Adapting Forests to Climate Challenges

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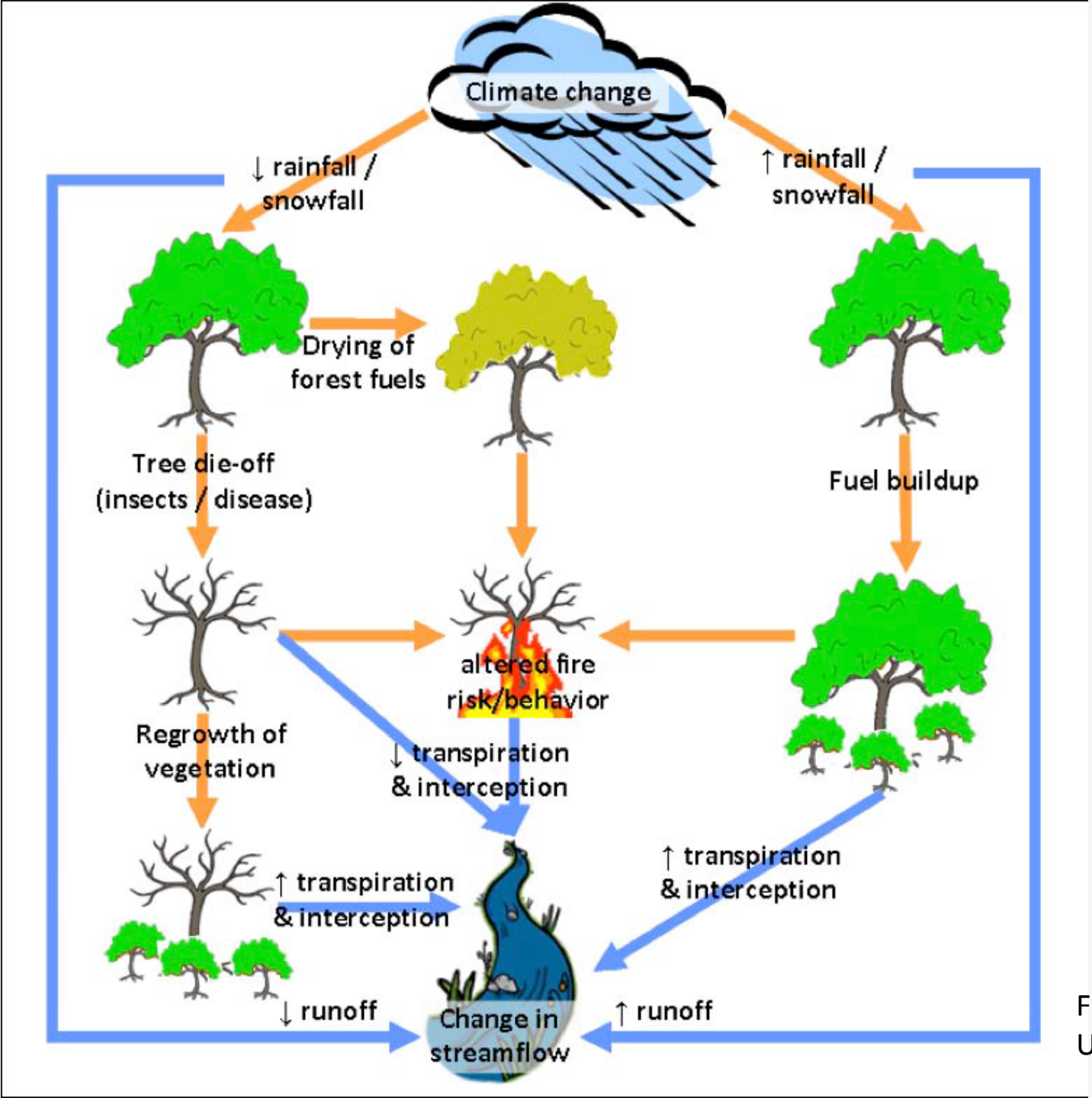
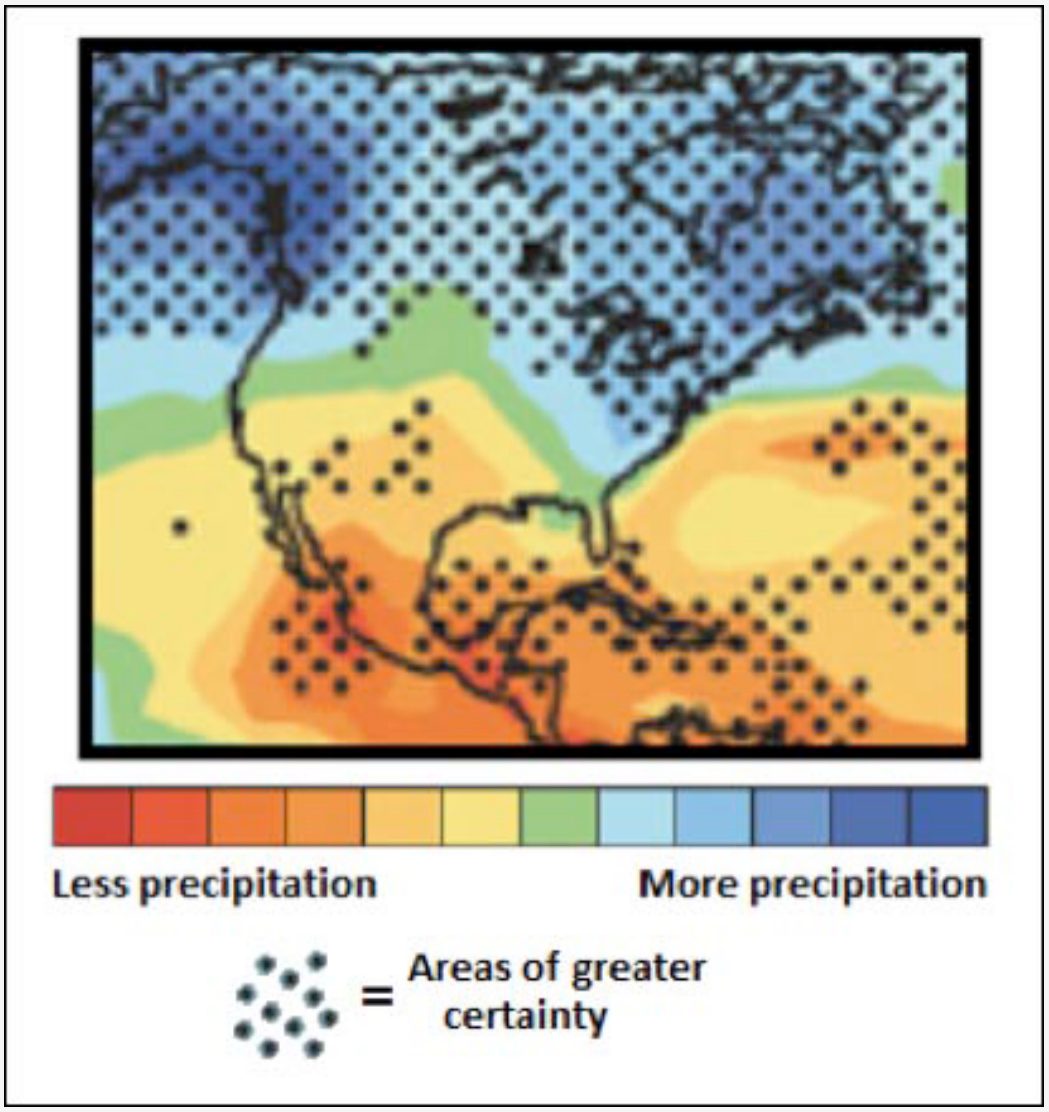


