Climate Change Effects on Forests: An Introduction to Issues

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The observed change in the climate system over roughly the past century is virtually certain to be due in part to human influences.

The observed changes in climate are very likely to continue, and even accelerate during the current century.

There are now many observed, well-documented impacts of changes in natural resources, animal and plant species, and ecosystems in many regions of the world.

Impacts in the future are very likely to grow in both number and magnitude.

Climate change and its impacts present challenges for adaptation in both the developing world, and as well among developed countries.
Overview of Possible Forest Effects

- Phenology and Productivity
- Ecosystem Processes
  - Carbon Storage
  - Water Flow
- Fire Frequency and Intensity
- Pests
- Shifting Species on the Landscape
Phenology and Productivity

- Good satellite-based evidence of broadening of growing season in northern temperate latitudes in North America

- Some evidence, but not broad, that productivity has increased
  - Many interacting factors on this last point (e.g. N deposition)

- Some forests already responding very dramatically to drought stress - large mortality events
Ecosystem Processes

Results from CO$_2$ enhancement experiments on forest stands show range of results

- Higher productivity, but extra C goes into short-lived pools (fine roots, twigs), not trunk growth or long-lived soil pools
- Strong interaction with ozone concentrations

Effects on other processes and services, e.g. water balances, not as well understood
Fire Frequency and Intensity

- Models have suggested for many years that increased fire risk and frequency was an important issue.
- Now have examples of changes in fire frequency and intensity clearly driven by climate variability.
- This, too, a story of multiple causative factors - interaction with fire suppression and pests.
Pests

- Classical response of environmentally stressed forests - greater pest infestations on weakened trees
- Seeing this clearly in several places in the US (Rockies, Southwest, Southeast)
- But also seeing pest infestations that are a direct response to changes in climate variability, especially in winter temperatures
For the past 20 years, modeling studies have suggested that a major impact in the long term would be movement of species to new “climate space”

How rapidly this would happen is not clear - models vary as to how well they simulate time-frames, and don’t have really good regional climate simulations

But do have examples now of tree-line changes and shifts in alpine vegetation

Likely that the general conclusions from models are robust in this regards
Seeing impacts now

Not a lot of guidance for the agencies to follow in terms of adapting to or coping with current or future change from climate (GAO report)

Clearly need to devote effort to understanding what management actions make sense
Main Conclusions

- Climate is indeed driving many ecosystems across thresholds that are important for managers to consider;
- The consequences of known thresholds challenge our current capacity to manage those ecosystems sustainably; and
- We require both better management techniques and a much better predictive capability to use our knowledge of thresholds more effectively in building adaptive management capacity.
Adaptation and Coping

Because changes occurring now, have both coping to current circumstances and questions about planning for future circumstances to consider.

Requires some knowledge of regional climate changes and environmental consequences.

Requires information on current practices for coping and understanding of factors that control vulnerability.

Requires ability to model effectiveness of adaptation strategies as part of integrated response portfolio.
Research Agenda

- Suggests that most important knowledge to get as quickly as possible is information about potential end-points and lag-times.
  - Importance of ecological modeling and monitoring
  - Importance of better regional climate change information
  - Importance of understanding potential costs and effectiveness of adaptation and management strategies

- What are potential magnitudes of important end-points?
- Are there thresholds we must worry about?
- To what degree is there sufficient ecological “buffering” to guard against cascading effects?
- What are the implications for atmospheric greenhouse gas concentrations and therefore emissions and mitigation costs?
  - Need integrated way of understanding potential portfolio of actions and their consequences
  - Collaborations of Ecosystem modelers, Integrated Assessment modelers and Earth System modelers have a lot of promise here