A FRAMEWORK FOR ASSESSING CLIMATE CHANGE VULNERABILITY AND IDENTIFYING ADAPTATION RESPONSES IN THE CENTRAL HARDWOODS REGION

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ABSTRACT

Introduction

The Central Hardwood region contains a mosaic of forests, woodlands, savannas, and other ecosystems that will increasingly be affected by a changing climate over the next century. Understanding potential impacts is important to sustaining healthy forests under changing conditions. The objectives of the Climate Change Response Framework (forestadaptation.org) are to develop partnerships among the science and management communities, assess climate change vulnerabilities, and provide tools to integrate climate change information into forest management.

Methods

Two ecoregional projects covering 71 million acres across the Central Hardwood region brought together numerous organizations in a collaborative effort to address climate change. Vulnerability to climate change under a range of future climate scenarios was assessed for 18 forest ecosystems in the Central Hardwood and Central Appalachian project areas. A panel of scientists and managers with expertise in forest ecosystems considered relevant literature and ecological principles together with impact model results to rate ecosystem vulnerability. This expert elicitation method was fundamental to incorporating the local knowledge and experience of the panelists in evaluating vulnerabilities.

Results and Discussion

Panelists first identified potential impacts on ecosystem drivers and stressors. Data from two downscaled climate models bracketing a range of potential futures projected average temperatures to increase by 2 to 8 °F by the end of the century. Although model results for precipitation differed by region, they generally projected decreases in precipitation in summer or fall. Decreased precipitation combined with increased temperatures could potentially decrease soil moisture availability in some areas. These changes have the potential to affect other ecosystem processes such as wildfire dynamics and soil erosion, or increase susceptibility or exposure to insect pests or invasive species.

Potential impacts to tree species were compared and contrasted by the panelists using the Linkages, Landis Pro, and Climate Change Tree Atlas models. All three impact models projected a potential decrease in species having ranges largely north of the region, such as American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*), and species currently existing as glacial relicts in the region, such as red spruce (*Picea rubens*) and eastern hemlock (*Tsuga canadensis*). All three impact

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models projected a potential increase in suitability for species having ranges largely south and west of the region, such as shortleaf pine (*Pinus echinata*) and loblolly pines (*Pinus taeda*). Mature trees that are projected to decline may experience slowed growth and reduced productivity but can potentially persist for many years after conditions become unsuitable. Climate change impacts on forest ecosystems may be observed sooner in early growth stages, especially germination and establishment. These impacts will ultimately lead to shifts in species composition within and among ecosystems.

Panelists identified attributes (both positive and negative) for each forest ecosystem related to its ability to cope with climate impacts, collectively known as adaptive capacity. These attributes were based on the current condition of the system given past and current management regimes, with no consideration of potential adaptation actions. Major attributes identified included species diversity, the range of landforms on which the ecosystem could exist, and the ability to withstand or bounce back after a disturbance. Current or past management was also identified as contributing to adaptive capacity in some cases. Ecosystems where past management reduced species, age, or genetic diversity were perceived as having lower adaptive capacity. Ecosystems where current fire or flood regimes differed dramatically from historic regimes were also perceived as having lower adaptive capacity. Management was perceived as increasing adaptive capacity if steps are currently being taken to restore natural ecosystem processes.

Panelists evaluated potential impacts on a forest ecosystem using a continuous scale from positive to negative, generally based on the overall number of positive versus negative impacts on drivers, stressors, and dominant species. Adaptive capacity was also evaluated on a similar scale from low to high. Across both project areas, vulnerability ratings ranged from low to high. Ecosystems dominated by oak species were generally rated low vulnerability, largely due to moderate impacts and high adaptive capacity. Northern and high-elevation ecosystems were generally rated high vulnerability, largely due to high impacts and low adaptive capacity.

Summary

As an increasing amount of relevant scientific information on forest vulnerability to climatic change becomes available, managers require ways to incorporate these broad concepts into forest management plans. We have developed "Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers" (Swanston and Janowiak 2012) to provide a structured approach for translating broad adaptation strategies into specific management actions and silvicultural practices. These resources, which include an adaptation workbook, are currently being used in collaboration with a number of natural resource managers to develop projects that implement a diversity of adaptation actions while also meeting manager-identified goals.

Literature Cited

Swanston, C.W.; Janowiak, M.J. 2012. **Forest adaptation resources: climate change tools and approaches for land managers.** Gen. Tech. Rep. NRS-87. Newtown Square, PA: U.S. Forest Service, Northern Research Station. 121 p.