ADAPTIVE SILVICULTURE IN A CHANGING CLIMATE

Michigan Society of American Foresters
Canadian Institute of Forestry, Central Ontario Section
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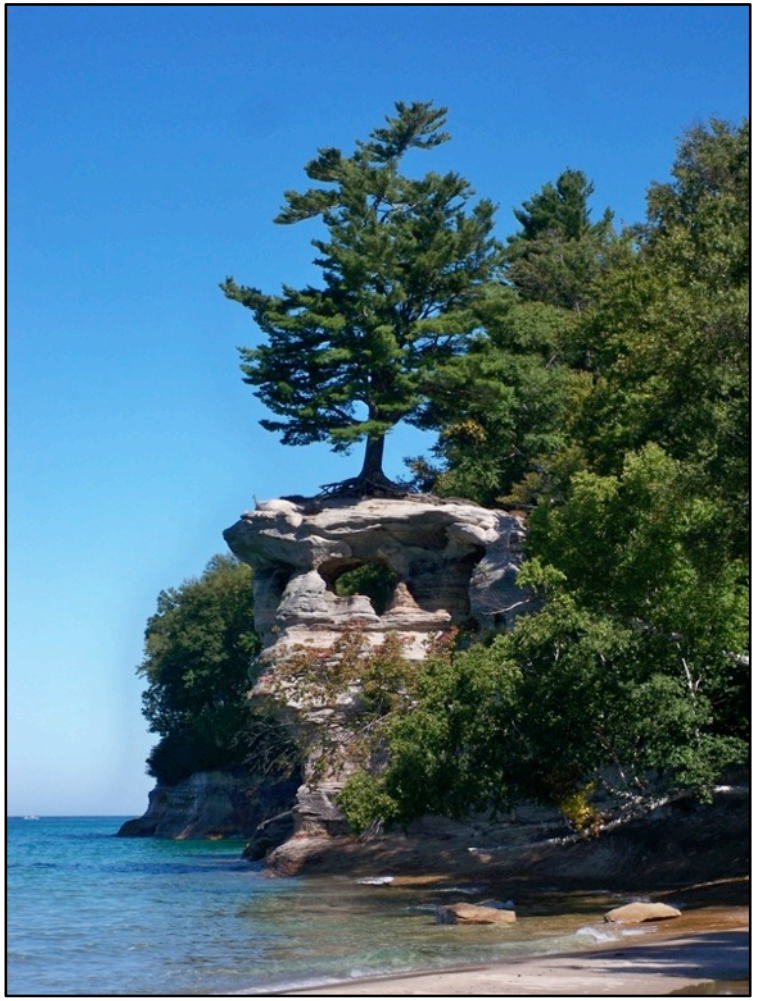
Roadmap ~ Climate Change Silviculture



Pictured Rocks National Lakeshore, MI

- Climate change
- Role of terrestrial ecosystems
- Silvicultural process
- What can we do as forest managers?
- Adaptive silviculture planning

CLIMATE CHANGE

feature article

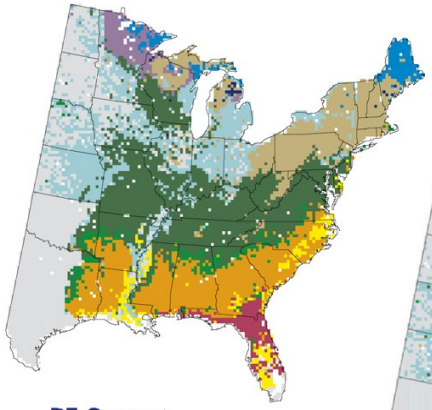
Communicating the science of climate change

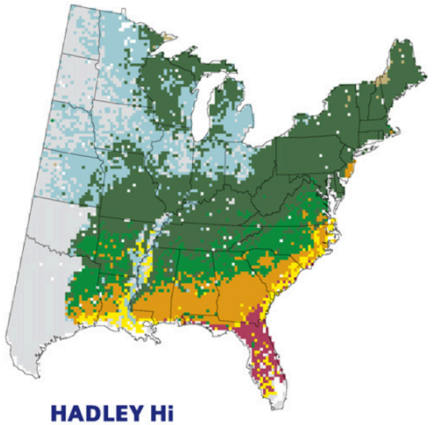
Richard C. J. Somerville and Susan Joy Hassol

Figure 1. Global warming's six Americas in May 2011, as categorized by a 2011 public-opinion study by a team from Yale and George Mason universities.[3]