Annual precipitation is declining and will probably continue to decline across large portions of the West. Other areas might experience increased precipitation.

Figure by Megan Matonis
US Forest Service RMRS

Estimated Changes in Precipitation



- *Models of future climates project less precipitation for the Southwest from 2080- 2099 relative to 1980-1999. Changes for the Northwest are less certain, but may involve higher precipitation in some years.*

Drought and Forests

"The ecological effects of changing precipitation may well outweigh changes related to temperature."

Charlie Luce

Rocky Mountain Research Station, US Forest Service

Drought can kill trees directly or by reducing their ability to combat insects and diseases. (near Salmon Idaho. C. Luce)

Confronting Climate Change

I. Adaptation Assist resources & ecosystems to accommodate changes imposed by climate

II. Mitigation Reduce human effects on climate system by sequestering CO_2 & decreasing greenhouse gas emissions

Often complementary…
sometimes conflicting

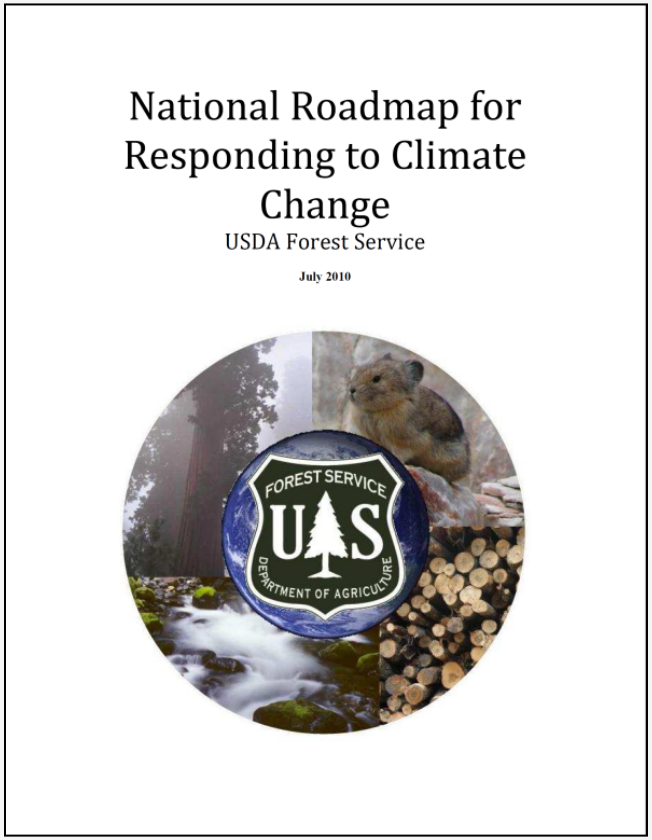
USDA Forest Service
Strategic Framework for Climate Change
2008

GOALS

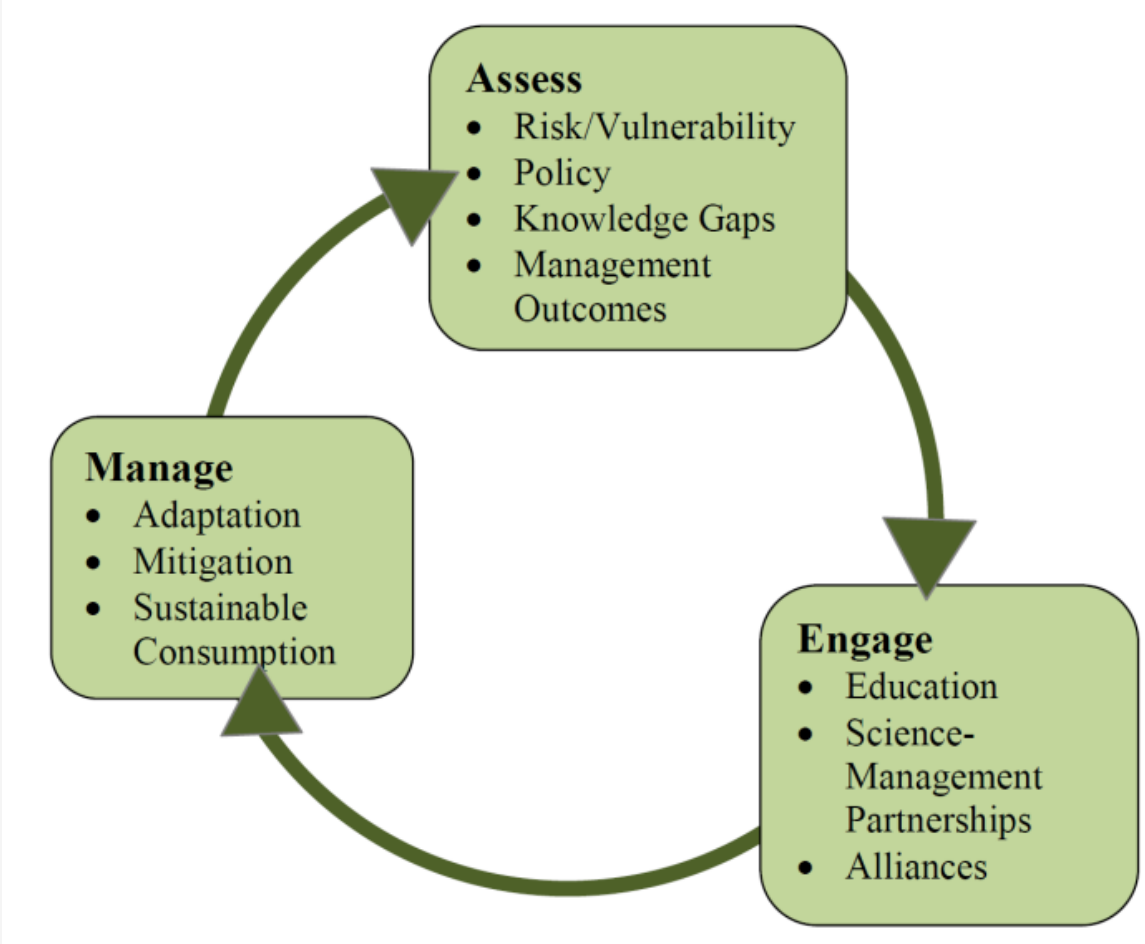
- Sustain ecosystem services
- Assist forests, grasslands, & communities to adapt
- Mitigate climate change through forestry actions
- Develop new scientific tools
- Create new collaborations
- Educate American citizens

