New Focus

Mounting threats lead to

It would appear that forests are finally having their day—and not a moment too soon. Around the world, trees are dying at an alarming rate, besieged by illegal logging, agricultural conversion, wildfire, and drought. According to the United Nations Food and Agriculture Organization, 13 million hectares of the world's forests are now lost to deforestation every year. In North America, climate change, insect invasions, and urban sprawl are altering and shrinking suitable forest habitat for critical wildlife species. Clearly, forests need new conservation and management strategies.

World leaders are taking notice. Speaking at the Copenhagen climate summit last December, U.S. Agriculture Secretary Tom Vilsack stressed the severity of the problem and the need to intervene. "Protecting the world's forests is not a luxury," he said. "It is a necessity" (USDA 2009).

In a very real sense, trees equal life for the vast majority of the planet's terrestrial plant and animal species. In states such as Illinois and Tennessee, for example, roughly three-quarters of species of conservation concern depend on forest habitat (University of IL, TN Division of Forestry). Because of the vital role that forests play in preserving wildlife, wildlife professionals are joining ranks as never before with foresters, policymakers, NGOs, local communities, and other nations to address and mitigate the threats facing forests. Those efforts are leading to innovations in forest management—but the challenge is daunting.

Mass Destruction. Killed by mountain pine beetles (inset), lifeless brown lodgepole pines mark a path of devastation across Wyoming and Colorado, where the bark-eating beetles have destroyed more than two million acres of trees. It's one of the largest beetle outbreaks ever to hit the region.

Bracing for Climate Change

As the changing climate ushers in severe wildfires, insect infestations, drought, and shifts in phenology, forestry professionals are preparing to weather the storm. In 2009 the USDA Forest Service (USFS) received $1.15 billion from the American Recovery and Reinvestment Act of

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management innovations

2009 (ARRA), which the Service will use to immediately address maintenance and building projects, as well as to investigate the impacts of climate change and managing wildfires (USDA 2009).

These goals require that forest managers shift away from old-model approaches and focus on how to improve the resiliency of ecosystems. New climate change models, for example, tailored to regional or even local-level scales, allow managers to more accurately predict changes in species distribution, and thus make informed adaptive management decisions.

To help in this effort, in 2007 the USFS launched the WestWide Climate Initiative, which gives national forest managers information about adapting to climate change. The program will culminate in a meeting in mid-April 2010, where organizers hope to have a climate change adaptation guidebook ready to present to managers. Constance Millar, a research paleoecologist for USFS's Pacific Southwest Research Station who helped lead WestWide, says the guidelines will include specific tools for managers such as a rapid screening process to monitor for sudden aspen decline, a dieback that may be related to climate that has killed 90 percent of aspens in certain areas of Colorado.

WestWide has also developed a Climate Change Resource Center, which features an online course titled "Adapting to Climate Change: A Short Course for Land Managers." The course includes information on climate projections, ecological responses to climate variability, and strategies land managers

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Forest photo credit: Colorado Division of Wildlife
Beetle photo credit: Forestryimages.org

can use to adapt to climate change. These strategies include such steps as conducting vulnerability assessments, developing adaptation plans, and translating these into a land management plan. "We're trying to be the nexus of what they can do" to adapt to climate change, says Millar.

Battling the Beetles

Climate change is largely to blame for the invasion of beetles—both native and non-native—which are killing forest trees, and occasionally urban trees, across North America. Native bark beetle numbers have risen because of warmer winters, which reduce winter mortalities, and longer summers, which enable extra breeding cycles. The beetles in turn exploit trees stressed by drought, overcrowding, and extensive wildfires. Bark beetle infestations have left millions of acres of dead and dying trees across the Rocky Mountain West, a crisis that recently prompted Agriculture Secretary Vilsack to pledge an additional $40 million to the USFS to combat the beetle (USDA 2009). Among other damage:

- In 2008 Colorado officials predicted that the rapid spread of the mountain pine beetle (*Dendroctonus ponderosae*) would most likely destroy all of the state's mature lodgepole pine forests within three to five years (Office of Governor Bill Ritter, Jr. 2008).
- Between 1996 and 2008, spruce beetles (*Dendroctonus rufipennis*) destroyed 374,000 acres of spruce trees in Colorado and 340,000 acres in Wyoming (Stoddard 2009).
- Since its discovery in Michigan in 2002, the emerald ash borer (*Agrilus planipennis*) has killed tens of millions of ash trees in Michigan alone and tens of millions more in 12 other states as well as Quebec and Ontario in Canada (see emeraldashborer.info).

