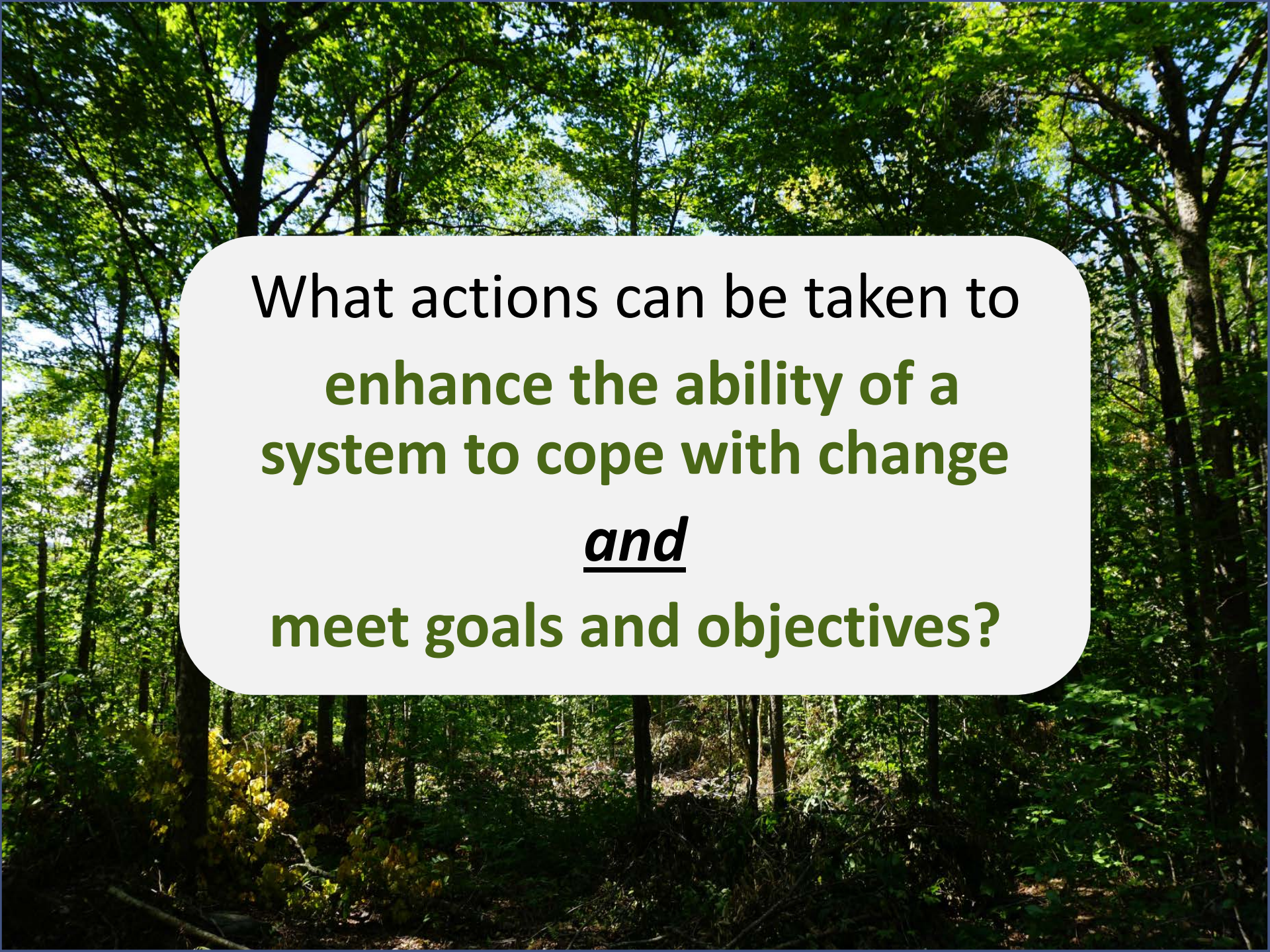




Observed Increase in Frost-Free Season Length

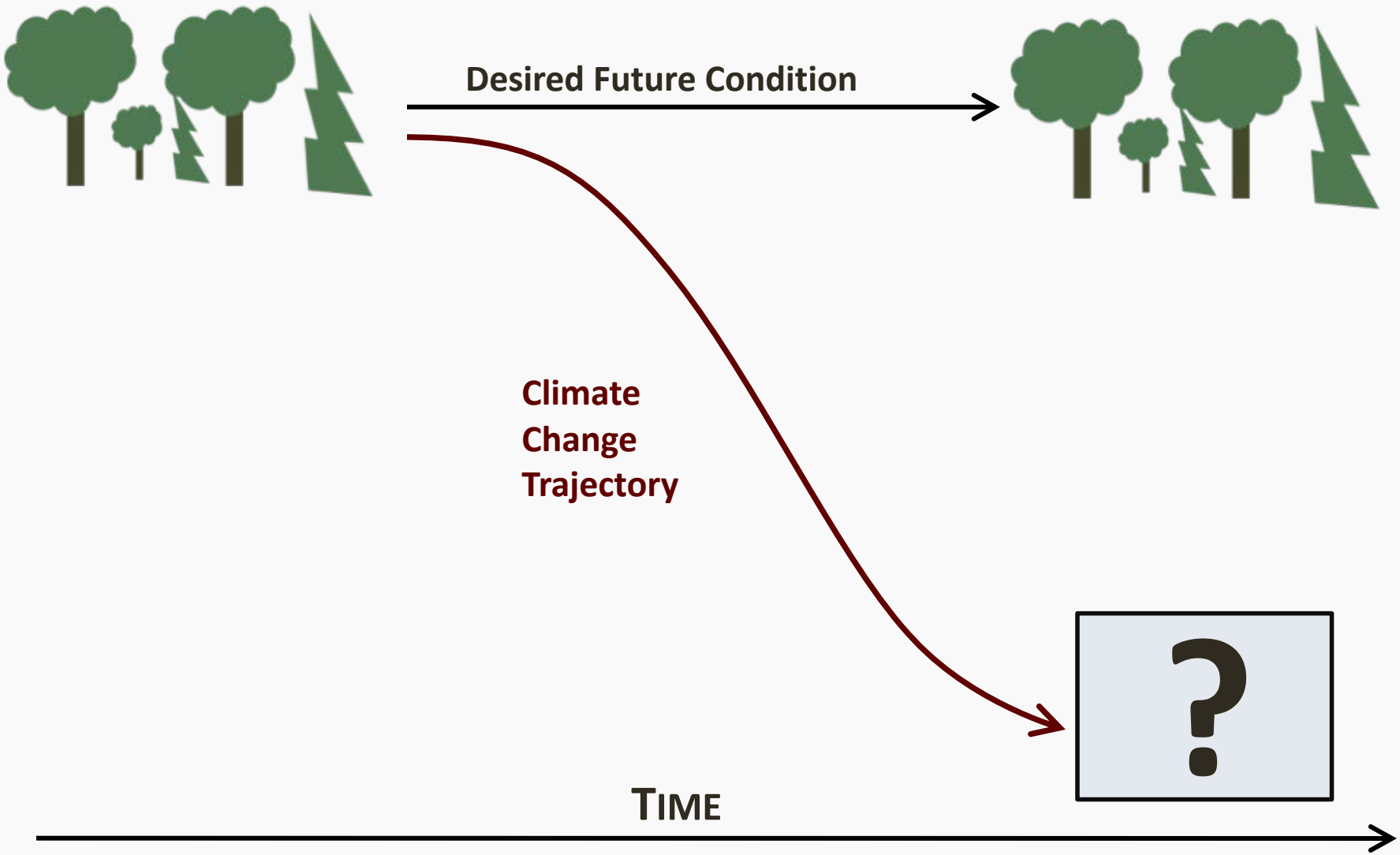



NCA 2014


Invasives
Natural Forest Dynamics
Desired Conditions
Timber Sale Revenue
Forest Health
Past Management History
Plan & Project Requirements
Wildlife Habitat
Disturbance: Past + Future
Recreation
And more!!
Climate Change


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

# Climate-Driven Changes



# Adaptation Options


**Manage for Persistence:**
Ecosystems are still recognizable as being the same system (character)

**Manage for Change:**
Ecosystems have fundamentally changed to something different

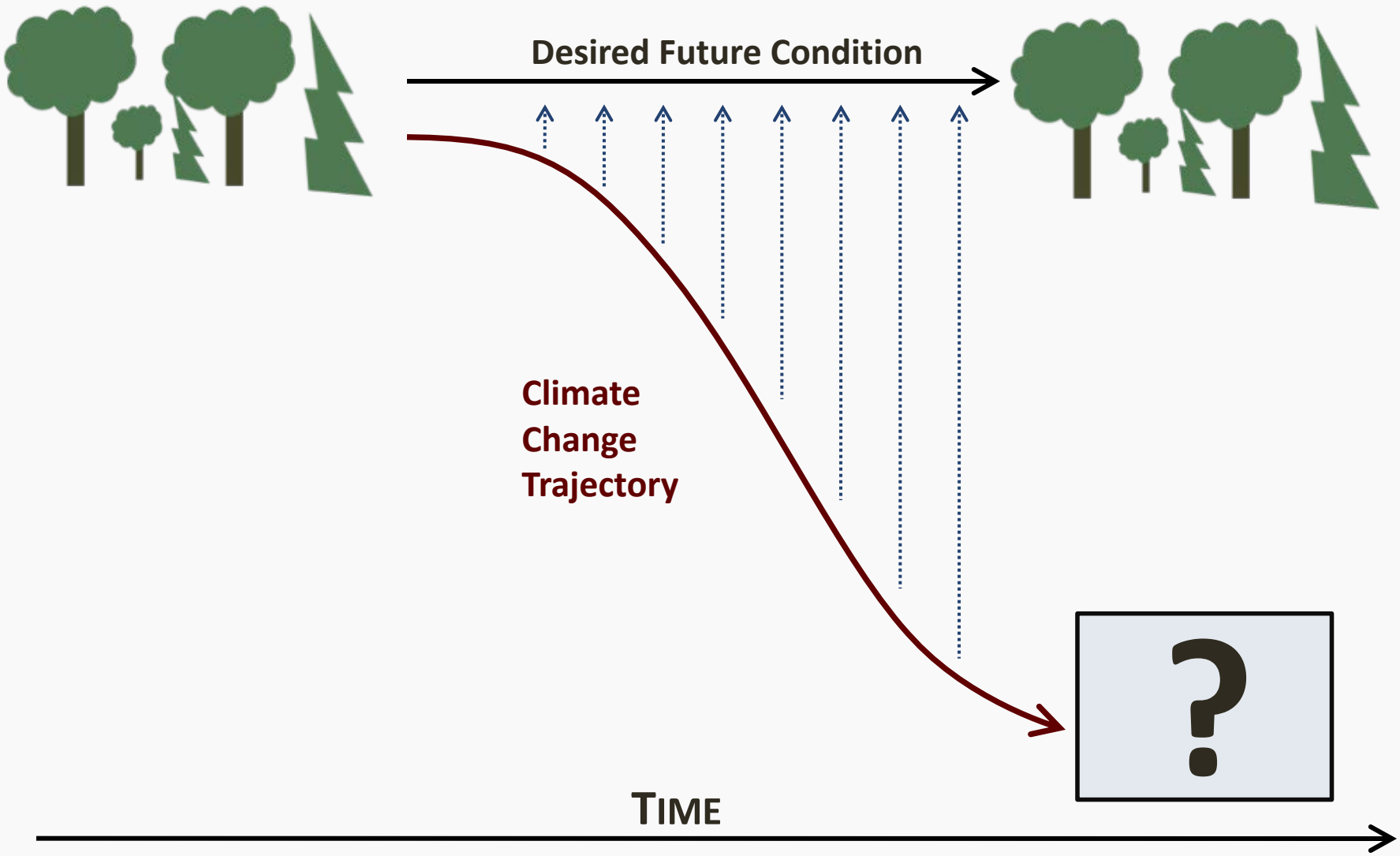
# Option #1 – Resistance

Improve the defenses of the forest against anticipated changes or directly defend the forest against disturbance in order to maintain relatively unchanged conditions