USDA Forest Service (USFS)

National Roadmap for Responding to Climate Change and Performance Scorecard, 2010



Modes of Action:



Lessons Learned

- Basic principles of ecosystem management remain valid
- Modify current practices using new information; adjust priorities
- Some practices may be inappropriate
- Manage for desired processes & ecosystem services
- Foster science-management partnerships

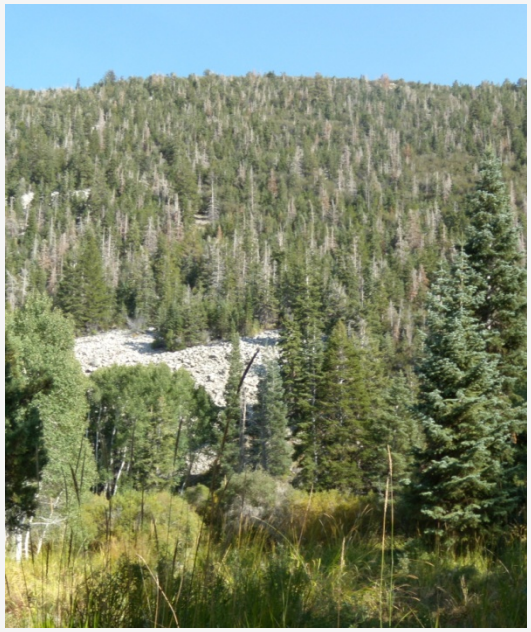
Despite uncertainty, defensible actions can be taken & effective decisions made

ADAPTATION PRINCIPLES TOOLBOX APPROACH

- No single solution fits all situations
- Mix & match tools
- Options differ for short- versus long-term
- Nimbleness matters: Be flexible, experimental, and innovative
- Take small risks, be willing to learn & change course in midstream
- Prioritize often

Management Decisions

Do Nothing:
No Advance Action



React after Disturbance or Extreme Events

Be Proactive:
Act in Advance

Incorporating Climate into Management;
Four Strategic Steps

Step 1: Assess Vulnerabilities

Step 2: Set Priorities

Step 3: Select Options, Strategies, and Tactics

Step 4: Monitor and Adjust

Adaptation Options

- Increase *Resistance*
- Promote *Resilience*
- Assist *Response* of Ecosystems
- *Realign* Altered Ecosystems

