Climate Change and U.S. Forests

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Topics to be covered today….

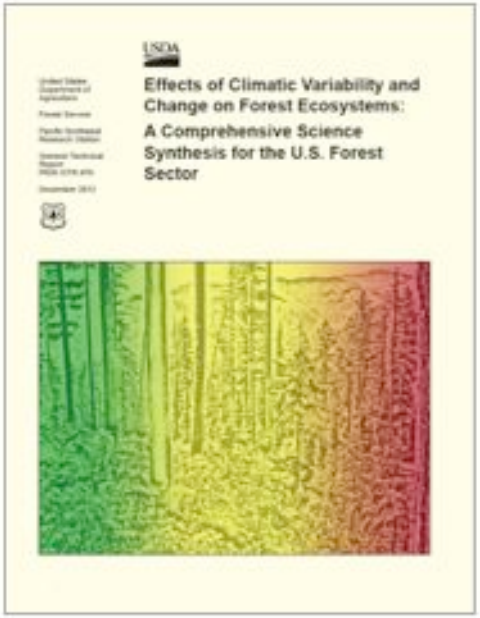
- *How Might Climate Change Impact the Nation's Forests?*
- *What are Some Possible Adaptation and Mitigation Strategies?*

2013 National Climate Assessment Technical Input Document

Vose, Peterson, and Patel-Weynand eds.

45 expert authors from federal service, universities, NGO's

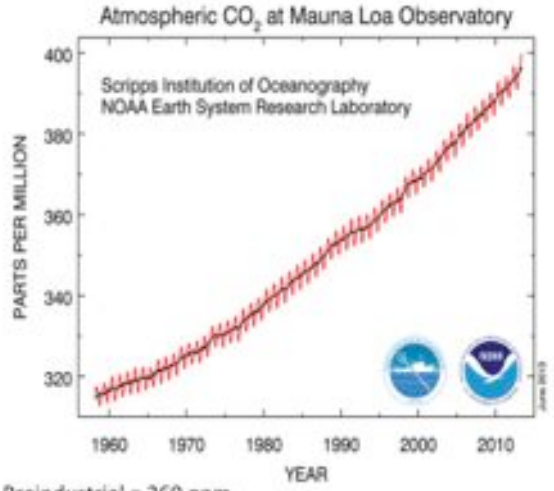
More than 1000 peer-reviewed citations



The Future

- *Higher CO_2 concentrations*
- *Warmer*
- *Drier in some places, wetter in others*
- *Extreme events more likely, more severe, longer lasting*

Rising CO_2 and other greenhouse gases



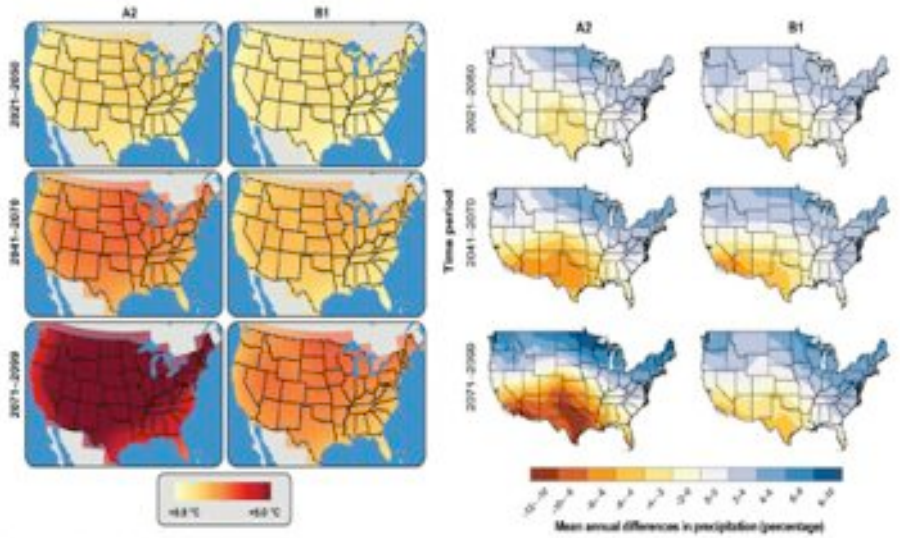
Preindustrial = 260 ppm

Changes in the Earth's Climate System…

- 1.4 °F over past 100 yrs
- Loss of Arctic ice
- Sea level rise (8" since 1870)
- Heat waves and extreme temperatures