- Short-term
- High-value

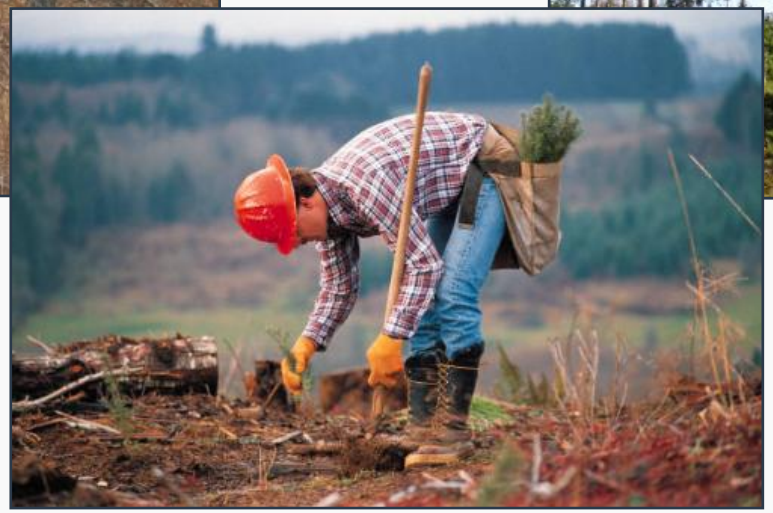
*Millar et al. 2007, 2008; DeRose and Long 2014*

# Option #1 – Resistance



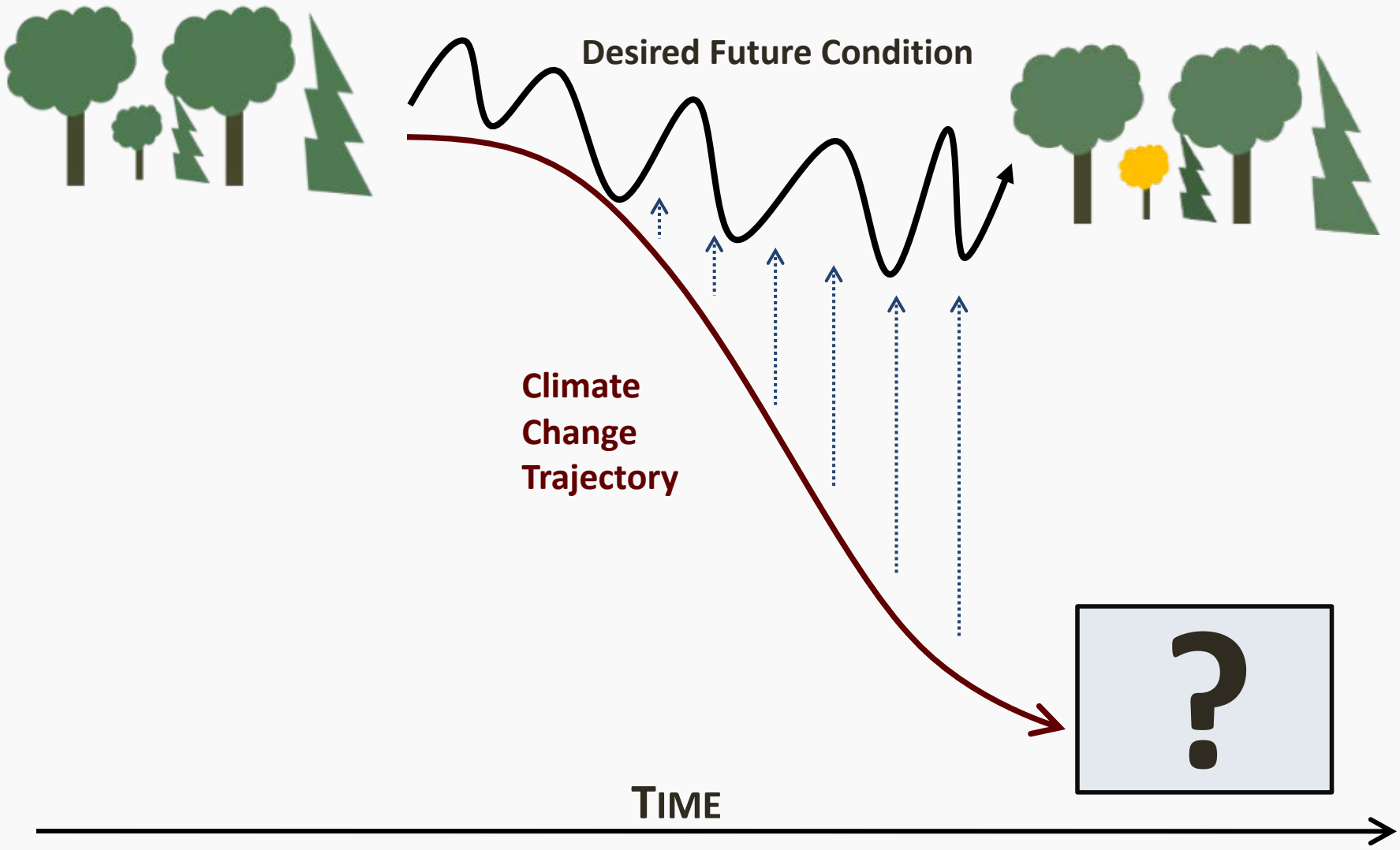
# Option #2 – Resilience

Accommodate some degree of change, but encourage a return to a prior condition after disturbance

