COMPASS

perspectives & tools to benefit southern forest resources

fall 2005

Forests Under Siege:

Fragmentation accelerates in the South

Southern Research Station

USDA Forest Service

INSIDE... the science

DEPARTMENTS

COMPASS
Science You Can Use!

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perspectives & tools to benefit southern forest resources

Compass is a quarterly publication of the USDA Forest Service Southern Research Station (SRS). As part of the Nation's largest forestry research organization—USDA Forest Service Research and Development—SRS serves 13 Southern States and beyond. The Station's 130 scientists work at more than 20 units located across the region at Federal laboratories, universities, and experimental forests.

Future issues can be obtained by returning the postcard included in this issue.

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The mission of the Southern Research Station is to create the science and technology needed to sustain and enhance southern forest ecosystems and the benefits they provide.

On the Cover: Example of land cover classification of the area around the Research Triangle Park airport. *(Kurt Riitters)*

Inside Cover Photo: A diverse landscape occurs naturally in the Southern Appalachians. *(Rodney Kindlund)*

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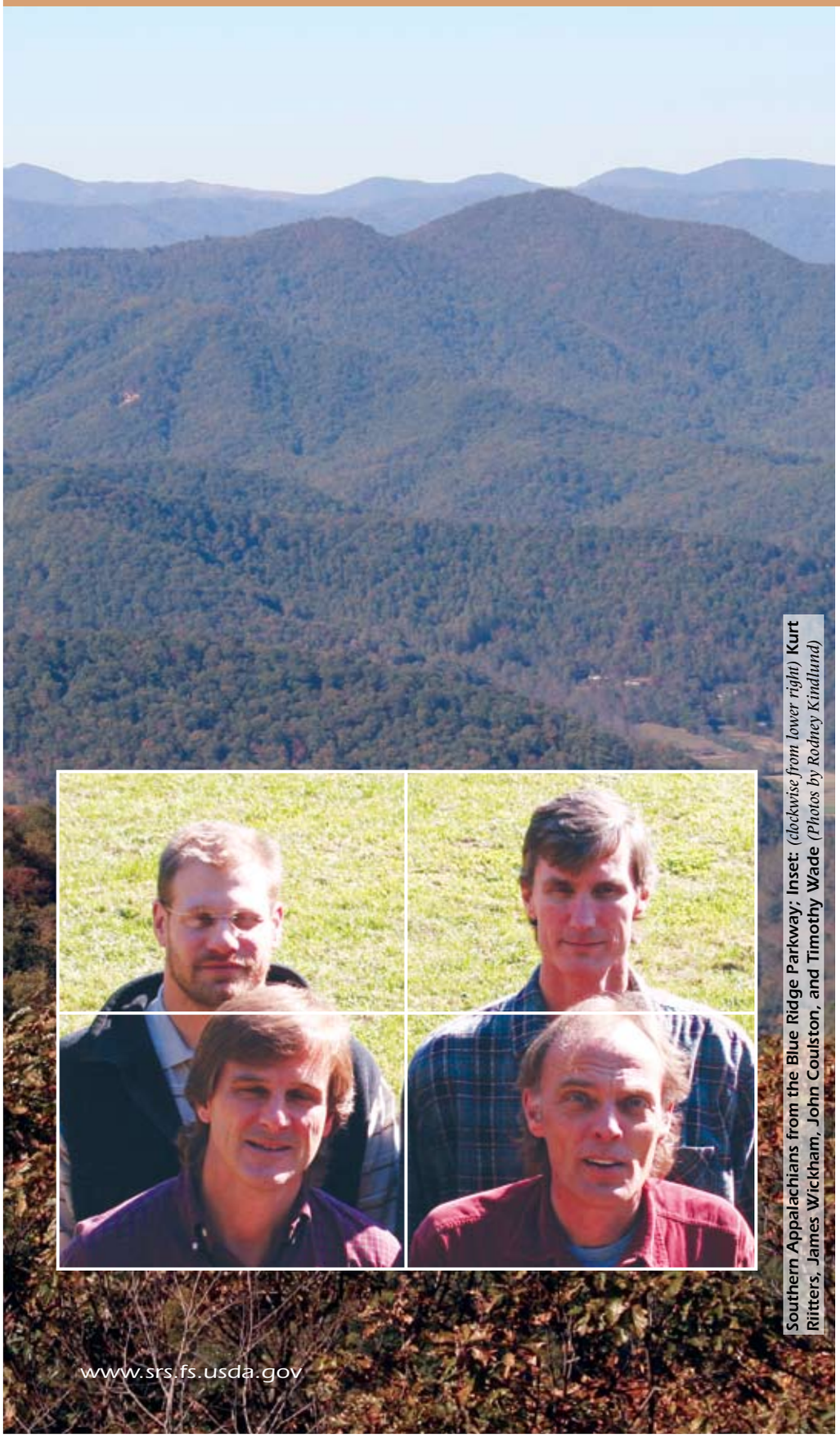
SOMETIMES A GREAT NOTION:
Visualizing Forest Fragmentation

by Zoë Hoyle



Southern Appalachians from the Blue Ridge Parkway; Inset: *(clockwise from lower right)* **Kurt Riitters, James Wickham, John Coulston, and Timothy Wade** *(Photos by Rodney Kindlund)*

It may seem pretty obvious that American forests are being split apart by roads, houses, and strip malls, but, until recently, it was difficult to visualize the extent and magnitude of forest fragmentation in the United States. Until, that is, Southern Research Station (SRS) researcher **Kurt Riitters** and his collaborators started applying a method called "moving windows" to landscape-scale analysis.

Riitters and three fellow landscape ecologists—**James Wickham**, **Timothy Wade**, and **John Coulston**—have come up with a deceptively simple method to make fragmentation of the landscape visually apparent. The four—Riitters and Coulston from the **SRS Forest Health Monitoring unit** in Research Triangle Park, NC, and Wickham and Wade from the nearby Environmental Protection Agency (EPA) National Exposure Research Laboratory—are using moving windows to produce information about forest fragmentation for high-level clients such as the Montréal Process, the H.J. Heinz Center, and the European Commission—as well as for regional planners in the Southeast.

A Window Opens

Riitters and Wickham started looking at ways to visualize landscape patterns more effectively in the 1990s, when they both worked at the Tennessee Valley Authority Landscape Ecology Project in Norris, TN. By 1995, when they published a landscape atlas of the Chesapeake Bay watershed (with the help of Wade, then at the Desert Research Institute in Reno, NV), the two were well aware of the limitations of the approaches used to assess forest fragmentation. Analysts would start out with landcover maps generated from Landsat satellite images that were divided into millions of tiny squares called pixels (short for

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What is Forest Fragmentation?

The 2002 *Southern Forest Resource Assessment* defined forest fragmentation as the breaking up of large, contiguous (touching one another) forested tracts into smaller or less contiguous tracts. This means that forests become islands and peninsulas—patches of woods disconnected from one another by roads, farms, suburbs, cities, and other human activities.

Why Should We Care About It?

Forest fragmentation has a wide range of effects on ecosystem services, defined simply as the benefits that forests provide to us. In addition to providing wood products, fuel, medicine, and recreation, forests:

- Clean our water and air
- Provide habitat to a huge diversity of life forms
- Take up carbon dioxide and produce oxygen
- Regulate climate by sequestering carbon
- Maintain the health of soil
- Absorb and detoxify pollutants
- Provide the setting for a wide range of recreational activities

When forests are divided into smaller and smaller parcels, the biological diversity of native animals and plants is diminished, water cycles are altered, nonnative invasive plants and animals are introduced, and air and water quality are affected. Forests weakened by fragmentation become more susceptible to damage from insects and diseases, and coming under stress, often degenerate into a condition of chronic ill health.

In the South, the highest concentrations of intact interior forests are on public lands in the Blue Ridge Mountains, the Cumberland Plateau, and the Allegheny Mountains. The lands surrounding these intact forests are, unfortunately, highly susceptible to fragmentation from roads and increasing development. Other areas especially susceptible include the Ozark and Ouachita Mountains in Arkansas, the Piedmont of North Carolina, and areas in the Mississippi River Valley, west Coastal Plain, and Interior Low Plateau.

Adapted from Southern Research Station general technical reports: Human Influences on Forest Ecosystems *and* The Southern Forest Resource Assessment.

Sometimes a Great Notion

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"picture elements"). They would count the pixels in a given area for each type of landcover and assign a number, or fragmentation value, to represent all of the pixels in the area. This aggregating method meant throwing away original information from the images, as well as removing the ability to make comparisons.

For the 1995 atlas, Riitters and Wickham introduced the idea of using moving windows to recover this lost information. "When you make a map of forest fragmentation using moving windows, it's like focusing a camera so that the detailed patterns stand out," says Riitters. "But the main benefit is that each pixel now has its own unique fragmentation value, a number that describes its particular context." This is especially important when looking at the effect of fragmentation on forest inhabitants. "When you start looking at fragmentation in relation to habitat, you need to be able to look at context," says Riitters. "The small block of forest that might provide adequate habitat for one species becomes problematic when you move out to the larger scale and realize that it is an island or part of a checkerboard. The *pattern* of forest loss is just as important as the amount lost."

"Fragmentation is scale dependent," says Riitters. "If you are a small creature requiring 50 percent forest cover over a small range, an area may not seem so fragmented, but if you are a large animal with a home range of 100 to 120 square miles, there may be very little suitable habitat in that same area."

Enter the Montréal Process

In 2000, when Riitters arrived in Research Triangle Park to take the position of deputy program manager at the SRS Forest Health Monitoring unit, Coulston, then a North Carolina State University (NCSU) employee specializing in landscape assessment techniques, was already working at the unit through a cooperative agreement between SRS and NCSU. Meanwhile, Wade and Wickham had also moved to the area to work for a new landscape ecology project at the EPA, so the team was in place when the Montréal Process came looking for someone to develop forest fragmentation information for the United States.

The Montréal Process, an international framework for measuring progress towards sustainable forest management, developed criteria and indicators to assess the condition of the world's temperate and boreal forest, with "fragmentation of forest types" as one indicator of biological diversity. In the United States, scientists recommended using what Riitters calls "the old method" to describe fragmentation for the continental United States. Riitters and his collaborators volunteered to provide the information, using the old aggregating method to come up with data for a preliminary assessment.

To generate the data, the team used a relatively new resource, the 1992 landcover maps generated from the National Land Cover Data (NLCD) database. Produced from satellite imagery, the maps are the result of years of work across multiple U.S. agencies. "Lots of people make landcover maps," says Wickham. "You can go to each of the States and get satellite-generated landcover maps, but they don't fit together. The 1992 NLCD map was the first effort to make a national landcover map that goes across boundaries to give consistent information."

Riitters and his colleagues couldn't stop with just generating data from the NLCD map using the old method. Their preliminary assessment included a discussion of the limitations of the method, and posed a series of research questions that they then set out to answer. "We used the old method they suggested to provide data for a preliminary assessment," says Riitters. "Then we generated the information using our moving windows, and did something they hadn't thought could be done. We provided them the means to analyze fragmentation at multiple scales."

How Do Moving Windows Work?

The moving window technique wasn't new—it had been used before in medical image processing. "New was the notion of applying this method to landcover maps," says Riitters. "In medical image processing, moving windows are used to standardize images and make them more continuous. We took it in the other direction, pulling out patterns in the landscape that you can't really see any other way."

In the moving window approach, a square window representing a unit of interest—for instance, the home range of a particular species—is moved across the landcover map one pixel at a time. As the window is moved, a fragmentation index is calculated within the window and used to generate a new map. This is putting it simply: there's a lot more involved than counting pixels. Making maps means dealing with the Geographic Information System (GIS) software used to analyze and map the spatial data the team generates. "A lot of what we do, in terms of presentation, relies on GIS software, "Riitters adds. "Tim Wade is our go-to guy in terms of what can be done visually."

