A Strategic Response to Climate Change: The U.S. Forest Service Approach[1]

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The focus of the U.S. Forest Service is first and foremost on the nation's forests and grasslands—on protecting and conserving them for all the benefits people get from them, both now and in the future. Forest and grassland ecosystems are shaped by climate. When the climate changes, many things change with it: temperature, precipitation, snowpack size, runoff amounts, soil moisture levels—the list goes on. Add eutrophication and declining water quality to the mix, plus invasive species, acid deposition, land use change, and a host of other factors, and today's land managers are confronted with a whole new problem environment (fig. 1). As ecosystems change, people can no longer rely on the benefits they provide, such as clean air and water, habitat for wildlife, opportunities for outdoor recreation, and more. Climate change has therefore become a focal point for the Forest Service: It threatens the agency's ability to fulfill its mission.

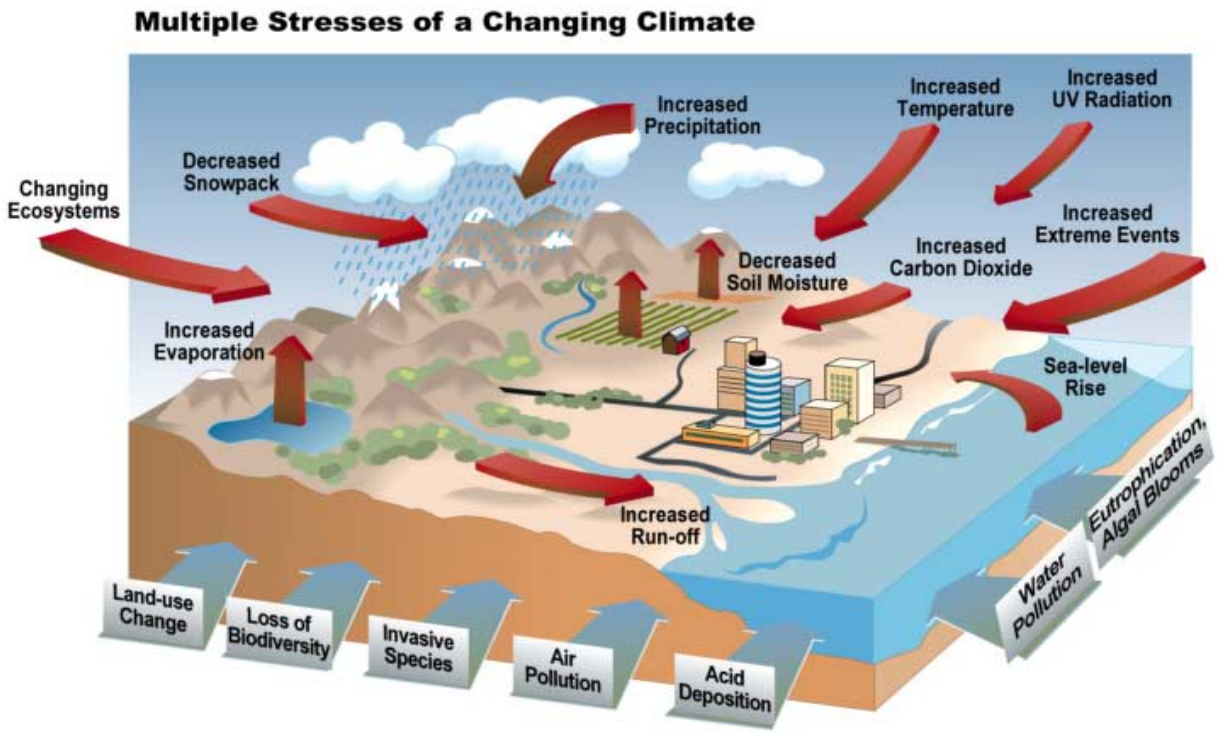

Figure 1—Climate change impacts, coupled with other stresses, are confronting land managers today with a whole new problem environment.

[1] The article summarizes the Forest Service's Strategic Framework for Responding to Climate Change (U.S. Forest Service 2008), drawing on materials presented by Cleaves (2009) and a study by Hayward and others (2009).
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How can the Forest Service respond? What can an organization like the Forest Service do to help the nation, and indeed the world, to meet the challenge of climate change?