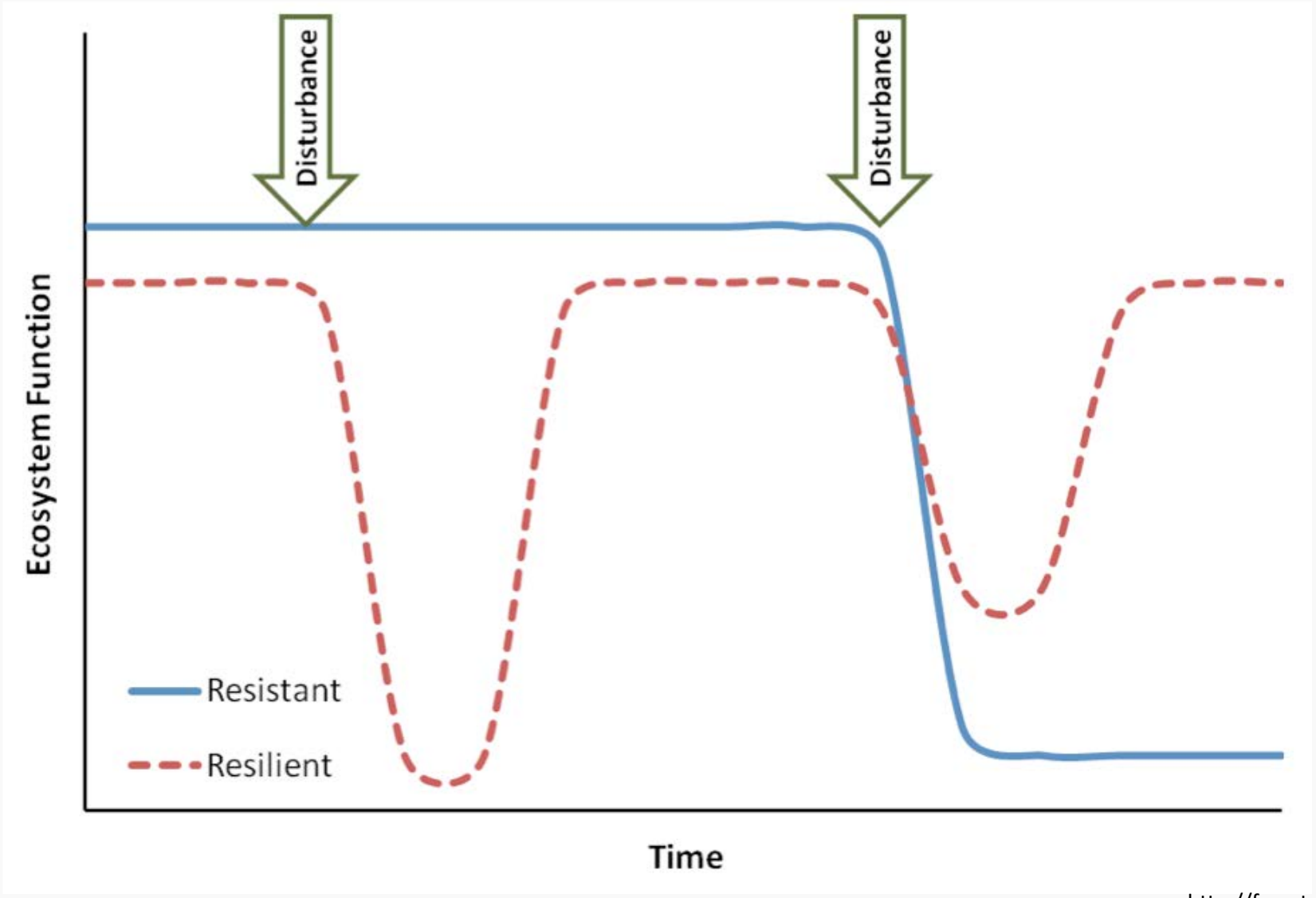


*Millar et al. 2007, 2008; DeRose and Long 2014*

# Option #2 – Resilience



# Resistance vs. Resilience



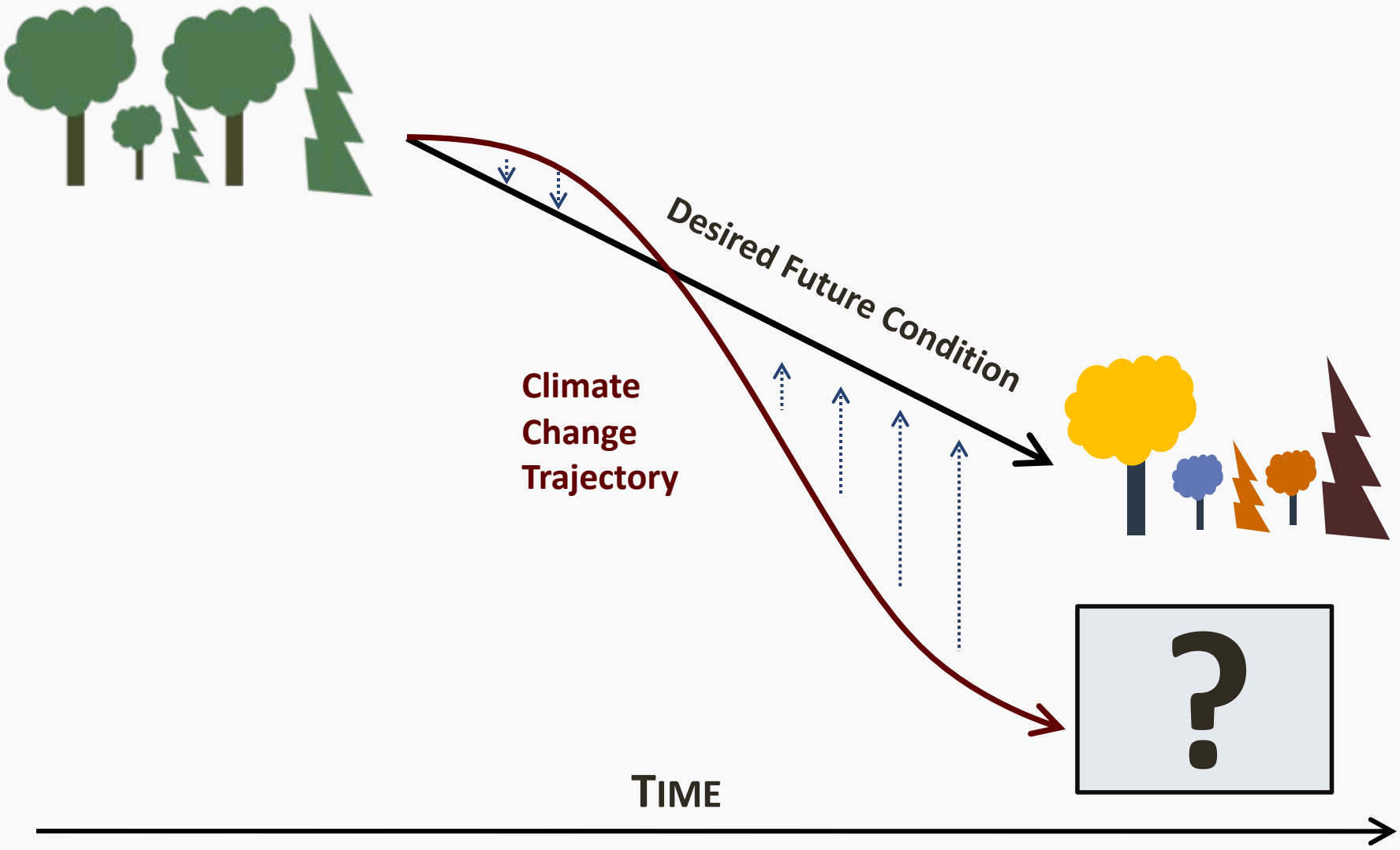

http://forestry.sfasu.edu

# Option #3 – Transition (Response)

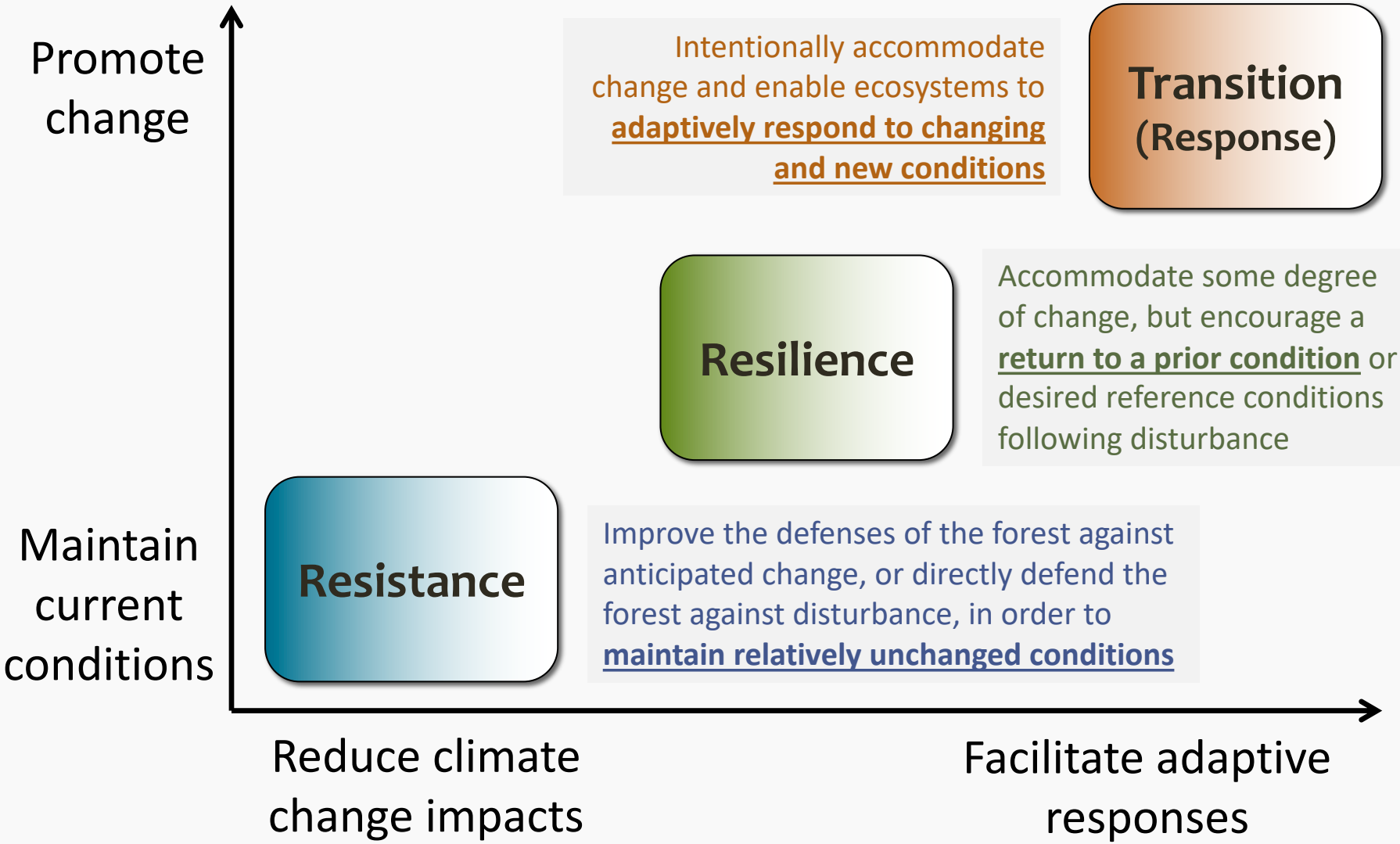
Intentionally accommodate change and enable ecosystems to adaptively respond to changing/new conditions

*Millar et al. 2007, 2008*

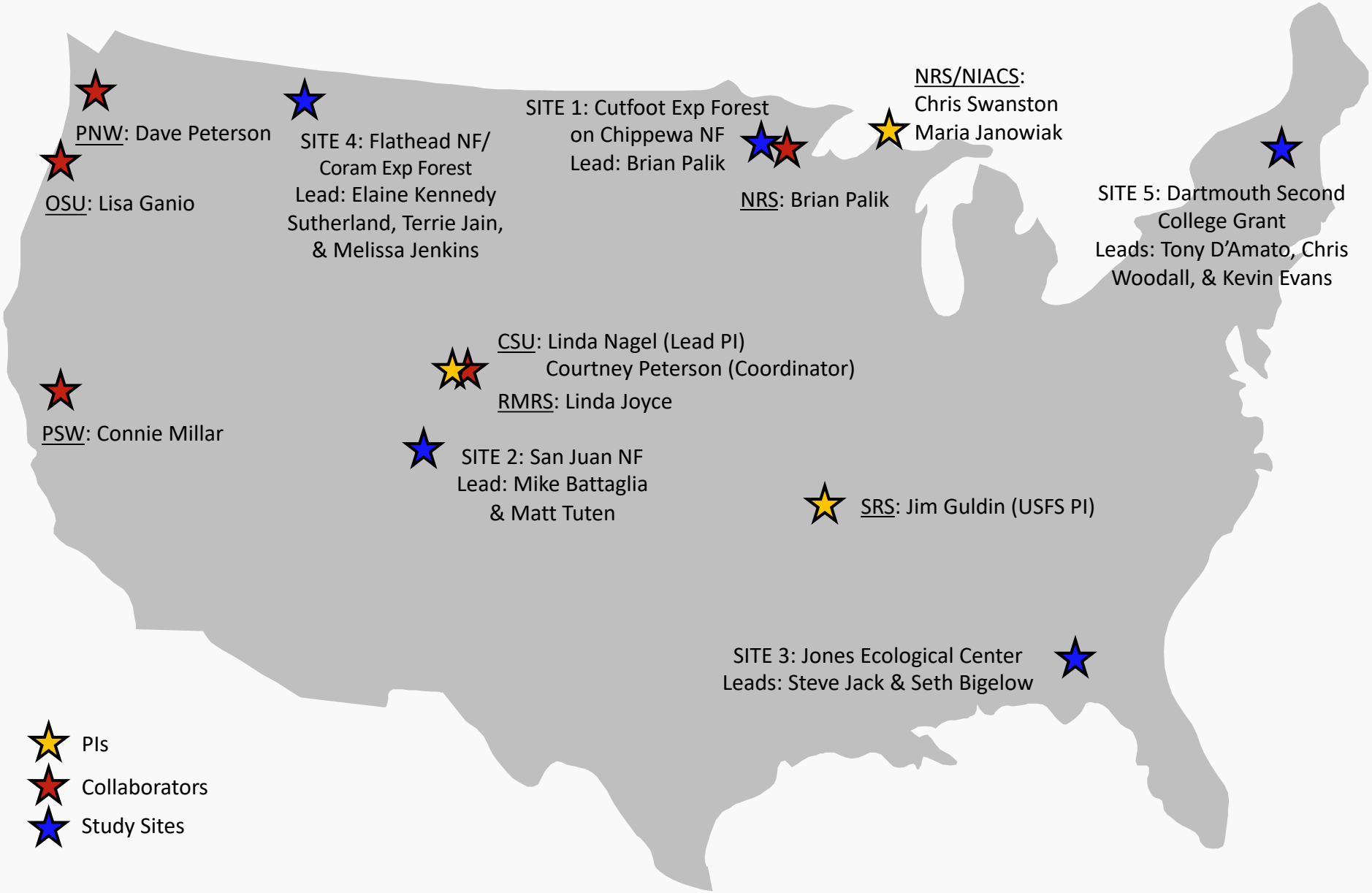
# Option #3 – Transition (Response)