The result is a richer source of information about forest condition and health. "We used to describe landscapes by what was contained in them," says Riitters. "By providing overlapping information, moving windows allow you to analyze context. Imagine you are standing on one of the forest pixels. This method allows you to examine the pattern elements all around you, and to use different windows to make comparisons."

For example, an ecologist can look at how forest fragmentation affects an animal species by making the window the size of the animal's home range, applying the window to the NLCD map, and then comparing the result to the species' needs for forest cover. This can be done for multiple species in the same region by using separate windows for each. This allows ecologists to evaluate a specific area in terms of the forest cover requirements of multiple species at one time and provides

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The Montréal Process

The 1992 Earth Summit, or United Nations Conference on Environment and Development (UNCED), called upon all nations to ensure sustainable development, including the management of all types of forests. Later, nine international working groups were formed to come up with the criteria and indicators to measure progress towards sustainability goals. The Montréal Process, one of the nine working groups, was brought together in June 1994 to develop criteria and indicators for temperate and boreal forests.

In 1995, the member countries agreed on 7 criteria and 67 indicators. One Montréal Process criterion is the conservation of biodiversity; fragmentation of forest types is one indicator within that criterion.

Present members of the Montréal Process include the United States, Canada, Japan, New Zealand, Australia, Republic of Korea, Chile, Mexico, China, the Russian Federation, Uruguay, and Argentina.

For more information:
http://www.mpci.org

Fragmentation map of the southeastern United States. *(Tim Wade, U.S. Environmental Protection Agency)*

Fragmentation of U.S. Forests

The following findings about forest fragmentation are a synthesis of information from eight articles published by Kurt Riitters and his colleagues over the past 5 years.

- Considering first the overall distribution of forest area, there is at least some forestland cover nearly everywhere in the lower 48 States.
- Forest is the dominant landcover for one-third of all land area, and 70 percent of all forest area is found in forest-dominated landscapes.
- Fifteen percent of forest is located in landscapes dominated by shrubs and grasses, and the remaining 15 percent occurs in landscapes dominated by agricultural and urban land uses.
- Considering the spatial arrangement of forestland, most forestland is near other forestland, over very large regions.
- The perimeter of a typical forest "patch" (clump of forest or forests touching one another at some point) is only about 300 feet from the perimeter of its nearest neighbor patch, except where there is not much forest, in which case that distance is 650 to 1,000 feet.
- At the same time, fragmentation is so common that one-half of all forest is within about 300 feet of forest edge, and less than 1 percent is more than 3,200 feet (0.6 mile) from forest edge.
- About half of all fragmentation is associated with the physical separation of distinct forest patches, and half is associated with small (less than 17 acres) perforations, or holes, in otherwise continuous forest cover.
- Overall, at least half of the fragmentation is associated with human land uses. Almost all fragmentation in the East is clearly due to human activities, whereas most fragmentation in the West is associated with semi-natural landcover types such as grassland and shrubland. Distinguishing natural from human factors is a problem in the West because landcover is a less accurate guide to actual land use.
- In both the East and the West, the largest reserves of intact forest are in public forests on land that is not suited for agriculture or urban development.
- In a global context, the Eastern United States contains the last major reserve of relatively intact temperate deciduous broadleaf forest, and this region is expected to experience significant urbanization—resulting in increasing fragmentation over the next 50 years.

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a more realistic picture of habitat availability.

"Fragmentation is scale dependent," says Riitters. "If you are a small creature requiring 50 percent forest cover over a small range, an area may not seem so fragmented, but if you are a large animal with a home range of 100 to 120 square miles, there may be very little suitable habitat in that same area. A larger window size, especially when applied to a rapidly developing area such as the Southeast, will reveal more fragmentation."

The limitation to this sort of analysis is the lack of scientific knowledge about how much forest cover different species need. But that need not put a damper on the process. "It's not just about species, but about the forest," interjects Wickham. "Forests themselves have a scale, and we can use this method to look at what happens to them at different scales in relation to climate, sprawl, and other issues. Think about it: if a forest stops functioning as a forest, you can say a lot about impacts on forest-dependent species."

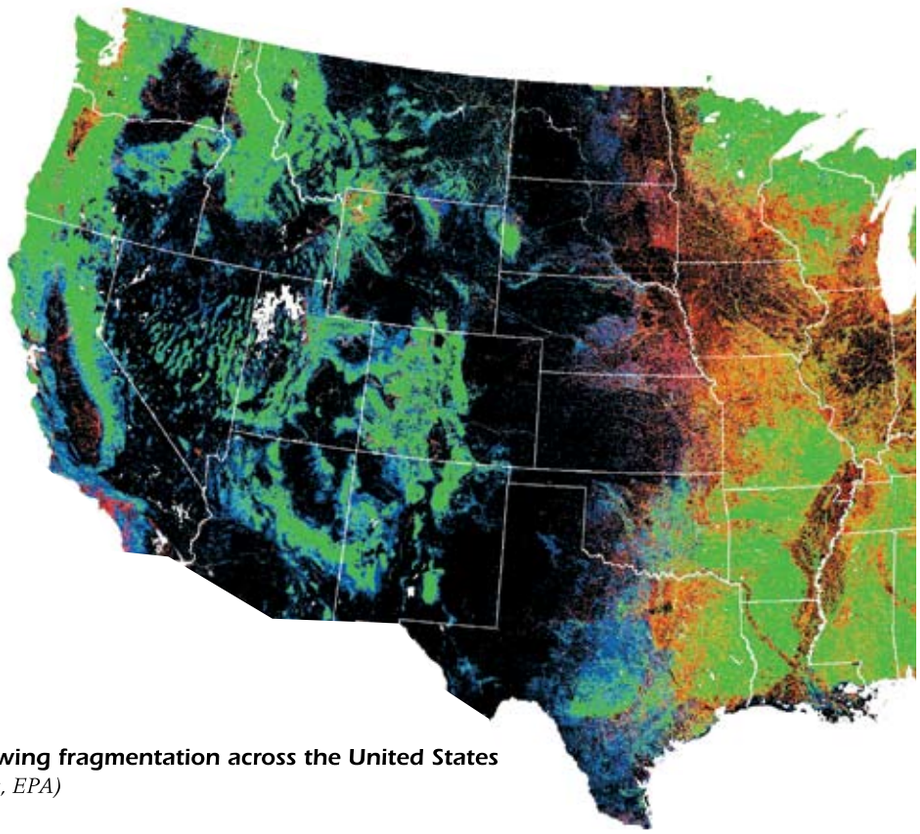
"The beauty of the method is that it generates fragmentation information that can be fed into many kinds of process models," adds Coulston.

"Using the same input data makes it possible to compare results from models that operate at different spatial and temporal scales."

How Fragmented are U.S. Forests?

What Riitters and his colleagues have found at the national scale is pretty dramatic. "While forest is still dominant where is occurs, the pervasiveness of fragmentation and roads in the continental United States is stunning," he says. "Many, if not all, aspects of the forest ecological condition are potentially at risk."

Results from the team's work published in the 2002 *State of the Nation's Ecosystems* report by the H.J. Heinz Center and included in the 2003 USDA Forest Service *Report on Sustainable Forests* showed that almost three-quarters of all U.S. forests were within 500 feet of a forest edge, with very little interior forest left along major rivers or near urban or agricultural areas. And this did not take into account the over 4 million miles of roads that crisscross the U.S. countryside.



Map showing fragmentation across the United States
(Tim Wade, EPA)

Because landcover maps derived from satellite imagery do not adequately portray the effects of roads, Riitters and his colleagues took the next step of superimposing road maps onto landcover maps. "Ecological impacts from roads may be the rule rather than the exception in most of the continental United States," says Riitters. "We found that 20 percent of all U.S. forestland is within 400 feet of a road, and the proportion increases rapidly as you move back from roads. Our analysis showed that over 80 percent of forestland is within 0.6 mile (3,200 feet) of a road, and only 3 percent of forestland is more than 3.1 miles from a road."

The impact of roads on forest ecosystems extends well past the roads themselves. "Effects from roads—what we call influence zones—stretch tens to hundreds of yards from the roads themselves," Riitters adds. "Water drainage patterns are disrupted and sediment loads to streams increased. While roads act as a barrier for some species, they serve as excellent corridors for the introduction of others, such as nonnative plant species."

The fragmentation information Riitters and his colleagues produced for the national assessments also did

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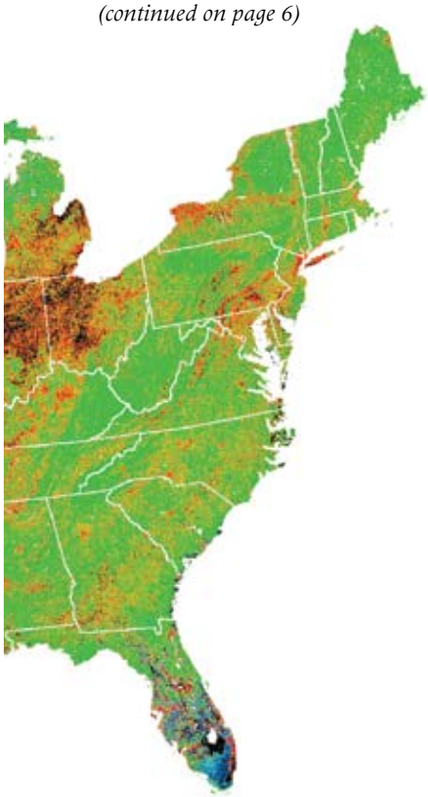

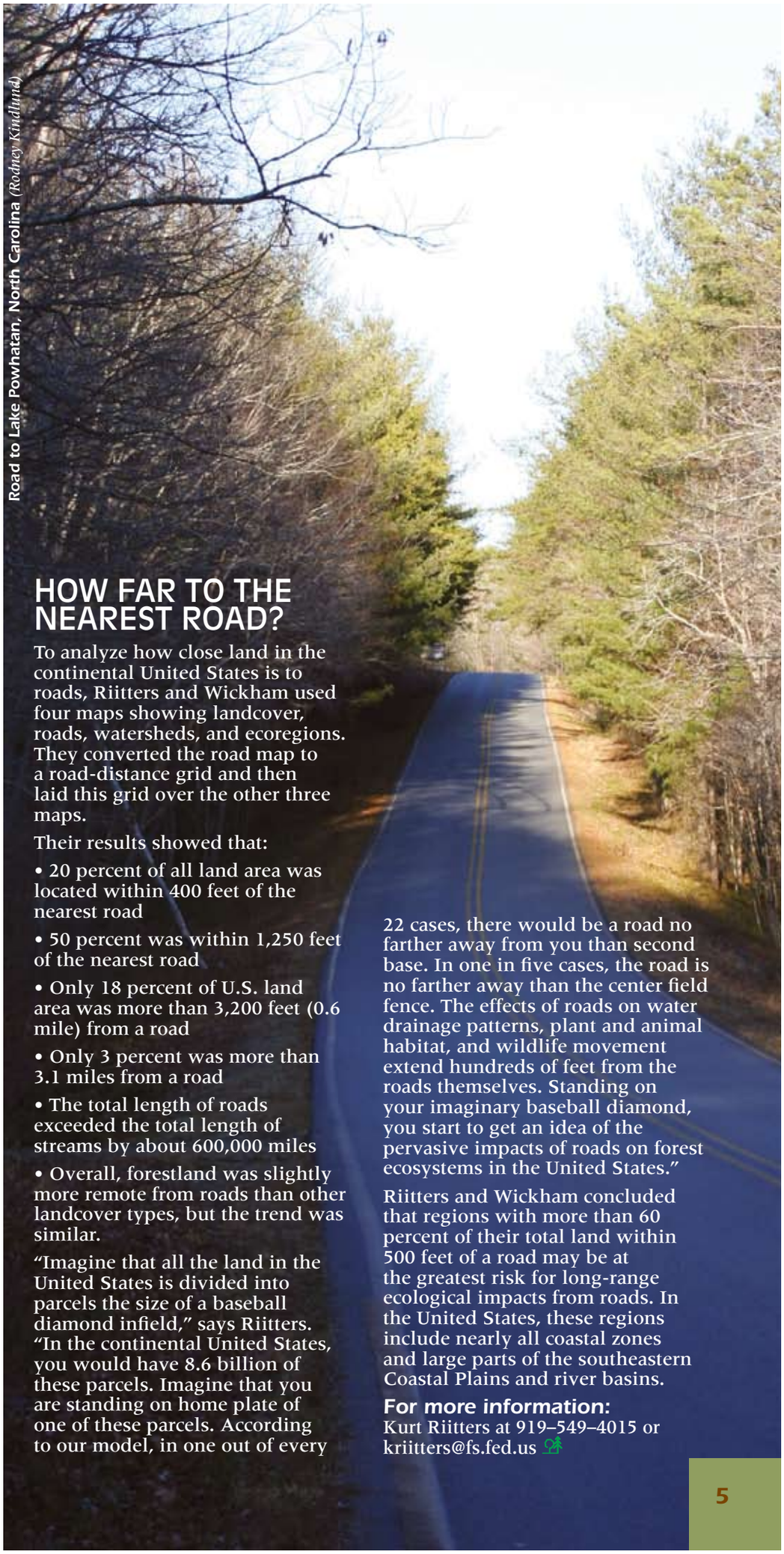

Road to Lake Powhatan, North Carolina *(Rodney Kindlund)*

HOW FAR TO THE NEAREST ROAD?