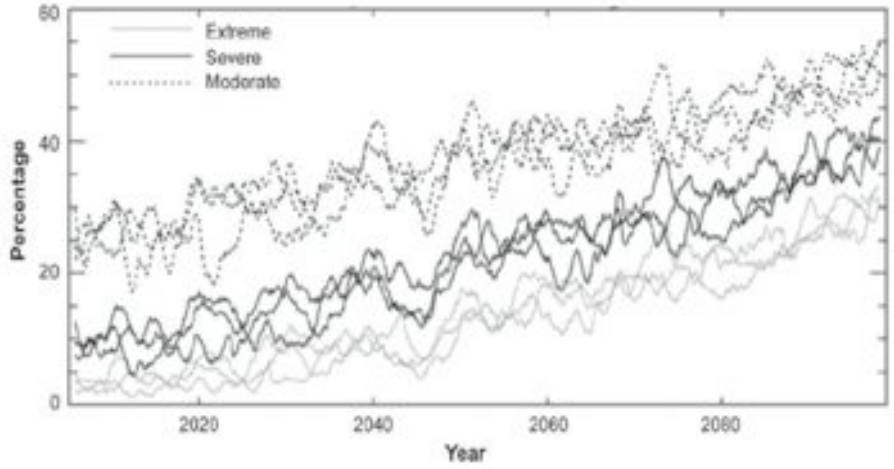
Temperature

Precipitation



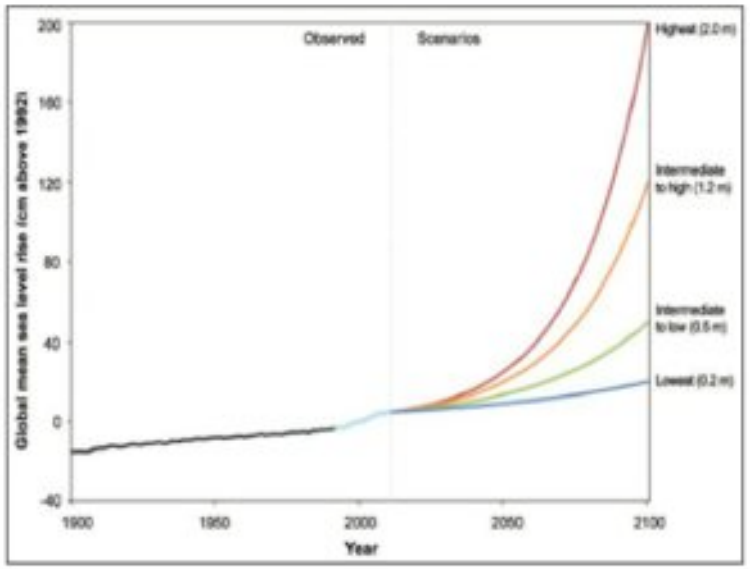
Chapter 2; and Kunkel et al. (2013)

DROUGHT SEVERITY



Chapter 2; Burke et al. (2006)

Sea Level Rise



Chapter 2. Paris et al. 2011

Climate Change Will Have Significant Impacts on the Nation's Forests

- **Direct Impacts**…
  - *Warming*
  - *Changing Precipitation (amount and extremes)*
  - *Elevated CO_2*
  - *Sea Level Rise*
- **Indirect Impacts** from Altered Disturbance Regimes…
  - *Fire*
  - *Insects & Pathogens*
  - *Invasives*
- **Combined Impacts** *or* **Stress Complexes**