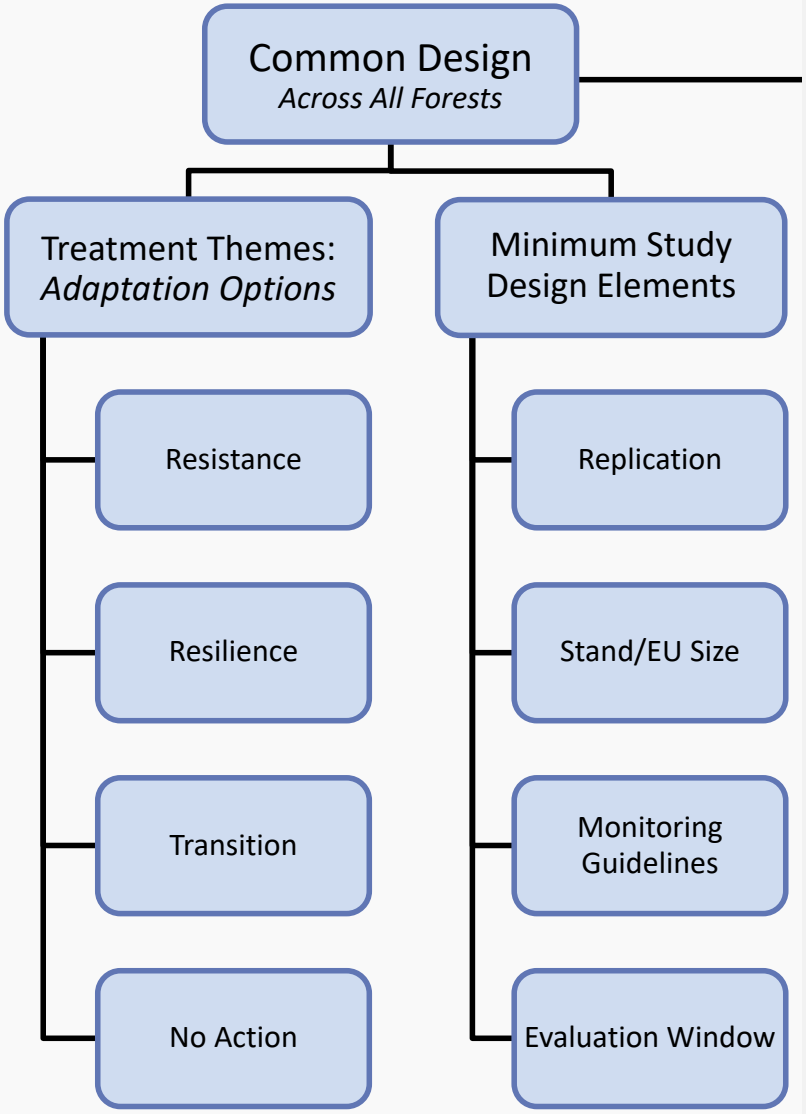
# Spectrum of Adaptation Options



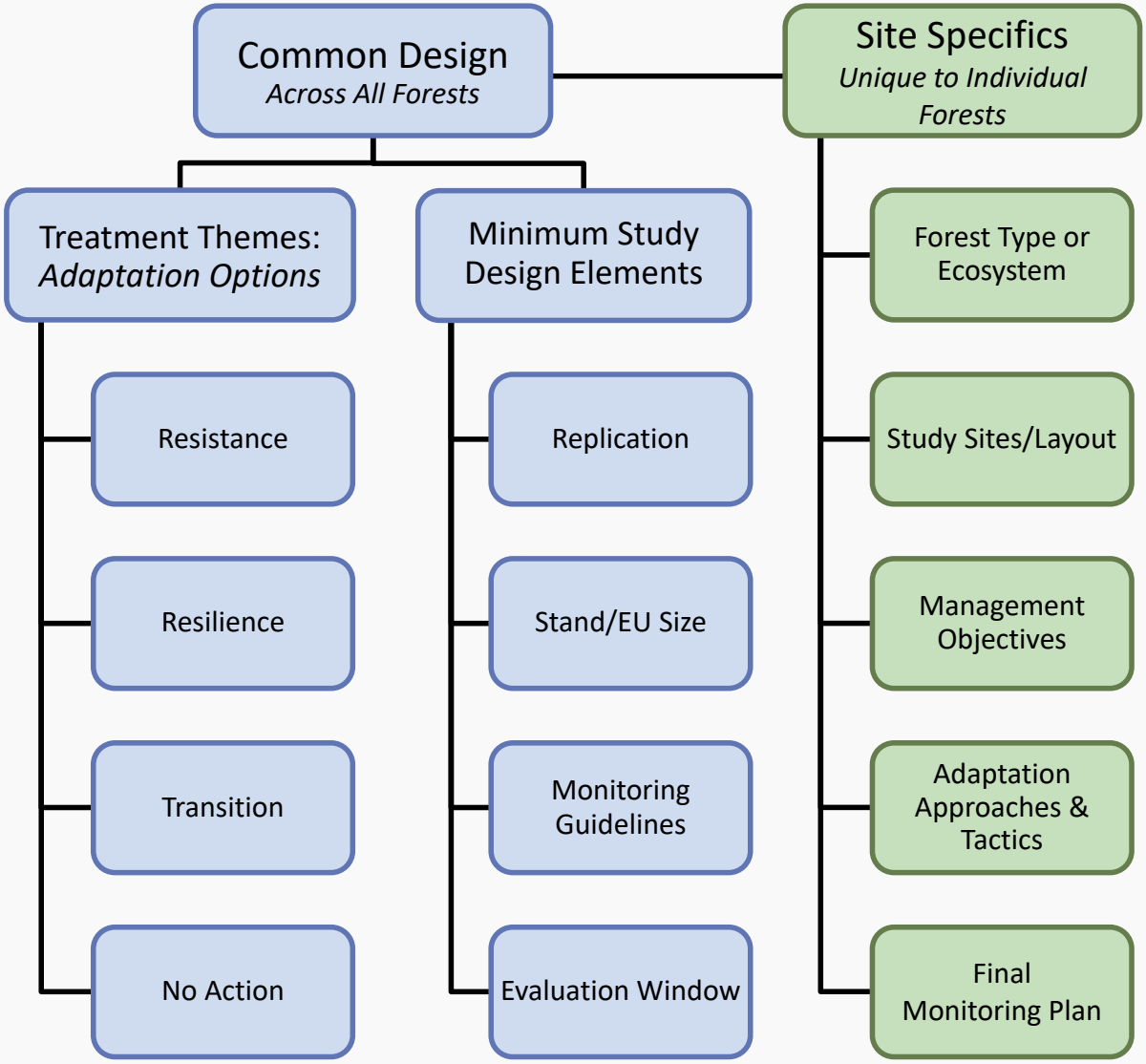
# Adaptive Silviculture for Climate Change (ASCC)



# ASCC Study Design



# ASCC Study Design



# Northern Institute of Applied Climate Science (NIACS)

CLIMATE

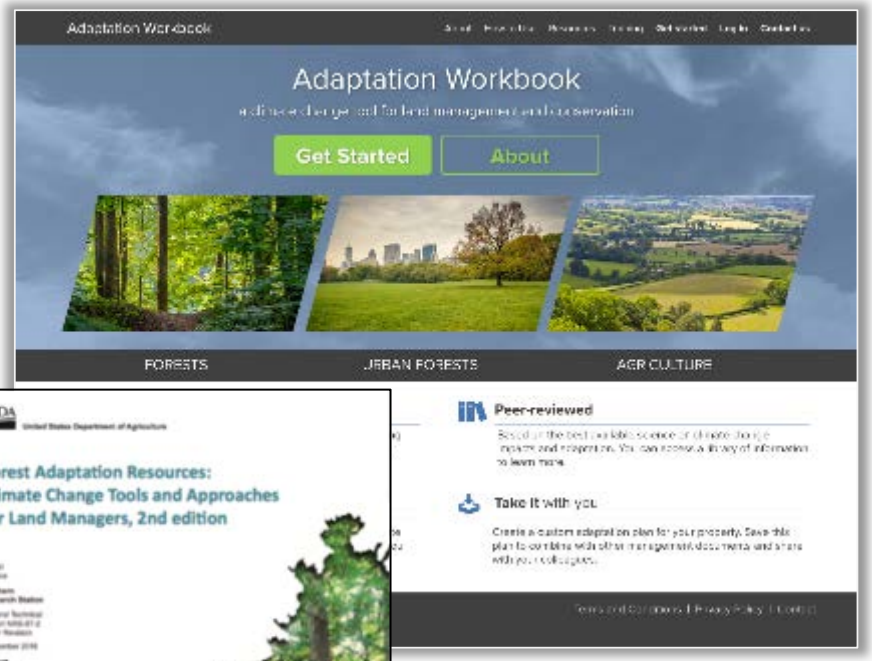
CARBON

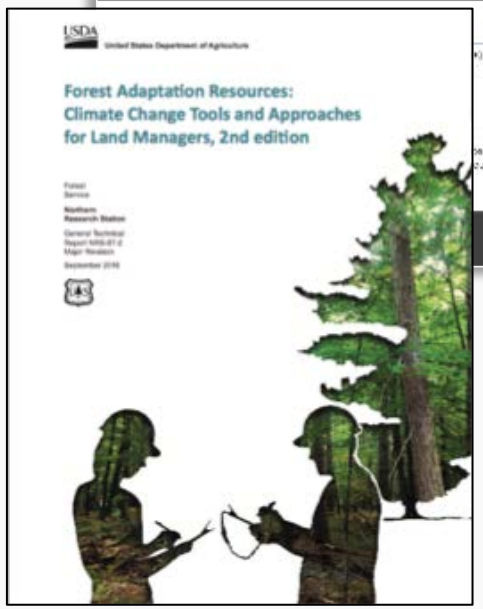
- Provides **practical** information, resources, and **technical assistance** related to forests and climate change
- Supports the **integration** of climate change information into natural resource management

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

## Address diverse needs with menu and workbook

- Adaptive management approach that incorporates climate change into each step
- Supports **diverse goals and objectives**
- Tailored to **local forest types**
- Menu of adaptation **strategies and approaches** for forest ecosystems
- **Does not make recommendations**




NIACS
Northern Institute of Applied Climate Science

# 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.

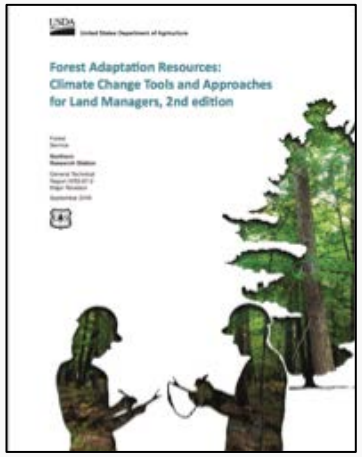
Adaptation Strategies and Approaches

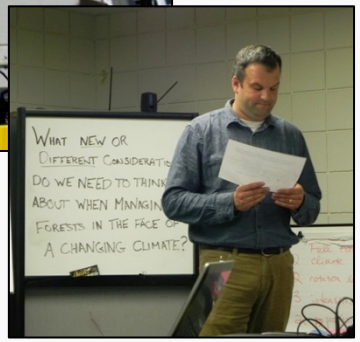
5. MONITOR and evaluate effectiveness of implemented actions.


