

Forest Research Advisory Council meeting

Targeting the yield definition in a shifting community fitness landscape

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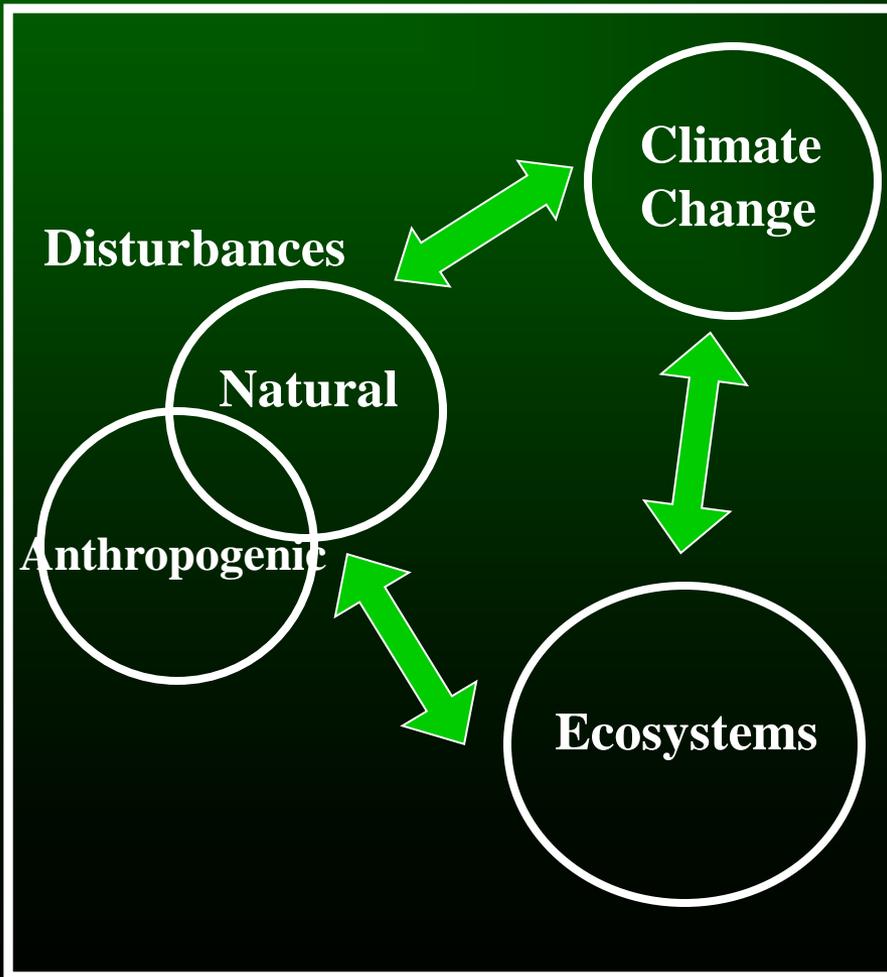
Climate Change

- Mean annual global surface temps. increased $\sim 0.74^{\circ}\text{C}$ from 1906-2005, with the change over the last 50 years twice that of the last 100 years.
- Since 1995, 11 of the warmest years on record have occurred.
- By the end of the century, mean annual increases of 1.8 to 4.0°C are expected (relative to 1980-1999).

IPCC. 2007. **Climate change 2007: The scientific basis**. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.



Climate Change and Disturbances



- **Fire regimes**
 - Increased severity
 - Possible changes in size, seasonality
- **Drought**
 - Increase in frequency
- **Insects and diseases**
 - Changes in distributions
- **Hurricanes, landslides, ice storms, windstorms**
 - Alterations are possible