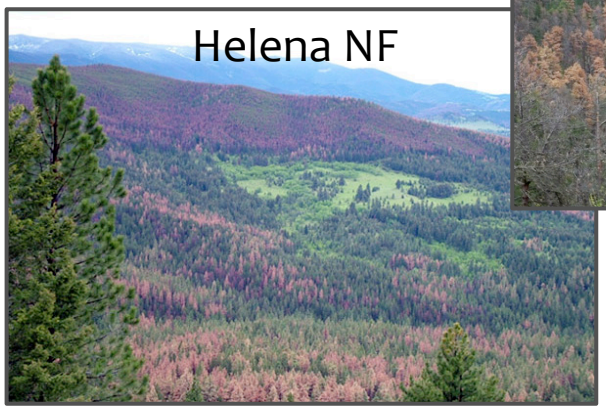
ROLE OF TERRESTRIAL ECOSYSTEMS

Increased Stresses



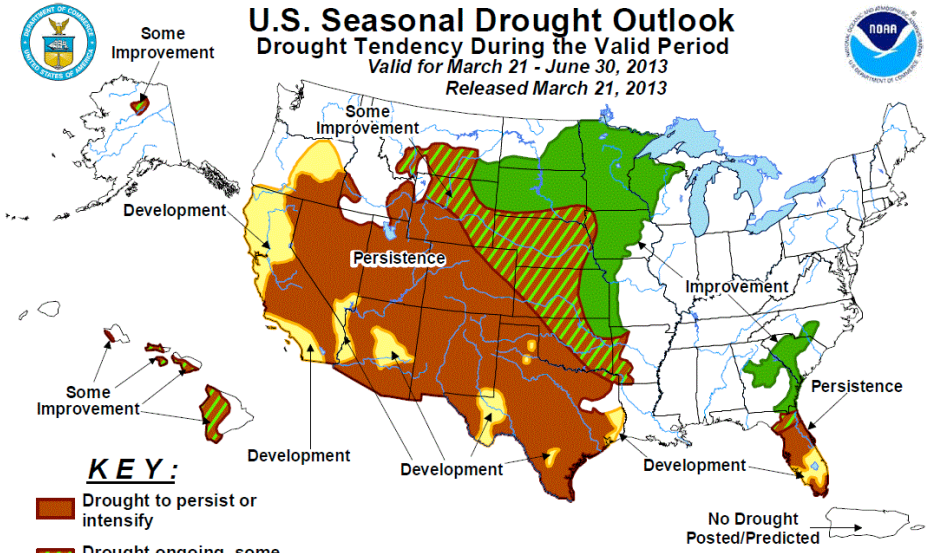


Shifts in species range distributions



Mountain Pine Beetle

Photo credit: Les Homan



Key Vulnerabilities ~ Midwest Region

- Risk will be greater in low diversity systems
- Disturbance will destabilize static ecosystems
- Greater problems for species already in decline
- Resilience may be weakened in fragmented ecosystems
- Further reductions in habitat will impact threatened, endangered, and rare species
- Ecosystem changes will have significant effects on wildlife
- Impaired ability of forested watersheds to produce reliable supplies of clean water
- Recreation within forested ecosystems may change in extent and timing
- Altered traditional and modern cultural connections to forests

Swanston et al 2011, Handler et al 2012

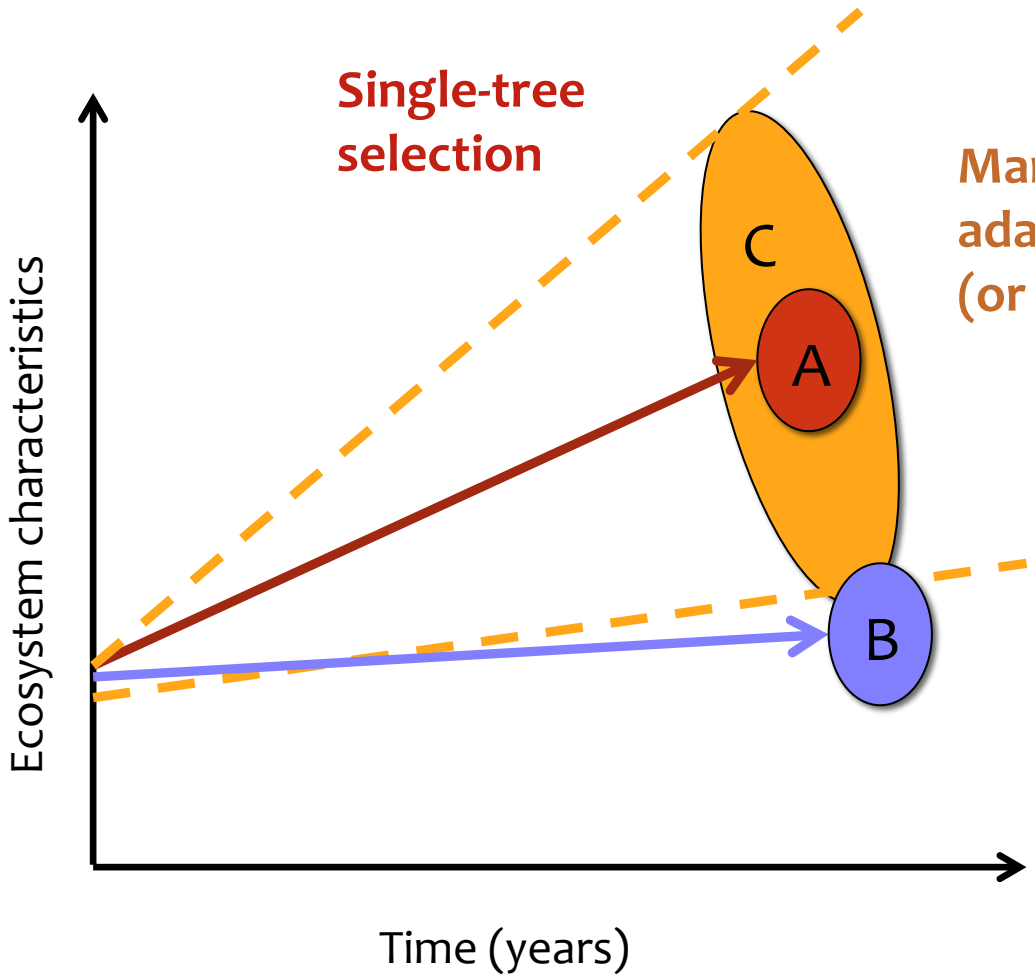
Accommodating change

- **Diversity** (**complexity**) will be the key to maintaining ecosystem function, even if the species mixture of the system changes
  - Species that are currently increasing
  - Species with wider ecological range of tolerances
  - Species with greater genetic diversity
  - Species and ecosystems adapted to disturbances
  - Species and ecosystems adapted to warmer, drier climates
  - Ecosystems with diverse communities and species
  - Ecosystems contained within larger, contiguous blocks