Credit: USFS

Unruly Ungulates. USFS employees erect an exclosure designed to keep deer, elk, and moose away from an aspen-regeneration area in Colorado. Overpopulated deer herds can impede forest health by eating young trees, which ultimately reduces forest diversity and wildlife habitat.

"When you put all these things together … it [reflects] the impact of global climate change," says Bruce Hagen, a retired urban forester from the California Department of Forestry.

In an attempt to control the mass destruction caused by bark beetles across the West, researchers at Northern Arizona University tested the impact of digitally altered recordings of the beetles own vocalizations. They found that the beetles not only stopped burrowing and mating, they also stopped chewing on the pine tree, suggesting that the acoustics of their calls could make them uncomfortable enough to leave that environment (Northern Arizona University Press Release).

The hemlock woolly adelgid (*Adelges tsugae*) illustrates how much damage a non-native insect can do. Introduced from Asia into the eastern U.S. in 1951, the creature has caused a rapid decline in eastern hemlock canopies across 17 states extending from Maine to Georgia. This not only affects birds and other species that depend on the tree canopy, but also brook trout and other aquatic species that rely on the cool temperatures of shaded streams.

Lacking effective natural enemies in the eastern U.S., this pest has been difficult to manage. In the 1990s, however, USDA researchers began exploring the biology and host range of five species of predaceous beetles that might be deployed to suppress populations of the adelgid. For example, extensive research has shown that *Sasajiscymnus tsugae*—a predatory beetle discovered in Asia—may be effective in feeding on the hemlock woolly adelgid as well as on other adelgid species.

Another forest pest, the emerald ash borer, is becoming a particular problem in urban forests, where ash is a popular species. When the emerald ash borer was discovered in Butler County, Pennsylvania in 2007, the state's Department of Agriculture imposed a quarantine prohibiting the movement of any ash materials from the area (Pennsylvania DCNR). Since then the pest has been found in 10 other counties in the state. In 2008 the Pennsylvania Department of Conservation and Natural Resources (DCNR) signed on to the National Detection Survey and also began testing the effectiveness of "Purple Traps"—sticky traps designed to attract the pest with compounds that a distressed ash tree would release. "Unfortunately, for every single pest we have to find individual management tools," says Houping Liu, a forest entomologist with the DCNR. This makes rapid eradication of new pests difficult.

Wrestling with Fire

Through much of the 20th century, a national forest policy of fight-every-fire led to a vegetative build-up that has fueled intense and severe fires in the last 30 years, particularly in the arid West. Compared to forty years ago, the number of major wildfires to occur each year has increased four-fold, and the area of forest burned has increased six-fold (National Wildlife Federation 2008).

Prescribed fire is a common tool to reduce fuel loads, but debates linger over where, when, and how to use fire to manage forest ecosystems. In the Southern Appalachians, for instance, managers conduct prescribed fires to reduce fuels such as mountain laurel and rhododendron. The burns, traditionally done in the dormant season when cool temperatures and steady winds make fires easier to control, benefit species that depend on hardwoods and their hard mast, such as the red-cockaded woodpecker (*Picoides borealis*) and fox squirrel (*Sciurus niger*).

Recently, however, scientists and managers have studied burning in the growing season, a time when lightning would have naturally ignited most fires. A report by research group Tall Timbers suggests that limited "lightning-season" burns could boost ideal habitat, nesting success, and other survival variables for wild turkeys (*Meleagris gallopavo*), Bachman's sparrows (*Amophila aestivalis*), and many other species (Cox and Widener 2008). One of the report's authors, biologist Jim Cox, says ecological support for the practice is sound, and many managers are already implementing later-season burns "as another tool in their toolbox." Of course, managers must study an area's fuel loads in order to assess whether the ecological benefits of in-season burns outweigh the risk of fire spreading out of control.

A warming climate complicates fire management. As climate shifts, "fire is probably going to be driving [wildlife] range shifts in very punctuated, abrupt changes," says Max Moritz, an extension specialist at the University of California-Berkeley. A single severe fire could wipe out a forest and displace a population permanently, says Moritz, who recently worked with colleagues to map out projected fire regime changes under climate change (Krawchuk *et al.* 2009). Such models may help managers plot out and conserve escape corridors—intact pathways of natural land that wildlife could use to migrate, temporarily or permanently, to safe haven.

Confronting Urban Sprawl

As urban centers swell, they consume and fragment the forests they displace. Heavy tree canopy in key regions of the U.S. has declined by more than one-third in the last quarter century (American Forests). Some conservationists are therefore turning their attention to preserving the trees that remain in developing landscapes. Urban forests "protect us from the sun, wind, and rain, and clean the air we breathe and the water we drink," says Greg McPherson, a researcher at the USFS Center for Urban Forest Research. "They are the jewel of our cities."

