

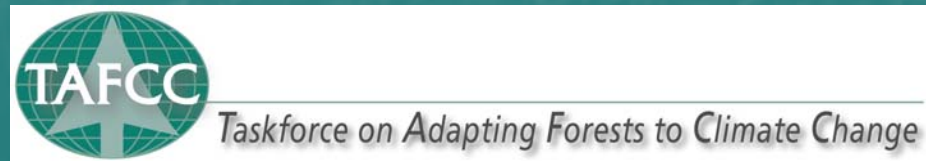
Silvicultural Approaches for Adapting Forests to Climate Change

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Taskforce on Adapting Forests to Climate Change
<http://tafcc.forestry.oregonstate.edu>

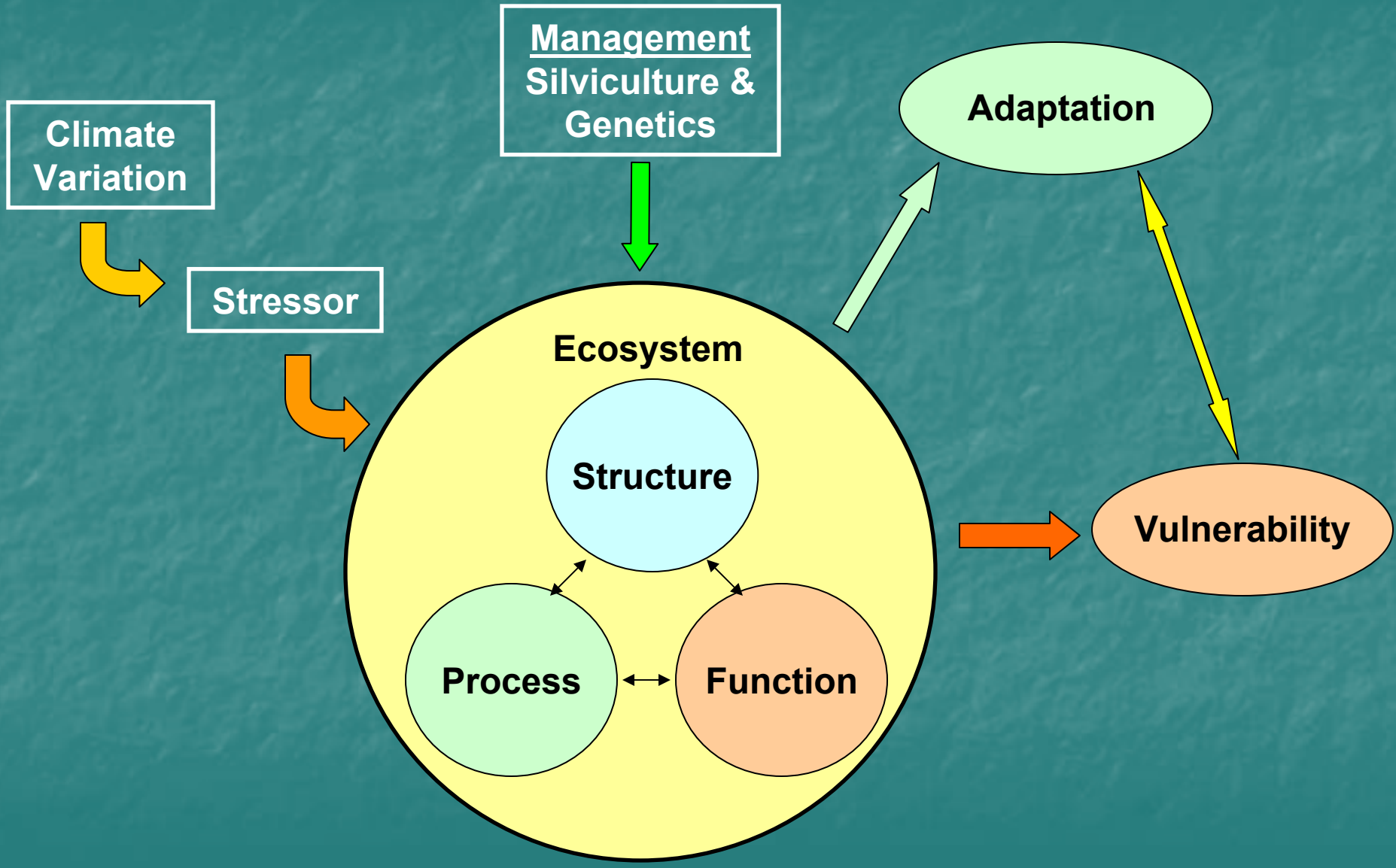


Outline

- Basic premise for silvicultural approaches to forest adaptation
- Framework for assessment and prescription



Climate Variation and Ecosystem Responses



Climate Variation and Stressors

■ Climate Variation

- Warmer summer
- Warmer winter
- Decreased precipitation
- Decreased snowpack
- Increased variation in temperature and precipitation
- Elevated CO₂
- Atmospheric deposition

■ Physical Stresses

- Moisture deficit
- Drought
- Heat load
- Fire
- Frost
- Floods
- Landslides and erosion

■ Biotic Stresses

- Insects
- Pathogens
- Herbivory
- Competitive interaction

Vulnerabilities

- Vulnerability is the degree to which a system is likely to experience harm due to exposure to a specified hazard or stress
- Vulnerability of a system to a hazard or stress is a function of exposure, sensitivity and adaptive capacity

Acclimation and Adaptation

- Plant populations may naturally adjust to climate change in three ways:
 - altered physiology and development in response to environmental change
 - evolution in place
 - migration to new habitats

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 - migration to new habitats
- Adjustments occur at species, population and genotype levels – *not as communities*

Adaptive Capacity

- The capacity of organisms, both individuals and groups, to respond to a change in the state of the system;
- Depends on initial diversity and the capability of component organisms to adjust and change

The Premise

- Long-term adaptation to climate changes will require healthy and productive forests in the short-term
- Silviculture can enhance adaptation by fostering the development of forest stands and landscapes resistant and resilient to climate change stresses
- Many silvicultural principles and approaches currently used to manage to stands or landscapes subject to climatic and disturbance stresses will be applicable to management in a future changing climate

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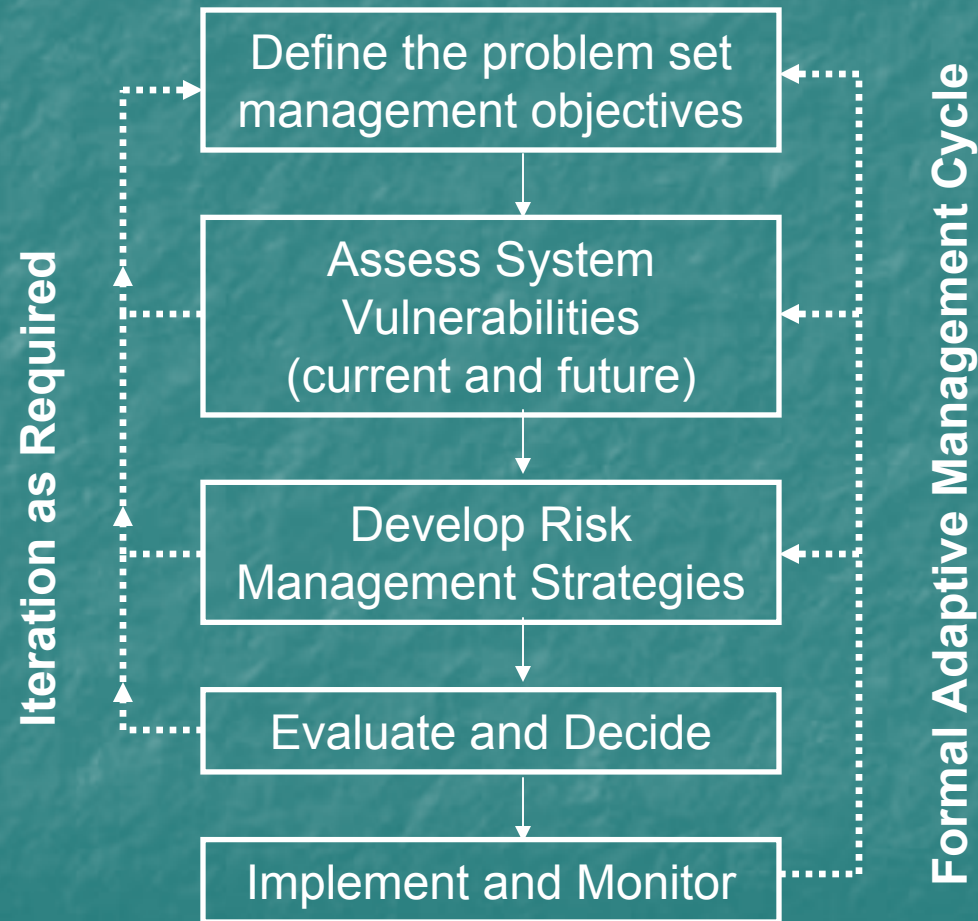
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- **Promote development of mixed-species forests**
- **Maintain a balance of age-classes, from regeneration to old-growth, at the landscape scale**