Swanston et al 2011

SILVICULTURAL PROCESS

Complexity ≈ Adaptive



Stand structure
Timber volume
Tree biomass
Habitat

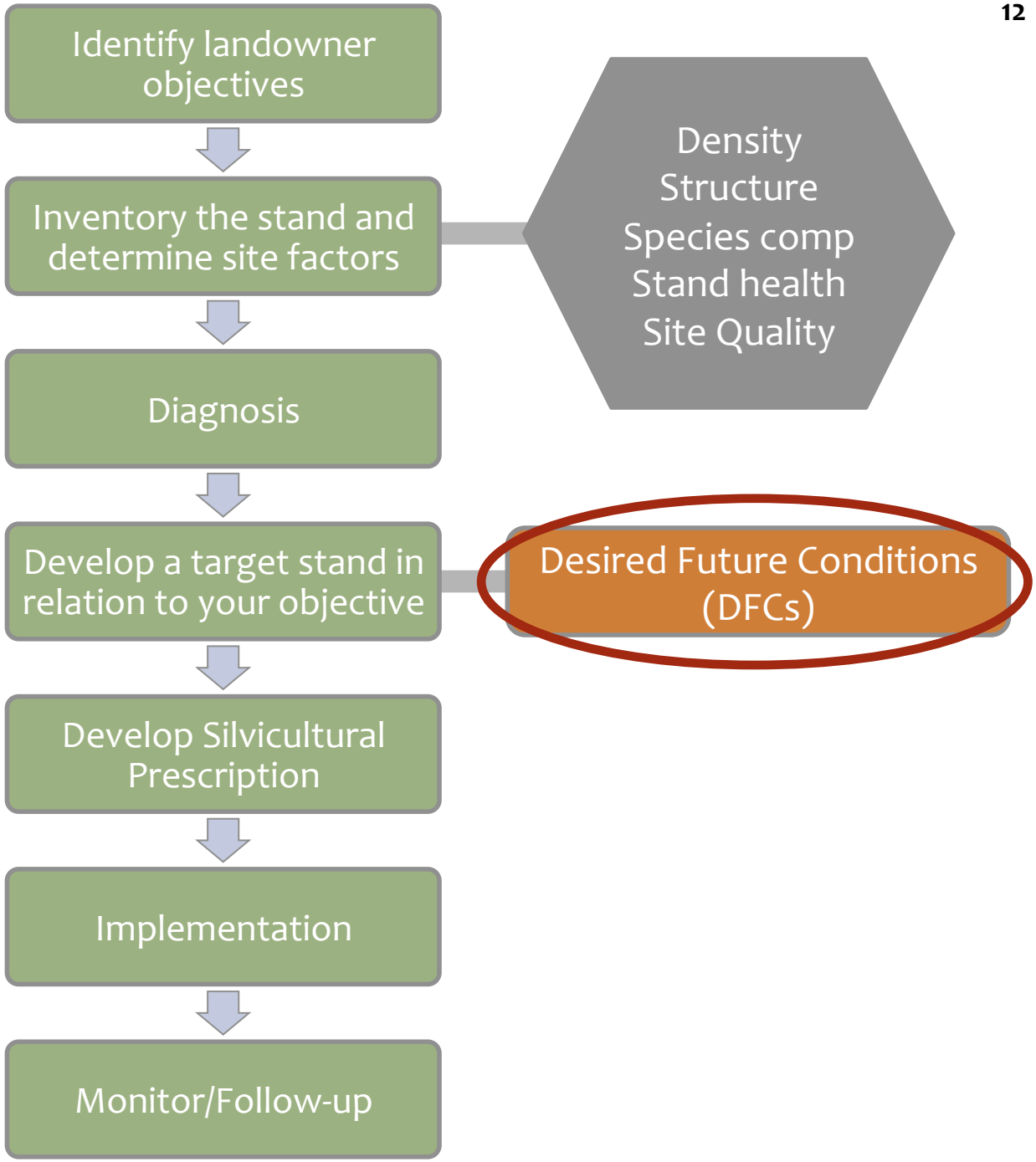
Managing for complexity allows forests to be "creative" in adapting to new altered conditions

Following Puettmann et al 2009

WHAT CAN WE DO AS FOREST MANAGERS?

What can be done during the course of active management on public and private lands that would increase the resistance and resilience of forest stands within the context of climate change?

The Silviculture Prescription Process



Desired Future Condition (DFC)

- **DFC** = a description of the land or resource conditions that are believed necessary if goals and objectives are fully achieved
  - SAF Dictionary of Forestry, 1998

Management will have to work with uncertainty

Desired Future Condition

TIME

Management will have to work with uncertainty

Desired Future Condition

Climate Change Trajectory

?

TIME

Management will have to work with uncertainty

Desired Future Condition

Increasing resources needed to maintain DFC

Climate Change Trajectory

?

TIME

Management will have to work with uncertainty

Desired Future Condition

Adaptation

Climate Change Trajectory

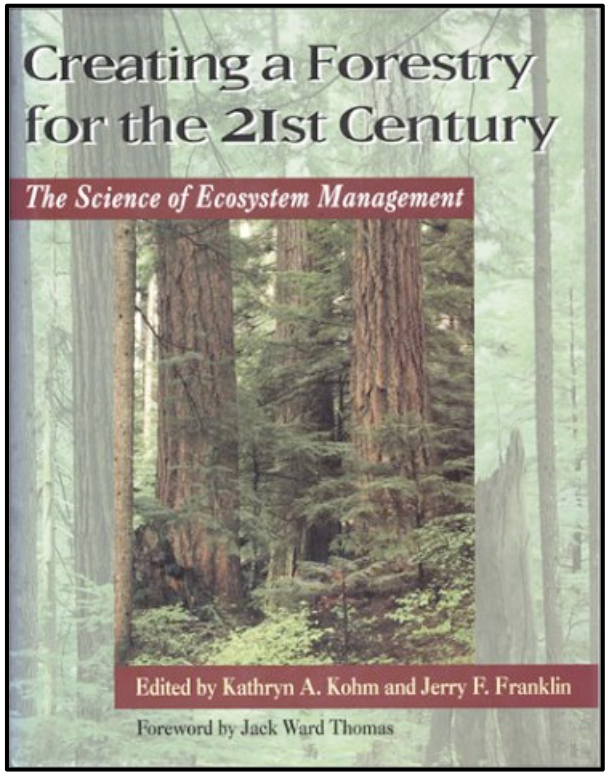
?