To analyze how close land in the continental United States is to roads, Riitters and Wickham used four maps showing landcover, roads, watersheds, and ecoregions. They converted the road map to a road-distance grid and then laid this grid over the other three maps.

Their results showed that:

- 20 percent of all land area was located within 400 feet of the nearest road
- 50 percent was within 1,250 feet of the nearest road
- Only 18 percent of U.S. land area was more than 3,200 feet (0.6 mile) from a road
- Only 3 percent was more than 3.1 miles from a road
- The total length of roads exceeded the total length of streams by about 600,000 miles
- Overall, forestland was slightly more remote from roads than other landcover types, but the trend was similar.

"Imagine that all the land in the United States is divided into parcels the size of a baseball diamond infield," says Riitters. "In the continental United States, you would have 8.6 billion of these parcels. Imagine that you are standing on home plate of one of these parcels. According to our model, in one out of every 22 cases, there would be a road no farther away from you than second base. In one in five cases, the road is no farther away than the center field fence. The effects of roads on water drainage patterns, plant and animal habitat, and wildlife movement extend hundreds of feet from the roads themselves. Standing on your imaginary baseball diamond, you start to get an idea of the pervasive impacts of roads on forest ecosystems in the United States."

Riitters and Wickham concluded that regions with more than 60 percent of their total land within 500 feet of a road may be at the greatest risk for long-range ecological impacts from roads. In the United States, these regions include nearly all coastal zones and large parts of the southeastern Coastal Plains and river basins.

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not identify hotspots, places where ecological impacts are most likely, or where particular types of forests are most at risk.

Coulston began working on this problem, applying methods developed for human epidemiology studies to the forests of the Eastern United States. "I took Kurt's fragmentation maps and used a technique that allows me to zoom in to find areas where fragmentation is significantly more prevalent," says Coulston. "The mathematical calculation I used was originally designed to search medical records for hotspots of human diseases."

Results published earlier this year show hotspots covering 20 percent of the Eastern United States, with most of the hotspots associated with human land use concentrated in the Piedmont of the Carolinas and in the upper Great Lakes region. However, the types and causes of fragmentation associated with hotspots varied with geography. "This tells me that how we look at and manage this type of fragmentation should be tailored to local conditions," says Riitters. "For instance, if the goal is to restore ecological function to a perforated forest, management could use information from our studies to fill holes in specific areas."

A New Map Adds Another Dimension

In 1993, several Federal Agencies—including the USDA Forest Service—formed a consortium to develop the dataset for the 1992 NLCD map used by Riitters and his colleagues to generate information about fragmentation. In 1999, a second generation consortium was formed to develop the next national landcover database, the NLCD 2001, from satellite images taken in 2000. When the new map is completed, Riitters and his team will generate new landcover pattern data that will feed into the 2007 Heinz Center report and the 2008 assessment of the sustainability indicators developed by the Forest Service for the Montréal Process.

"The information from the 2001 map will add the dimension of temporal change," says Wickham, who is a key player in the current NLCD process. "Because the 1992 and 2001 datasets are compatible, we will be able to produce snapshots of how forest loss happens over time in the United States. We can look at the hotspots Coulston and Riitter identified to see if they are growing or diminishing—or if hotspots have cropped up in new places."

Researchers and planners will be able to use these fragmentation comparisons and the moving windows technique to inform regional and local planning. At the EPA, Wickham has already been using Riitters' maps to look at water issues. The relationship between landcover and water quality is not linear; relatively small losses of forest can result in much larger declines in water quality. EPA regional planners are also interested in looking at how certain land use decisions affect forest fragmentation over a large scale, and at the cumulative impact of local land use changes on air and water quality and wildlife habitat.

"At a more local level, planners could use multiple-scale windows to look at the broader impact of their local decisions," says Riitters. "How does allowing a use that removes forest on the 25-acre level affect what happens in terms of fragmentation at the 2,500-acre level? How does preserving a specific 25-acre parcel contribute to a regional network of forest habitat?"

Having comparison data will not only make it easier to show people what is happening to forests at the national, regional, and local levels, it may even help individuals make decisions about their own land. "We can take it down to a very fine level, even to the 2-acre lot you plan to build your house on," says Riitters. "With moving windows, you could analyze how clearing different parts of your property will affect forest fragmentation or the connectivity of habitat at a larger level."

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INVESTIGATING LANDSCAPE PATTERNS WITH THE HEINZ CENTER

The H. John Heinz III Center for Science, Economics and the Environment (Heinz Center) was founded in December 1995 in honor of Senator H. John Heinz III, and is dedicated to improving the scientific and economic foundations for environmental policy through collaborations among industry, environmental organizations, academia, and the Government.

In 2002, the Heinz Center issued a landmark report, *The State of the Nation's Ecosystems*, which identified key indicators for informing policy discussions, provided data where available, and highlighted major gaps in knowledge about the Nation's ecosystems. The report provided some 100 indicators for 10 categories, including the category "fragmentation and landscape pattern." Kurt Riitters and his colleagues provided the assessments of forest fragmentation for the 2002 report.

"The Forest Service was one of our partners in the process, and brought Kurt's work to our attention," says Robin O'Malley, project director of the center's Environmental Reporting Program. "He's now a formal member of our working group on indicators."

O'Malley's program is focused on building an infrastructure for reporting on ecosystem issues—a set of technical eyes and ears that can provide the larger and longer view of what is going on across all U.S. ecosystems. "We're looking at building something that will be here 30 to 50 years out," says O'Malley.

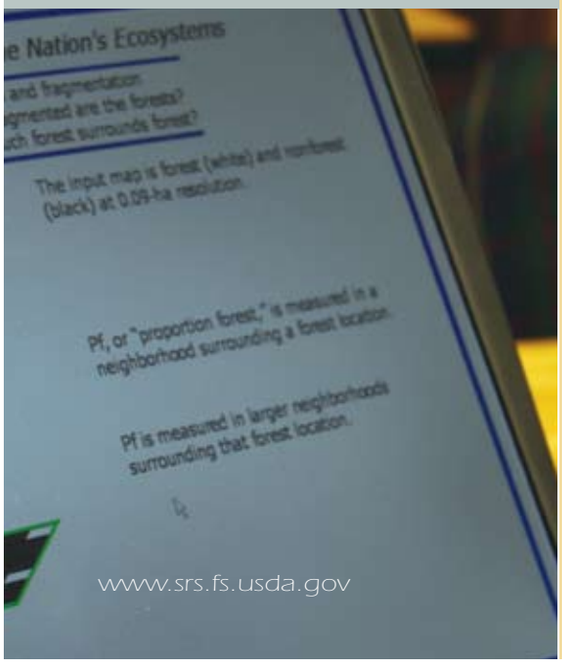
For the next report, due out in 2007, O'Malley and his working group have widened the focus from forest fragmentation to landscape patterns to look at the effect of context on ecosystems. "The 'moving window' method developed by Kurt and his group provides a much more nuanced way of looking at the landscape than the standard, patch-based approach did," says O'Malley.

"You can't be too uncomfortable with ambiguity to do this kind of work," he adds. "It's really great to work with someone like Kurt, who keeps generating new questions and moving to the next level. We are deeply grateful for the creative work he and his colleagues have done for the Heinz Center."

For more information about the Heinz Center:

Robin O'Malley at 202–737–6307 or Omalley@heinzctr.org

The State of the Nation's Ecosystems
Web site: http://www.heinzctr.org/ecosystems



The Center for Landscape Pattern Analysis

Kurt Riitters, James Wickham, Timothy Wade, and John Coulston are the founding fathers of the **Center for Landscape Pattern Analysis**. You won't find much about the center on the Web, and you won't see its name on an office door. This unique collaboration between two Federal Agencies and a State university is more about bringing people together to work on interesting problems in landscape ecology than establishing an official presence.

"Though strictly unofficial, the center has come to represent the primary source for nationally consistent fragmentation analyses," says Riitters, who is also deputy program manager for the **Southern Research Station (SRS) Forest Health Monitoring unit**. "Our national-level clients include the Montréal Process, the H.J. Heinz Center, the U.S. Environmental Protection Agency (EPA), and the U.S. Geological Survey (USGS). We are also involved in international collaborations with the North Atlantic Treaty Organization, researchers at the University of Lecce in Italy, and the European Commission's Joint Research Center."

Among themselves the team members have developed a supercomputing headhouse—an infrastructure based in hardware, procedures, and computer code that allows them to process landcover maps composed of tens of billions of pixels quickly and efficiently. The fragmentation information generated by the center can, in turn, be fed into other process models.

Examples of center collaborations at the national level include:

- Through Wickham, the center works with EPA scientists on models that predict the effect of landcover changes on water quality.
- With Elizabeth Smith at the EPA Regional Vulnerability Assessment Program, the team generates landcover data used to assess the future impacts of urbanization in the mid-Atlantic region.
- With Ken Cordell, project leader of the SRS unit in Athens,GA, the team has assessed the degree of solitude provided by wilderness areas nationwide.
- Global maps produced by Wade were used in the United Nations report, *The Millenium Ecosystem Assessment*, to illustrate the extent of human impacts on natural ecosystems.
- The Tennessee Valley Authority incorporates fragmentation data and techniques into the large area habitat models they use to evaluate reintroduction strategies for southeastern wildlife species such as the Florida panther and the black bear.
- The Forest Service *Forests on the Edge* study, issued in May 2005, used watershed-level summaries of forest fragmentation prepared by the center.

Riitters emphasizes that the center's work is about adding value to the multimillion dollar investments others have made in satellites and mapping. "We are practical," he says. "We don't ask questions that require more and better data; instead we ask questions that the available data can answer, revealing patterns that are not visually apparent. It turns out that the answers are quite stunning."

Housing Density Increases on Key Southeastern Watersheds

In May 2005, the USDA Forest Service, Pacific Northwest Research Station published *Forests on the Edge*, the first in a series of reports about the effects of increases in housing density in privately owned forests. The following is excerpted from the report.

Concern about the effects of development on America's private forests has risen sharply since the 1990s, when the conversion of forestland to developed uses reached a million acres per year. Forest Service researchers estimate that, by 2050, an additional 23 million acres of U.S. forestlands may be lost.

