Role of the U.S. Forest Service

HELPING FORESTS, GRASSLANDS, AND WILDLIFE ADAPT TO SHIFTS IN CLIMATE

By Monica S. Tomosy, Frank R. Thompson III, and Douglas A. Boyce, Jr.

Credit: Jim Greer

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This fall, the U.S. Forest Service (USFS) will release a comprehensive new guidebook designed to help managers develop climate adaptation options for National Forests (Peterson *et al.* 2011, in press). The adaptation process is based on partnerships between local resource managers and scientists working collaboratively to understand potential climate change effects, identify important resource issues, and develop management options to minimize damaging impacts and capitalize on new opportunities.

At its core, the new guidebook highlights the crucial link between science and management, bridging the two with practical tools designed for the field and based on forest type. For example, one section outlines a science-based triage system enabling managers to rank wildlife habitat as either needing immediate treatment, stable, or too far gone to save.

Credit: Bill DeLuca

A gray jay takes a perch in a spruce tree in New Hampshire's White Mountain National Forest. As temperatures warm, spruce, fir, and other cold-weather conifers may give way to mixed and deciduous forest expanding upward from lower elevations, threatening the habitat of various species of jays, chickadees, warblers, and other montane species.

An awareness of the need to cope with climate change is nothing new to the Forest Service, which has been conducting climate change research for over 20 years since receiving authority to address the issue in a 1990 amendment to the Forest and Rangeland Renewable Resources Planning Act of 1974 (PL 93-378). As amended, the Act calls on USFS to "account for the effects of global climate change on forest and rangeland conditions, including potential effects on the geographic ranges of species, and on forest and rangeland products" (PL 101-606).

Today, the need for such action has become acute as rising temperatures and shifting weather patterns begin to make their mark on the 193 million acres of national forests and grasslands under USFS management—and on the wildlife those lands support. The USFS is therefore addressing the relationship between climate change and invasive species, wildfires, insect infestations, water supply, economics, and biodiversity conservation. It has also launched several new efforts to support this work.

Climate Change Advisor. In March 2010, Forest Service Chief Tom Tidwell named David Cleaves to fill a new post as Climate Change Advisor. Cleaves specializes in decision science and risk analysis, and his office helps USFS programs and regions coordinate a national climate change response. "Communication, alignment, and integration are the challenges that this office is undertaking," says Cleaves, who is "encouraged" by USFS' growing ability to "integrate climate change into our traditional programs."

National Roadmap. In February 2011, the Forest Service published a National Roadmap for Responding to Climate Change, which identifies short-term and long-term actions to assess risks, engage broad-based partnerships, and manage resources through

adaptation and mitigation. Actions range from identifying immediately vulnerable species and ecosystems to forecasting long-range changes in land-use patterns and human uses of natural resources.

Planning Rule. In February, USFS released its draft National Forest System Land Management Planning Rule, which requires managers to evaluate effects of climate change on ecological sustainability. The plan includes a monitoring provision to detect changes in conditions related to wide-ranging wildlife species such as peregrine falcon or grizzly bear that live outside National Forest or Grassland boundaries. It also includes an assessment of ecological, economic, and social conditions and sustainability trends within the broader landscape. This combination of broad-scale assessments beyond forest boundaries, plus monitoring, should enable managers to make effective project and policy decisions. The final rule is expected by the end of 2011.

Performance Scorecard. The USFS implemented a Climate Change Performance Scorecard to assess progress in 10 different areas for each National Forest and Grassland. Scores are assigned in areas such as employee education, carbon reduction, setting priorities, developing alliances, assessing vulnerability, and integrating science with management.

Interagency Task Force. The USFS actively participates in the Council on Environmental Quality's (CEQ's) interagency Climate Change Adaptation Task Force, launched in 2009. The Task Force includes a working group that is developing a national strategy to safeguard fish, wildlife, plants, and the natural systems upon which they depend. This strategy will be prepared for release in 2012.

Because climate impacts on wildlife spread well beyond National Forests and Grasslands, the Forest Service embraces a landscape-scale conservation approach that considers all lands and multiple users, management objectives, and partners. "We cannot sustain the nation's forests by focusing just on the national forests," says Chief Tidwell. "Forest ecosystems typically form mosaics—mosaics of plant and animal communities *and* mosaics of land ownerships" (Tidwell 2009). USFS professionals therefore work with the Department of the Interior's Landscape Conservation Cooperatives (LCCs), the National Climate Change and Wildlife Science Center, and regional Climate Science Centers, as well as with the CEQ's Regional Adaptation Consortia, to identify conservation needs, determine scientific priorities, provide expertise in science-based land management, and leverage resources to meet common objectives.