Direct Impacts

- **Higher Growth** where nutrients and soil moisture and available
- **Lower Growth** in water limited forests and where benefits offset by disturbance
- **Higher Mortality**
- **Changing Suitable Habitat –** species distributions
- **Altered Hydrologic, Nutrient, and Carbon Cycling Processes**

Changing environmental conditions will substantially alter suitable habitat for many species

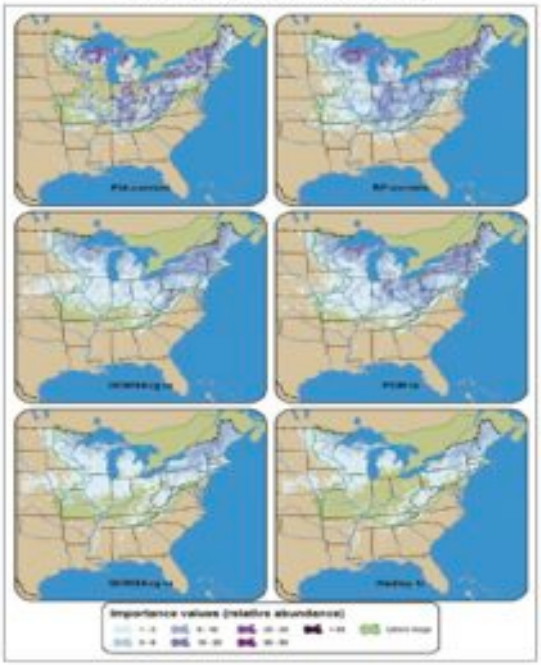
Losers & winners

400 to 800 km northward movement by 2100

Pace of change will likely be faster than species can migrate!

Chapter 2; Prassad & Iverson 1999

SPECIES DISTRIBUTION MODELS



Altered Cycles

- Changing snow amount (lower) and snowmelt timing (earlier)
- Increased flooding, erosion, landslide potential
- Higher N in streams
- Increased C storage in eastern forests
  Potential increase may be offset by loss of forests, drought, other disturbance
- Decreased C storage in western forests