Basis for Responding

In a sense, the Forest Service has long been responding to climate change. Climates fluctuate naturally—oscillating, for example, between periods of wet and dry or hot and cold. In writing land management prescriptions for forests and grasslands, Forest Service professionals have always studied local and regional climate patterns, taking precipitation, soil moisture, and other climatic conditions and trends into account.

By the 1980s, however, there was rising concern among scientists that climates were changing on a global scale in ways that went beyond natural fluctuations. Such concerns translated into a congressional mandate to the Forest Service to include climate change research in its 5-year scientific reports under the Forest and Rangeland Renewable Resources Planning Act of 1974. Ever since, Forest Service scientists have been in the forefront of climate change research, generating studies and contributing to the U.S. Climate Change Science Program and the Intergovernmental Panel on Climate Change (IPCC)—see, for example, Joyce and Birdsey (2000), IPCC (2007), Joyce and others (2008), Millar and others (2007), and Ryan and others (2008).

In January 2005, the Forest Service invited hundreds of forest stakeholders and other partners to a Centennial Congress in Washington, DC. Participants identified climate change as one of the major long-term challenges to conservation in the 21st century. Within a year, Forest Service Chief Dale Bosworth had elevated climate change to a national concern for the agency. In local, regional, and national forums, Forest Service leaders began wide-ranging discussions on how best to address the issue, and a national team was formed to devise an agencywide climate change strategy. In October 2008, the team completed the Forest Service Strategic Framework for Responding to Climate Change (U.S. Forest Service 2008a), the approach outlined in this paper.

A Strategic Approach to Climate Change

The job of the Forest Service is to ensure that America's forests and grasslands provide its citizens with plentiful ecosystem services. Ecosystem services are the benefits people obtain from ecosystems—basic services such as food, water, wood, and medicine; environmental services such as pollination, erosion control, wildlife habitat, and carbon sequestration; cultural services such as recreation, ecotourism, and educational and spiritual values; and supporting services such as nutrient cycling, soil formation, and primary productivity (Millennium Ecosystem Assessment 2005). The nation's forests and grasslands contain vital components of biodiversity, an essential part of America's national heritage. They provide most of the water Americans use for drinking, agriculture, and industry. They furnish fiber for paper, lumber, and other wood products. They provide clean air, livestock feed, and recreation opportunities; and they support habitat for myriad plant and wildlife species. Healthy and productive forests and grasslands can also supply renewable energy and other offsets for fossil fuel emissions.

Climate change threatens all of these services. Since the 1980s, Americans have seen such effects as changing water regimes, spreading bark beetle infestations, and increasing wildfire severity and area burned. Even if global greenhouse gas buildups were reversed today, global temperatures would continue to rise for the next hundred years (IPCC 2007), bringing regional warming, changes in precipitation, weather extremes, severe drought, earlier snowmelt, rising sea levels, changes in water supplies, and other effects. As it is, global greenhouse emissions are still rising, exacerbating all of these long-term effects. The capacity of many plant and animal species to migrate or adapt will likely be exceeded. Ecosystem processes, water availability, species assemblages, and the structure of plant and animal communities and their interactions will change. In many areas, it will no longer be possible to maintain vegetation within the historical range of variability. Land management approaches based on current or historical conditions will need to be adjusted.

The Forest Service's Strategic Framework for Responding to Climate Change is based on seven strategic goals in three broad categories: foundational, structural, and action (see the sidebar). Like the challenges themselves, the goals are interconnected; things done to achieve one goal tend to help meet the other goals. The key is to coordinate approaches to each goal as complementary parts of a coherent response to climate change. All seven goals are ultimately designed to achieve the same end: to ensure that Americans continue to get the ecosystem services they want and need from their forests and grasslands.

Forest Service Goals for Addressing Climate Change

Foundational:

1. **Science:** Advance scientific understanding of the environmental, economic, and social implications of climate change and related adaptation and mitigation activities.
2. **Education:** Advance public understanding of sustainable resource consumption and land management in an era of climate change, including the need for adaptation and mitigation.