Framework for developing and evaluating climate change adaptation strategies



Objectives: *Why Do We Manage Forests?*

- **Maintenance and/or Creation of Resilient Ecosystems**
 - Biodiversity
 - Wildlife habitat
 - Fish habitat
 - Long-term productivity
 - Resistance and resilience to disturbance
- **Tangible Products**
 - Timber
 - Water
 - Carbon
 - Non-timber Forest Products
- **Other Social Values**
 - Aesthetics
 - Recreation
 - Cultural Importance

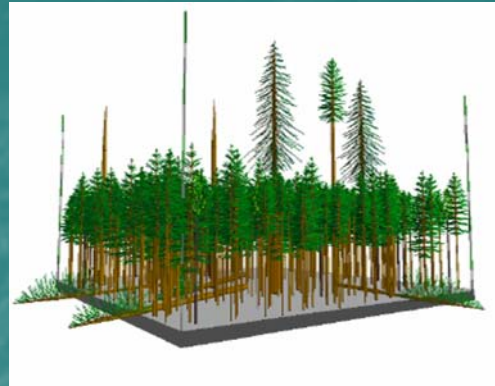
Vulnerability Assessment



Vulnerabilities Vary with Stand Development



Establishment



**Stem
Exclusion**



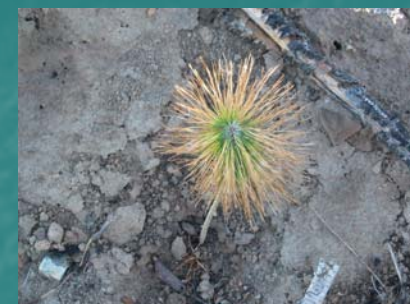
**Complex
Structure**

Lack of site dominance	Density dependent mortality	Individual Tree/ Disturbance Mortality
Lack of seed/propagules	Insect epidemics	Insect epidemics
Herbivory	Drought	Drought
Shrub Competition	Windthrow	Windthrow
Fire	Fire	Fire

Vulnerabilities Vary with Stand Development

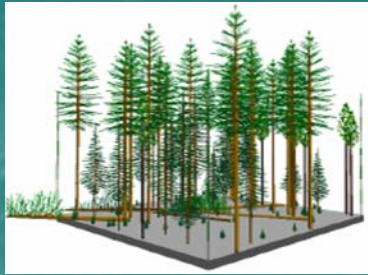


Establishment



<u>Climate Variation</u>	<u>Stress</u>	<u>Stress Mediator</u>	<u>Affected Process</u>	<u>Vulnerability</u>
Increased Summer Temperature	Increased Heat Load	Transpiration	Natural Seedling Establishment	Dessication
		Matabolism/ Membrane Integrity	Natural Seedling Establishment	High-temperature Injury
		Net assimilation/ Carbon allocation	Seed Production	Few or Poor Quality Seed