Indirect Impacts and Stress Complexes

Indirect Impacts - ***Changing Disturbances Regimes***

wildfire

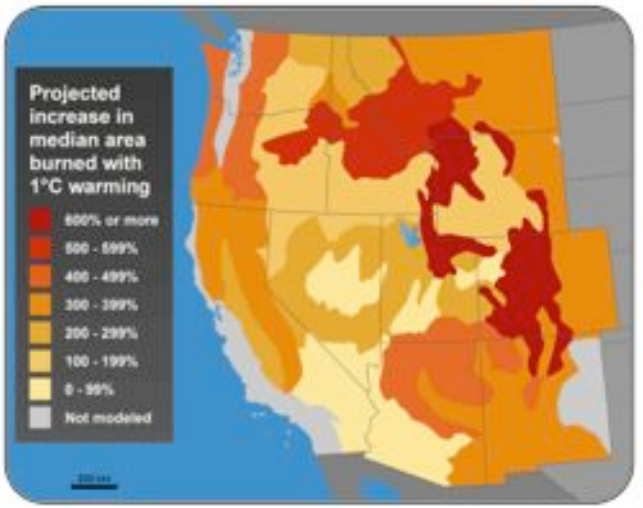
insects & pathogens

invasives

Stress Complexes – ***Combinations of Stressors***

Warming + Drought + Fire Exclusion + Insect Outbreaks

Wildfire area burned

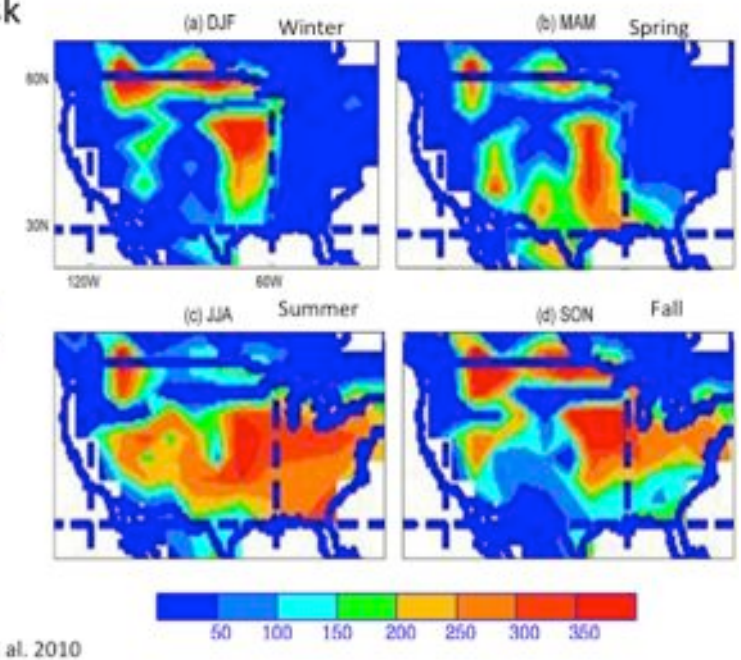


Statistical model output: Changes compared to 1950-2003.

Data from J. Littell

Wildfire Risk

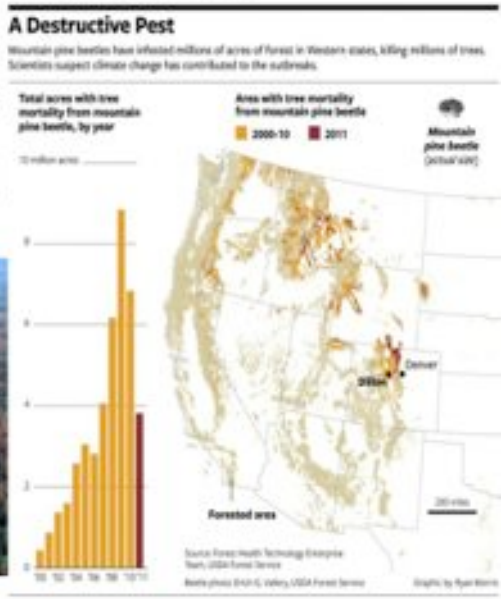
Changes in Keetch-Byram Drought Index



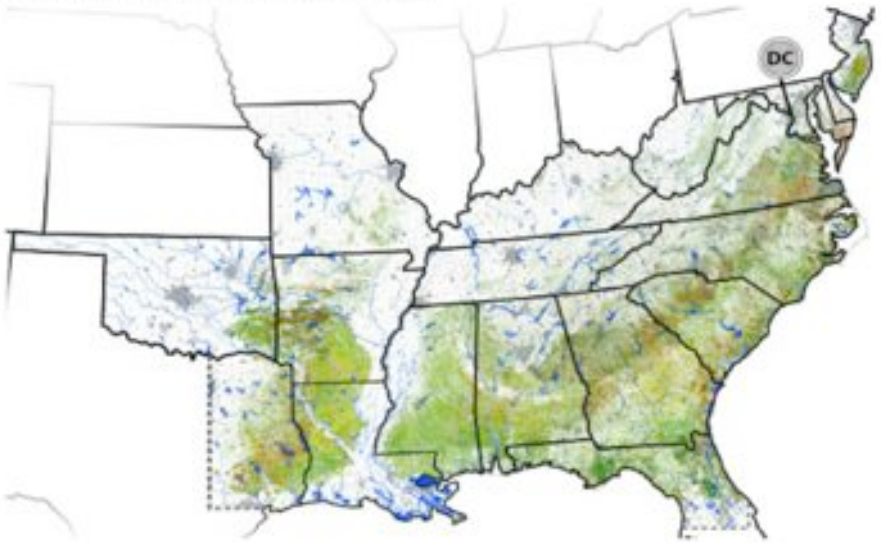
Chapter 2 – Liu et al. 2010

Insect outbreaks continue….