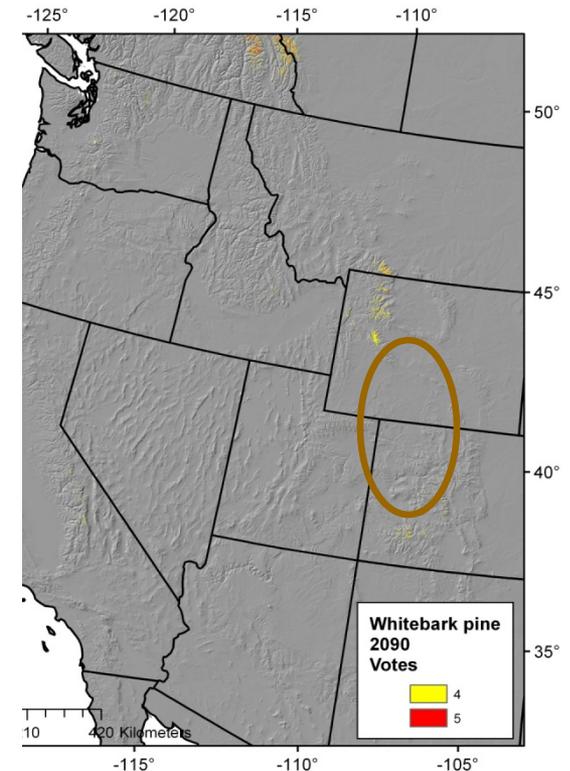
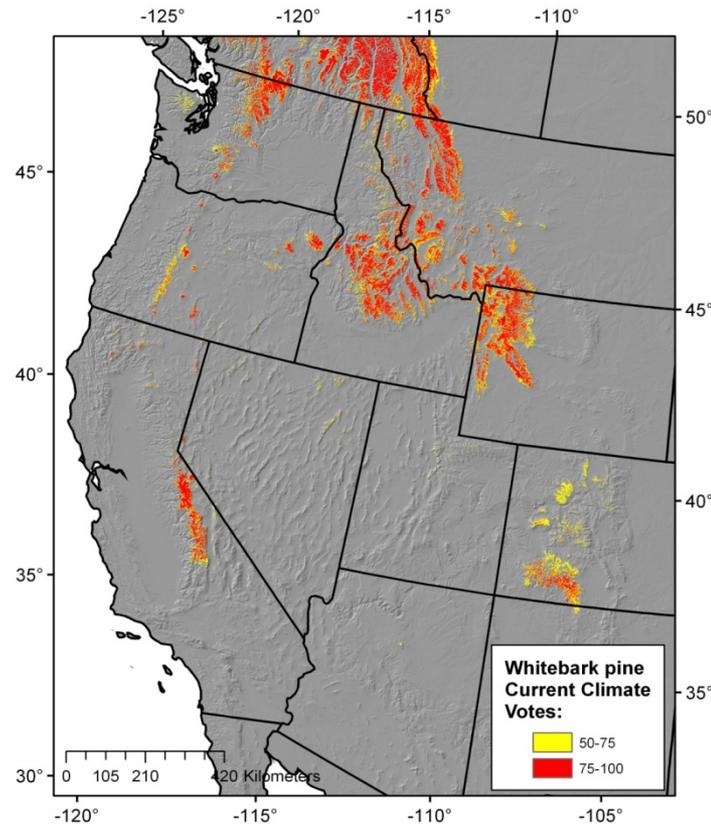
Fitness landscapes in a changing environment

What do we understand is meant by Fitness Landscape?

Most of the current literature refers to this term as the capability of an organism to fit in its environment, which is mostly related to its genetic information and its interaction with the environment which is translated in its adaptation capability to those specific environmental growing conditions.

Plant-climate Relationships

By the end of the century, ~50% of the West is predicted to experience climates that are incompatible with the vegetation occurring there today.



Gerry Rehfeldt, Nick Crookston and Dennis Ferguson Rocky Mountain Research Station, Moscow, ID

<http://forest.moscowfs1.wsu.edu/climate/index.html>



Understanding Ecosystem Changes

- Effects of multiple stresses on ecosystem processes
- Species migration and composition changes
- Climate change and disturbances
- Implications for land management (adaptation and mitigation)