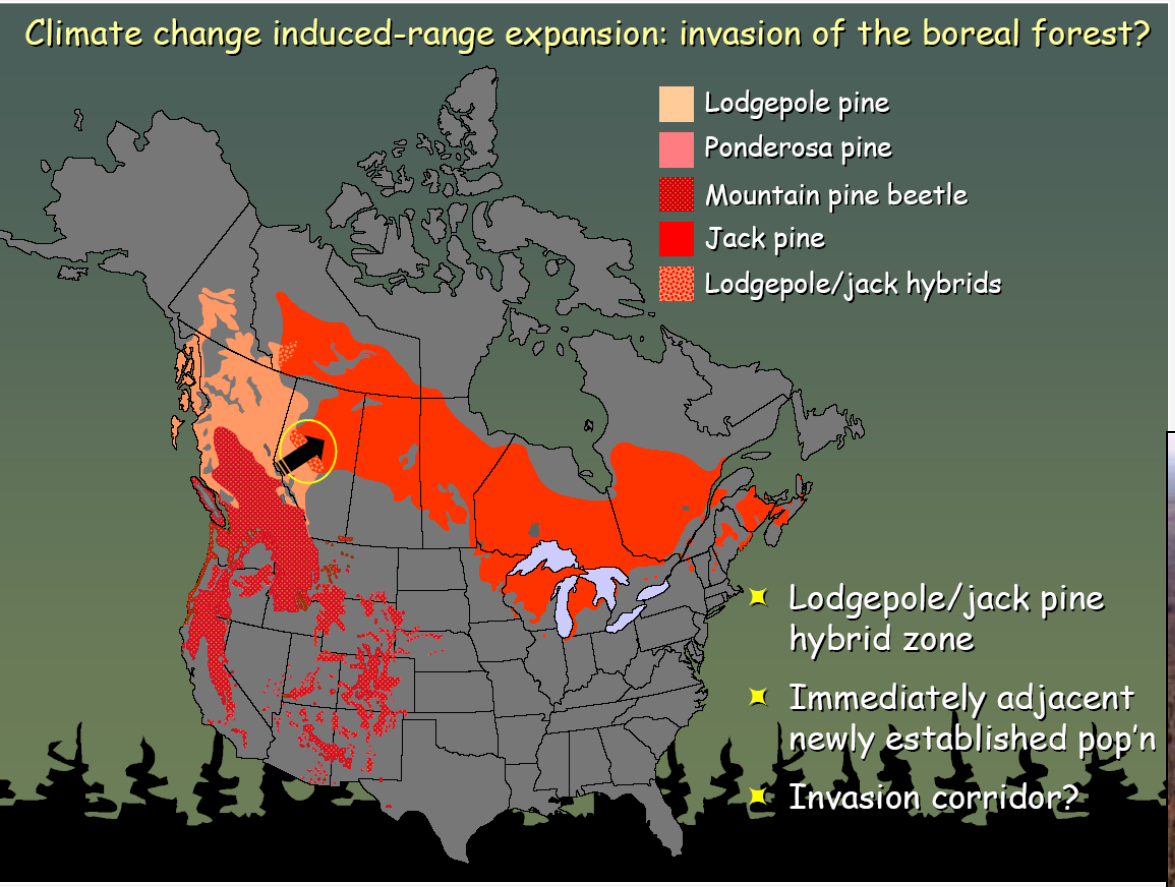
Millar et al. 2007

OPTION 1: Increase *Resistance* to Change

-- Defend highest-value resources against change

Strategy: Resist movement of beetles into new host species

Tactic: Aggressive beetle control at ecotone of *Pinus contorta* and *P. banksiana*



British Columbia: *Pinus contorta* & mountain pine beetle
Carroll et al. 2003

OPTION 2: Promote *Resilience*

Improve the capacity of ecosystems to return to something resembling prior conditions after disturbance

Strategy: Minimize stress, provide buffers and emergency back-ups

Tactics:

- Thin Forest Stands
- Stock Seed Banks
- Prescribe Fires
- Make Snow at Ski Areas

OPTION 3: Assist Adaptive *Responses*

Assist transitions to new
ecological conditions or locations

Ecological conversions are occurring already;
novel ecological communities are likely

Forest to Grassland

Colorado plateau, *Pinus edulis*

Drought & bark beetles

Grassland to Forest

Great Basin, *Pinus monophylla*

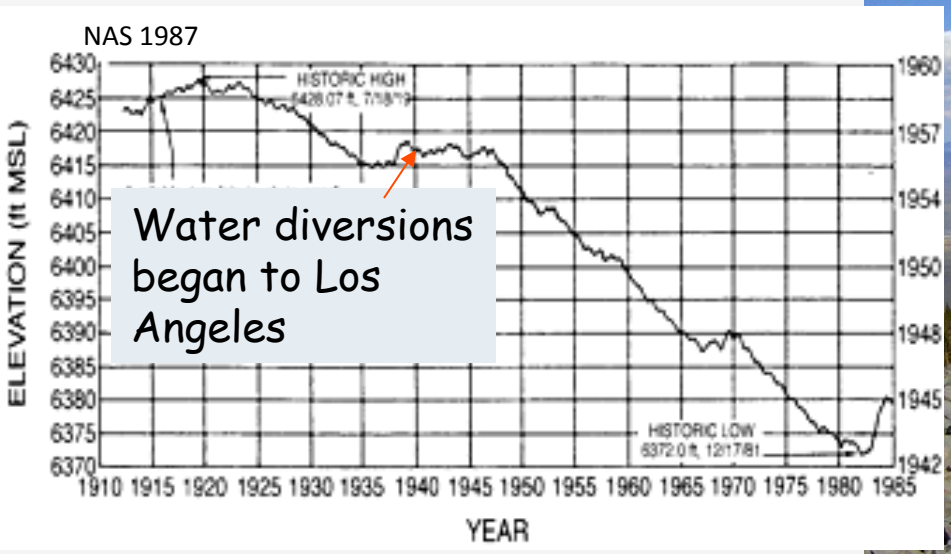
Warming & fire suppression

OPTION 4: *Realign* Altered Ecosystems to Current and Future Dynamics

Strategy: Use information about future conditions as target for restoration

Tactic: Base target for Mono Lake level on projections of increased drought and lower run-off