Forests on the Edge displays and describes housing density projections on privately held forestland for the continental United States by watershed. For the report, researchers selected only those fourth-level watersheds (consisting of an average of a million acres) that had 10 percent or more forest cover and 50 percent or more of the forested land in private ownership. A total of 1,026 of the Nation's 2,149 fourth-level watersheds met these criteria.

The analysts projected that more than 15 of the 1,026 watersheds selected will experience housing density increases on more than 200,000 acres of their surface area. All of the top 15 watersheds are located in the Eastern United States, with 9 located in the Southeastern United States.

For more information about the Forests on the Edge project:

Susan Stein at 202–205–0837 or sstein@fs.fed.us

The full text of Forests on the Edge *is available at http://www.fs.fed.us/projects/fote/reports/fote-6-9-05.pdf*

RAPID CHANGES IN FOREST OWNERSHIP INCREASE FRAGMENTATION

by David Wear

In the Southeastern United States, the area, distribution, and structure of forests are almost exclusively determined by the choices of private landowners. Nearly 90 percent of forestland is held by more than 5 million individuals or firms with a broad diversity of objectives regarding their forests. In spite of this diversity, land use and resource management has played out in generally predictable ways. Overall, lands tend to move toward the use that has the highest market value, more timber is harvested in response to increasing prices, and forest investments have tracked well against expectations about future timber returns. This predictability allows us to anticipate how southeastern forests could be reshaped by ongoing economic trends and to anticipate the implications for the forest benefits valued by residents of the region.

This article focuses on three important and interacting changes affecting private forests in the South. One is land development fueled by economic and population growth. A second related effect is new patterns of growth that place higher population densities in the vicinity of forests. The third change is the restructuring of the forest products industry, which has long held many of the largest tracts of contiguous forests in the Southeastern United States. These three dynamics will determine the future extent and fragmentation of the South's forests.

Changing Land Uses and Ownership

A comparison with recent history will show just how rapidly southeastern forests are changing. While the total area of forestland in the region varied little between the 1950s and the 1990s (plus or minus 5 percent), anticipated economic growth could result in a loss of 10 percent of forests by the year 2020—an amount of forest loss not seen since the agricultural boom of the early 19th century. In areas that remain rural, landowners could offset forest loss by shifting some agricultural land to forest uses, but this depends on the strength of timber markets relative to markets for agricultural products. Even if losses due to urban growth were completely offset by gains from agricultural lands, the structure and location of future forests would be very different from today's forests.

Forecasts of economic and population growth in the South indicate that urbanization will dominate current and anticipated changes in forests for decades to come. The conversion of forestland to developed uses represents the most direct and predictable outcome of this growth. A less direct, yet substantial implication of anticipated growth is the increasing density of population in large areas surrounding the urban centers of the region. Unlike growth patterns observed in the 1960s, 1970s, and 1980s, where the populations of counties outside of metropolitan areas declined while cities grew, growth in the 1990s and beyond has been spread across both rural and urban counties. The result is a parsing of rural land into smaller and smaller tracts and an expanding presence of humans in forested ecosystems—that is, growth in what has come to be called the wildland-urban interface.

Timber management has shaped and will continue to affect the structure of forests, especially in the South. As timber inventories declined in other parts of the United States, the area of the South's plantation forests increased from zero acres in 1950 to more than 32 million acres in 1999. The majority of these intensively managed forests were established by forest industry. These companies have managed the largest contiguous blocks of forests in the South, and together comprised more than 20 percent of the region's timberland in 1999. The recent restructuring of the forest industry holds important

implications for the future structure of southern forests.

Between the 1950s and 1990s, the area of forests owned and managed by forest industry varied little in the South. This started to change in the late 1990s, and since 1999, the industry has rapidly divested its land holdings. The sale of forestland can be traced to the rapid consolidation of the wood products sector since the late 1990s. To service the debt resulting from these acquisitions, buyers have liquidated low-return assets, especially timberland.

Fundamental to the decision to sell timberland is a change in the perception of the availability of raw materials. While holding timberland was once viewed as a necessary safety net against interruptions in the flow of raw materials—indeed, industry's large land holdings probably explain the vast expansion in the South's share of the sector since the 1950s—timber supply from other owners is now viewed as reliable and plentiful. As a result, actually owning forests is no longer seen as necessary for participating in the sector; industry ownership of forests has declined precipitously since 1999. In 5 years, as much as 20 million acres or 50 percent of the timberland once owned by industry has been sold, and recent announcements suggest that much of the remainder could be sold in the near future.

Implications for Forests

Taken together these forces of change have important implications for the ownership and management of southern forests. Conversion of forestland to developed uses is concentrated in expanding metropolitan areas—especially in the Southern Appalachian Piedmont, along the Atlantic and gulf coasts, and throughout Florida. Population density continues to expand in large areas along the periphery of these metropolitan areas, and the changing demographics of forest landowners give rise to new preferences and priorities for forests under their control. Though complex and sometimes subtle, we might

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LOSS OF INTERIOR FOREST IN THE SOUTHEAST TIED TO ECONOMIC DEVELOPMENT

In an article published fall 2004 in the journal *Ecology and Society*, Southern Research Station (SRS) researchers **David Wear**, **John Pye**, and **Kurt Riitters** provided a visual forecast of the effects of economic growth on interior forest habitat in the Southeast.

"Almost 90 percent of the land in the Southeastern United States is privately owned," says Wear, project leader of the **SRS Economics of Forest Protection and Management unit** in Research Triangle Park, NC. "This means that major land use changes are being shaped by hundreds of thousands of individual decisions. We project that continuing urbanization and low-density residential development over the next decades could have a profound impact on the forest ecosystems in the Southeast."

Many of the species that thrive in interior forest habitats cannot live in forest edge habitats. "Maintaining the species diversity of a forest means having suitable proportions of edge and interior habitat," says Riiters, deputy program manager for the **SRS Forest Health Monitoring unit** in Research Triangle Park, NC. "As development proceeds, edge habitat becomes more plentiful and interior habitat more scarce. For this study, we focused on interior forest as an indicator of available habitat for species that tend to decline when forests become too fragmented."

The researchers used county-level data to estimate and model changes in interior forest in a study area that included the 12 States in the Southeastern United States bordered in the north by Kentucky and Virginia and in the west by Texas and Arkansas. Most of these States are still more than 60 percent forested, but 5 are among the top 10 nationwide for rates of urbanization.

The researchers used a sophisticated combination of economic analysis, landcover modeling, fragmentation analysis, and other factors to make their forecasts. As expected, they found that interior forest cover decreases in relation to increases in road density, population density, and household income. Interior forest also decreases as the value of agricultural products and site productivity rise. Forecasted changes, however, were not consistent across the region.

"Our forecasts to the year 2020 show the future loss of interior forest highest in the Southern Appalachian Piedmont of North and South Carolina, with the gulf prairies and marshes in Texas and the Florida coastal lowlands following," says Wear. "We project that 66 percent of the loss of interior forests will come from urban counties, which indicates the importance of the forests that fringe major cities."

Seven of the ten metropolitan areas slated to lose the most interior forests are in Florida, with the St. Petersburg-Clearwater area losing 34.5 percent of its interior forest. Columbia (SC), Atlanta (GA), and the Research Triangle area in North Carolina (Raleigh-Durham-Chapel Hill) round out the top 10. Large areas of interior forest loss are also forecast for counties around Knoxville and Nashville in Tennessee, and counties along the Gulf of Mexico from the panhandle of Florida to Louisiana.

"With the exception of the Southern Appalachian Highlands, where a quarter of the land is publicly owned, the future protection of biodiversity in the Southeast will depend on what happens on private land," says Wear. "The model presented in our article gives us the ability to focus our attention on the areas where biodiversity is most threatened by development and population growth."

Full text of the article available online at http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=8455

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Fragmentation and Forest Health

by Bud Mayfield

Due to pressures of population growth, development, changing land use values, and other social and economic factors, private forestland in the United States is becoming increasingly fragmented. During each year between 1997 and 2001, more than a million acres of forests were converted to developed uses, nearly double the rate between 1982 and 1992. Forest landscapes are also becoming increasingly subdivided; average forest tract sizes are declining while numbers of landowners are increasing. Large tracts of forestland are routinely subdivided and sold to multiple owners who are not necessarily interested in managing or even retaining the forest cover. These pressures are likely to continue and intensify in the rapidly growing South.

Like wildfire prevention, watershed protection, or wildlife conservation, management for forest health (including keeping damaging insects and diseases at tolerable levels) frequently requires a broadscale or "landscape" approach to be most effective. Forest pest outbreaks can be precipitated by forest conditions that stretch across large geographic areas. When the landscape is a fragmented mix of multiple ownerships, reducing overall forest susceptibility or vulnerability to specific pests becomes extremely difficult. Differing landowner attitudes and objectives, lack of communication and cooperation among owners, and limitations to using traditional forest management practices on small tracts all contribute to the challenge.

The southern pine beetle is an excellent example of a pest that becomes more difficult to manage as forests become increasingly fragmented. Southern pine beetle outbreaks can occur at scales of hundreds of square miles, and individual infestations can expand rapidly to kill pines on multiple acres.

Promptly harvesting and removing infested pines is the best way to stop infestations from expanding, and thinning helps reduce stand susceptibility, and prevent infestations from becoming established. On large forested tracts, both of these management techniques can usually be accomplished as commercial harvests that bring revenue to the landowner. On small, isolated tracts or wildland-urban interface lots, however, the value of harvested wood is usually not enough to offset logging costs, and it may not be possible to use traditional harvesting operations in residential settings. On these small parcels,

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Rapid Changes in Forest Ownership

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summarize this demographic change as a shift from a rural-utilitarian to an urban-aesthetic perspective on forest values. This shift suggests changes in land use and management away from timber uses and toward a more hands-off approach.

The fragmentation of forest ownerships in lands outside metropolitan areas limits many management opportunities—for example, parcel size may fall below the scale that can support harvest or fuel treatments. Increased human presence also interferes with ecosystem functions—for example, higher road densities allow invasive species to move through a landscape, and human presence can reduce the habitat value for certain forest-specialist species, including imperiled amphibians and neotropical migrant birds.

Sales of forest industry timberland will have a strong impact on fragmentation in the South. As a group, industry holdings are unique in terms of their size, contiguity, and high capitalization. The unusually large blocks of forests held by the industry are the result of a one-time confluence of economic and social conditions that led to large-scale divestitures of State and Federal public land in the South following the Civil War. The ongoing divestiture of industry land pulls apart these large holdings and fragments ownership and forest cover. Parcels located near metro and extra-metro areas are split off and developed. A large share of the land will remain under forest cover and management, but many of these industry lands have been purchased by Timber Investment Management Organizations (TIMO), an ownership class with a very different management model from that of the forestry industry.

TIMOs don't own land outright. Rather, they act as intermediaries, acquiring and managing forests for investors that range from individuals to pension funds. The way these investments work can lead to forest fragmentation. Investments are often structured as closed-end funds, with forest parcels bundled to form an investment fund with a fixed term. At the end of the term, the assets of the fund (forest parcels) must be sold and the returns distributed to the investors. By definition, the land must be sold, likely to another group of investors, with some portion possibly sold for development.

This cycle of investment and distribution raises questions regarding forest sustainability. Investors under this type of ownership have a shorter time horizon for planning forest management. Will investment decline, and forest conditions change under this management model? This style of management also suggests an increased specialization of forestland use. Ownership of large blocks by industry led to the bundling of forests with different qualities. In some cases, environmentally sensitive forestlands with low productivity were ignored as the more productive sites were managed for timber, resulting in a set of de facto protected lands. The new model of forest investment—where the scale is smaller and more specialized and returns are defined by cash flows on a fixed term—provides no direct incentive to support this bundling. We expect that these nonproductive lands—often sensitive wetland areas or other special habitats—are likely to be split off to other owners. Will valuable ecosystem services be impacted?