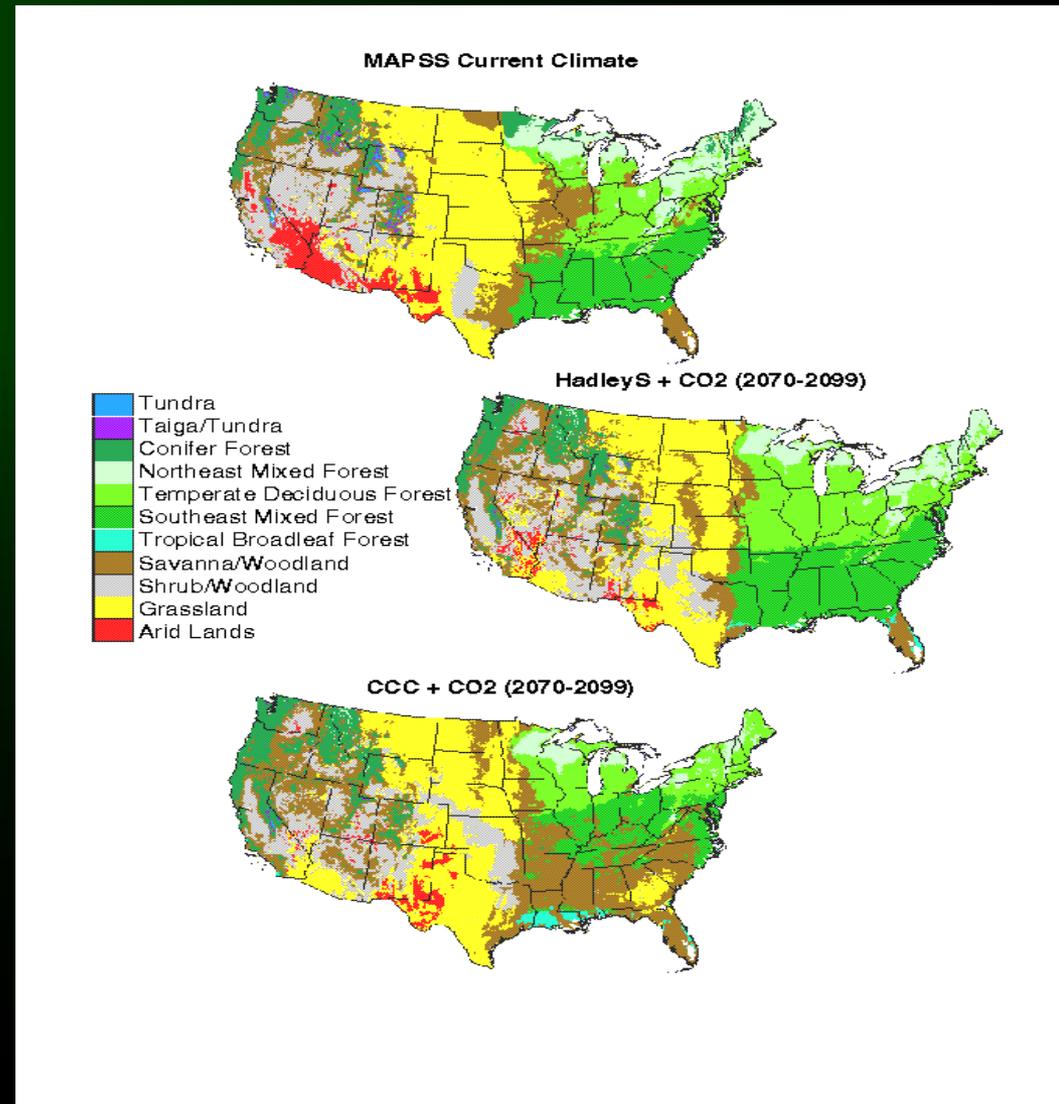
Climate Change and Forest Processes

- **Productivity**
 - Under elevated CO₂, forest productivity increases, subject to moisture and nutrient conditions
 - Under warmer scenarios, increased drought, fire
 - Climate only changes result in a decline in productivity
- **Carbon Storage**
 - Modest warming could increase carbon storage
- **Water Use**
 - Runoff could increase in areas of the US
- **Interactions with Air Pollutants**
 - N deposition
 - Tropospheric ozone