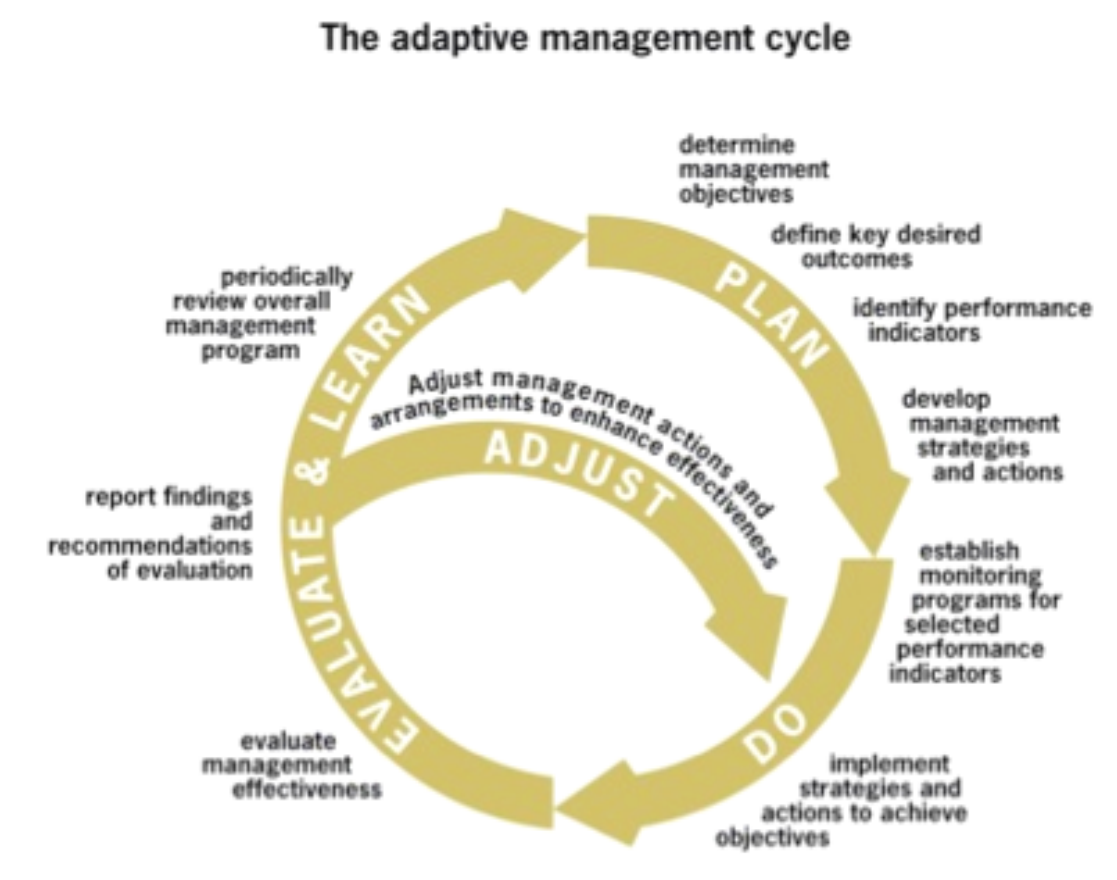
"Historic range of variability" (pre-disturbance conditions) as a management target will often be inappropriate



Step 4: Monitor and Adjust

Policy implemented as an experiment

Adaptive management is essential under changing conditions



Simple is ok! Always implement so you can learn and adjust

What does Restoration Mean?

USDA Forest Service:

"Restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on re-establishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions."