Conclusions

All of the changes described in this article suggest an increasingly fluid situation for forestland and resources in the South. Long perceived as a sector for investing very patient, long-term capital, land and forest assets are becoming increasingly liquid. Not unlike other mature sectors of the economy, this increased liquidity is an outcome of increasing specialization within the forest products sector and a vastly expanded flow of information regarding asset values and markets. Loss of forestland and increasing fragmentation should be anticipated throughout much of the region.

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EDGE EFFECTS

by Claire Payne

Fragmentation is the principal cause of ecological change in forested urbanizing landscapes, according to *The Southern Forest Resource Assessment Summary Report*. Editors, **David Wear** and **John Greis**, say designing development so some forest connectivity is retained could provide important habitat and other benefits, especially for neotropical migratory birds.

Sustainable forests include associated parts: trees, soil, water, plants, animals, timber, and minerals. These interdependent components are ecological capital. The infrastructure they create includes species biodiversity and human economic health. The ecological effects of fragmentation are most easily discerned at its edge.

Birds, Spiders, and Mammals

Susan Loeb, ecologist and project leader at the **Southern Research Station (SRS) Endangered, Threatened, and Sensitive Wildlife and Plants in Southern Forests unit** in Clemson, SC, found that early successional small mammals that live in vegetation regenerating after an area has been cleared, such as old-field mice and cotton rats, depend on patch size to maintain abundance and diversity. Populations on smaller patches are more susceptible to local extinction than on patches with larger population densities. Because large clearcuts may fragment late-successional forests to unacceptable levels, a balance must be maintained between the number and size of early and late-successional patches to maintain a full complement of species within an area.

Fragmentation effects can't be generalized across all species—a small rodent might not be able to cross an agricultural landscape, whereas a bird could fly without restriction.

Fragmentation thus results in another selective filter for the distribution of plants and animals, according to SRS scientists **John Pye** and **Vic Rudis**, and colleagues. Pye is an ecologist with the **SRS Economics of Forest Protection and Management unit** in Research Triangle Park, NC. Rudis is a forester with the **SRS Forest Inventory and Analysis unit** in Knoxville, TN.

Carolina wrens, indigo buntings, hooded warblers, and eastern towhees were more numerous in the small openings and interior edge habitats created when Hurricane Opal in 1995 caused blowdown conditions in the Blue Ridge Mountains. **Cathryn Greenberg**, ecologist with the **Bent Creek Experimental Forest**, says, "We suggest that canopy gaps increase bird diversity at a landscape scale by providing habitat patches for some species that require young, second-growth forest, and serve as magnets for recruitment and foraging." These positive effects occurred within a complex forested landscape.

At the **Savannah River Site** near Aiken, SC, more green tree frogs were found in canopy gaps than in closed canopy forest. The tree frogs benefited from an increase in insects and flies, as well as the early successional vegetation of the edge habitat, according to SRS researchers **Scott Horn**, **James Hanula**, **Michael Ulyshen**, and **John Kilgo**. Hanula leads the **SRS Insects and Diseases unit** in Athens, GA, where Horn and Ulyshen conduct research. Kilgo, a wildlife biologist based at the Savannah River Site, works with the **SRS Center for Forested Wetlands**.

However, Kilgo found that gaps at the Savannah River Site did not result in an increased abundance of arthropods, a primary food source

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Tree frog *(USDA Forest Service)*

Fragmentation and Forest Health

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prevention or control treatments usually come at a net expense to the landowner, with tree removals potentially costing hundreds to thousands of dollars.

Furthermore, when forests are subdivided into numerous small and adjacent ownerships, pest infestations (like those of the southern pine beetle) can easily spread across property boundaries and become the problem of multiple owners. Without careful and purposeful cooperation among neighbors, poor management or inaction can lead to hostile accusations and even litigation.

As the momentum toward increased forest fragmentation builds, forestry professionals and agencies need to find ways to encourage and enable practical forest management on small tracts. Many private landowners of small forest parcels do not attend traditional forestry workshops. Direct mailings, mass media, or presentations through nonforestry venues should be used more frequently to disseminate forest management information. Owners of small tracts can be encouraged to cooperate with adjacent owners and jointly contract for management services such as thinning. Economic incentives for managing small woodlots and wildland-urban interface forests should be developed and promoted. In addition, the need to prevent or control specific pests should not be presented in isolation, but within the broader context of improving forest health and with appeals to other compatible benefits such as improved timber value, wildfire risk reduction, and wildlife habitat enhancement.

Above all, coordinated economic and social strategies that promote the retention of forests on private property are needed in the face of competing development interests and poorly planned urban sprawl. Without this, forest landscapes will only become increasingly fragmented and forest health more difficult to achieve.

Bud Mayfield is a forest entomologist with the Florida Division of Forestry, Forest Health Section located in Gainesville, FL.

Rapid Changes in Forest Ownership

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Rapid change in the ownership and condition of forests places pressure on already scarce ecosystem conditions and services. Among these, rare forest types, including many wetland types, imperiled animal species, water quality, and recreation may be the most affected. Protecting and enhancing the flow of ecosystem services in the face of a rapidly changing forested landscape may define the greatest challenge for the resource management professions.

Anticipating change can help us plan for and respond to a different future. Anticipating forest loss, fragmentation, and ownership changes in the South raises three observations regarding potential responses. First, the fragmentation of the remaining large blocks of forest ownership will probably come as a one-time and irreversible event, and opportunities for protecting values in contiguous forests will shrink substantially in the next few years. Industry land sales provide a unique opportunity for conservation interests to partner with TIMOs to protect ecosystem benefits. Second, as the pace of change quickens, the need for timely and effective change monitoring grows. And finally, the effects of landownership changes on management and forest conditions, the structure and value of forests in a fragmented wildland-urban interface, and the impacts of forest loss and fragmentation on ecosystem services are unknowns that define an extremely important research agenda for natural resource science.

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(Rodney Kindlund)

EDGE EFFECTS

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for many birds, including hooded warblers. Kilgo says, "more than half (52 percent) of all spiders collected were greater than 328 feet from a gap edge, suggesting that spiders, like arthropods in general, were negatively impacted by gaps. My results indicate that foliage-dwelling arthropods are negatively affected by group-selection harvest gaps in bottomland hardwood forests during early summer." Hooded warblers apparently encountered fewer prey and presumably foraged less efficiently near gaps. Hooded warblers foraging for fledglings maintained a constant attack rate, regardless of greater distances between areas of prey abundance. Does foraging faster and farther to maintain the necessary food supply for fledglings exert an energetic burden on warblers? Kilgo says that although the birds have adapted to exploit small canopy gaps within mature forests, research needs to consider the possibility of energy depletion during postbreeding and migration periods.

Cerulean warblers are declining across their breeding range, largely because of the extensive loss and fragmentation of their breeding and wintering habitat, according to **Paul Hamel**, wildlife biologist at the **SRS Center for Bottomland Hardwoods Research** in Stoneville, MS. These sky-blue birds winter along the northern Andes Mountains in northern South America and breed throughout much of Eastern North America, but are limited to large patches of mature, deciduous forest for nesting. Although cerulean warblers were formerly among the most abundant breeding warblers in the Ohio and Mississippi River Valleys, their numbers plummeted in the 1900s. The birds are extremely sensitive to deforestation because they nest so high in the forest canopy, and because habitat fragmentation aids brood parasitism by brown-headed cowbirds, as well as nest predation. Also, small fragments exhibit substantially

lower prey abundance than larger fragments.

Soil, Roads, and Water

Soil disturbance related to forest fragmentation frequently leads to erosion and sedimentation. Erosion control blankets use stitching and netlike mesh fabrics of various materials (plastic, nylon, twine) to hold materials (straw, coconut husk, jute, wood, etc.). These products provide an organic matrix to retain soil moisture, promote seed germination, and disperse erosion-causing energy from raindrops. **Christopher Barton**, formerly with the **SRS Center for Forested Wetlands** in Charleston, SC, used rolled erosion control blankets to help restore 15 degraded Carolina bay wetlands on the Savannah River Site. The blankets were effective for their stated purpose, but were hazardous to snakes. The products' mesh sizes of 10 and 20 mm^2 provided easy entry for the black racer, rat snake, water snake, corn snake, and eastern hognose. Once inside the mesh, the snakes couldn't escape. Fourteen of the nineteen trapped snakes died while tangled in the mesh, either due to lacerations from twisting and thrashing, overheating, or being unable to escape predators, including fire ants. A smaller mesh size would be safer for snakes and possibly other wildlife.

Roads and vehicular traffic in eastern Texas have depressed populations of the Louisiana pine snake and the timber rattlesnake. Roads with moderate use affect snake density by as much as 50 percent up to a distance of about 500 yards, according to **Craig Rudolph**, **Richard Conner**, and **Richard Schaefer** of the **SRS Integrated Management of Wildlife Habitat and Timber Resources unit** in Nacogdoches, TX. Seventy-nine percent of the landscape of the Angelina National Forest is within 500 yards from a highway or Forest Service system road corridor. A substantial proportion of the expected snake fauna have been eliminated across the landscape due to road-related mortality.

Fragmented River, Freshwater Mussels

Pearly mussels are among the most endangered animals in fresh waters. These bivalve creatures live in the sediment of rivers, streams, and lakes. Most pearly mussels live from 5 to 6 years to decades; some can live a century. Mussels play important roles in freshwater ecosystems and are economically valuable for their shells and pearls. The Cumberland River basin in Kentucky and Tennessee supported one of the world's most diverse mussel faunas, including species exclusive to that river system. When a natural or anthropogenic catastrophe occurred, mussels could travel to another tributary to recolonize. When the Cumberland River was dammed in the 1950s, tributaries were isolated and connectivity lost.

Three or four Cumberland River tributaries persisted as mussel refugia in 1985. The Little South Fork in Kentucky and Tennessee was most significant because it supported an intact example of the 26 species unique to the river basin. The Little South Fork also had the largest populations of endangered and imperiled species, according to **Wendell Haag**, fisheries research biologist, and **Mel Warren**, fisheries research scientist and team leader for the **SRS Forest Hydrology Laboratory** in Oxford, MS.

Rapid mussel population declines during the early 1980s were associated with surface mining on the lower section of the river during the late 1960s and 1970s. By the late 1980s and early 1990s, oil extraction activity was implicated in mussel declines on the upper section of the river. Loss of the Little South Fork as a conservation refugium resulted in the loss of populations of at least nine mussels of global conservation significance, including the littlewing pearly mussel and the Cumberland bean.

Nature Hates a Void

Invasive species thrive where fragmentation interrupts forests. Melaleuca, also known as paperbark trees, grow at a voracious pace in

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Carolina Wren *(Bill Duyck)*

EDGE EFFECTS

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sparsely forested south Florida. In the Southcentral States, forest fragment size associated with bottomland hardwoods was directly linked with livestock grazing in small areas and logging in intermediate-sized sections, according to Rudis in 1995. The 1997 Forest Inventory and Analysis survey of Georgia indicated the presence of kudzu, honeysuckle, and privet two to seven times more frequently when edged by nonforest land. "This suggests that conditions at the edge provide the access and light needed to grow and propagate selected nonnative species," says Rudis.