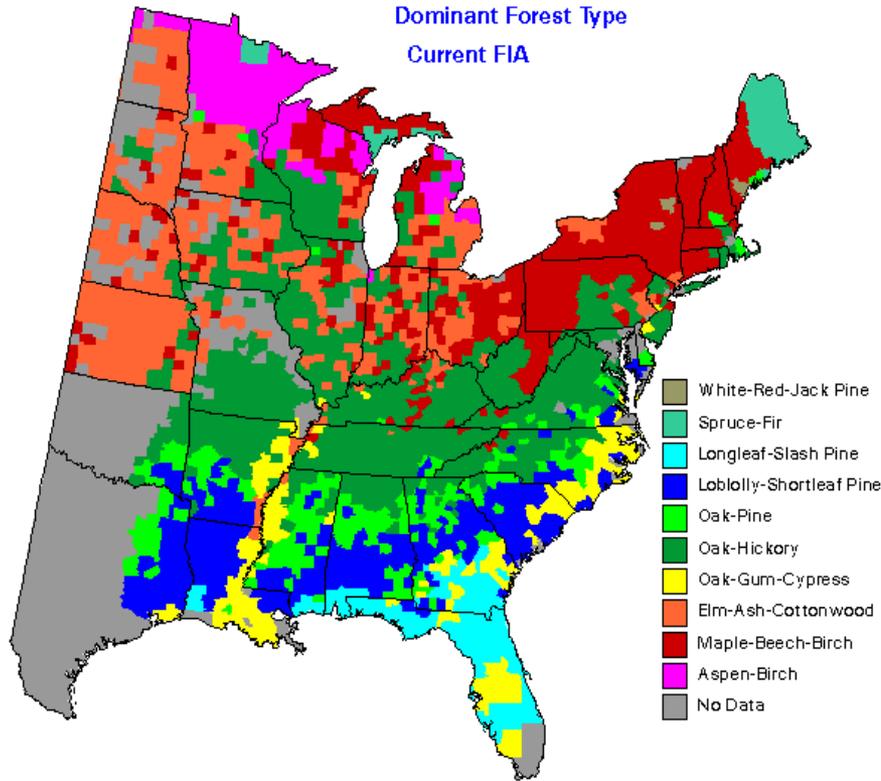
Ecosystem Changes: Vegetation distributions

- Results influenced by
 - Treatment of CO₂ effects
 - Particular climate scenario
- Results indicate
 - Direction of change
 - Magnitude uncertain
- Sensitive to climate
 - Species composition
 - Vegetation boundaries