Structural:

3. **Policy:** Integrate climate change into agency policies, program guidance, and communications, and coordinate across all departments at all levels.
4. **Alliances:** Build strong national and international alliances for sustainable forest management in an era of climate change, including adaptation and mitigation.

Action:

5. **Adaptation:** Enhance the capacity of forests and grasslands to adapt to the environmental stresses of climate change and continue delivering ecosystem services.
6. **Mitigation:** Manage forests and grasslands to reduce the buildup of greenhouse gases while continuing to deliver a full range of ecosystem services.
7. **Sustainable operations:** Reduce the environmental footprint of agency operations and become a leading example of a green organization.

Foundational Goals

The Forest Service's strategic response to climate change is founded on science and education.

Science

Understanding climate change is predicated on sound science. The Forest Service has a good foundation in climate change science, with broad-scale studies reaching back to the 1980s and with relevant data collected on the agency's system of experimental forests and ranges, first established in 1908. However, much remains to be learned about the effects of climate change and its cumulative impacts on natural and human systems in the new problem environment (fig. 1).

In August 2008, the Forest Service laid out a 10-year research strategy for studying climate change (U.S. Forest Service 2009a). Researchers are beginning to model climate change impacts on species, vegetation structure, stand dynamics, water supplies, and disturbance patterns at regional and local scales. They will help translate science into land management applications, including user-friendly databases, predictive models, decision support tools, and monitoring systems, helping to reduce the uncertainties associated with climate change. Researchers will also develop more cost-effective methods of greenhouse gas accounting; carbon sequestration and storage in vegetation and soils; and biomass utilization, including the substitution of energy from wood for fossil fuels.

Researchers have begun working with individual national forests to apply climate change science to particular landscapes so that land managers can make better decisions. For example, the Pacific Northwest Research Station in Portland, OR, has worked with the Olympic National Forest in Washington to plan for future conditions affecting wildlife and fish, such as Pacific salmon. Similarly, the Rocky Mountain Research Station in Fort Collins, CO, is working with the Shoshone National Forest and its neighbours in the Greater Yellowstone Area to plan for future conditions affecting American beaver as well as whitebark pine and the animals that depend on it, such as Clark's nutcracker and grizzly bear.

Education

Such efforts are sustainable only through strong public support. Unless the public understands the effects of climate change and is willing, through its elected representatives, to provide needed funds, the Forest Service will not achieve its climate-related goals. Americans can best participate in decisions about public land management and take related actions if they are environmentally literate, with a good understanding of climate change, its impacts on ecosystems, and what can be done to address them. The Forest Service has a long tradition of building environmental awareness; in 2007, the agency made it a national priority to reconnect Americans with nature, particularly children (Kimbell and others 2009). In partnership with other organizations, the Forest Service will provide high-quality, science-based education and outreach on the role of forests and grasslands in delivering ecosystem services in an era of climate change.

Structural Goals

Next to a firm foundation of science and public support, the Forest Service needs the right institutional structure to respond to climate change. Success will depend on formulating the right policies and forming the right partnerships.

Policy

On the national forests and grasslands, local district rangers typically make most on-the-ground decisions, implementing various land management strategies and learning from the outcomes. Decentralized decisionmaking has been an organizational strength; but climate change calls for coordinated management actions over large geographic areas, and the Forest Service's decentralized management structure might hinder the necessary coordination. In response, the Forest Service has formulated guidelines for national forests to take climate change into account in revising their land and resource management plans, partly to help coordinate programs across ranger districts.

Other potential constraints have statutory roots. The federal budgetary process operates on an annual cycle. Accordingly, land managers might have to alter priorities from year to year, whereas climate change might require a sustained response over decades or even centuries. Under the National Environmental Policy Act, Forest Service planning processes have typically taken 2 to 3 years for a project and up to 10 years for a land and resource management plan, which might prevent a timely response to climate change. For example, the Forest Service might need to take rapid action to keep climate change from passing tolerance thresholds for species or ecosystems; even a 2-year planning delay could conceivably drive a sensitive species into extinction. Moreover, laws such as the Clean Water Act might not allow a climate change response that does long-term good but short-term harm to water quality or other resources. Climate change brings a growing need for swift, decisive land management responses to rapid, unexpected, and sweeping changes in environmental conditions. Current planning and policymaking processes for federal land managers might need corresponding reform.