Mountain pine beetle and other insects are increasing in spatial extent, including at high elevations – this will probably continue.

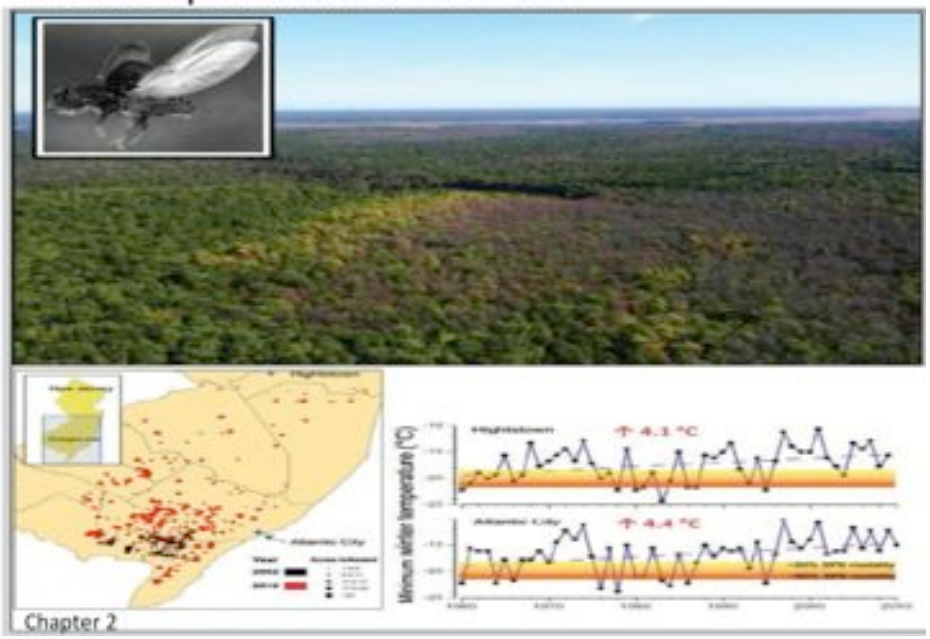


Southern Pine Beetle Hazard Map



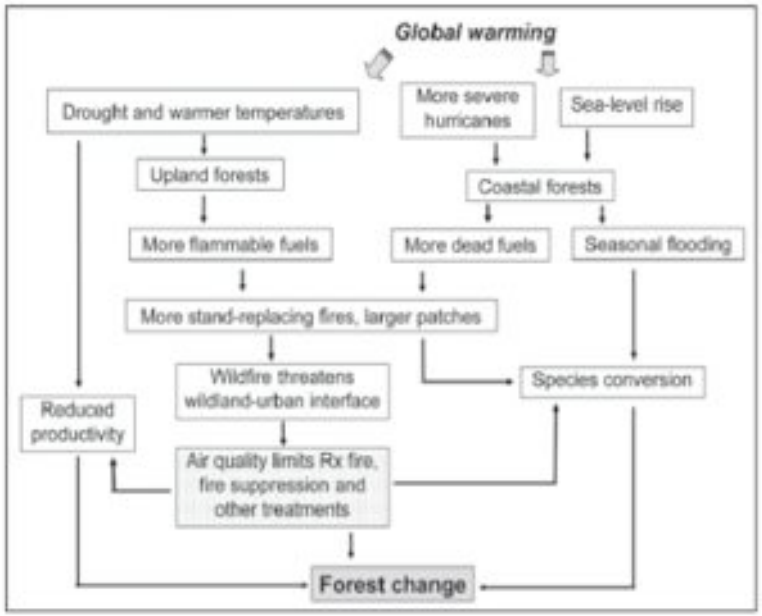
USDA FS Forest Health Protection Website