Field plot within Rim Fire

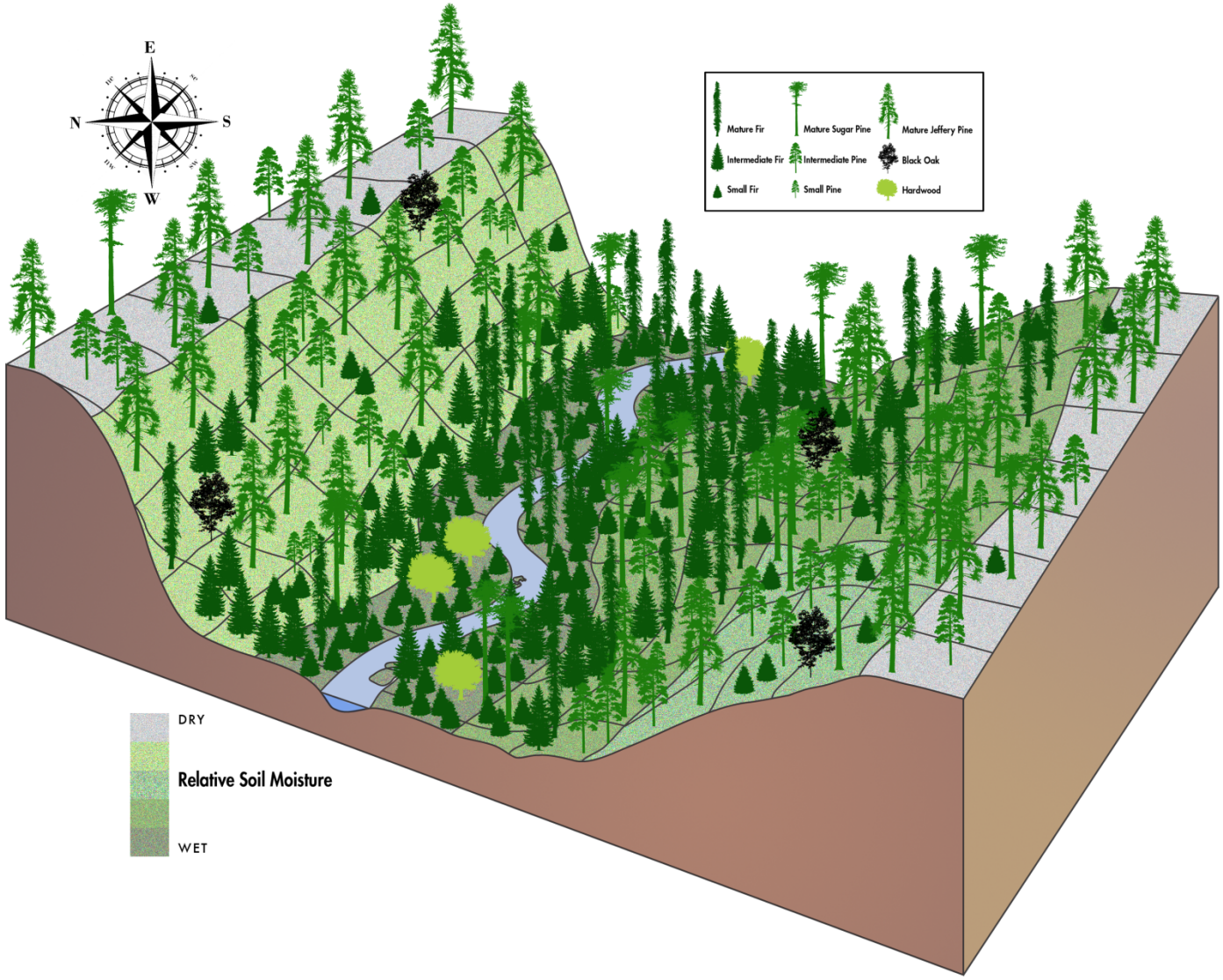
Pre-fire (15-Jul-2013)

Post-fire (25-Sep-2013)

What do we Restore? Ecosystem Composition, Structure, and Function

- Composition:
  - Conifers (pines, firs), some hardwoods, shrubs, openings, and a diverse array of fauna
- Structure
  - different seral stages, densities of vegetation, individual trees and logs (cavities, platforms, etc.)
- Function
  - Processes that drive systems, e.g. fire, climate, flooding

Landscape Heterogeneity



Ecosystems are controlled by spatial and temporal heterogeneity of patterns and processes.

A more heterogeneous landscape likely ensures that disturbances in mixed-conifer forests are more brief and spatially confined.

Integrating data and predictions

- What seed source has the greatest success within each elevation band in the Rim Fire area?
  - Do trees from lower elevations (hence adapted to warmer climates) perform better?
  - Do trees from more southern seed zones perform better?
  - How important are seed zone and elevation band in terms of early tree survival and growth?