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

# Workshop Day One

*CC and Adaptation Training*




1. Climate science overview
2. Climate change trends, impacts, and vulnerabilities for the region
3. Considerations for silvicultural decisions (exercise)
4. Climate change adaptation and silvicultural decision making
5. Developing adaptation approaches and tactics

# Workshop Day Two

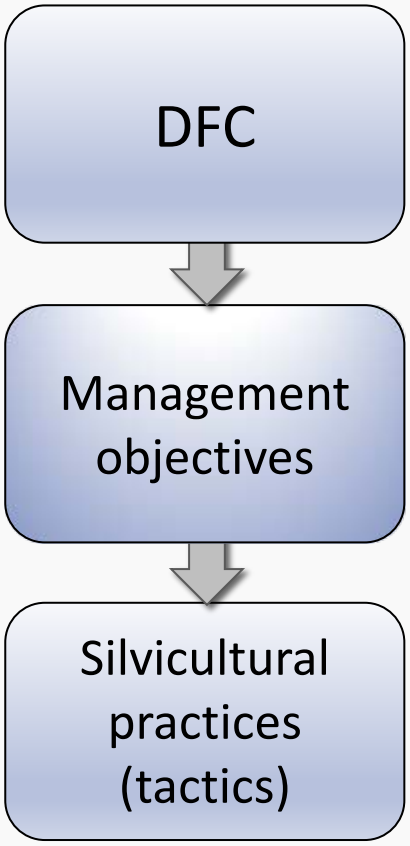
*Visit the Field*



# Workshop Day Two

*Developing the Experimental Treatments*

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




**What are the desired future conditions?**

**<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**
- **Recommend tactic?**

# Workshop Day Three

*Finalize Treatments, Timeline, Monitoring Plan*

Key Response Variables to be collected at each ASCC site

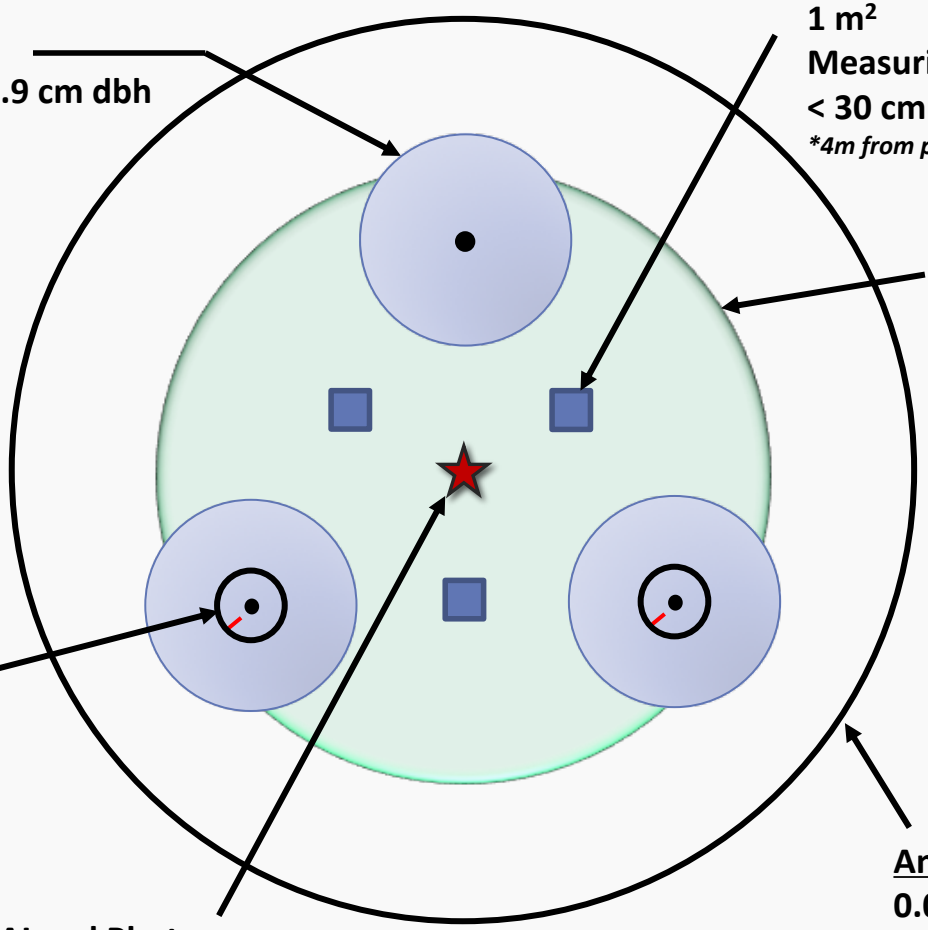
| | Species Composition | Forest Health | Productivity |
|---|---|---|---|
| Overstory | Species richness<br>Species diversity<br>Relative density<br>Relative dominance | Mortality<br>Crown density<br>Crown dieback<br>Live crown ratio<br>Tree damage (DSI) | Biomass increment<br>Basal area increment |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

# 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)**

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

**LAI and Photos**

**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***

# CORE Management QUESTIONS

Nagel et al. 2017

*Conceptual*

1) Will adaptation approaches and treatments work in a real-world context to **meet local management goals** and objectives?
2) How **feasible** are the treatments silviculturally, as well as in terms of financial, social, or other management constraints?
3) How does our **idea of desired future conditions** (DFCs) **change with each treatment type**?
4) What does it mean to deliberately create a future-adapted ecosystem, and **why would a manager choose to do this**?
5) **What tradeoffs exist** between achievement of adaptation objectives and other common objectives for a given region and ecosystem type?

# CORE Scientific QUESTIONS

Nagel et al. 2017

*Hypothesis-driven*

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

# The ASCC Sites

**Flathead National Forest / Coram Experimental Forest, MT**

- Western larch/mixed-conifer
- Climate concerns include uncertain precipitation patterns, earlier snowpack melt, and increased risk of wildfire

**Cutfoot Experimental Forest / Chippewa National Forest, MN**

- Red pine-dominated, mixed species
- Climate concerns include increased drought stress, increased risk of wildfire, and increased insect and disease outbreaks

**Second College Grant / Dartmouth College, NH**

- Northern hardwoods
- Climate concerns include increased wind and ice events, increased drought stress, and loss of key ecosystem service species


**San Juan National Forest, CO**

- Warm-dry mixed conifer
- Climate concerns include warming, variable precipitation patterns, earlier snowmelt, increased risk of wildfire and insect outbreaks

**J.W. Jones Ecological Research Center, GA**

- Mixed pine - hardwood system of the southeastern coastal plain
- Climate concerns include increased drought severity and extreme weather events

# ASCC STUDY SITES:
# Cutfoot Experimental Forest, Minnesota

# Cutfoot Experimental Forest, MN

- Chippewa National Forest
- Workshop: June 25-27, 2013
- Fire dependent, mixed-species, dry woodland - red pine dominated mixed with white and jack pine, overly dense, hardwood encroachment
- Minor species: paper birch, northern red oak, red maple, white spruce, and aspen
- Dense understory of *Corylus* (hazel)
- Average basal area 180 $ft^2$/ac
- Fire-origin 1918; fire exclusion since
- Largely single cohort
- Current condition: vulnerable to climate change and forest health issues

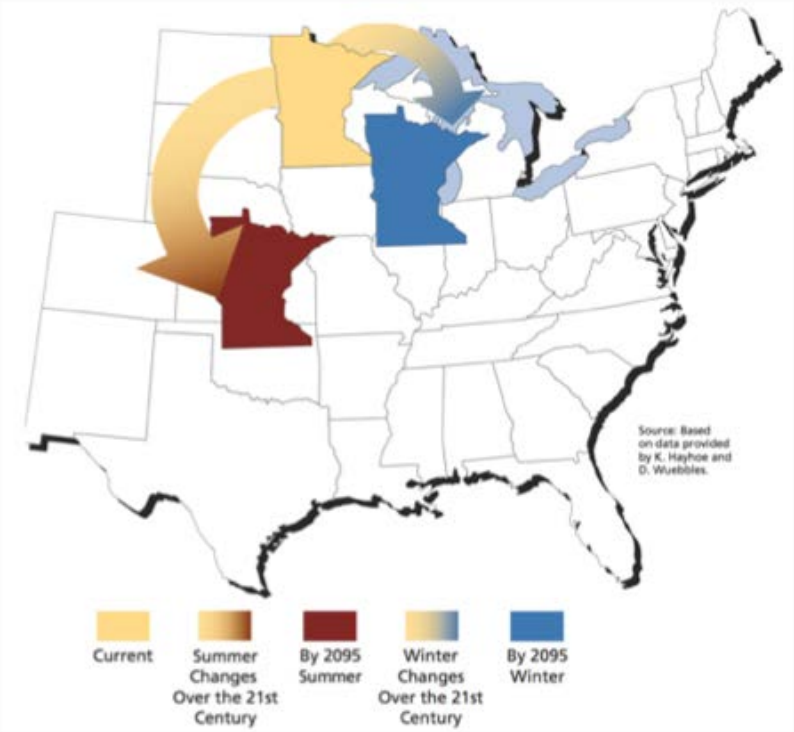


www.dnr.state.mn.us/ec

# Cutfoot Experimental Forest, MN

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)