TIME

Desired Future Condition (DFC)

- The concept of "Desired Future Conditions" should be replaced with "Desired Future Dynamics"
  - Kohm and Franklin 1997

- Refocus on *desired future dynamic processes* rather than static goals of composition and structure



Climate Change = Adaptive Silviculture

- **RESISTANCE** – improve the defenses of the forest against effects of change
- **RESILIENCE** – accommodate gradual change, usually returning to a prior condition after disturbance
- **RESPONSE** – intentionally accommodate change, enabling ecosystems to adaptively respond
- **REALIGNMENT** – move heavily disturbed systems into alignment with current and future conditions rather than restoring to a historical baseline
- **REDUCE** – mitigation of greenhouse gases through carbon sequestration and renewable energy use

Silvicultural Opportunities

Millar et al 2007, 2008

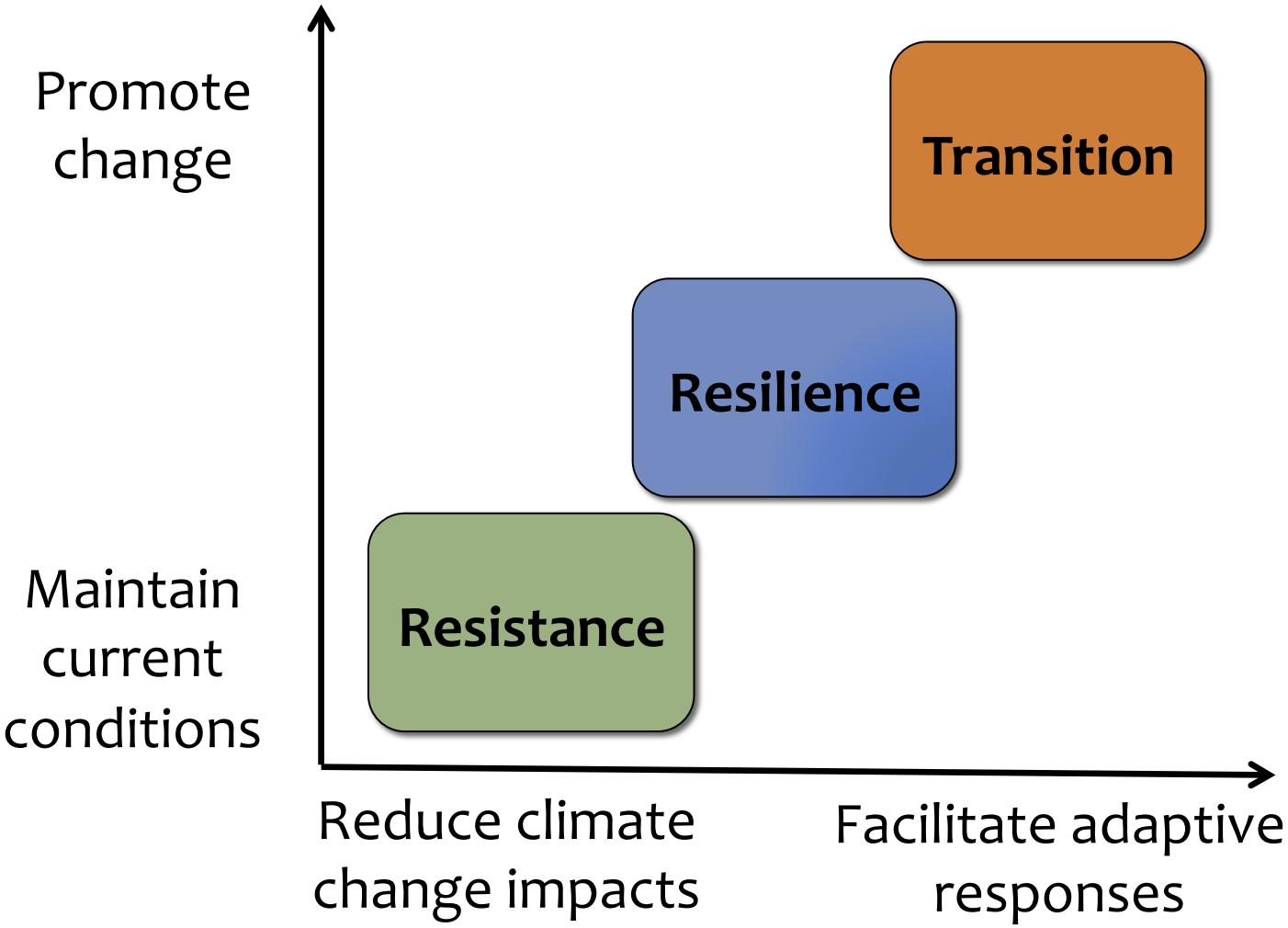
Adaptive Silviculture for Climate Change (ASCC)

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
  - Primary objectives: compare key variables among various climate change adaptation treatments in 3-5 different forest types across the United States
    - Forest growth and productivity
    - Overstory and understory species composition
    - Forest health and/or tree vigor

Treatments
Resistance
Resilience
Transition
No Action
Sensu Millar et al 2007

Adaptation options occupy a continuum of management goals related to their levels of desired change in ecosystem attributes and their mechanism for coping with climate change



Responses to "chronic change"