Fragmentation provides an opportunity for invasion by pests and diseases. Decline disease syndrome is a progressive interaction of abiotic events, such as site, soil type, and climate change, and biological factors or agents that eventually can lead to individual tree death and widespread forest mortality. Decline diseases involving climate may be of particular concern for future southern forests if predictions of extremes in atmospheric temperature and precipitation resulting from increased greenhouse gases hold true. **Dan Wilson**, **Ted Leininger**, **Bill Otrosina**, **David Dwinell**, and **Nathan Schiff** report that if there are major systematic changes occurring in the climate, they will likely give rise to more numerous decline-related insect and disease problems. Wilson and Schiff conduct research with project leader Ted Leininger at the **SRS Center for Bottomland Hardwoods** in Stoneville, MS. Bill Otrosina works with the **SRS Biological Foundations of Southern Forest Productivity and Sustainability unit** and is stationed in Athens, GA. David Dwinell recently retired from the **SRS Insects and Diseases of Southern Forests unit** in Athens, GA.

(Rodney Kindlund)

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EFFECTS ON THE TWO-LEGGED CREATURES: Where Will We Recreate?

by Carol Whitlock

In the South, forest ownership and recreation demand are trends heading in opposite directions, with consequences that could possibly change the culture of society, as well as the look of the landscape.

Most forestland in the South is and will continue to be in private ownership. Since early in the last century, large tracts of forestland have been in the hands of timber companies, a situation that benefited local communities by providing both high-paying jobs and access to recreational opportunities as long as recreation use did not interfere with forest management and harvesting. Some of these arrangements became formal with local clubs and counties leasing industry land for hunting, fishing, and other recreational uses. Regardless of specific use, southerners were accustomed to having abundant and relatively inexpensive recreation nearby.

This loose network of recreation users and willing landowners is now unraveling. Southern population growth outpaces that of the Nation as a whole, especially on the Piedmont Plateau, the Atlantic Coastal Plain, and the area adjacent to Mobile Bay. In addition, participation in recreation activities is growing faster in the South than in the rest of the United States.

On the supply side, there is a great shift of ownership from forest industry to other private individuals and corporations who have very different objectives and management philosophies. The result is fragmentation, which decreases both the practicality of new owners managing their land for timber production and the likelihood that they will seek assistance and develop management plans for improving their forestland.

"It is our expectation that these types of timberland divestitures will continue for a long time," said Michael Clutter, University of Georgia forest finance professor, at a briefing during the Southern Group of State Foresters meeting in December 2005. "In fact, our study indicates that in three years' time it's possible there will be only one forest products company with timberland holdings exceeding a million acres in the U.S. South."

Among the new owners are timber investment management companies, which have little connection to nearby communities. Local community members suffer when high-paying mill jobs leave and are replaced with lower paying jobs in service and tourism industries, and when they encounter gates on lands that they had come to think of as "theirs." Increasingly forestlands are being developed and further fragmented to accommodate the huge demand for primary and secondary homes near natural amenities. Forested mountains, riversides, wetlands, and other natural amenities are likely to continue to attract such development.

Aside from the timber industry, private owners of forestland have generally been reluctant to allow people who are unrelated by family ties to engage in recreation on their land. In the last 15 years, land development has intensified this reluctance to the point where less than 10 percent of owners have any interest in being recreation providers. Further complicating the recreation access picture is the recent dramatic increase in the recreational use of all-terrain (ATV) and other off-highway motorized vehicles on forestlands. ATV sales have skyrocketed, as has ridership. Unauthorized use creates informal roads, more fragmentation, and causes many private owners to close yet more of their previously open lands.

Lacking incentives for managing their forests as in the past, landowners are likely to continue the trend of further fragmentation and creating barriers to trespass by their neighbors. This puts greater pressure for recreation on the South's public forests, which are already the second most heavily used, with each acre of national forest land supporting 1.9 visitors. It also changes the fabric of rural living, ending century-long traditions of community access to nearby lands for hunting, fishing, and gathering.

"The trend toward closing more private land to recreational uses is likely to continue into the future as those uses become more individual amenity based, rather than raw wood material production based," says **Ken Cordell**, project leader of the **Southern Research Station Recreation, Wilderness, Urban Forest, and Demographic Trends Research unit** in Athens, GA. "This will put more demand pressures on public lands, where management challenges and recreation use conflicts are likely to escalate."

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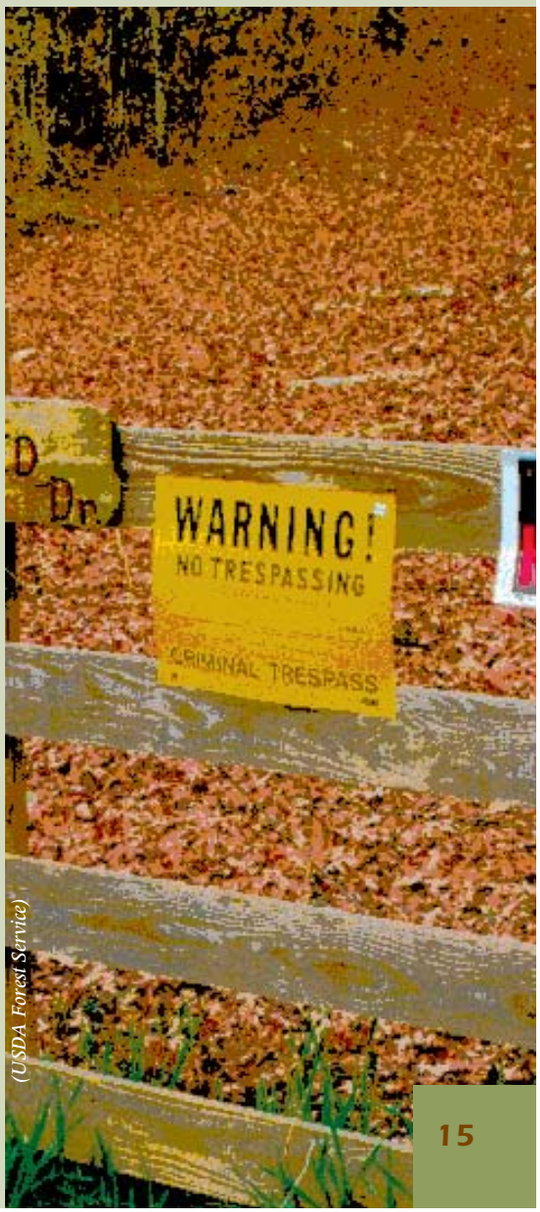

(USDA Forest Service)

Katie Greenberg *(Rodney Kindlund)*

SNAPSHOT from the Field...

Greenberg Strikes a Balance Between Family and Research

by Perdita Spriggs

Research scientists are well known for the intensity of their work, which often includes exhaustive hours and extensive travel. Being both a mother of five and a research scientist can make achieving the delicate balance between family and work even more challenging.

However, research wildlife ecologist **Cathryn (Katie) Greenberg** shows that the balance can be achieved, especially when given the right circumstances. With a USDA Forest Service career that spans nearly 15 years, Greenberg has spent most of her time at the **Bent Creek Experimental Forest** in Asheville, NC, where her research focuses primarily on how natural and manmade disturbances affect plants and animals. She has authored or coauthored nearly 50 publications and was touted as a "Woman of Achievement" by the *Asheville Citizen-Times* in 2000. So how does Greenberg—wife, mother, and accomplished research scientist—manage to do it all? A peek inside her life shows us that it's not always easy, but it can be done.

What's your secret to balancing work and family life?

My husband, Stan, and I have four boys and a girl ranging in age from 5-year-old twins to an 11-year-old. Providing a healthy, happy life to each child takes a lot of time and work, and the tradeoff is less time spent on a career that gives me great

personal fulfillment. When we began our family, I decided that I would be satisfied with doing my best—conducting research close to home and within the bounds of a 40-hour work-week. Given those constraints, I generally balance my time the same as other working mothers.

My ability to comfortably balance work and family is a union of several circumstances. First, I have a highly supportive supervisor who gives me the resources I need to conduct studies and allows me the freedom to manage my own schedule. Having the flexibility to take short days (I now work 80 percent time) or work at home in the evenings is critical when you're a working parent, because children need time and attention. Second, I work with dedicated, competent technicians who do most of the research-related field work. I trust their high-quality work, and that frees me up to do the other half of research—study design, data analysis, and writing. Third, Stan and I are a good team; he does half the work at home. And finally, high-quality childcare arrangements give me the peace of mind to concentrate on work.

How did ecological research first pique your interest?

I've always loved nature, but I didn't know that people actually got paid for running around in the woods! I discovered that ecology was a "respectable profession" after I'd already majored in philosophy as an undergraduate. A backpacking trip took me to the Great Smoky Mountains National Park (Smokies), where I stayed for 6 months volunteering for the natural resource management division. After that, I took some classes at North Carolina State University to prepare for graduate school. I gained more field experience working as a field assistant on a small cat project in Belize, and as a technician on a vegetation crew ground-truthing satellite imagery of forest types in the Smokies. I was fascinated by the interplay between plants and animals, and realized that I could do meaningful, conservation-related work by studying how humans impact nature.

After receiving my master's degree in wildlife ecology from the University of Tennessee, Stan and I moved to Gainesville, FL, so that he could pursue his Ph.D. at the University of Florida. I worked for 2 years as a biologist for the Florida Department of Transportation before pursuing my own Ph.D. in wildlife ecology with a minor in botany.

When did you join the Forest Service family?

The Forest Service "adopted" me in 1990 as a co-op student with the Southern Research Station Intensive Management Practices Assessment Center (IMPAC) in Gainesville, FL. Once I finished my Ph.D., I was offered a permanent position. The unit closed in 1995, and I was given the option to move to Asheville, NC.

What are some of your current research interests?

One of the studies I'm excited about is our long-term (now in its seventh year) effort to quantify how much fleshy fruit (berries, etc.) and hard mast (acorns, hickory nuts) is produced in young, recently harvested stands compared to mature forest. Fruits and nuts are key food resources for many animals. Land managers need to know how management activities affect quantities and species of fruit and mast produced, and how production changes seasonally as young stands mature.

A Florida cooperator and I are continuing a long-term study of how fire suppression affects amphibians in Florida longleaf pine sandhills. Since 1994, we have continuously sampled eight ephemeral ponds in Florida sandhills—four in regularly burned and four in fire-suppressed, hardwood-invaded habitat. We're also finding out how dramatically ponds differ across the landscape and over time as sources of amphibian reproduction—and the importance of conserving many wetlands within landscapes for amphibian diversity.

What are edge effects and how do your studies relate to them?

Forest, field, or roadside edges are disturbed areas with an abundance of light; these conditions can promote a high occurrence of invasive, exotic plants. One of my studies examines how animals can promote the spread of these species. We are studying whether, and how much, animals consume the fleshy fruits of exotic vs. native plants found along the forest edge. This gives us an indirect look at how fast seeds are dispersed and which species are preferred.

What do you enjoy most about your research?

I enjoy working on practical questions that yield answers that can be used by land managers. I hope that my work will help them to better understand the impact of forest management activities on wildlife and wildlife-related resources.

Where do you see yourself in the future?

For now, I enjoy doing science, and my current job fits well with my family-related obligations. In the future, I may consider research management.

Piecing together the Knowledge & Application

The Forest Encyclopedia Network provides natural resource professionals and the public the scientific knowledge and tools they need to achieve their objectives. The Network is designed to connect scientific results, conclusions, and impacts with management needs and issues. Now the ever-expanding scientific knowledge-base of forest information can be organized into an integrated system that can be readily accessed. Visit the Forest Encyclopedia Network online at:

www.forestencyclopedia.net

Forest Encyclopedia Network

This effort is sponsored by the USDA Forest Service, Southern Research Station and Southern Regional Extension Forestry

Southern Appalachians from the Blue Ridge Parkway overlooking south Asheville, NC *(Rodney Kindlund)*

www.srs.fs.usda.gov

TAX BENEFITS FOR FOREST LANDOWNERS

by John Greene

The American Jobs Creation Act of 2004 includes four provisions specifically for forest landowners. Two are broad in focus and affect many owners.