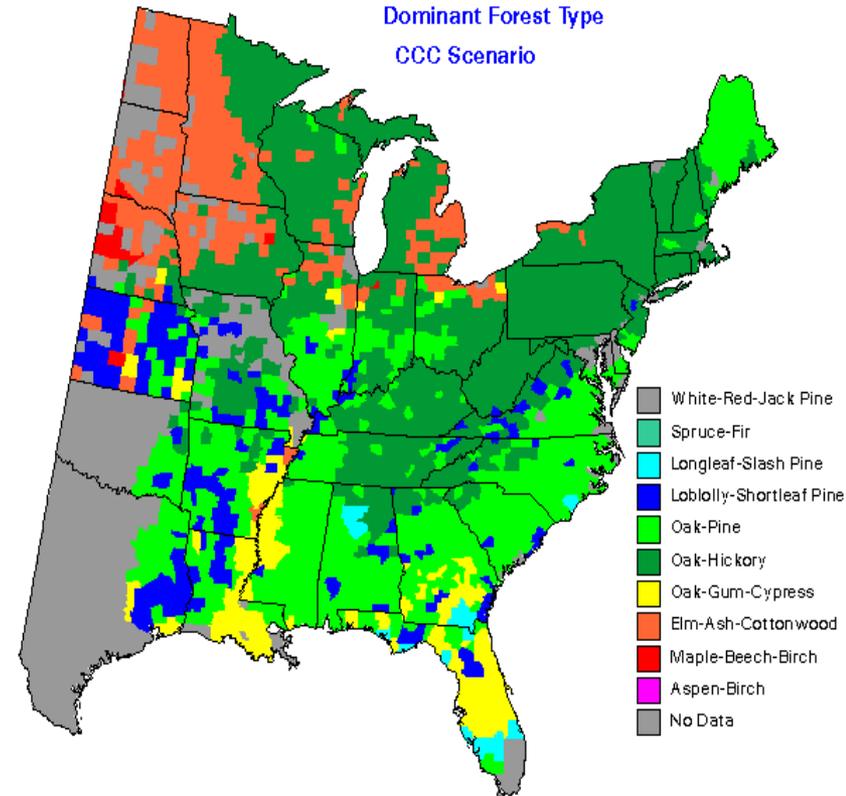


Ecosystem Changes: Tree Species Migration

Dominant Forest Type
Current FIA



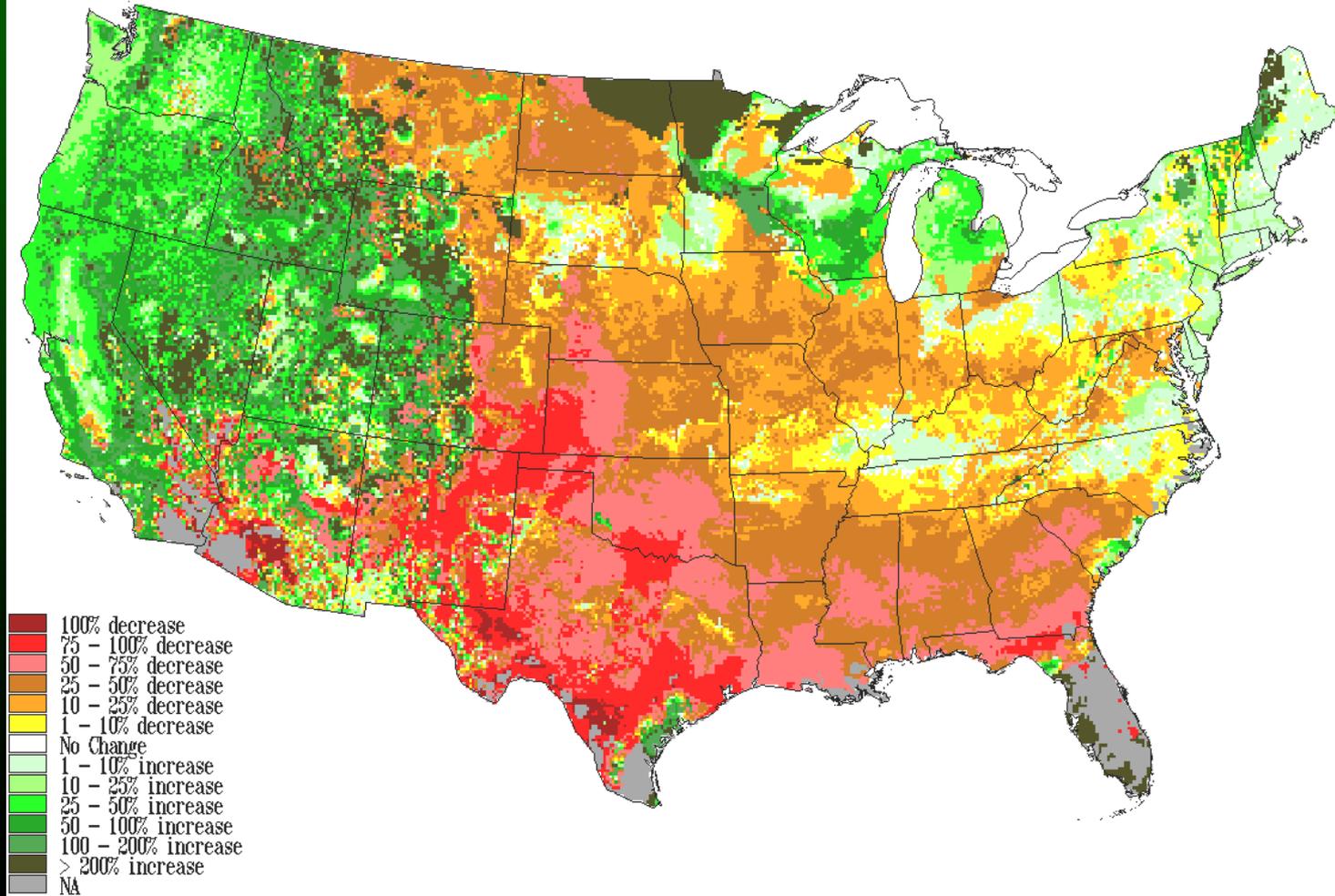
Dominant Forest Type
CCC Scenario



Water Cycle: Potential Effects of Climate Change on US Forests