	Resistance	Resilience	Transition
Species composition responses to chronic change			
Forest health responses to chronic change			
Forest productivity responses to chronic change			
Developmental responses to disturbance and extreme events			

Species composition responses

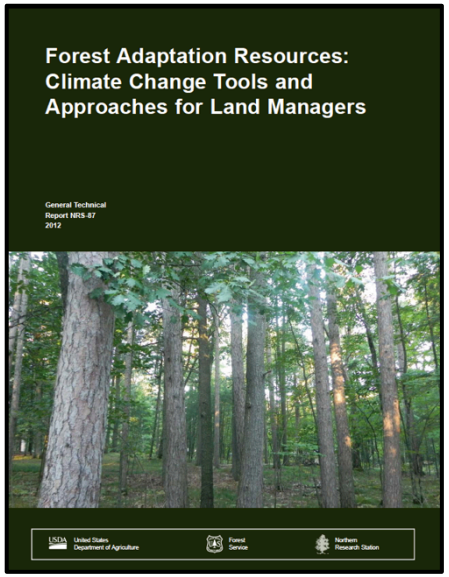
	Resistance	Resilience	Transition
Species composition responses to chronic change	*Abundance* and *diversity* of species characteristic of the current plant community is maintained *within an acceptable range within a desired time frame*	Abundance and diversity of species characteristic of the current plant community *may temporarily deviate* from the acceptable range, *but will return to the acceptable range within a defined period of time*	Abundance of *future-adapted species* and/or *genotypes* is *increased* to a desired level within a defined period of time

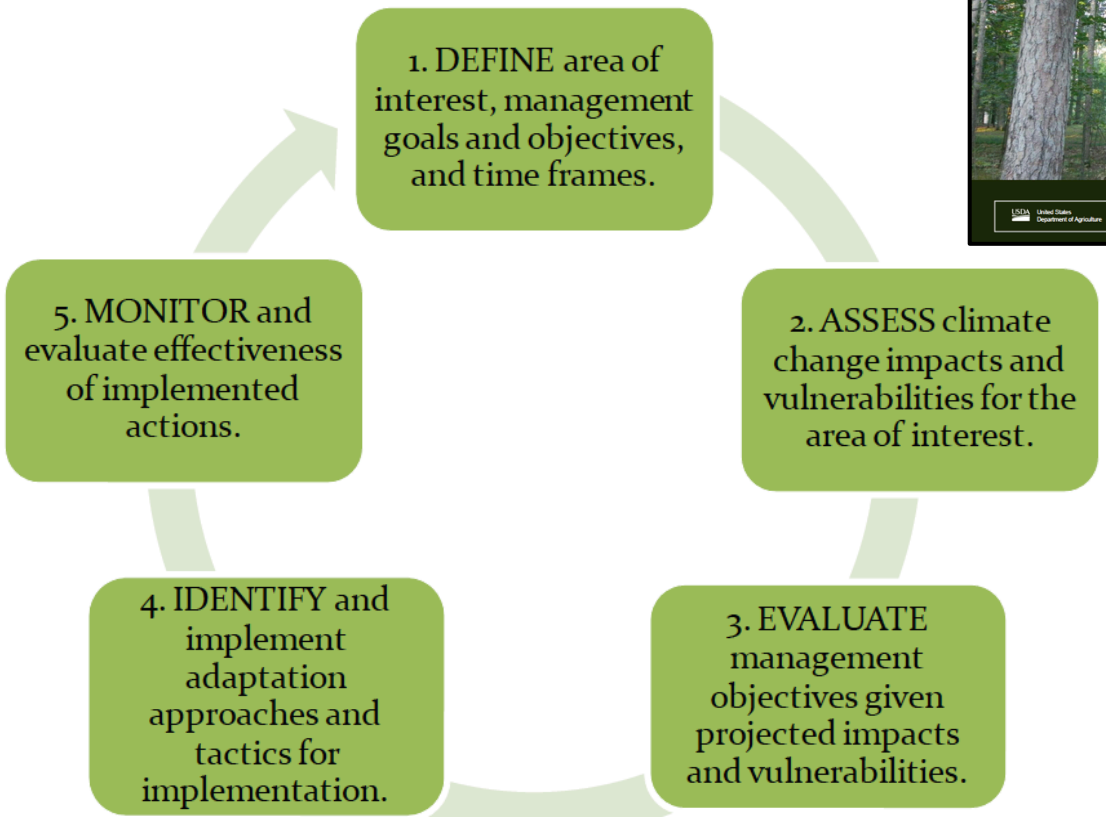
Species composition responses

	Resistance	Resilience	Transition
Example: Well-stocked, uneven-aged northern hardwood stand dominated by SM, YB, BW, and EH on a well-drained loamy sand	- *Maintain* combined stocking of *dominant species* (SM, YB, BW, EH) between 70-100 ft^2/ac through next 30 yrs - Maintain understory cover and species richness *within 20%* of current levels through next 30 yrs	- Combined stocking of SM, YB, and EH will fall between 70-100 ft^2/ac *within one cutting cycle following deviation outside this range* - Understory cover and species richness will fall within 20% of current levels *within 5 yr of deviation outside this range*	- Combined stocking of all species will be 50-100 ft^2/ac in 30 yr - *Future-adapted species* (NRO, WP, RM) ≥ 25% of total BA in 30 yr - *Regen of NRO, WP, and RM is ≥ 50%* of current seedling and sapling densities in 30 yr