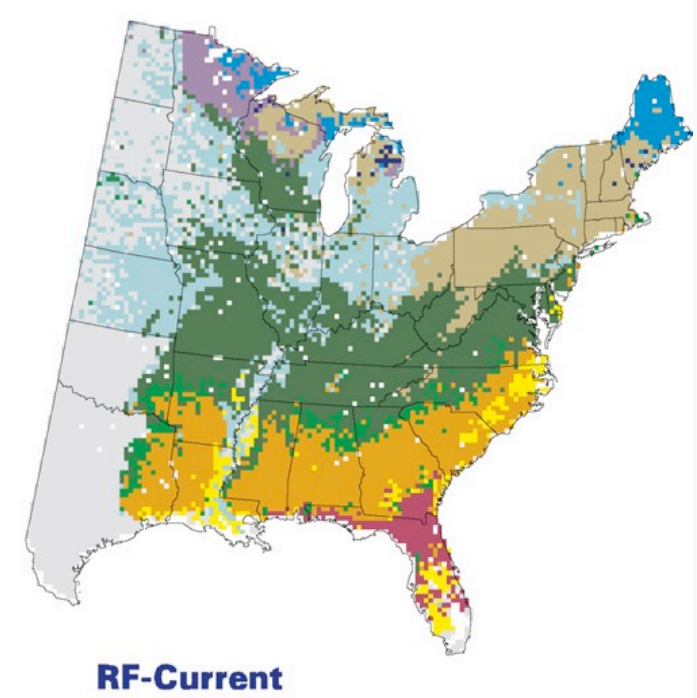

http://www.ucsusa.org/greatlakes/glchallengereport.html

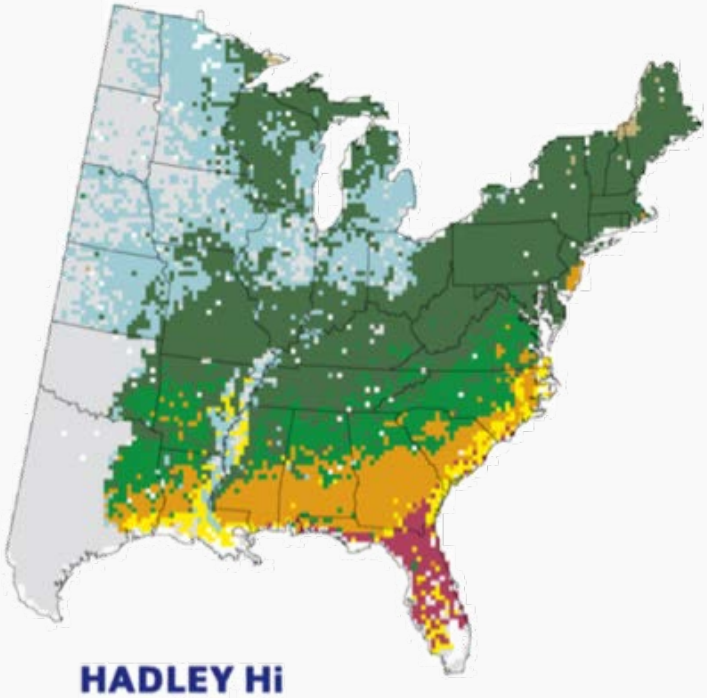
# Cutfoot Experimental Forest, MN

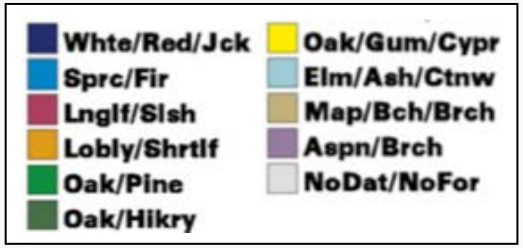
## Species Range Shifts

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

### Tree Atlas




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

# Cutfoot Experimental Forest, MN

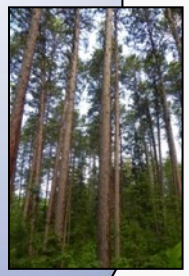
Promote Change

Maintain current conditions

## Spectrum of Adaptive Forest Management Treatments

### Resistance

Management Goal: maintain relatively unchanged conditions over time
Strategy: promote red pine dominance



### Resilience

Management Goal: allow some change in current conditions, but encourage a return to reference conditions
Strategy: red pine dominance, increase future-adapted species over time

Future-adapted species:
eastern white pine
jack pine
red oak
bur oak
red maple

### Transition

Management Goal: intentionally accommodate change and enable ecosystems to adaptively respond to changing conditions
Strategy: reduce red pine, increase future-adapted species

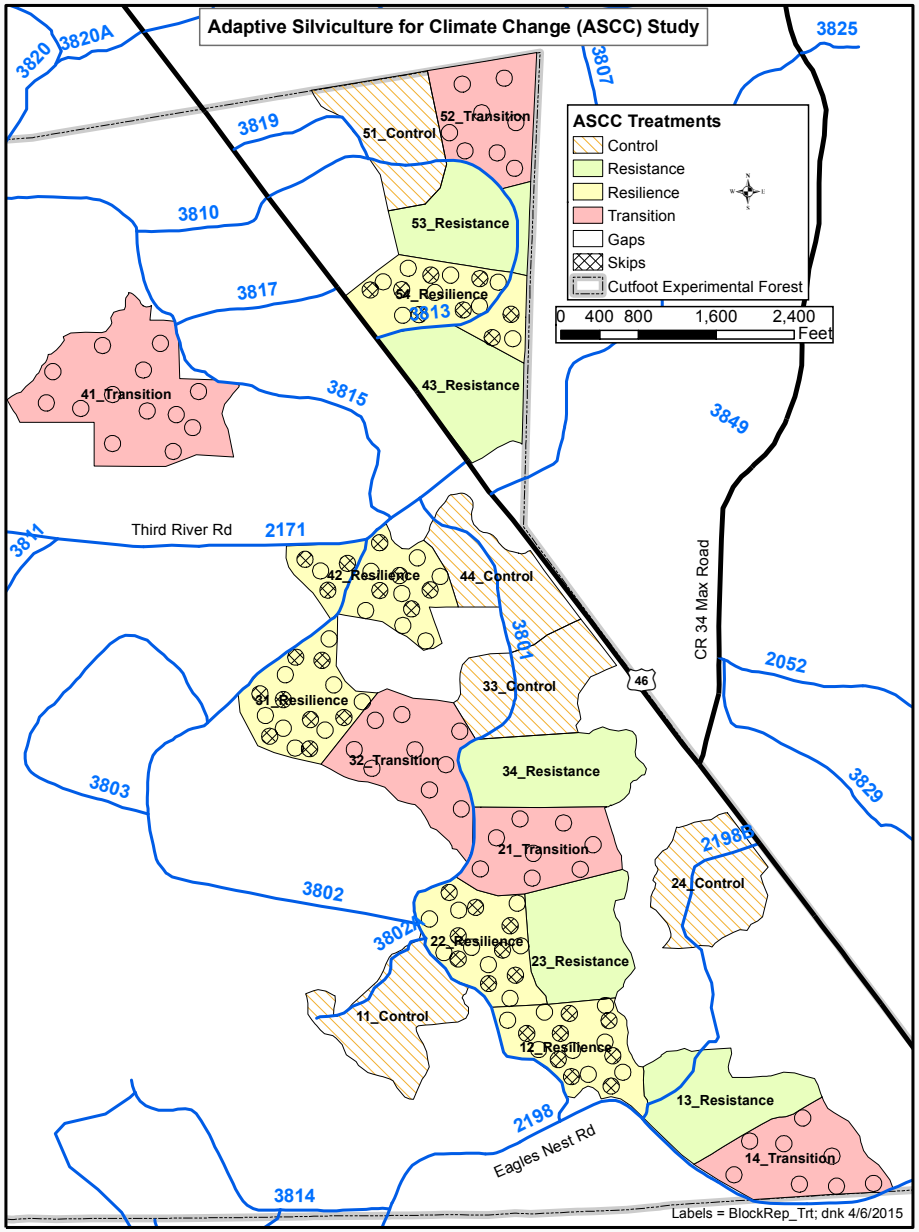
Future-adapted species:
eastern white pine
red oak
bur oak
white oak
red maple
bitternut hickory
black cherry
ponderosa pine

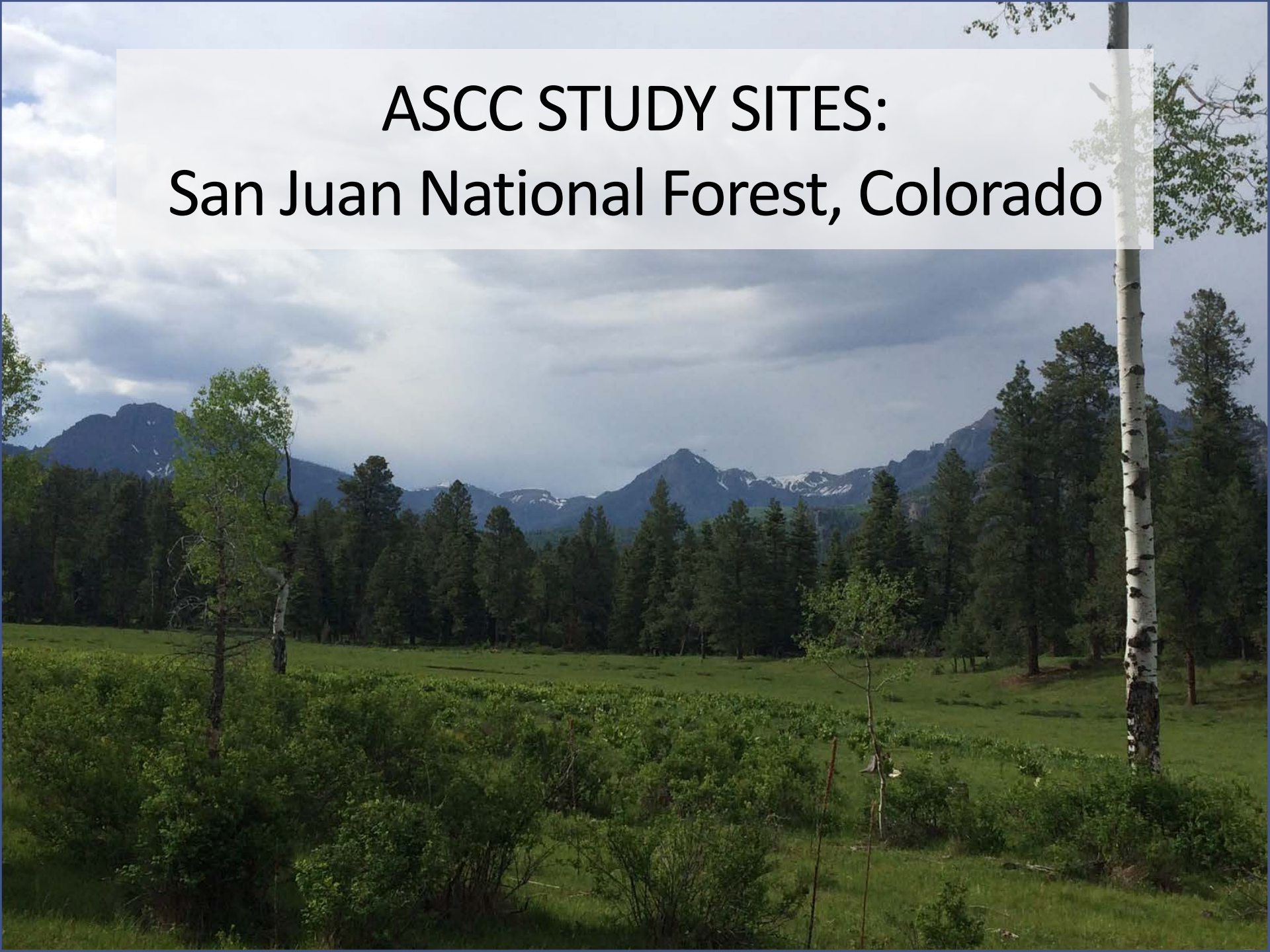
Reduce climate change impacts

Facilitate adaptive responses

# Cutfoot Experimental Forest, MN

- 5 Replicates (500 ac)
- Control/Resistance
  - 7 plots
- Resilience
  - 3 in gaps
  - 3 in skips
  - 5 in matrix
- Transition
  - 3 in gaps
  - 6 in matrix
- Total Plots = 170