For a climate change strategy to succeed, the Forest Service needs a cohesive, well-coordinated approach across entire landscapes. Several national strategies are in place or under development that could complement and reinforce such an approach, including strategies on water, open space, invasive species, biomass utilization, ecological restoration, integrated vegetation management, and research and development. The agency has begun taking climate change into account in formulating policies, program guidance, and communications, particularly with respect to forest planning, environmental analysis, and budget guidance. Coordination across Forest Service Deputy areas (especially National Forest System, Research and Development, and State and Private Forestry) will be key. Some regional offices and research stations are taking action to improve integration.

Alliances

The Forest Service manages 193 million acres of national forests and grasslands, including entire landscapes in some parts of the country. Where the agency manages large blocks of land, it alone can muster a coherent response to climate change on a landscape scale. Through partnerships forged by its State and Private Forestry organization, the Forest Service can also influence management on almost 430 million acres of state, private, and tribal forest lands. However, most of the nation's forests and grasslands are a patchwork quilt of various landownerships, including checkerboard patterns in the West and fragmented federal landholdings in the East. Under such circumstances, engineering a coordinated response to climate change across landscapes and landownerships is extremely difficult—but necessary. Piecemeal solutions are a waste of time and money.

Ultimately, success will hinge on everyone pulling together across jurisdictions. The scale of climate change ranges from local to global; its enormity and complexity are almost unfathomable. No organization working alone can handle the challenges it poses, and the Forest Service is therefore forging alliances. For example, it is working with partners and scientists from across the country to create a broad framework for conserving fish and wildlife at local scales. That framework includes translating general recommendations into climate change adaptation strategies for particular landscapes, species, or ecosystems. Using such tools, various landowners and land managers can coordinate their responses to climate change.

Around the world, organizations of all kinds, both governmental and nongovernmental, have been developing strategies for addressing climate change. The Forest Service can learn from and build on their insights and experiences. The agency has a long record of working with partners to achieve shared objectives, collaborating in areas ranging from cooperative research, to forest health, to fire suppression. The Forest Service will strive to build broad alliances, both nationally and internationally, to meet the challenge of climate change.

Action Goals

The Forest Service's foundational and structural goals for responding to climate change set the stage for taking action in three distinct areas: adaptation, mitigation, and sustainable operations. All three hinge on a strong foundation in science and education as well as an institutional structure based on sound policies and strong alliances.

Adaptation[3]

A central goal for the Forest Service is to help natural systems adapt to the effects of climate change while still providing all the ecosystem services that people want and need. There are two kinds of adaptation—anticipatory and opportunistic. Anticipatory actions, designed to prevent disruptions, might include constructing new water storage facilities, thinning forests to increase tolerance to drought and resistance to wildfire and insects, and helping species survive through

[3] Technically, "facilitated adaptation" (reflecting human agency) as opposed to "natural adaptation" (denoting natural responses to the effects of a changing climate, such as species migration or behavior modification).

genetic conservation or migration to suitable habitat. Opportunistic actions, designed to take advantage of disturbances such as wildfires, might include planting new species or genotypes better adapted to future conditions and altering a forest structure to enhance ecosystem resiliency under future conditions.

Climate change is fraught with risk and uncertainty, and land managers will need to take both into account in adaptation-related projects. Some methods might be expanded, such as planting more diverse species or genetic mixes during reforestation. New management strategies might be used, such as assisted migration or moderating extreme streamflows. Climate change is likely to dramatically alter snowpack size and the amount and seasonality of precipitation, so land managers will need to address climate-related water issues, especially in the arid West. For both water and vegetation management, specific adaptation techniques will need to be developed and evaluated. Monitoring and adaptive management will be key.

Current activities to restore ecosystems, including thinning and fire use, generally serve to promote ecosystem health and resilience in the face of future climate-related stresses. However, institutional barriers as well as a lack of markets for small-diameter timber and other restoration byproducts might constrain adaptation-related projects. The Forest Service's Woody Biomass Utilization Strategy addresses both institutional barriers and the need for new markets (Patton-Mallory 2008). The Forest Service will also work with communities, private landowners, other agencies, and international partners, helping them adopt adaptation techniques.