ADAPTIVE SILVICULTURE PLANNING

Forest Adaptation Resources



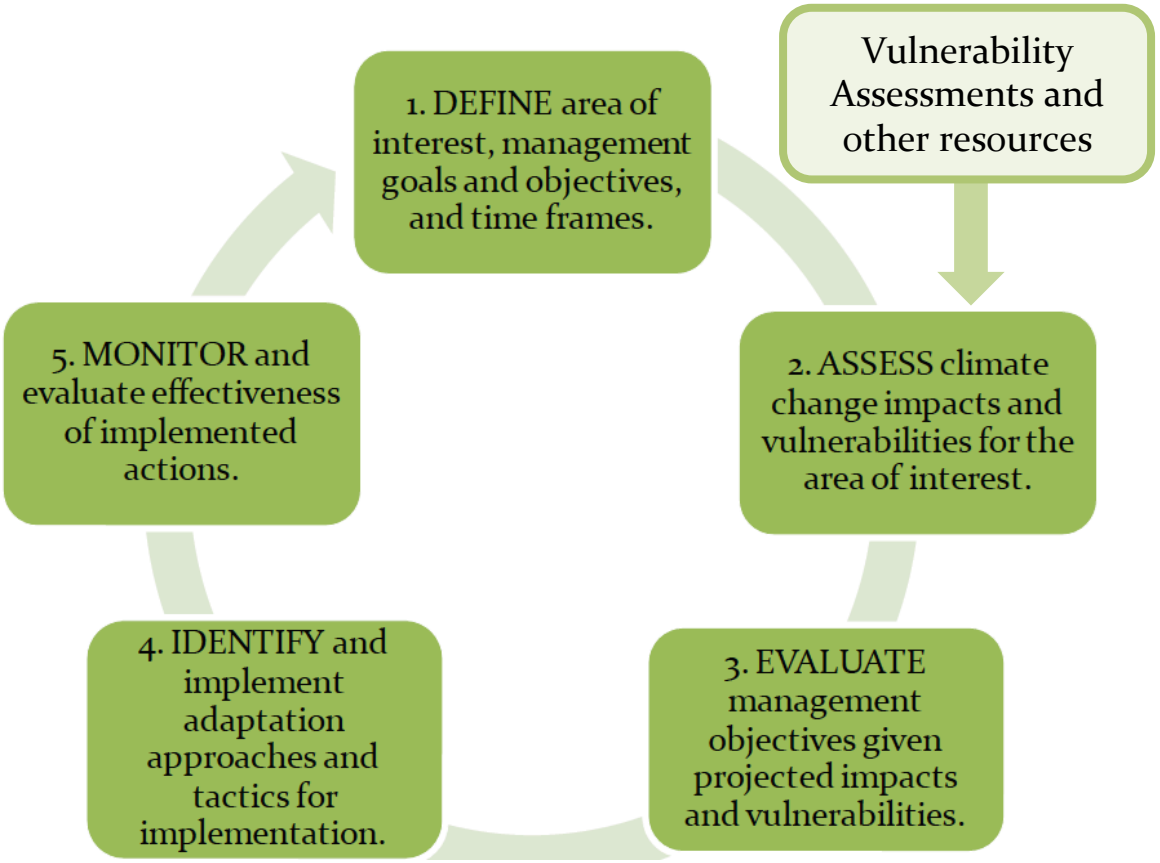


Swanston and Janowiak 2012

1. Define area of interest

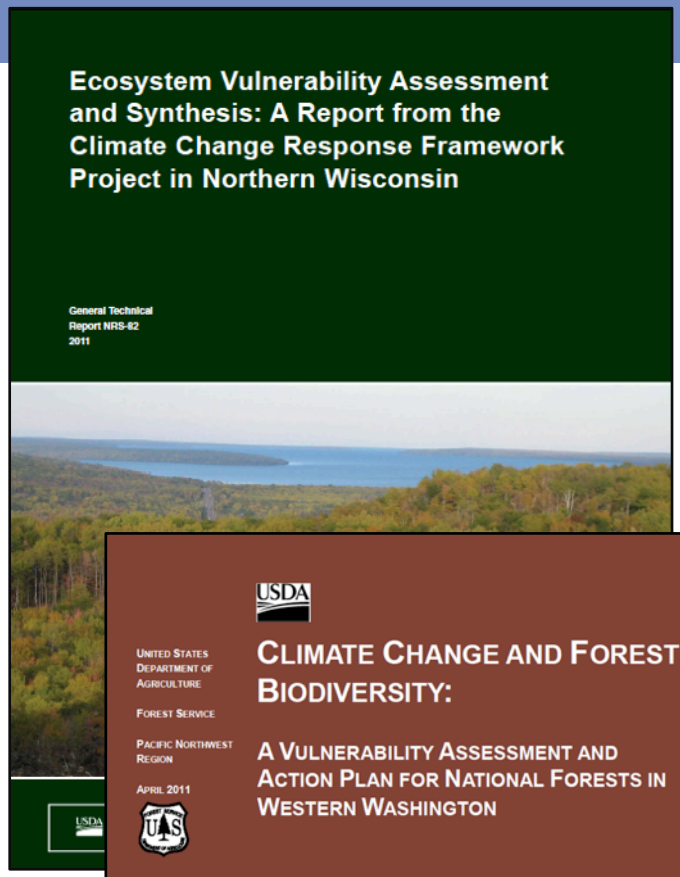
- Northern hardwood stand dominated by sugar maple in the eastern Upper Peninsula of Michigan
- Minor component of:
  - Yellow birch
  - Eastern hemlock
  - American basswood
  - Eastern white pine