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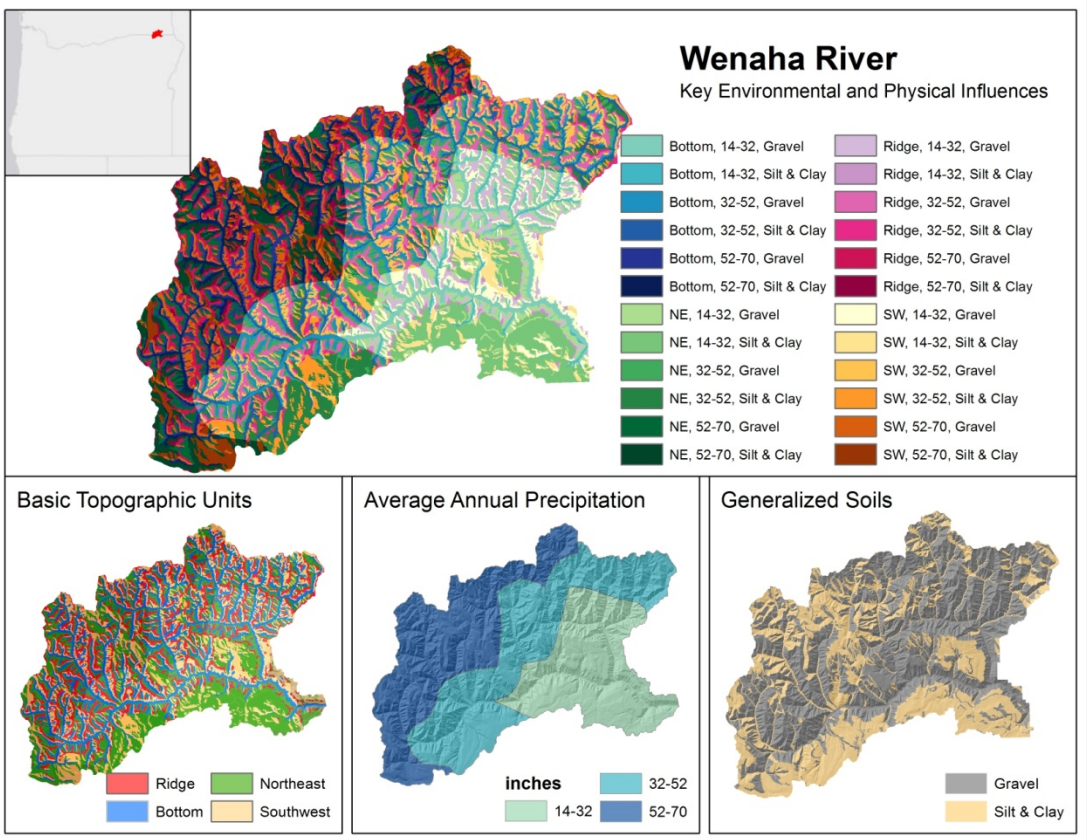
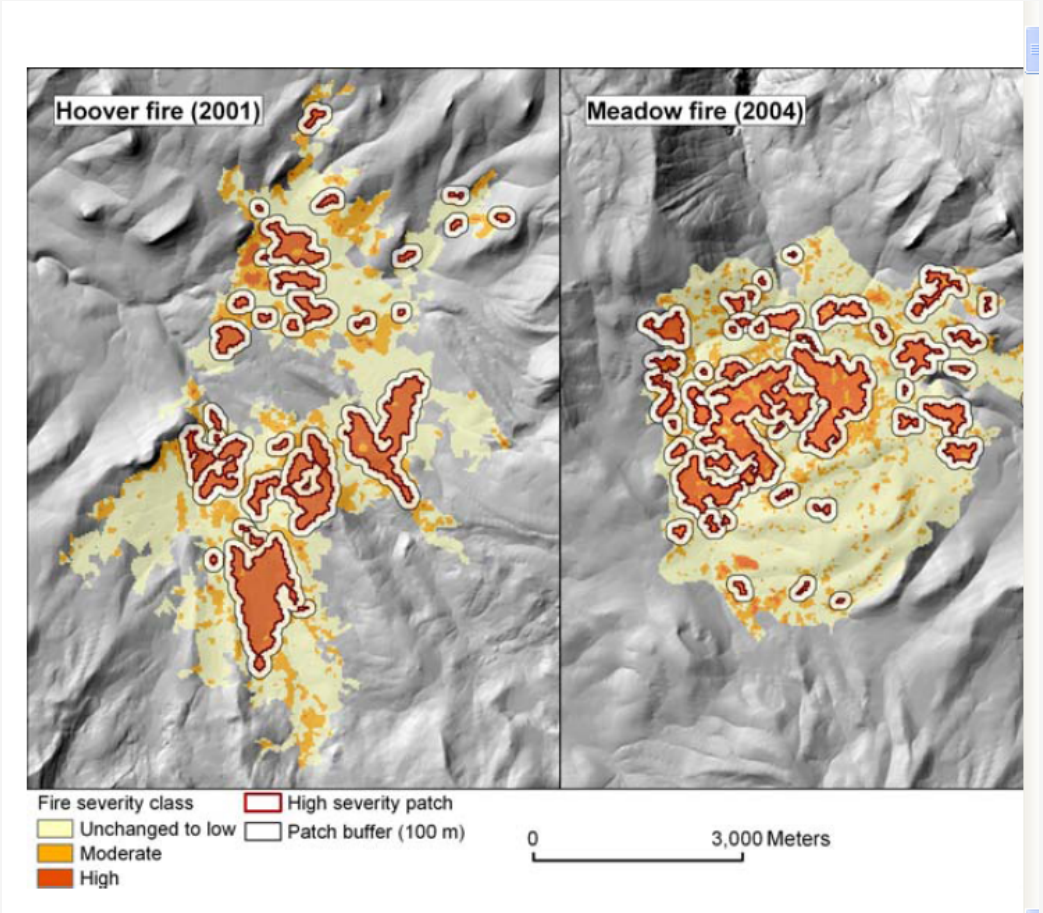


Forest Heterogeneity

What is this and why do we want it?

- Fire is the major influence on forest structure and composition in the west
- Fire created/can create a very patchy environment of densities and ages
- This provides for a diversity of habitats
- Resulting stands are resilient to subsequent fire, disease, drought, insects



Fire severity of two recent fires in Yosemite NP, one of the few places where fire has been active in recent times; how fire shapes the forest when it is allowed to do its ecological work (Collins and Stephens 2010)