...and expand into new areas



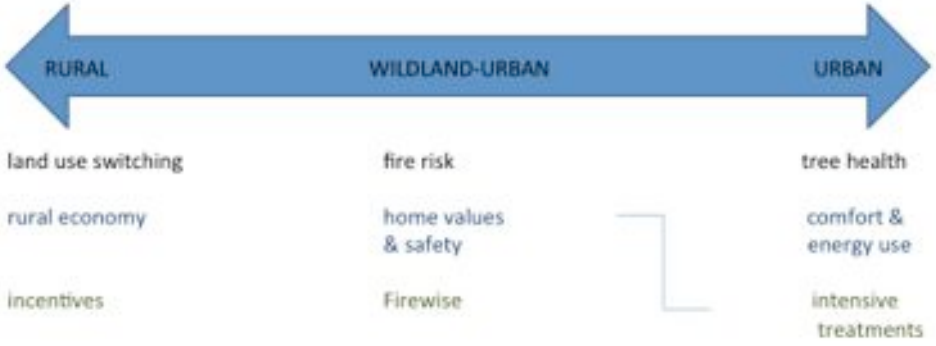
Ranges and competitive ability on many invasives are projected to increase – *Cogon Grass*

STRESS COMPLEXES

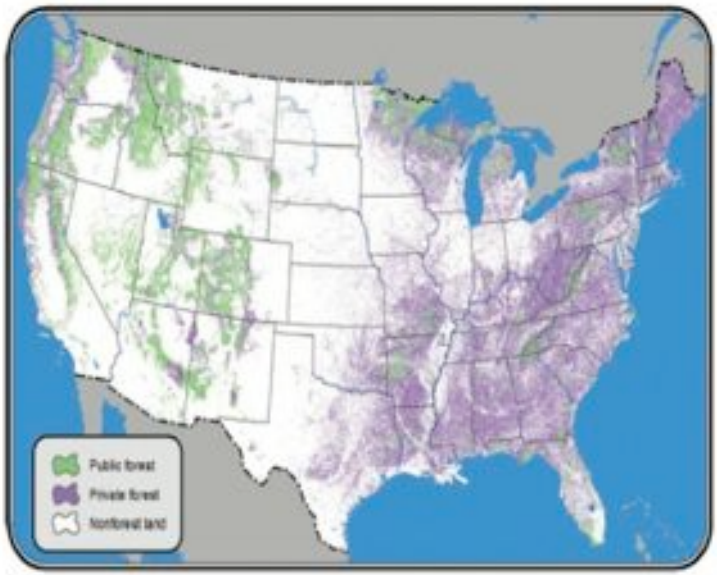


Chapter 2 – Don McKenzie

Impacts, Consequences, and Potential Management Responses Will Vary across the Rural to Urban Gradient



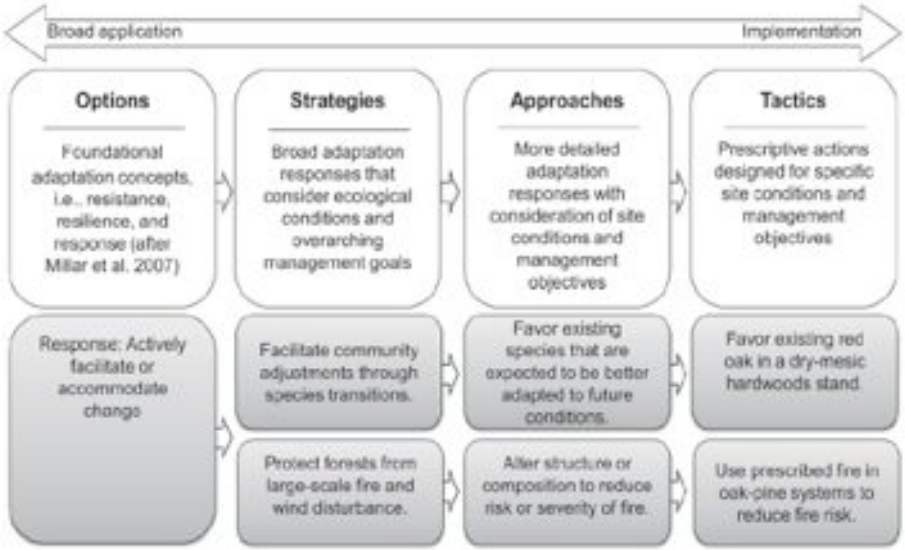
Differences in ownership patterns will likely influence management responses!