Credit: Darren A. Miller

Credit: Jim Cox

Prescribed burns. Land managers use controlled fire (top) to reduce hardwoods and regenerate understory vegetation. New research shows that when such fires are conducted in the growing season, they can benefit a variety of birds such as Bachman's sparrows (*Aimophila aestivalis*), which build and hide their nests within protective groundcover (above).

Baltimore, Maryland has become a test case for the importance of urban trees. The Baltimore Ecosystem Study (BES), funded by the National Science Foundation, found that of all the bird species that appear in the mid-Atlantic region during the breeding and summer seasons, fully one-third occur in Baltimore. Furthermore, it's clear that certain birds associate with certain types of neighborhoods. Eastern bluebirds (*Sialia sialis*) and northern flickers (*Colaptes auratus*) tend to congregate in older areas with mature trees, while crows (*Corvus brachyrhynchos*) and starlings (*Sturnus vulgaris*) dominate inner city environments (Nilon *et al.* in press). The study's authors hope to give homeowners information about how they might "manage" their yards by planting or saving certain types of trees to benefit various species of birds.

Outside major cities, linear forest corridors known as greenways can offer habitat to many wildlife species if they are well-designed. North Carolina State University associate professors George Hess and Chris Moorman have found, for example, that greenways designed primarily for recreation—with wide paved paths flanked by strips of mown grass—correlate with

lower bird diversity and fewer sensitive species such as downy woodpeckers (*Picoides pubescens*) and indigo buntings (*Passerina cyanea*) (Hull 2003). On the other hand, wider greenways with more natural growth of trees and underbrush attract neotropical migrants and, Hess hypothesizes, may be associated with increased snake diversity (Kohut *et al.* 2009).

Practicing Adaptive Forestry

Wildlife managers across North America are working with forestry experts to adopt regionally tailored on-the-ground measures that can help sustain healthy, productive forests and, at the same time, support forest-products industries and benefit wildlife. Among the primary approaches:

Support variable structure. Forest structure—the top-down layers of canopy, snags, young trees, underbrush, and leaf litter—is critical to the survival of many species. Timber harvest, however, often tends to simplify forest structure to the detriment of wildlife. Pine martens (*Martes martes*), for example, a state-endangered species in Wisconsin, rely on downed debris to find their rodent prey, and on hollowed-out but still-living trees to hide from predators, keep warm, and bear young. Recognizing the need for variable structure, Wisconsin forest management guidelines now recommend that conifers be retained as "significant structural components," preferably in clumps to boost seed production. Retaining conifers is valuable because they are associated with several warbler species and raptors, as well as with pine martens and other boreal species at the southern extent of their range.

Credit: John and Karen Hollingsworth/ USFWS

Credit: USFS

Tailored management. To help ensure nesting success for red cockaded woodpeckers (*Picoides borealis*), a U.S. Fish and Wildlife Service employee erects a nest box (above right). By banding and tracking newborn birds (above left), biologists are learning that careful forest management is improving the odds for these endangered birds.

Conduct strategic clearcuts. For five to 20 years after an area has been clearcut, it may provide thick ground cover that is ideal habitat for certain wildlife species. Ruffed grouse, for example, use the growth in clear-cut areas to escape from predators, nest, and rear young (Harper *et al.* 2006). Yet clearcuts also eliminate trees producing hard mast (acorns and nuts), which are important food sources for forest species like grouse and deer. Managers are learning to compromise. In eastern forests, for example, some managers have turned to the shelterwood system, a type of cut that leaves a small amount of mast-producing trees standing after an initial harvest. The "leave" trees may then be cut several years later, after the first cut areas have begun to regenerate. Early studies on small mammals and other species have shown that shelterwood cuts have no negative effect on wildlife populations, and may even boost populations (von Trebra *et al.* 1998). In the western U.S., managers on public lands pursue a similar strategy, creating small openings in the forest canopy to replicate natural disturbances and allow pine trees to regenerate.

Study shifts in succession. Researchers have long understood that different wildlife species inhabit forests at various stages of succession—the natural replacement of animal and plant species in an area over time. Recent studies, however, show that some old patterns may be shifting. Wildlife species once strongly associated with mature forests, such as ovenbirds (*Seiurus aurocapillus*) and worm-eating warblers (*Helmitheros vermivorus*) have been shown to use regenerating clearcuts in the post-breeding season (Vitz and Rodewald 2006). "The juveniles and adults move into these successional habitats presumably to use the thick cover as protection from predators or to eat the abundant fruits," says Amanda Rodewald, associate professor of wildlife ecology at Ohio State University's School of Environment and Natural Resources. Land managers can use such knowledge to structure suitable habitat.