Av. % Change ROFF

Across 7 GCM models



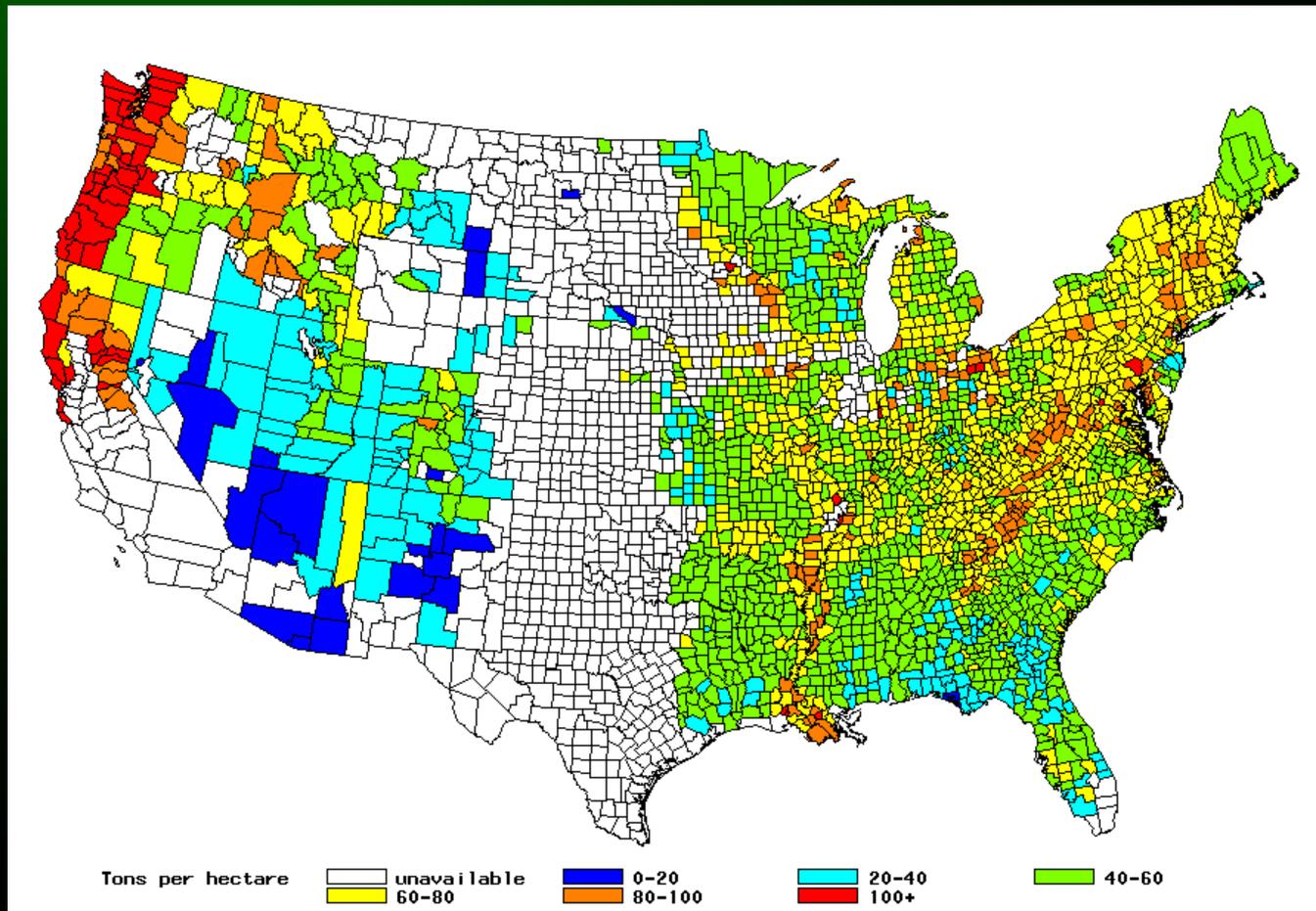
- Climate change impacts on water quantity and quality
- Effects of water stress on ecosystem physiology
- Effects of climate change and air pollution on nutrient cycling