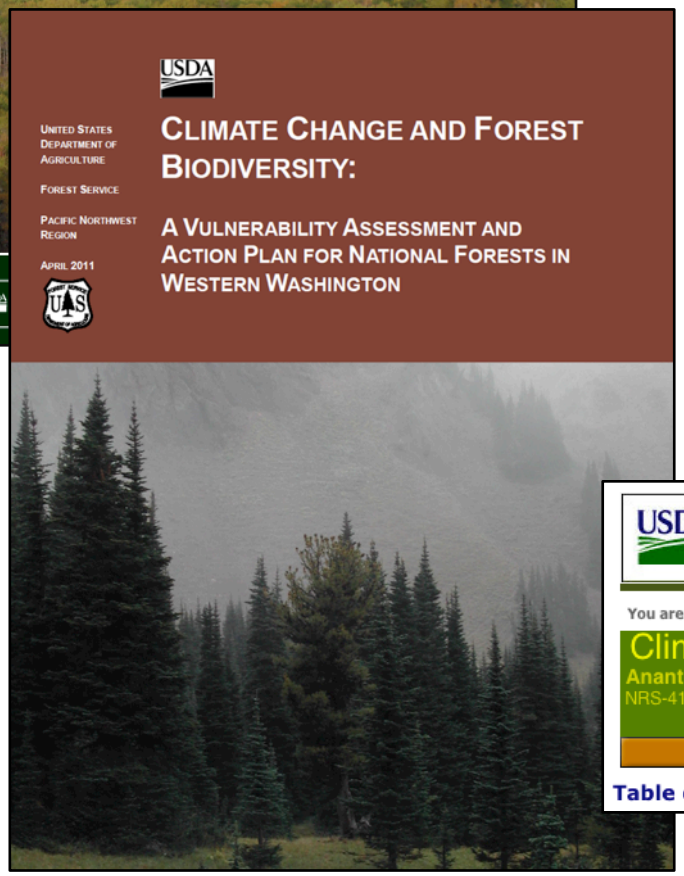
Forest Adaptation Resources

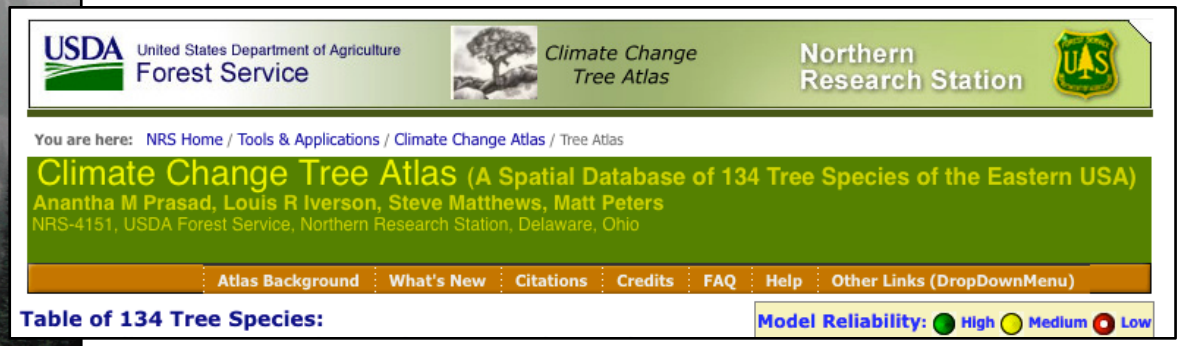


Swanston and Janowiak 2012

Vulnerability Assessments







2. Assess climate change impacts and vulnerabilities

- Warmer temperatures
- Altered precipitation regimes
- Increased potential for drought
- Many species expected to fare worse in the future
  - Sugar maple, yellow birch, eastern hemlock, eastern white pine
- Some species may increase in the future
  - Northern red oak, white ash, species not currently on the Hiawatha NF
- Increases in pests and disease
  - Emerald ash borer, sugar maple decline, other…

Forest Adaptation Resources

Vulnerability Assessments and other resources

1. DEFINE area of interest, management goals and 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 for implementation.

5. MONITOR and evaluate effectiveness of implemented actions.

Swanston and Janowiak 2012

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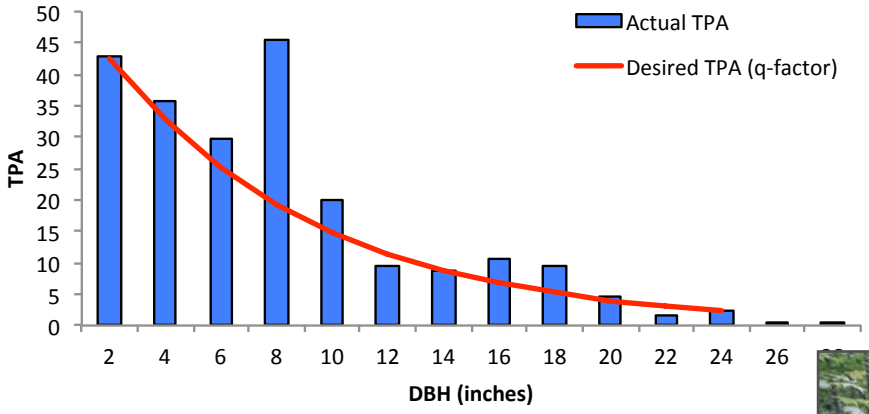
Swanston and Janowiak 2012

Uneven-aged northern hardwoods management

Residual BA = 19 m^2/ha (85 ft^2/ac)
Maximum res diameter = 61 cm (24 in)
q-factor = 1.3



Individual tree selection in northern hardwoods dominated by sugar maple (*Acer saccharum*) homogenizes species composition

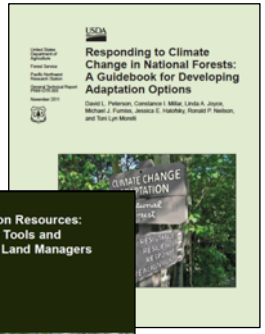
"Maplization"
"Acerification"

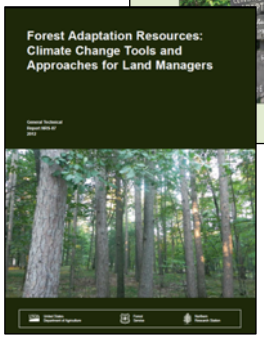
3. Evaluate management objectives given impacts and vulnerabilities