Tax Treatment of Reforestation Costs

Previously, owners could take a 10 percent reforestation tax credit on and amortize (write off over 8 tax years) up to $10,000 per year of their out-of-pocket costs to establish timber. The 2004 law allows owners to deduct outright up to $10,000 per year of these costs and amortize any additional amount, again over 8 tax years. The reforestation tax credit was repealed. Although the reforestation tax incentives changed, the rules about which costs qualify remain the same.

Deduction of Management Expenses

The American Jobs Creation Act of 2004 removed filing-status restrictions on owners who qualify as active participants in their timber-growing enterprise and who sell timber. The law allows these owners to deduct their management expenses most fully. To ensure that timber income is taxed as a capital gain rather than ordinary income, owners must dispose of timber under the provisions of IRS code section 631. Under the 2004 law, an outright sale of stumpage—as with a lump-sum sale—also qualifies as a section 631 disposal. For tax purposes, the "date of disposal" for a disposal with an economic interest retained remains the date the volume of cut timber is first definitely determined; for an outright sale, the "date of disposal" is when ownership of the timber changes hands.

Two other provisions which affect forest landowners have a more narrow focus. One allows owners to revoke an election under section 631(a) of the IRS code one time without IRS consent. The second changes the tax treatment of the sale of certain real assets by real estate investment trusts (REITs) that own land.

For more information:
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John Greene interpreted the forest landowner benefits of the American Jobs Creation Act of 2004. He is a research forester with the Evaluation of Legal, Tax, and Economic Influences on Forest Resource Management unit in New Orleans. Claire Payne contributed to this article.

The USDA Forest Service has published two documents related to the filing of Federal income taxes and timber sales for the year 2005. The first, co-authored by John Greene and Larry Bishop, taxation specialist with Region 8, addresses frequently asked questions, and the second provides tips for forest landowners. Both documents were updated December 1, 2005.

FAQs: http://www.fs.fed.us/cooperativeforestry/library/timbertax.pdf

Tax Tips: http://sref.info/news_items/newsitem_12.15.2005

Landowner's

TOOLBOX

(USDA Forest Service)

RECOMMENDED READING

Sometimes a Great Notion

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Tax Benefits for Forest Landowners

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What Can Experimental Forests Teach Us About Fragmentation?

Turner, M.G.; Pearson, S.M.; Bolstad, P.; Wear, D.N. 2003.Effects of land-cover change on spatial pattern of forest communities in the Southern Appalachian Mountains (USA). Landscape Ecology. 18: 449–464. http://www.srs.fs.usda.gov/pubs/6309. [Date accessed: December 1, 2005].

Since the 1920s, the USDA Forest Service has maintained a system of experimental forests to test hypotheses and collect long-term data about the ecological effects of fire, grazing, insect infestations, air pollution, and other disturbances. In the South, researchers from Federal agencies and universities use 15 active experimental forests for studies ranging from the practices needed to maintain healthy forests, to the water filtration functions of forests, to habitat restoration for endangered species.

Experimental forests are some of the few places in the United States where long-term data are collected about forests and how they change over time. These living laboratories also serve as demonstration sites where cooperators and landowners can see the results of different forest management options.

WHAT CAN EXPERIMENTAL FORESTS TEACH US ABOUT FRAGMENTATION?

In the early 1900s, Southern Appalachian forests were extensively grazed by livestock. Steep mountain land was cleared and planted with corn. Logging was done with little regard for erosion from roads and skid trails. Such land was not wanted by private individuals and could be bought for delinquent taxes.

In 1933, the USDA Forest Service established the **Coweeta Hydrologic Laboratory** for a program of watershed management research. Early studies on erosion control and soil stabilization for roadbanks and abandoned agricultural land led to the realization that further work required complete watershed instrumentation to provide continuous measurements of stream flow and precipitation. An intensive program of weir construction began at Coweeta in 1934 along with a network of 56 rain gages, numerous groundwater wells, and meteorological stations.

Over the next 80 years, scientists conducted a variety of watershed experiments at Coweeta. Early studies documented the harmful effects of mountain farming, woodland grazing, and unrestricted logging. Water-yield experiments measured stream flow responses to complete or partial forest cuttings and conversion from one type of cover to another. The knowledge from these early experiments became the basis for tests on intensive multiresource management of forests and provided guidelines for watershed management and best management practice standards for public and private forests. Later experiments introduced improved methods of cable logging and forest road design for managing steep mountain lands to minimize damage to soil and water.

Coweeta's early emphasis on how land management practices affect the hydrologic cycle has evolved into a broader context that examines ecosystem processes of water, carbon, and nutrient cycling at watershed scales. Based on the legacy of information dating back to the 1930s, the research combines short-term experiments and long-term measurements to determine how a range of terrestrial and aquatic ecosystem processes respond to management practices,

The Coweeta Basin in Otto, North Carolina. *(USDA Forest Service)*

natural disturbances, and the atmospheric environment. The goal is to identify practices that mitigate impacts on soil chemistry, aquatic life, terrestrial mammals, insects, and plants, and forest succession, growth, and health.

This long-term research within the Coweeta basin provides fundamental information on the structure and function of managed and unmanaged forest ecosystems in the Southern Appalachians. Although most studies take place within the Coweeta basin, several new study sites have been installed throughout the region to address larger scale issues such as forest fragmentation and other consequences of land use change. The centerpiece of the cooperative effort is the Long-Term Ecological Research Program (LTER) with the University of Georgia, begun in 1980 and funded through the National Science Foundation. Coweeta is one of 26 LTER sites in the United States.

The new regional studies focus on characterizing historic, contemporary, and future land use patterns and understanding the impacts of land use change on terrestrial and aquatic resources. In addition to Coweeta scientists, the research involves cooperators from the University of Georgia, Virginia Polytechnic Institute and State University, Duke University, Mars Hill College, University of North Carolina at Asheville, University of Minnesota, and University of Wisconsin-Madison. Study sites outside Coweeta are located on the Little Tennessee River and the French Broad River basins.

These studies examine human land use choices as the primary disturbance on the private lands that cover approximately 55 percent of the Southern Appalachians to address the following questions:

How does land use change interact with environmental change to alter diversity and ecosystem processes?

How are land use decisions influenced by social, economic, and ecological factors?

Can future land use patterns and ecological consequences be predicted by understanding relationships among socioeconomic factors, land use change, and ecosystem structure and function?

The long-term research information from the Coweeta basin provides the "benchmark" for characterizing the impacts of forest fragmentation and other consequences of land use change on watershed resources.

Jim Vose, ecologist at Coweeta for the last 18 years and project leader since the retirement of the legendary **Wayne Swank** in 1999, sees these new studies as an excellent opportunity to continue serving the people of the Southern Appalachians. "Coweeta has a stellar group of scientists on staff representing the full range of biological and physical disciplines, joined by economists and social scientists from the best universities in the country," he says. "With the long-term data, rigorous methodologies, and indepth understanding of ecosystem structure and function that have made Coweeta famous, this team is poised to provide credible information that can have a positive impact on the mountains that we all love."

For more information:
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around the STATION...

JIM BARNETT RETIRES WITH LENGTH OF SERVICE AWARD

by Claire Payne

Since **Jim Barnett** began working for the USDA Forest Service in 1953, he has seen and created a lot of change. Barnett worked his first 4 years as a temporary employee on the Kanisku National Forest, now part of the Idaho Panhandle National Forest. Jim served 3½ years in the Coast Guard in Mobile, AL. As a green ensign, he spent half the time as a buoy tender, and credits that experience with helping him build leadership skills and an ability to get along well with people.

When Barnett returned to the Forest Service with his undergraduate degree in forestry, he was assigned to the Pineville, LA, forestry center. In those days, Forest Service research had not established the current system of assistant directors. Since the Forest Service was founded in 1905, the Agency has had 15 leaders. Jim served under eight, beginning with Chief Richard E. McArdle. Barnett supervised and mentored at least 15 scientists during his tenure as project leader of the **Southern Research Station Ecology and Management of Even-Aged Southern Pine Forests unit**.

Jim has officially retired, but he'll still be at the Alexandria Forestry Center as he works on a summary of seed physiology for all southern pine species. Jim also enjoys woodworking and gardening, and has a long list of "honey-do" projects waiting for him at home. Thank you, Jim, for your dedicated service and enthusiastic leadership.

Ancient Forest Ecosystems in the Midsouth Conference in March 2006

The seventh eastern old-growth conference focuses on ancient forest and endangered species science and conservation in the Southcentral United States. The conference meets in Little Rock, AR, March 24–25, 2006. Speakers will describe the aesthetic, conservation, and scientific values of native old-growth forest types, including the bottomland hardwood-baldcypress community, the oak-hickory, oak-pine, eastern redcedar, and Cross Timbers ecosystems. The successful restoration of the pine-bluestem ecosystem on the Ouachita National Forest, including the endangered red-cockaded woodpecker, will also be described. The conference

Experimental Forests

1	Bent Creek	NC
2	Blue Valley	NC
3	Coweeta	NC
4	John C. Calhoun	SC
5	Santee	SC
6	Scull Shoals	GA
7	Hitchiti	GA
8	Olustee	FL
9	Chipola	FL
10	Escambia	AL
11	Tallahatchee	MS
12	Delta	MS
13	Harrison	MS
14	Palustris	LA
15	Stephen F. Austin	TX
16	Crossett	AR
17	Alum Creek	AR
18	Sylamore	AR
19	Henry F. Koen	AR

includes a half-day visit March 25 to the ancient cypress-tupelo forests of Bayou DeView in the Dagmar Wildlife Management Area, near the rediscovery site of the ivory-billed woodpecker.

The eastern old-growth conference is free and open to the public, but space is limited and early registration required. Sponsors include the Forest Service, Southern Research Station, Managing Upland Forests of the Midsouth unit; the University of Arkansas, Department of Geosciences, Tree-Ring Laboratory; and the Eastern Native Tree Society.

Participants can earn Society of American Foresters continuing education units.

For more information:
http://www.srs.fs.usda.gov/4106/meetings/EOGC2006/EOGC2006.htm or contact Don Bragg at 870–367–3464, ext. 18 or dbragg@fs.fed.us.

Forest Environmental Threats Conference July 2006

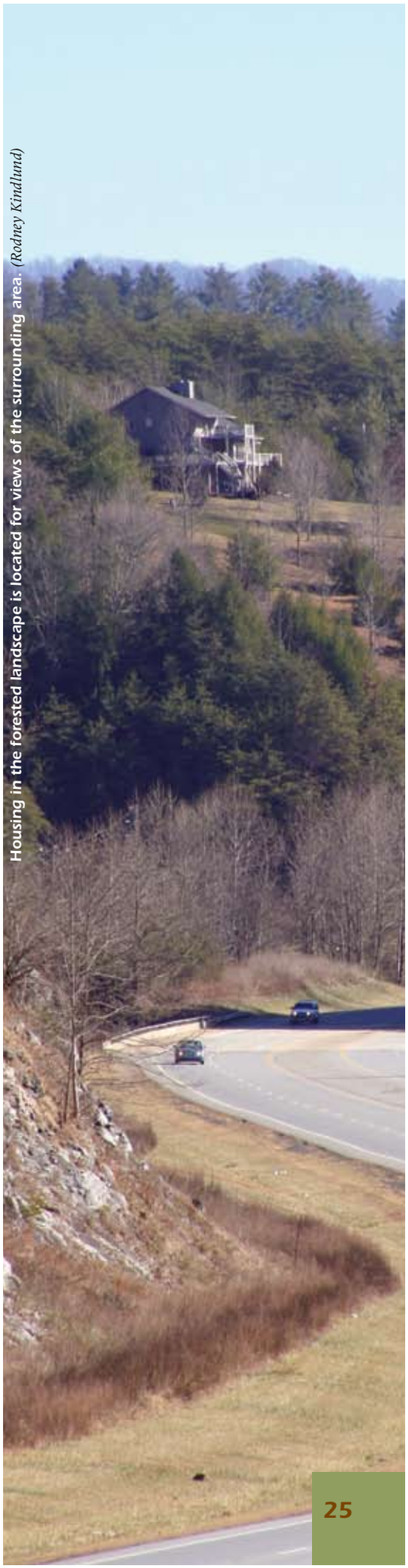
North America's forests and rangelands face many environmental threats that often act in concert and with no regard for land ownership and administrative boundaries. As such, they are difficult to identify and anticipate, much less manage or control. A conference will meet in Boulder, CO, July 18–20, 2006, to explore the latest information on threat assessment and management. Meeting planners want to encourage meaningful exchange among those developing new knowledge and tools for threat assessment and those responsible for managing forests and rangelands. The intended audience includes scientists, educators, policymakers, property owners, land managers, and students. The program will include scientific and case study sessions, oral and poster presentations, and panel discussions.