Vulnerabilities Vary with Stand Development



Complex Structure



Climate Variation

Increased summer temperature
&
Decreased summer soil moisture

Stress

Increased heat load
&
Increased moisture deficit

Stress Mediators

Canopy Leaf Area
Net carbon assimilation rate
Transpiration
Secondary compounds

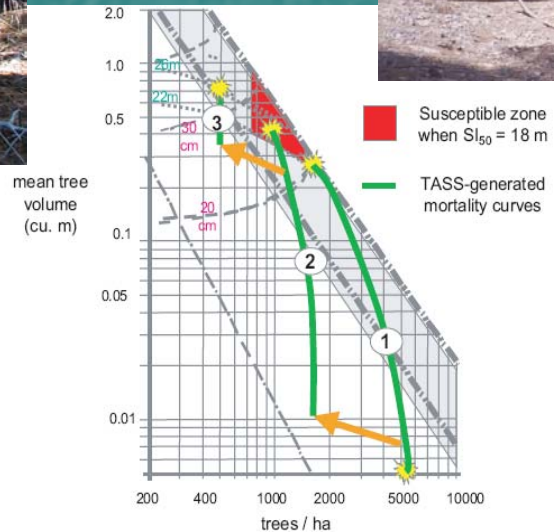
Affected Processes

Growth & Vigor
Plant defense

Vulnerability

Decreased productivity
Drought
Insect Infestation

Identification and Evaluation of Silvicultural Options



Silvicultural Options: Tools in the Toolkit

- **Silvicultural Options**
 - Natural regeneration
 - Artificial regeneration
 - Site preparation
 - Competing vegetation manipulation
 - Composition manipulation
 - Density management
 - Fertilization
 - Regeneration harvest
 - Fuels reduction
 - *Others*

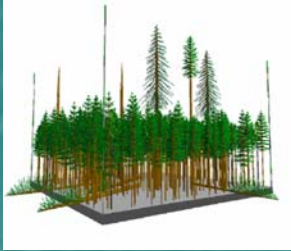


***Systematic and Site Specific Application
in a Landscape Context***

Linking Silvicultural Options to Identified Vulnerabilities

- Post-disturbance lack of seed source → Planting
- Density dependent beetle infestations → Thinning
- Frost damage to regeneration → Partial overstory retention

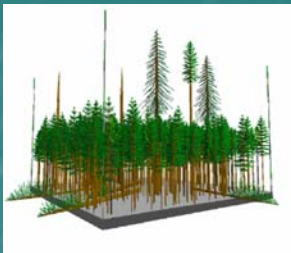
Silvicultural Options Vary with Objectives and Stand Development



Stem Exclusion

<u>Vulnerability</u>	<u>Management Objectives</u>	<u>Silvicultural Objectives</u>	<u>Silvicultural Options</u>	<u>Potential Collateral Issues</u>
Drought & Insect Infestation	Late-Successional Forest & Resilient & Resistant Forest	Improve site water balance & Enhance vegetation diversity	Thinning - Density management Manipulation of understory vegetation Underplanting	Fuels Erosion Exotic species Competition

Silvicultural Options Vary with Objectives and Stand Development



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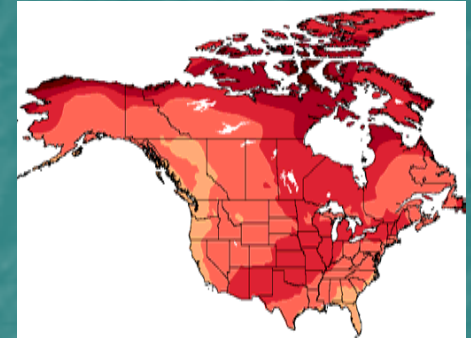
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Drought Insect Infestation Decreased productivity	Resilient & Resistant Forest	Improve site water balance Allocate site resources to crop trees	Thinning - Density management Manipulation of understory vegetation	Fuels Erosion Exotic species Competing vegetation
	Timber production	Regenerate Stand with Improved Sources	Regeneration Harvest	Adapted Planting Stock