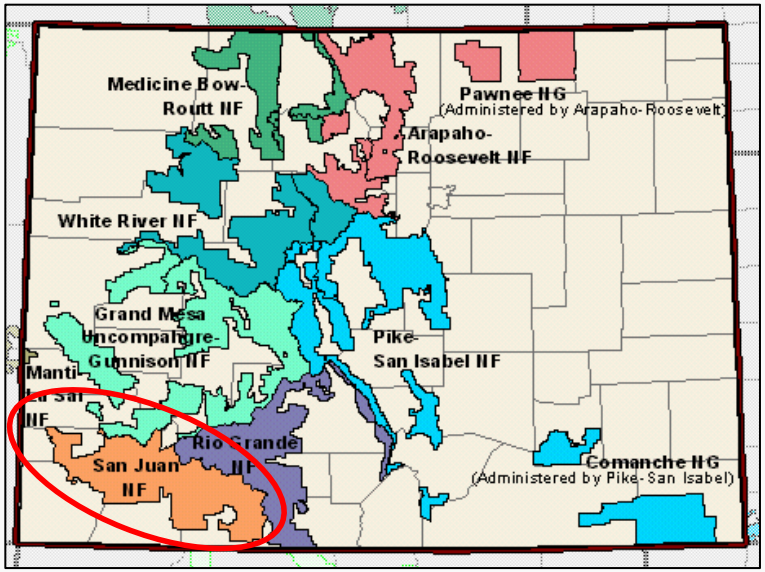





# ASCC STUDY SITES:
# San Juan National Forest, Colorado

# San Juan National Forest, CO

- Workshop: March 4-6, 2014
- Dry Mixed Conifer Forest (Ponderosa pine, Douglas-fir, White Fir, Aspen, Gambel Oak)
- Site Considerations:
  - Variable topography [aspect and slope position]
  - Wildland-urban interface
  - Historically, frequent fire. Current conditions are outside HRV



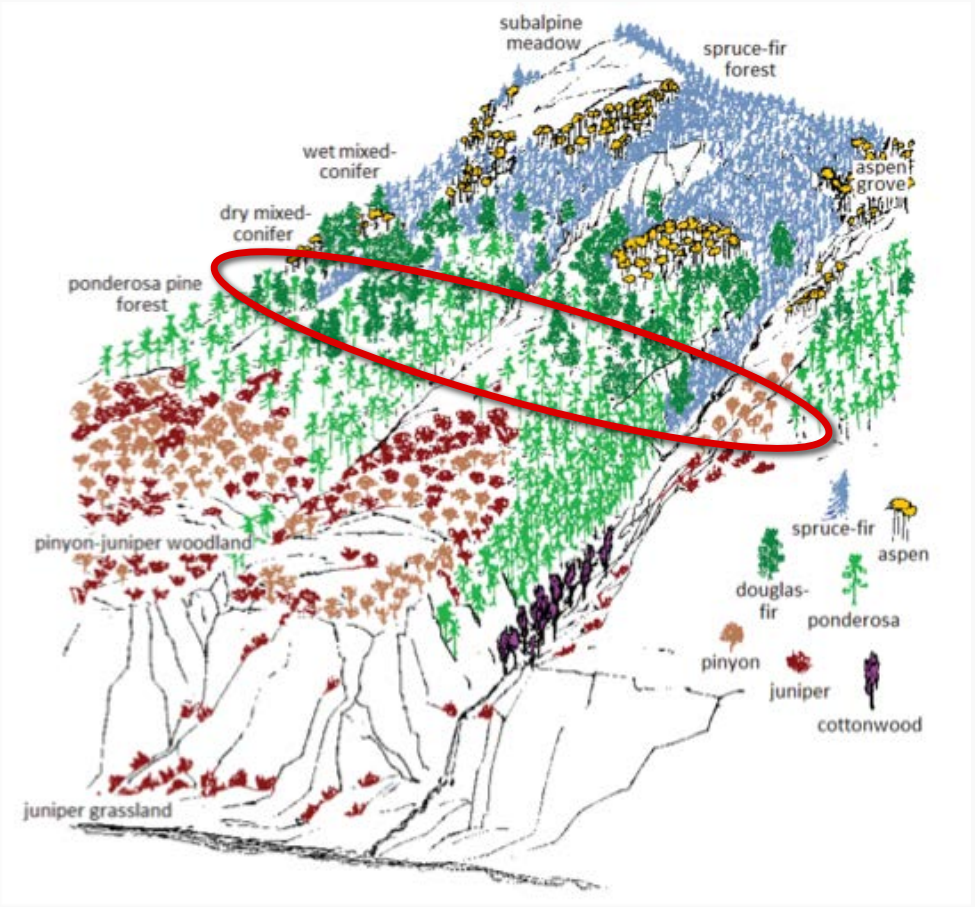

# San Juan National Forest, CO

## Climate Change Impacts:

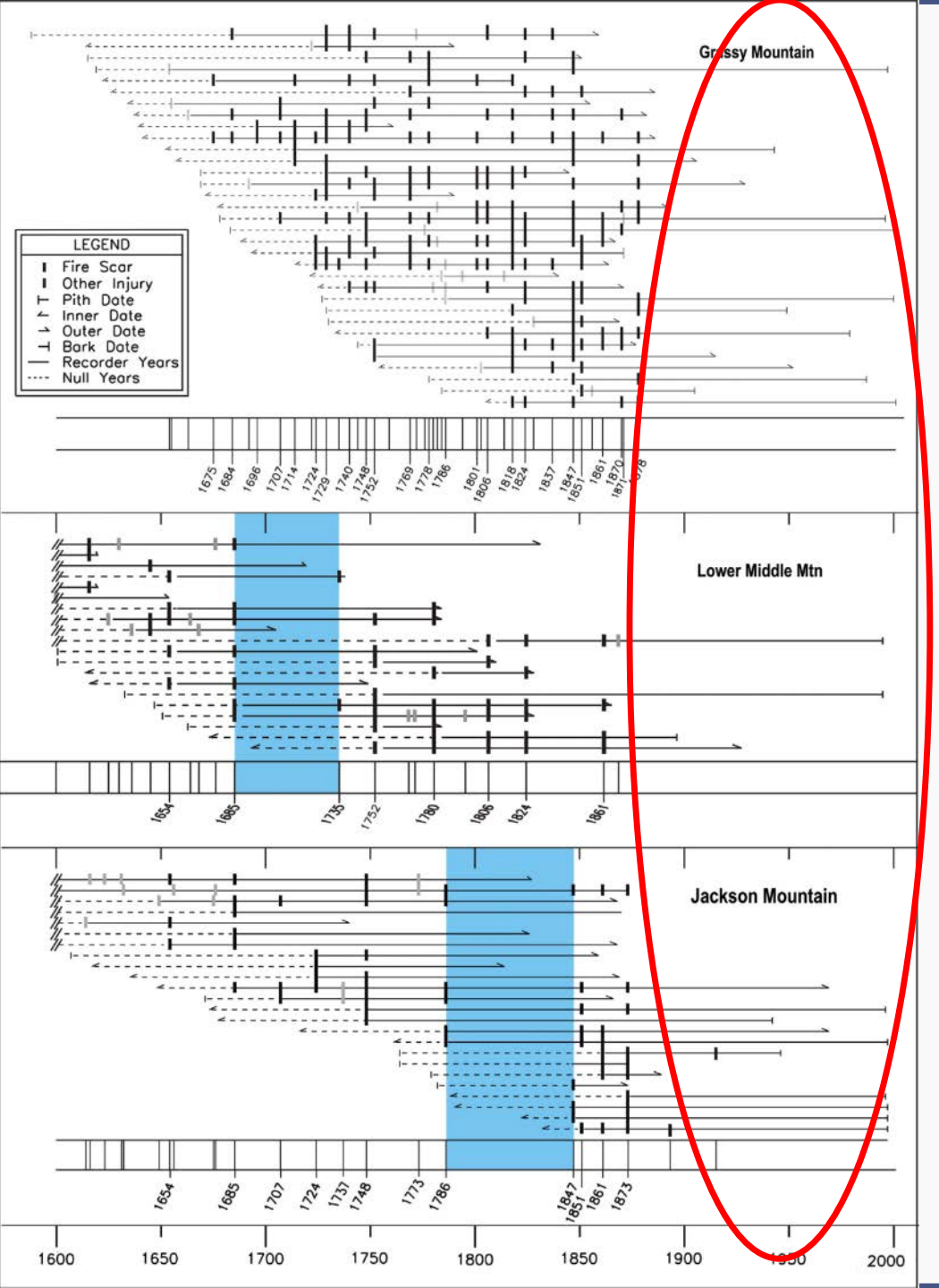
- Increase in temperature throughout all seasons
- Earlier snowmelt = longer growing seasons, greater potential for drought, and longer fire seasons
- Increase in potential for wildfire and insect/disease outbreaks

## Expected species impacts and vulnerabilities:

- Sagebrush ↑
- Gambel oak ↑
- Piñon-Juniper ↓
- Ponderosa pine slight ↓ or little change
- Mixed conifer neutral / ↓
- Aspen ↓ and shift upslope/elevation




Reynolds et al 2013




# Warm dry mixed conifer forests

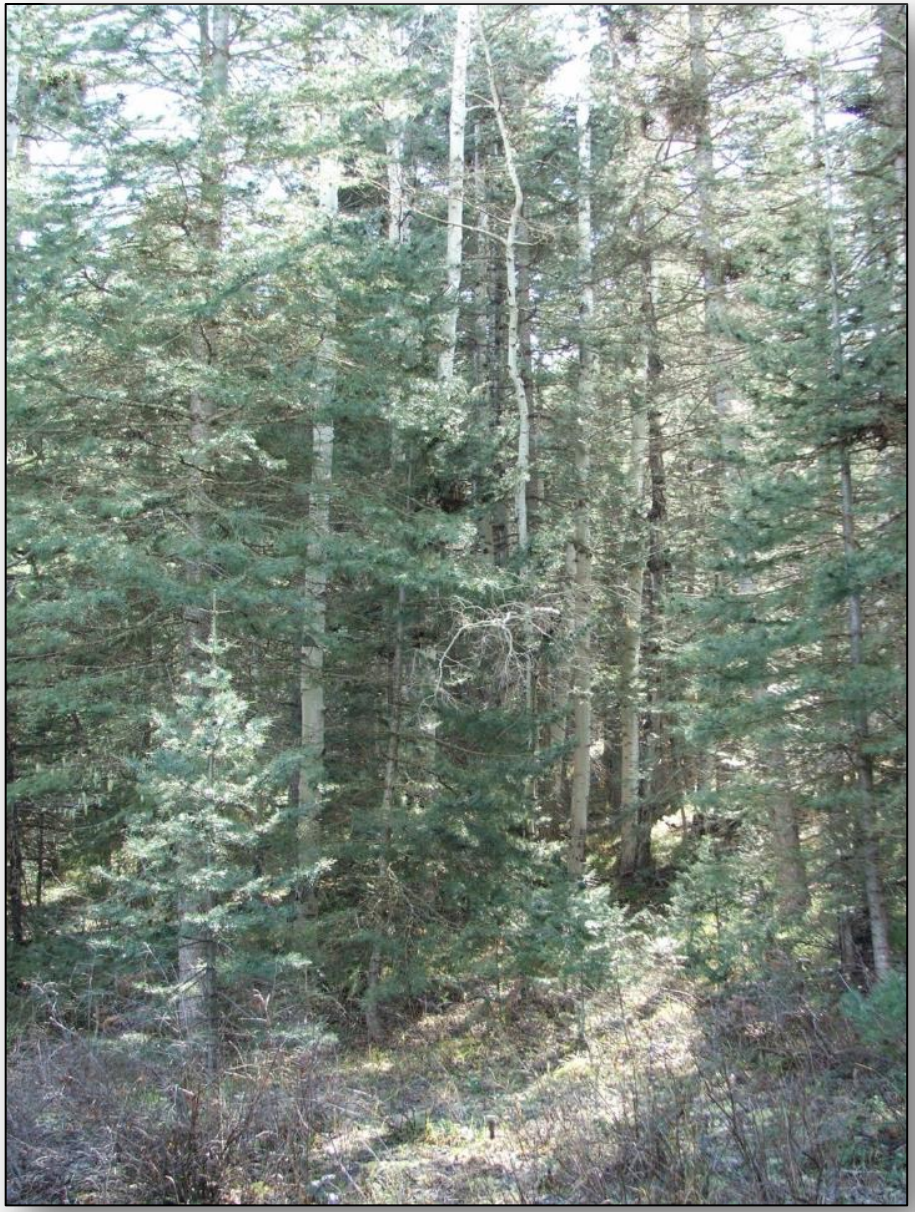
Mean Fire Interval = 10 yrs
No Fire free period