- Historic management objective: high-quality sugar maple sawtimber
- Silviculture approach: uneven-aged, balanced age structure by a q-factor, short cutting cycle length

- Contemporary management objective: increase resiliency, promote species diversity and complexity
- Silviculture approach: alternative methods that promote regeneration of midtolerants and species that are expected to fare better in a future climate

Forest Adaptation Resources





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Swanston and Janowiak 2012

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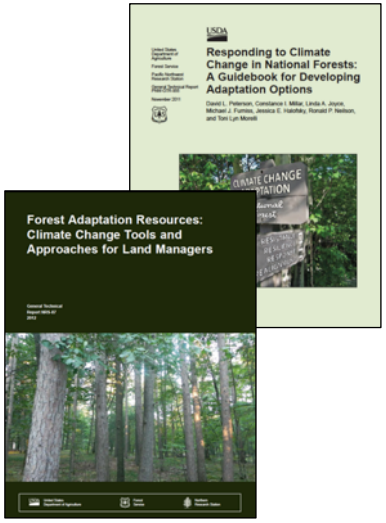

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Adaptation Strategies and Approaches

Silviculture Rx Process

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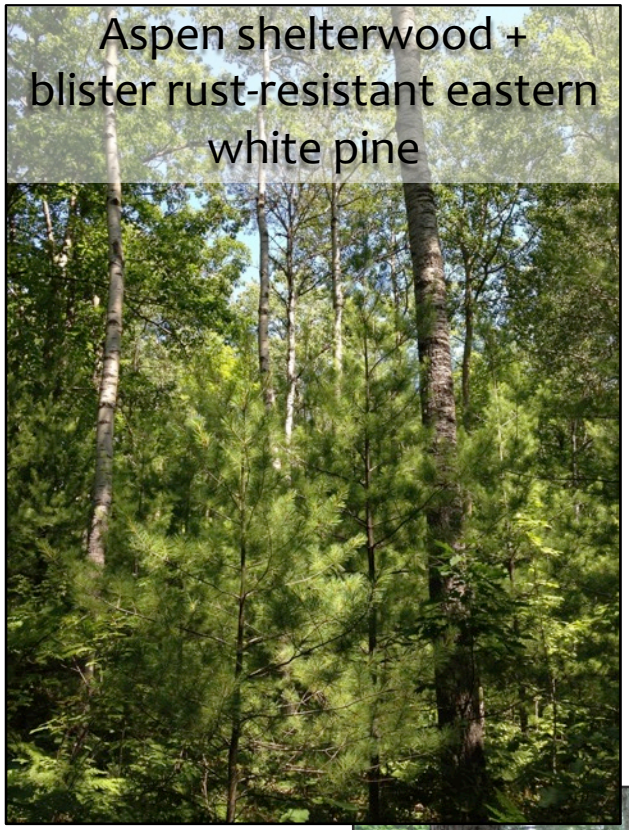
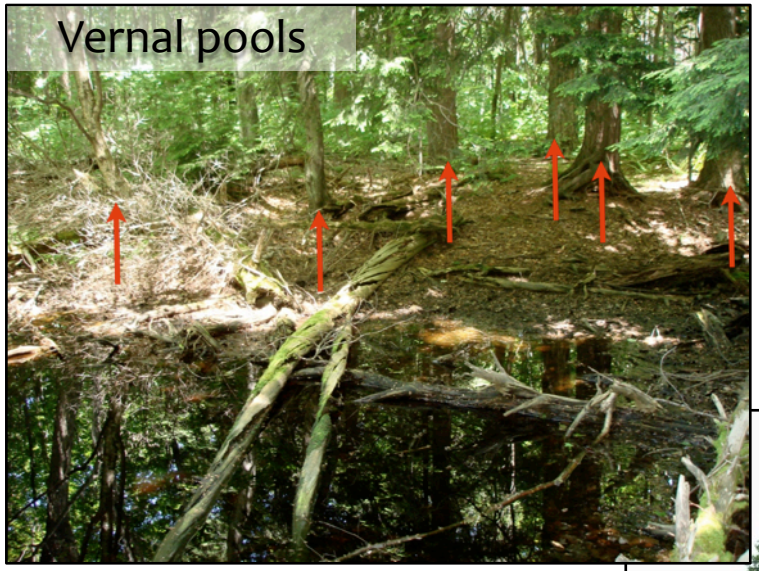
Swanston and Janowiak 2012

Manage for Complexity

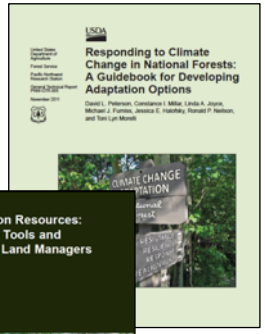


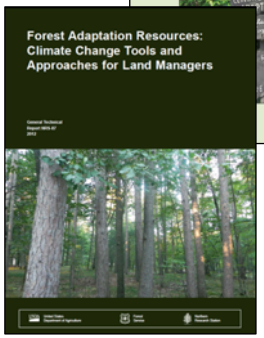


4. Identify adaptation approaches and tactics for implementation

- Business as usual isn't going to work
- Enhance and maintain species and structural diversity in northern hardwoods
  - Create CWD
  - Yellow birch seed-tree + group selection
  - Protect vernal pools
  - Femelschlag
  - Rethink shelterwoods
  - Use appropriate planting stock
  - Think creatively

Forest Adaptation Resources





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Swanston and Janowiak 2012

Summary – Silviculture + Climate Change

- Business as usual isn't going to cut it
- We must incorporate climate change into natural resource management
- Defining management goals and objectives based on a range of future conditions will be more practical than using historic benchmarks alone, especially in the context of "restoration"
- Managing for complexity may increase resilience
- Adaptive management will help us attain the ultimate goal of sustaining ecosystem function