Courtesy of USFS

Addressing USFS environmental analysts, forest ecologist Linda Parker discusses an ongoing ecosystem atmosphere study (ChEAS) to assess carbon flux within the Chequamegon-Nicolet National Forest in Wisconsin, a net carbon sink. Researchers will conduct an experimental timber harvest and assess changes in the exchange of CO_2 between the forest and atmosphere.

As articulated through its Global Change Research Strategy, the USFS focuses climate change science on four key areas: adaptation science, mitigation, decision support, and collaboration and delivery. Wildlife and climate research in these areas is accomplished through five USFS Research Stations, two Threat Assessment Centers (Eastern and Western), the Puerto Rico-based International Institute of Tropical Forestry, and a network of university, agency, industry, and NGO partners. In addition, the USFS has 81 Experimental Forests and Ranges and a Forest Inventory and Analysis program through which long-term research and monitoring have been conducted for decades. The following examples illustrate USFS efforts to help wildlife, fish, and their habitats adapt to a shifting climate.

Strides in Adaptation Science

Understanding and predicting species distributions and range shifts in response to climate change is critical to developing conservation strategies such as assisted migration. USFS scientists have documented poleward range shifts of over 200 winter resident birds such as Cooper's hawk, northern bobwhite, and clay-colored sparrow across North America (LaSorte and Thompson 2007), and have mapped potential future distributions of tree and

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Credit: Wayne Owen

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A brown bear hunts for salmon in Alaska's Tongass National Forest. USFS scientists are studying phenological impacts of climate change on salmon that affect fish availability for bears, birds, and other wildlife. The wolverine (far right) depends on areas with spring snow cover for dens and dispersal pathways. USFS researchers use models to predict how climate changes will affect such wildlife habitats and populations.

bird species by modeling habitats based on environmental variables and future climate scenarios (Prasad *et al.* 2009). "We have recently documented long-term shifts in elevational distribution of montane birds in the White Mountains of New Hampshire, along with correlations of bird abundance and reproductive success with temperature and precipitation," says USFS scientist David King (King *et al.* 2008).

Because future climates will likely stress wildlife habitat across the continent, the USFS is using projected climate-change data to map climate-induced shifts in habitat location, extent, and quality. Typically, states hoping to increase populations of species of conservation concern (such as the greater prairie-chicken) focus their conservation efforts on habitats expected to be under the greatest stress from climate change (such as the grassland-forest interface). However, USFS researchers studying first-generation State Wildlife Action Plans developed a terrestrial climate stress index, demonstrating that "the locations where current stressors were most pronounced did *not* overlap with the location of high future stress associated with climate change" (Joyce *et al.* 2008). Such information can help states prioritize conservation actions.

Similarly, three researchers from the USFS Rocky Mountain Research Station developed a climate adaptation tool called the System for Assessing Vulnerability of Species (SAVS), designed to help managers assess relative vulnerability or resilience of vertebrate species in habitats with changing climates (Bagne *et al.* 2011). The SAVS tool asks 22 questions about predictive criteria in four broad areas—habitat, physiology, phenology, and biotic interactions. The point total creates a relative vulnerability score, which in turn helps inform management action.

Forest Service adaptation science incorporates historical data, habitat analyses, GIS mapping, radio telemetry, and genetic data. In studying wolverines in high-elevation forests of the northern Rocky Mountains and Cascade Range, for example, USFS researchers described the species' bioclimatic envelope, evaluated landscape-level conservation genetics, and projected the potential effects of global warming on the extent and connectivity of wolverine habitat. They've found that the wolverine's circumboreal range and dispersal corridors are limited by the distribution of spring snow cover, indicating that the species is highly susceptible to warming climates in the southern portions of its range (Aubry *et al.* 2007, Schwartz *et al.* 2009, Copeland *et al.* 2010, McKelvey *et al.* 2011).

Looking forward, the Forest Service is, for the first time, applying various climate scenarios linked to the Intergovernmental Panel on Climate Change, with three climate projections per scenario to project future forest and grassland conditions. This effort will be part of USFS's Resources Planning Act (RPA) Assessment, a decadal analysis of water, wildlife, recreation,

rangeland, and forest conditions. The resulting RPA report will be a foundation for future adaptation science by linking wildlife habitat and demographic projections with vulnerability assessments and management scenarios.

Mitigation Science

The need for adaptation is influenced by climate mitigation activities, such as reducing CO_2 or other greenhouse gas emissions or increasing carbon sequestration. Adaptation activities also can affect mitigation options.