Mean Fire Interval = 30 yrs
Fire free period = 50 yrs

Mean Fire Interval = 24 yrs
Fire free period = 61 yrs

Korb et al 2013

# San Juan National Forest, CO



Photos: Steve Hartvigsen, USDA Forest Service, San Juan National Forest

# San Juan National Forest, CO

## Desired Future Condition, *generally*

**More open, park-like; PP dominant; more clumpy with openings in between; more multi-cohort; more younger age classes of PP; healthier aspen; more variability in fuel loading and age classes at landscape scale**

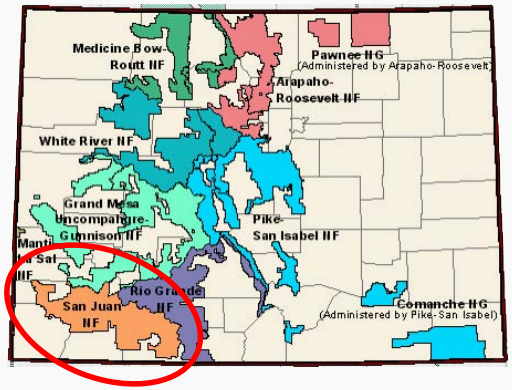
Current condition → ***silviculture*** → Desired condition

Photo credit: S. Hartvigsen

# San Juan National Forest, CO

Promote Change

Maintain current conditions




## Transition

Management Goal: intentionally accommodate change and enable ecosystems to adaptively respond to changing conditions

Strategy: Environment dominated by **openings**, retain PP and DF in **clumps**, Aspen in swales and N slopes, remove all WF

Species:
ponderosa pine ↑
Douglas-fir ↑
white fir ↓
aspen in clumps
grass/shrub/oak/RMJ/SWLP ↑

## Resilience

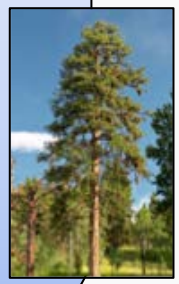
Management Goal: allow some change in current conditions, but encourage a return to reference conditions

Strategy: variable tree cover and openings (1 ac), increase drought-tolerant species

## Resistance

Management Goal: maintain relatively unchanged conditions over time

Strategy: maintain proportional PP, DF, WF, AS

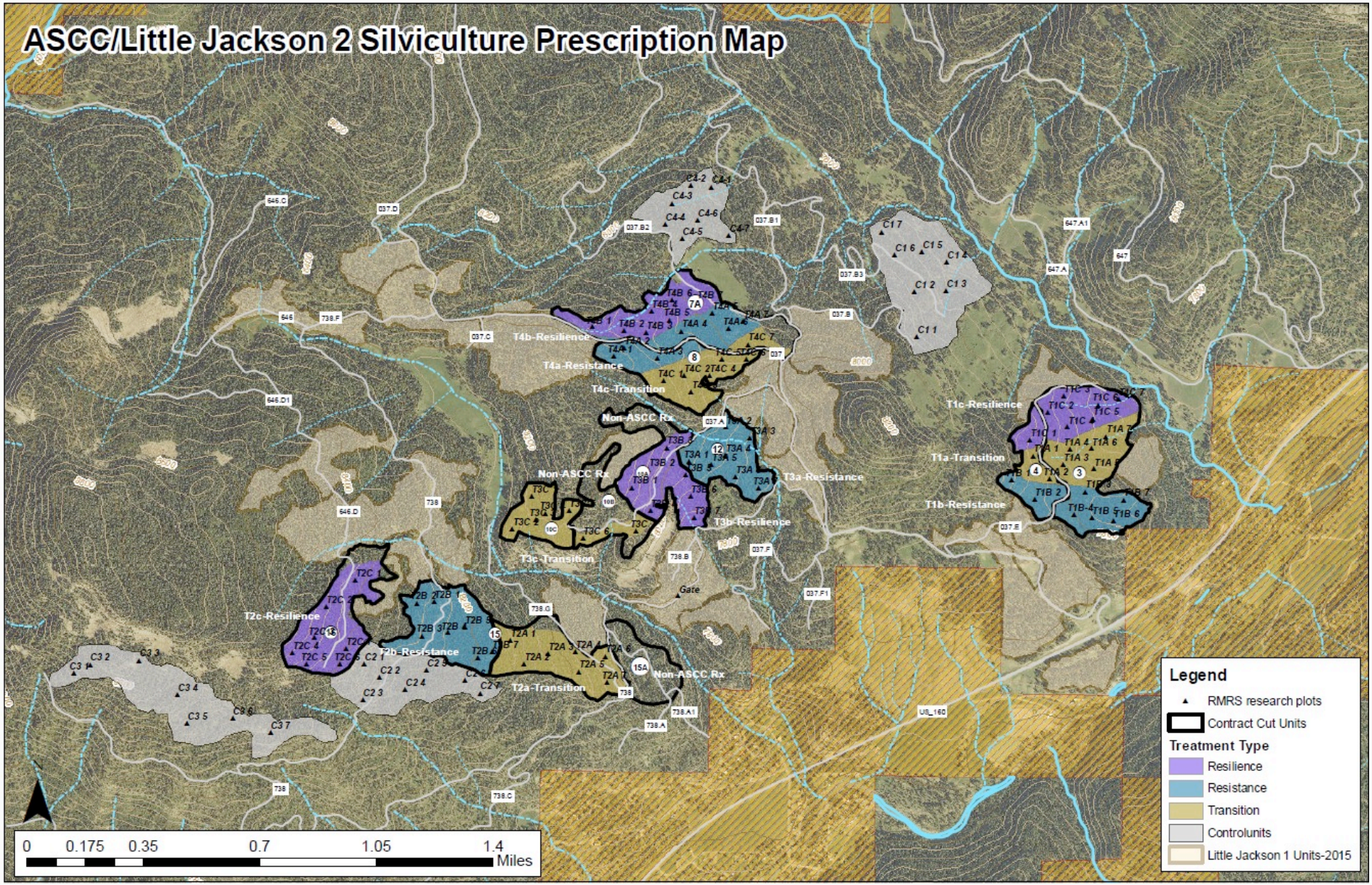


Species:
ponderosa pine ↑
Douglas-fir ↑
white fir ↓
aspen in clumps

Reduce climate change impacts

Facilitate adaptive responses

# San Juan National Forest, CO



# ASCC – Fast Facts

- 2,100 acres currently being harvested (or designated no action) and measured
- 3 USFS National Forests involved as project sites, 3 USFS Research Stations
- 2 large private entities involved as project sites
- 6 universities engaged in ASCC project research
- Over **275,000** seedlings have been planted on the Minnesota ASCC site
- 170 (MN) + 112 (CO) + 112 (GA) + 200 (NH) + 112 (MT) = **706** re-measurement plots dedicated to ASCC project research

# For More Information About ASCC

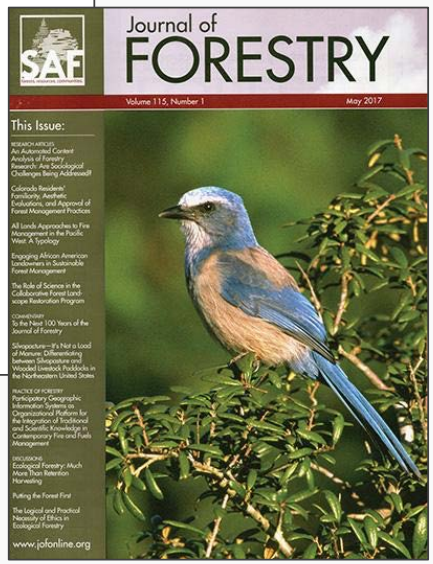
RESEARCH ARTICLE

*J. For.* 115(3):167-178
https://doi.org/10.5849/jof.16-039


silviculture

## Adaptive Silviculture for Climate Change: A National Experiment in Manager-Scientist Partnerships to Apply an Adaptation Framework

Linda M. Nagel, Brian J. Palik, Michael A. Battaglia, Anthony W. D'Amato, James M. Guldin, Christopher W. Swanston, Maria K. Janowiak, Matthew P. Powers, Linda A. Joyce, Constance I. Millar, David L. Peterson, Lisa M. Ganio, Chad Kirschbaum, and Molly R. Roske




**Linda Nagel, Professor and Department Head**
**Forest & Rangeland Stewardship, Colorado State University**
linda.nagel@colostate.edu
www.forestadaptation.org/ascc

May 2017, *Journal of Forestry*
Proceedings of the 2015 National Silviculture Workshop

# ASCC is Awesome!

- Advance our understanding of how forest management can foster adaptive responses to the impacts of uncertain climate futures
- Advance communication of climate change adaptation at a national scale
- Look for opportunities to continue managing forests to be diverse, resilient, and valuable to all of us into the future

# Thank you!

ASCC website coming soon: www.AdaptiveSilviculture.org!

For more information about the ASCC National Network, contact:


**Linda Nagel**
ASCC National Project Lead
Linda.Nagel@colostate.edu

**Courtney Peterson**
ASCC National Project Coordinator
Courtney.Peterson@colostate.edu


Colorado State University · USDA Forest Service · NIACS Northern Institute of Applied Climate Science · Dartmouth · The University of Vermont · University of Minnesota · Michigan Technological University 1885 · The Joseph W. Jones Ecological Research Center at Ichauway