Seeking a Sustainable Future

On a global scale, nations increasingly recognize that sustainable forestry balances the world's need for forest products with the necessity for forest health and biodiversity. At the 1992 United Nations Earth Summit in Rio de Janeiro, participants including 172 governments and 2,400 non-governmental representatives created a document informally referred to as "Forest Principles." The principles included non-legally binding regulations that addressed illegal logging and deforestation as well as the need for independent certification programs to regulate trade in wood and wood products.

In 1993, the Forest Stewardship Council was created as an international consortium of loggers, forest-

ers, sociologists, and environmentalists who offered a rigorous certification process to ensure sustainable forestry. Today, approximately 5 percent of the world's forests are FSC certified (FSC Facts and Figures). Similarly the Sustainable Forestry Initiative, launched in 1994, has certified more than 135 million acres of forest land where local communities, landowners, and resource professionals across North America implement sound forest management measures to protect water quality, wildlife habitat, protected species, and biodiversity on their land. SFI recently launched a new standard that includes requirements for logger training. Approximately 117,000 loggers have been trained in sustainable forestry practices, which include methods to preserve young, medium-aged, and mature trees while logging a forest.

As long as the demand for wood products and agricultural land grows, forest degradation and deforestation will remain a global concern. According to The Nature Conservancy (TNC), the forest products industry is estimated at $150 billion per year, and every year more than 32 million acres of the world's forests are logged, often illegally (TNC). The United States is a major contributor to the high demand. "The U.S. is an exporter of timber, it's an importer of timber, it's a processor of timber," says Jack Hurd, director of TNC's Asia-Pacific Forest Program, established to work with governments, land managers, communities, and corporations to encourage the legal trade of forest products.

To help prevent products of illegal logging from entering the U.S., in May 2008 Congress amended a law that's part of the Farm Bill to comprehensively ban imports of illegally logged wood that has been cut in violation of a foreign nation's laws, treaties, and regulations. The legislation "is changing the way companies across the global supply chain are thinking about their sourcing practices and traceability of their products," Hurd says.

In addition, organizations such as the International Tropical Timber Organization and the World Bank, are addressing deforestation by establishing standards for sustainable tropical timber management and helping countries analyze their forest resources more rigorously. According to Hurd, more global attention and resources are now helping tropical forested nations "manage those forest resources in a more sustainable fashion."

Sustainable management will benefit not only wildlife and habitat, but also the air we breathe. Trees and the soils they grow in store vast amounts of carbon. Deforestation releases that carbon dioxide into the atmosphere, a major greenhouse gas contributing to

Credit: Jonathan Gilbert/GLIFWC

Selective harvest. Pine martens (*Martes martes*) and many other wildlife species require standing, hollowed-out trees to hide from predators, keep warm in northern winters, and bear their young. Forestry methods like single-tree harvest allow loggers to keep such trees in place.

global warming. To address this issue, at December's climate summit in Copenhagen, five countries joined the U.S. in support of UN-REDD+ (Reducing Emissions from Deforestation and Forest Degradation), pledging a total of $3.5 billion for the cause. The program will compensate landowners in developing countries for *not* cutting down forests, with an aim to eventually stop forest deforestation—an activity which contributes nearly 20 percent of the world's greenhouse gas emissions.

Since the primary objective of REDD+ is to reduce carbon emissions, some researchers fear that REDD+ funding may go solely to forests with the greatest carbon-sequestration potential (such as Amazonian forests) rather than to those with higher numbers of threatened species (such as Asian forests). Targeted trade-offs could potentially resolve this problem. According to one study, REDD+ could distribute funds in such a way as to double potential biodiversity conservation while only reducing carbon sequestration potential by 4 to 8 percent (Venter *et al.* 2009). According to UN-REDD National Programme Officer Clea Paz, "special incentives are intended to be directed at areas with high biodiversity," helping maximize the benefits of REDD+ beyond carbon.

As the eyes of the world focus on forests, scientists and forest managers are finding ways to address the complex tangle of issues that threaten the earth's trees. No longer is forest management a simple question of conservationists versus loggers. "Those of us doing the science, we're past that," says Max Moritz. "It's so much more complicated than that. So much more interesting than that." ■

This article has been reviewed by subject-matter experts.

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