Nationally, forests and wood products sequester an average of 790 million metric tons of CO_2 per year on 253 million hectares of forestland, making forests and wood products the most significant source of land-based carbon sequestration (Heath *et al.* 2011). The USFS understands the carbon value of sustaining forests, of planting them where none existed historically (afforestation), of replanting in historic locations (reforestation), and of using forest biomass as an alternative to fossil fuel (Ryan 2008). USFS has therefore conducted a great deal of research to understand carbon movement and storage throughout forest ecosystems, and applies that knowledge to forest management.

To help land managers better understand the carbon role of forests, the USFS has developed several tools for carbon inventory and accounting. These include the Carbon On Line Estimator (COLE), the i-Tree for assessing urban forests, the U.S. forest Carbon Calculation Tool (CCT), and the Forest Vegetation Simulator (FVS), which models forest growth and yield.

Providing Decision Support

Ready access to accurate, science-based information about land management options and implications is key to conservation planning. To help advance this goal, the Eastern Forest Environmental Threat Assessment Center has developed the Template to Assess Climate Change Impacts and Management Options (TACCIMO), a web-based tool to help federal, state, and private land managers navigate the maze of climate-change information. TACCIMO uses peer-reviewed publications, regional databases, and environmental modeling to help managers evaluate the projected impacts of climate change and other environmental stressors on forests and grasslands. A land manager can select a region or location and examine which stresses (e.g., wildfire, drought, or flood) are expected to impact desired future conditions (e.g., water storage or biodiversity). The program then offers relevant management options, such as thinning, stream restoration, or altering the mix of species for planting.

In the George Washington National Forests (GWNF), for example, insights gained through TACCIMO led managers to modify their approach for managing native brook trout and beaver habitat. "The geospatial report allowed us to scale down potential changes in temperature and precipitation to the GWNF," says forest ecologist Ken Landgraf. "It was a great help in preparing the environmental effects section of our EIS."

The USFS provides further decision support by integrating landscape, climate, and wildlife models to assess impacts on habitat suitability, abundance, and viability for wildlife species as diverse as martens, songbirds, and even walrus and polar bears. These analyses, which provide spatial and demographic implications of different climate-change management strategies, are being applied at the scale of landscapes, eco-regions, Bird Conservation Joint Ventures, and LCCs (Amstrup *et al.* 2008, Cushman *et al.* 2011, Jay *et al.* 2011, Millspaugh and Thompson 2009).

Credit: Ryan Brady/Wisconsin DNR

A flash of red reveals a male spruce grouse, seen in his courtship display territory in Wisconsin's Chequamegon-Nicolet National Forest. This game bird inhabits the northern forests of the U.S. and Canada, feeding largely on the needles of spruce and other weather-dependent conifers.

Collaboration and Delivery

To provide scientific information that land managers can readily use, the USFS offers a web-based Climate Change Resource Center featuring peer-reviewed research and practical information that focuses on the application of climate change science to ecosystem management. Though the main audience is land managers working on U.S. public lands, private landowners and international ecosystem managers also use this resource, which includes video lectures, case studies, fact sheets, and links to source documents. On the ground, the USFS recently launched a pilot project in Wisconsin's Chequamegon-Nicolet National Forest (CNNF) designed to provide a model of regionally coordinated climate change adaptation planning. CNNF staff used the Climate Change

Response Framework Project to assess climate vulnerability and potential adaptation tactics for spruce grouse. Working with regional partners, they determined that spruce grouse habitat was highly vulnerable to climate change due to decreased regeneration of preferred tree species, changes in hydrology, and encroachment of non-preferred species. "Our team learned that there is no 'one size fits all' approach for responding to climate change," says the CNNF's Linda Parker. "The project provided us with a menu of approaches to draw from, and an 'Adaptation Workbook' helped us apply them." The collaborative model developed in this pilot program is currently expanding to seven additional states and 10 national forests.

The Forest Service offers in-person workshops and online training for land managers. The Northern Institute of Applied Climate Science, for example, offers a week-long course titled Training in Advanced Climate Change Topics (TACCT), which covers climate science, ecosystem adaptation, and greenhouse gas mitigation. Online, a short course titled Adapting to Climate Change covers 15 topics such as forest carbon storage, downscaled models, and observed ecological changes. Such practical science-based information can help land managers plan for a range of uncertainties.

Through collaboration and knowledge-sharing, the Forest Service is integrating climate change adaptation science into land management practices to conserve biodiversity along with other values that forests provide. How wildlife will respond to climate change is uncertain, but it is clear that wildlife and their habitats will stand a better chance when essential scientific knowledge becomes available to public, private, and international wildlife professionals. ■

This article has been reviewed by subject-matter experts within the USFS.

For a complete bibliography and additional resources about USFS climate science, go to *www.wildlife.org*.