Evaluation and Prioritization – *Which Options Are Worth Doing?*

- Efficacy
- Risk tolerance
- Logistical feasibility
- Economic feasibility

Monitoring Ecosystem Response and Vulnerability

- Global climate dynamics discernable at ecoregion or larger spatial scales and at decadal or longer time scales
- Ecosystem responses and sensitivities determined at the landscape or larger scales
- Silvicultural activities based on stand-level conditions or trends as evaluated in a landscape context



What are Useful Indicators of Stress or Vulnerability?

■ Landscape

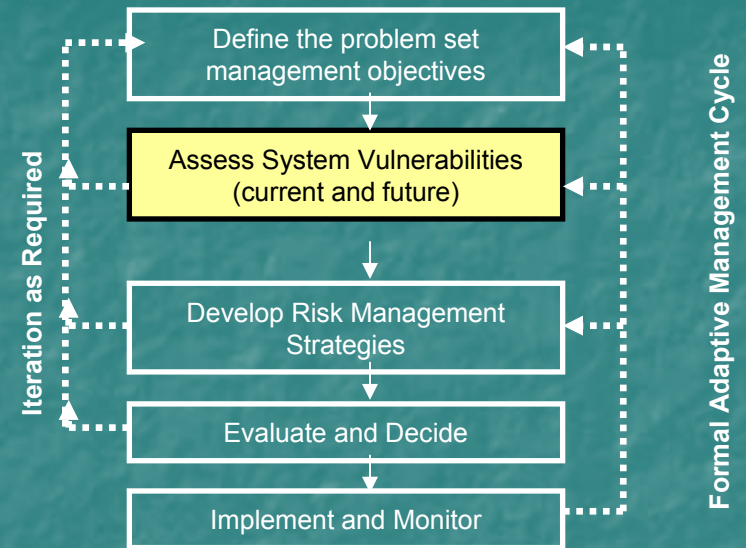
- Watershed runoff abundance and timing
- Water quality
- Stream network contraction
- Vegetation composition and spatial pattern
- Vegetation productivity
- Vegetation mortality
- Abundance and spatial distribution of insect and disease populations
- Abundance and distribution of focal wildlife species

■ Stands

- Crown damage
- Foliage shedding
- Abnormal growth
- Decreased frost hardiness
- Decreased pathogen/pest resistance
- Low fertility
- Foliage wilt/dessication
- Bark damage
- Altered flowering/seed production

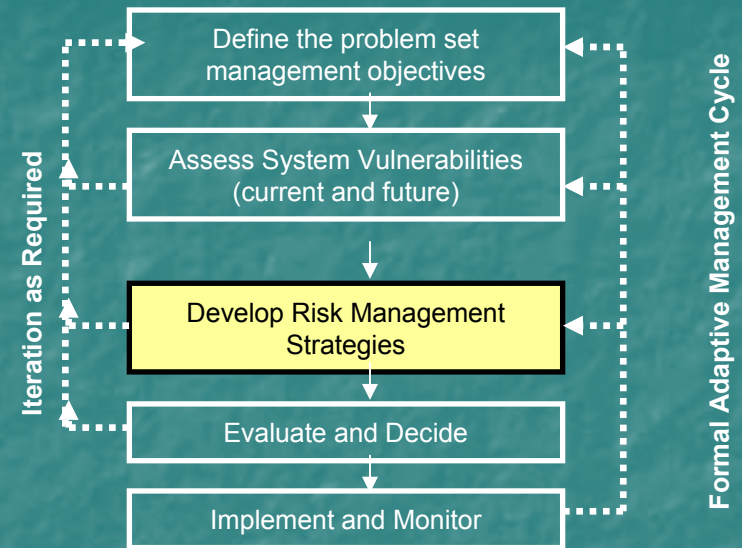
Outstanding Questions

- **What are the potential vulnerabilities to be associated with specific forest types at various stages of development?**