Mitigation

Adaptation will be complemented by mitigation. Carbon accrues in trees, soil, and wood products; this alone gives forestry a role to play in offsetting greenhouse gas emissions. Net carbon uptake by forest ecosystems in the United States currently offsets about 10 percent of the carbon dioxide emissions from burning fossil fuels in the United States (Birdsey and others 2006). Moreover, because wood resources are renewable, wood-based bioenergy can offset emissions from burning fossil fuels. Forests destroyed through land use conversion or damaged by insects, disease, and wildfire add carbon to the atmosphere. Accordingly, mitigation activities might include increasing carbon sequestration, avoiding deforestation, using more renewable fuels, and reducing emissions from disturbances such as wildfires. Moving harvested biomass into solid wood products and fossil fuel substitutes and incorporating forest residues into soil are also good ways of sequestering carbon.

The Forest Service will strive to optimize forest and grassland health and productivity, balancing carbon sequestration against other ecosystem services. On national forest land, carbon sequestration potential is limited by the many small trees that make forests susceptible to wildfire, insects, and disease. Land managers can reduce the risk and increase the potential for carbon sequestration by removing small-diameter materials and letting remaining trees grow larger, based on principles outlined in the Forest Service's policy for ecological restoration and resilience (U.S. Forest Service 2008b).

Most opportunities for increased carbon sequestration on forests and grasslands are on private lands. The Forest Service can contribute research and decision support for mitigation-oriented management activities, working with partners at home and abroad. For example, the agency will work closely with the new Office of Ecosystem Services and Markets in the U.S. Department of Agriculture to help private forest landowners take advantage of emerging markets for ecosystem services, including carbon markets. The Forest Service's Open Space Conservation Strategy describes ways of preventing conversion of forests to developed land (U.S. Forest Service 2007).

Adaptation and mitigation are generally linked: Systems that are well adapted to climate-related stresses tend to store more carbon. Modeling in California's Sierra Nevada, for example, found that open mixed-conifer forests with widely spaced large old trees are best adapted to the local fire regime *and* store the most carbon over time (Hurteau and North 2009). In the Southeast, research suggests that the original open longleaf pine forests have advantages over forests dominated by other pines (Burns and Honkala 1990; U.S. Forest Service 2009b). Longleaf pine forests are more resistant to wildland fire, pathogens, and insects; less prone to hurricane damage; and more tolerant of warmer, drier conditions. In addition, longleaf pine grows faster and might capture more carbon underground. In many southeastern landscapes, restoring longleaf pine forests might be the best bet way to respond to climate change while optimizing critical habitat for the red-cockaded woodpecker and other wildlife.

Sustainable Operations

With about 29,000 employees and thousands of buildings and vehicles across the country, the Forest Service has an obligation—and an opportunity—to mitigate climate change by reducing its own ecological footprint, thereby setting an example. The agency is exploring ways of reducing its footprint in five key areas: energy use, water consumption, green purchasing, fleet and transportation, and waste prevention and recycling (U.S. Forest Service 2009c). Through its sustainability leadership initiative, the Forest Service is also striving to exceed related requirements set in the past by legislation and executive order. Opportunities for reducing the agency's ecological footprint include, for example, implementing recycling programs, increasing options for telecommuting, locating facilities near mass transit stations, and obviating the need for travel through the use of videoconference technology.

Next Steps

Now that the Forest Service has a strategy for responding to climate change, what comes next? In some ways, the Forest Service is already addressing climate change. Restoration activities in long-needle pine forests, for example, tend to help ecosystems adapt to climate change by enhancing their resilience to drought and disturbances. However, the next step for the agency is to specifically work toward all seven goals outlined in the strategy.

In January 2009, the Forest Service adopted a plan for implementing the Strategic Framework (U.S. Forest Service 2009d), forming teams to work toward each goal and setting objectives and deadlines. The Sustainable Operations Initiative, for example, has set baselines and met initial objectives for reducing the Forest Service's ecological footprint, such as reducing the agency's

fuel use by 2 percent in fiscal years 2007–08. Based on the Framework and the associated Implementation Plan, the agency is working with partners to protect and sustain America's forests and grasslands for generations to come.

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