Chapter 3. Wear and Joyce

What can we do about climate change in forest ecosystems?

- Slow it down = Mitigate (manage carbon)
- Buy some time = Adapt (prepare systems and species)



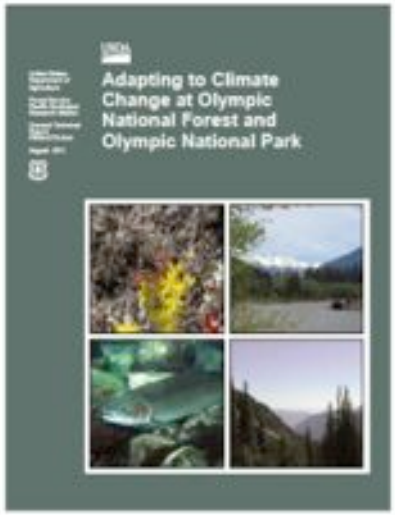
Carbon mitigation *strategies*

- Increase forest area (afforestation), decrease deforestation, or both.
- Manage carbon in existing forests.
- Use wood as biomass energy, in place of fossil fuel or in wood products for C storage and in place of other building materials

Carbon mitigation *tactics*

- Reduce harvest.
- Protect large carbon stocks.
- Implement fuel treatments where appropriate.
- Increase forest growth.
- Store carbon in wood products, reduce milling waste.
- Substitute wood for fossil-fuel intensive materials (steel, concrete).
- Use wood for bioenergy.

Adapting to climate change – Information & tools



Adapting to climate change – Information & tools

Adapting to climate change – Information & tools

Climate Change Resource Center
U.S. Forest Service

http://www.fs.fed.us/ccrc

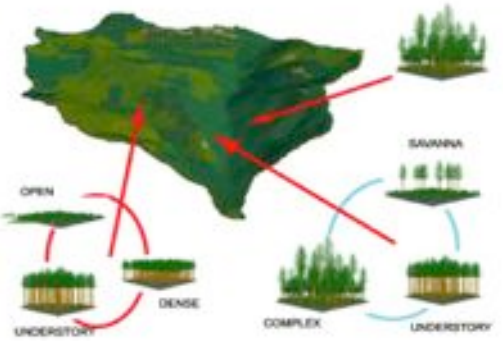
Adaptation – what's happening?

- Adaptation activities have increased greatly over the past 5 years, often led by federal agencies.
- Most adaptation is strategic, focused on resistance and resilience to stressors.
- Not much implementation in formal planning and policy.
- Not much implementation on the ground.

Increase resilience at small spatial scales
Implement treatments that minimize loss of structural and functional groups

Increase resilience at large spatial scales
Increase landscape diversity

Google Earth imagery © Google Inc.



Conclusions – *disturbances*

- Increased fire will have major ecological, social, and economic effects by mid 21st century.
- Bark beetles and other insects will have major effects in many forests.
- Invasive plants and some pathogens will increase, but with uncertain long-term outcomes.

Conclusions – *processes*

- Hydrology and biogeochemical cycling will vary by system; interactions with disturbance, snowpack.
- Species will move up and north, but with high variability; BCE and process models disagree on space-time relationships.
- Carbon storage will decrease in the West, may increase in the East.

Conclusions – *management, risk*

- Many land management agencies have developed principles and tools for adaptation:
  climate smart ≈ *sustainable*
- Adaptation strategies are becoming more common; on-the-ground adaptation tactics are rare.
- Risk management framework is needed to evaluate change in ecosystem services.