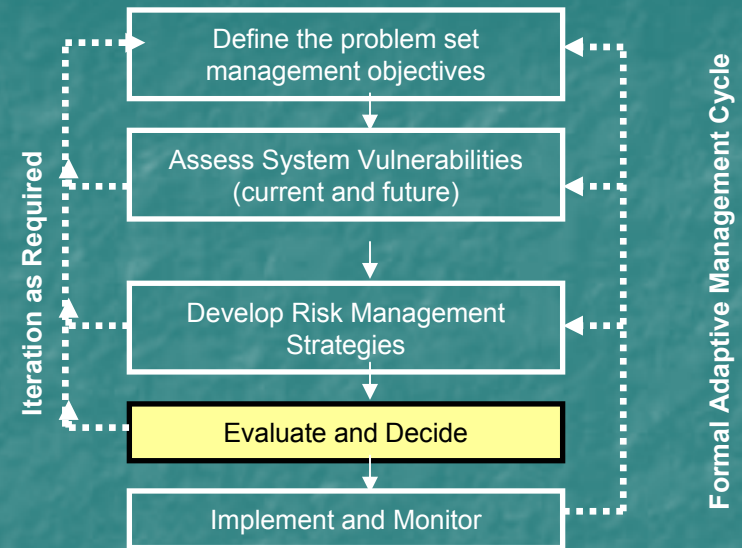
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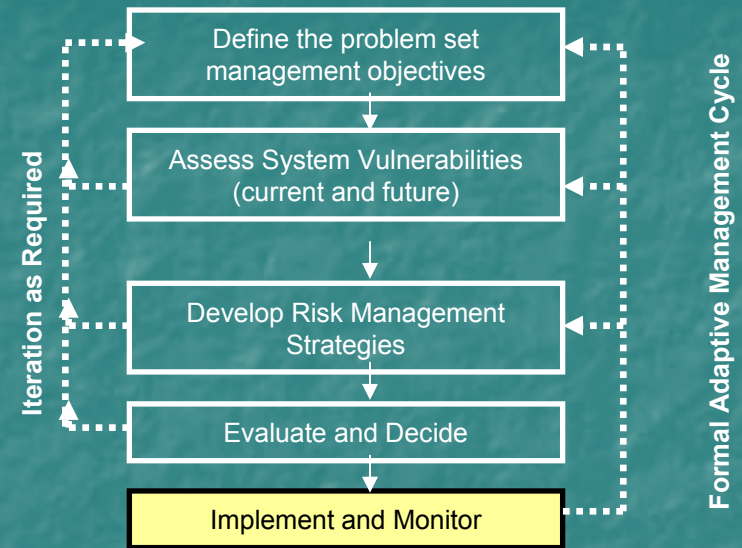
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- **What can prior research and experience tell us about the effectiveness of silvicultural options for dealing with future climate stresses?**



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- What can prior research and experience tell us about the effectiveness of silvicultural options for dealing with future climate stresses?
- **What processes would serve as indicators of performance for silvicultural actions?**



Next Steps for TAFCC - Silviculture

- Develop literature based review of scientific information supporting silvicultural approaches to climate change adaptation
 - Collaborative effort of scientists and practitioners
 - Peer-reviewed scientific journal “review” article
 - General audience “problem analysis”

Next Steps for TAFCC - Silviculture

- Develop literature based review of scientific information supporting silvicultural treatment and system approaches to adaptation
 - Collaborative effort of scientists and practitioners
 - Peer-reviewed scientific journal "review" article
 - General audience "problem analysis"
- Potential packaging as an Expert Systems decision support tool?

Questions?