– Integrated ecosystem process and hydrologic models



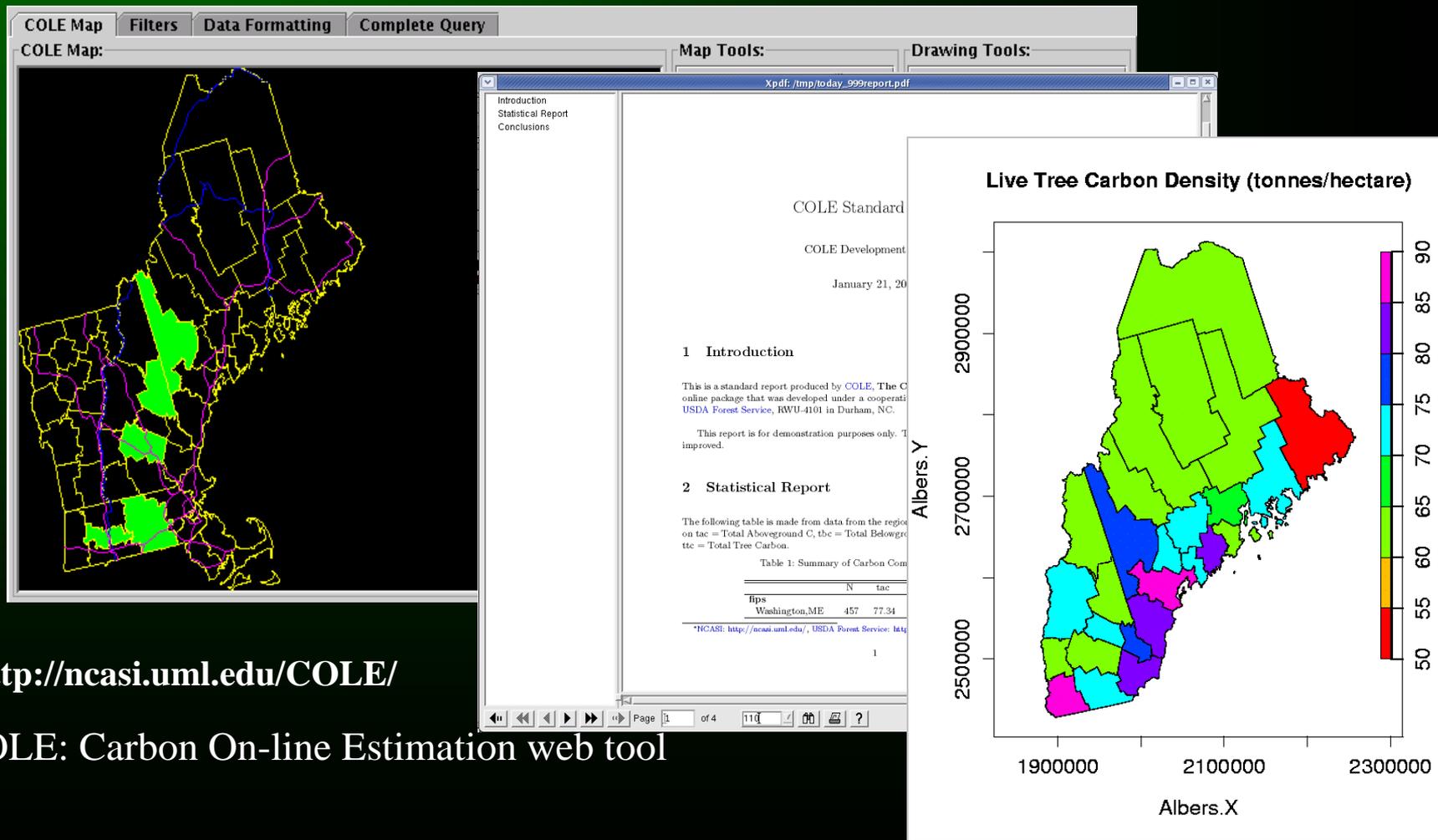
Carbon Stocks and Stock Changes Estimated from Forest Inventory Data

Tree carbon per hectare by U.S. county



Decision Support: Transferring research results to land managers

Action: Research to enhance carbon accounting tools



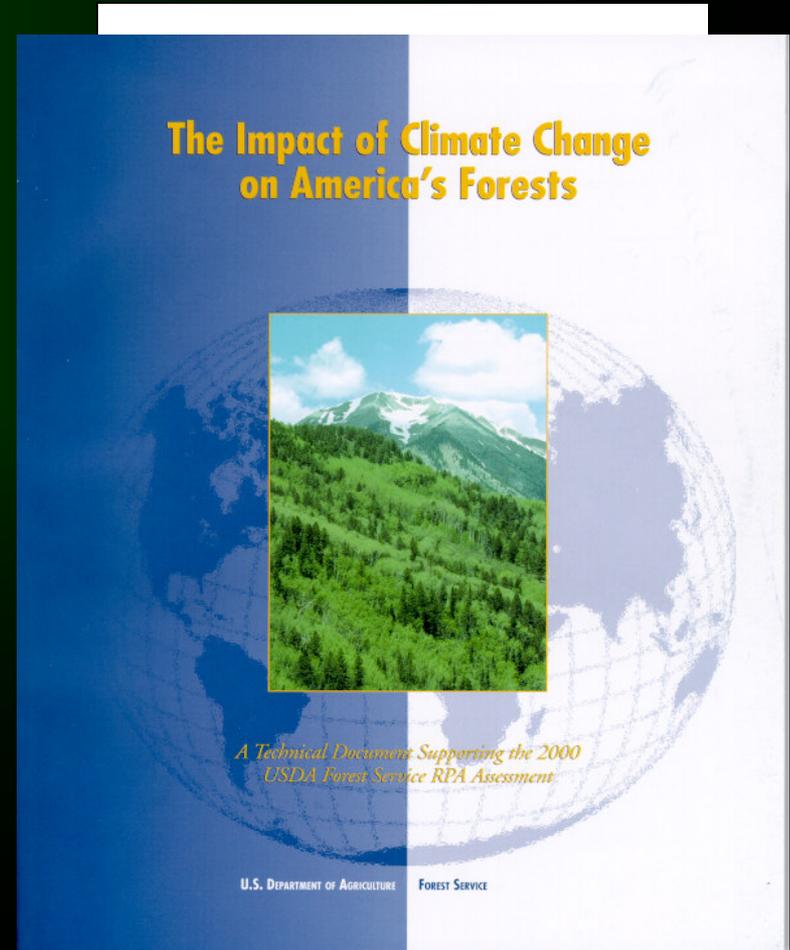
<http://ncasi.uml.edu/COLE/>

COLE: Carbon On-line Estimation web tool



Forest Service Strategic Planning Resource Assessments

- Mandated by RPA of 1974
- The periodic assessments synthesize and integrate:
 - Current scientific knowledge,
 - Current inventories of resource conditions and
 - Analyses of alternative future conditions.
- RPA climate change assessments: 1990, 1995, 2000



Ecosystem Changes

Implications for Forest Management

- **Reduce non-climate stresses**
- **Intensify habitat and species management**
- **Reduce the risk of catastrophic disturbances**
 - Insects, diseases, invasives, fire
- **Consider climate variability in management and restoration plans**
 - National forest plans
 - Other public and private forest values
 - Adjust natural resource yield and harvest models
- **Landscape management**
 - migration corridors, edges of ranges
 - Protect coastal wetlands, allow for sea-level rise



Silviculture can be the answer....

- Increase spatial heterogeneity (i.e, in terms of composition, age, structure, etc.).



S. Munson, FHP-R4



Our challenge is not in merely sustaining the systems we have, or in restoring selected systems. **Recognizing that *that our Nation's natural resource systems will be stretched to meet domestic needs in a global economy*, the real challenge is to enhance the capacity of all systems to meet future resource needs.**



Then some thoughts for discussion are:

- **What are the new sciences that the academic community has to address and what we have to continue working on?**
i.e., Geospatial technology operation, improve remote sensing and monitoring techniques, modeling for different purposes (Global change projections, risk assessment, vulnerability assessment), landscape genomics, optimization techniques.
- **What science is needed to support natural resource management in a changing future?**
- **What should be the new emphasis areas of the Forest Service Research and Development?**
- **What kind of partnerships could be established with the academic and scientific community to address these big issues under restricted budget conditions?**





USDA Forest Service Research & Development

Science Serving Society

Questions?