Sponsors include the Forest Service: the Western Wildland Environmental Threat Assessment Center, Pacific Northwest Research Station, the Eastern Forest Environmental Threat Assessment Center, Southern Research Station, and Cooperative State Research, Education, and Extension Service; Southern Regional Extension Forestry; and the Southern Forest Research Partnership.

For more information:
http://www.forestencyclopedia.net/Encyclopedia/Threats or contact John Pye at 919–549–4013 or jpye@fs.fed.us.

Errata...

In the last issue of COMPASS, the photo credit line was inadvertently hidden by the photo on page 14. The photo caption and credit should read, **"Male, 24-day old red-cockaded woodpecker being fed by a helper at the nest cavity entrance."** *(©Derrick Hamrick, Images of the Wild)*. The editorial staff regrets the oversight.



Housing in the forested landscape is located for views of the surrounding area. *(Rodney Kindlund)*

A sunny winter day at SRS Headquarters, Asheville, NC *(Rodney Kindlund)*

NEW PRODUCTS

Southern Pine Ecosystems

1 Ylioja, Tiina; Slone, Daniel H.; Ayres, Matthew P. 2005. **Mismatch between herbivore behavior and demographics contributes to scale dependence of host susceptibility in two pine species.** Forest Science. 51(6): 522-531. *[Editor's note: Slone was a Southern Research Station scientist when he co-authored this paper.]*

The impacts on forests of tree-killing bark beetles can depend on the species composition of potential host trees. Host susceptibility might be an intrinsic property of tree species, or it might depend on spatial patterning of alternative host species. We compared the susceptibility of loblolly pine (*Pinus taeda*) and Virginia pine (*P. virginiana*) to southern pine beetle (*Dendroctonus frontalis*) at two hierarchical levels of geographic scale: within beetle infestations in heterospecific stands, and across a forest landscape dominated by monospecific stands. In the former, beetles preferentially attacked Virginia pine, but in the latter, loblolly stands were more susceptible. This hierarchical transition in host susceptibility was predicted from knowledge of (1) a behavioral preference of beetles for attacking loblolly versus Virginia pine, (2) a negative correlation between preference and performance, and (3) a mismatch in the domain of scale between demographics and host selection by individuals.

Wetlands, Bottomlands, and Streams

2 Barton, Christopher; Kinkead, Karen. 2005. **Do erosion control and snakes mesh?** Journal of Soil and Water Conservation. 60(2): 33-35. *[Editor's note: Barton wrote this article while employed at the Center for Forested Wetlands, Southern Research Station.]*

from the Southern Research Station...

Erosion control blankets provide an organic matrix to retain soil moisture, promote seed germination, and disperse erosion-causing energy from raindrops. Rolled erosion control blankets were used to help restore 15 degraded Carolina bay wetlands. The blankets were effective for their stated purpose, but were hazardous to snakes. The products' mesh sizes of 10 mm^2 and 20 mm^2 provided easy entry for the black racer, rat snake, water snake, corn snake, and eastern hognose. Fourteen of the 19 trapped snakes died, either due to lacerations, overheating, or being unable to escape predators, including fire ants. A smaller mesh size would be safer for snakes and possibly other wildlife.

3 Devall, Margaret S.; Thien, Leonard B. 2005. **Inland occurrence of the strand plant *Ipomoea pes-caprae* (Convolvulaceae) around Lake Nicaragua.** Southwestern Naturalist. 50(3); 380-384.

Ipomoea pes-caprae (railroad vine, Convolvulceae) is a pantropical, perennial beach plant that forms large patches just above the high tide line on coastal beaches and dunes throughout tropical and subtropical areas of the world. In spite of its wide distribution, only rare occurrences of *I. pes-caprae* have been documented in inland habitats. We report on an extensive population of *I. pes-caprae* growing on the shores of Lake Nicaragua in the interior of Nicaragua.

4 Horn, Scott; Hanula, James L.; Ulyshen, Michael D.; Kilgo, John C. 2005. **Abundance of green tree frogs and insects in artificial canopy gaps in a bottomland hardwood forest.** American Midland Naturalist. 153: 321-326.

We found more green tree frogs (*Hyla cinera*) in canopy gaps than in closed canopy forest. Of the 331 green tree frogs observed, 88 percent were in canopy gaps. Likewise, higher numbers and biomasses of insects were captured in the open gap habitat. Flies were the most commonly collected insect group, accounting for 54 percent of the total capture. These data suggest that one reason green tree frogs were more abundant in canopy gaps was the increased availability of prey and that small canopy gaps provide early successional habitats that are beneficial to green tree frog populations.

5 Kilgo, John C. 2005. **Harvest-related edge effects on prey availability and foraging of hooded warblers in a bottomland hardwood forest.** The Condor. 107: 627-636.

The effects of harvest-created canopy gaps in bottomland hardwoods on arthropod abundance and, hence, the foraging ecology of insectivorous birds is unknown. This study determined that arthropod prey abundance was highest in forested areas >100 m from a gap edge and that foraging attack rates were highest >30 m from a gap edge. Hooded warblers apparently encountered less prey and foraged less efficiently where arthropods were least abundant, near gaps. However, when birds were foraging for fledglings, attack rates did not vary by distance from gaps, suggesting that prey availability may not be limiting in these forests, despite the effects of harvest gaps on arthropods.

6 Lockhart, Brian Roy; Meadows, Steve; Portwood, Jeff. 2005. **Southern hardwood forestry group going strong after 50 years.** Delta Wildlife. 12(1): 5-6.

The Southern Hardwoods Forestry Group celebrated its 50th anniversary in November 2005. The group provides a medium for exchange of ideas on the management and utilization of hardwood timber. The focus has expanded through the years to include wildlife habitat management and other ecological values. The Southern Hardwood Forestry Group continues to serve as an important outlet for the dissemination of hardwood research and management information.

7 Richter, Stephen C.; Young, Jeanne E.; Siegel, Richard A.; Johnson, Glen N. 2001. **Postbreeding movements of the dark gopher frog, *Rana sevosa* Goin and Netting: implications for conservation and management.** Journal of Herpetology. 35(2): 316-321.

Conservation plans for amphibians often focus on activities at the breeding site, but for species that use terrestrial habitats for much of the year, an understanding of nonbreeding habitat use is also essential. We used radio telemetry to study the postbreeding movements of individuals of the only known population of dark gopher frogs, *Rana sevosa*, during two breeding seasons. Movements away from the pond were relatively short and usually occurred within a two-day period after frogs initially exited the breeding pond. Dispersal distances for some individuals may have been constrained by a recent clearcut on adjacent private property. When implementing a conservation plan for *Rana sevosa* and other amphibians with similar habitat utilization patterns, we recommend that a terrestrial buffer zone of protection include the aquatic breeding site and adjacent nonbreeding season habitat.

8 Strayer, David L.; Downing, John A.; Haag, Wendell R. [and others]. 2004. **Changing perspectives on pearly mussels, North America's most imperiled animals.** Bioscience. 54(5): 429-439.

Pearly mussels (*Unionacea*) are widespread, abundant, and important in freshwater ecosystems around the world. Catastrophic declines in populations have led to research on mussel biology, ecology, and conservation. Research has begun to benefit from and contribute to ideas about suspension feeding, life history theory, metapopulations, flow refuges, spatial patterning and its effects, and management of endangered species. Significant gaps in understanding and apparent paradoxes in pearly mussel ecology have been exposed. To conserve remaining mussel populations, scientists and managers must simultaneously and aggressively pursue both rigorous research and conservation actions.

9 Warren, Melvin L., Jr.; Haag, Wendell R. 2005 **Spatio-temporal patterns of the decline of freshwater mussels in the Little South Fork Cumberland River, USA.** Biodiversity and Conservation. 14: 1383-1400.

The Little South Fork Cumberland River, Kentucky and Tennessee, USA, was a globally important conservation refugium for freshwater mussels (Mollusca: Unionidae) because it supported an intact example (26 species) of the unique Cumberland River mussel fauna, including imperiled species. We used previous surveys and our 1997–1998 survey to reconstruct the historical fauna, to describe spatio-temporal patterns of density and number of species, and to evaluate the probable sequence and cause of observed mussel declines. We were interested in better understanding how mussel assemblages respond to chronic disturbances, and how these changes manifest in persistence patterns. Of the total species recorded from the Little South Fork, 17 (65 percent) are seemingly extirpated and five others appear near extirpation. Declines are associated with at least two, temporally distinct major insults. The river appears lost as a conservation refugium for mussels. We suggest that the river could be restored and mussels reintroduced if an interagency taskforce is formed to identify and mitigate specific stressors.

Mountain and Highland Ecosystems

10 Bragg, Don C. 2004. **Historical reflections on the Arkansas Cross Timbers.** Journal of Arkansas Academy of Science. 58: 32-36.

Küchler's original map of potential natural vegetation suggested that the eastern-most extension of the "Cross Timbers" oak-dominated woodland reached into extreme western Arkansas. Recent investigations have found possible old-growth Cross Timber communities in narrow strips along steep, rocky sandstone and shale ridges near Fort Chaffee and Hackett. General Land Office surveyors before 1850 reported many ridges and slopes dominated by grassy, stunted oak woodlands, with extensive prairies and richer bottomland terraces. Historical accounts help show that, though far more restricted in this extent than comparable stands in Oklahoma or Texas, Cross Timber communities are possible in Arkansas.

Inventory and Monitoring

11 Chang, S.J.; Busby, R.L.; Pasala, P.R.; Goelz, J.C. 2005. **VB Merch-Slash: a growth-and-yield prediction system with a merchandising optimizer for planted slash pine in the west gulf region.** RP SRS-36. Asheville, NC; U.S. Department of Agriculture, Forest Service, Southern Research Station. 16 p.

A Visual Basic computer model that can be used to estimate the harvest value of slash pine plantations in the west gulf region is presented. The model uses a dynamic programming algorithm to convert stand tables predicted by COMPUTE_P-SLASH into a listing of seven products that maximizes the harvested value of the stand.

12 Chang, S.J.; Busby, R.L.; Pasala, P.R.; Leduc, D.J. 2005. **VB Merch-Lob: a growth-and-yield prediction system with a merchandising optimizer for planted loblolly pine in the west gulf region.** RP SRS-35. Asheville, NC; U.S. Department of Agriculture, Forest Service, Southern Research Station. 15 p.

A Visual Basic computer model that can be used to estimate the harvest value of loblolly pine plantations in the west gulf region is presented. The model uses a dynamic programming algorithm to convert stand tables predicted by COMPUTE_P-LOB into a listing of seven products that maximizes the harvested value of the stand.

13 Coulston, John W.; Ambrose, Mark J.; Riitters, K.H.; Conkling, Barbara L. 2005. **Forest health monitoring: 2002 national technical report.** Gen. Tech. Rep. SRS-84. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 97 p.

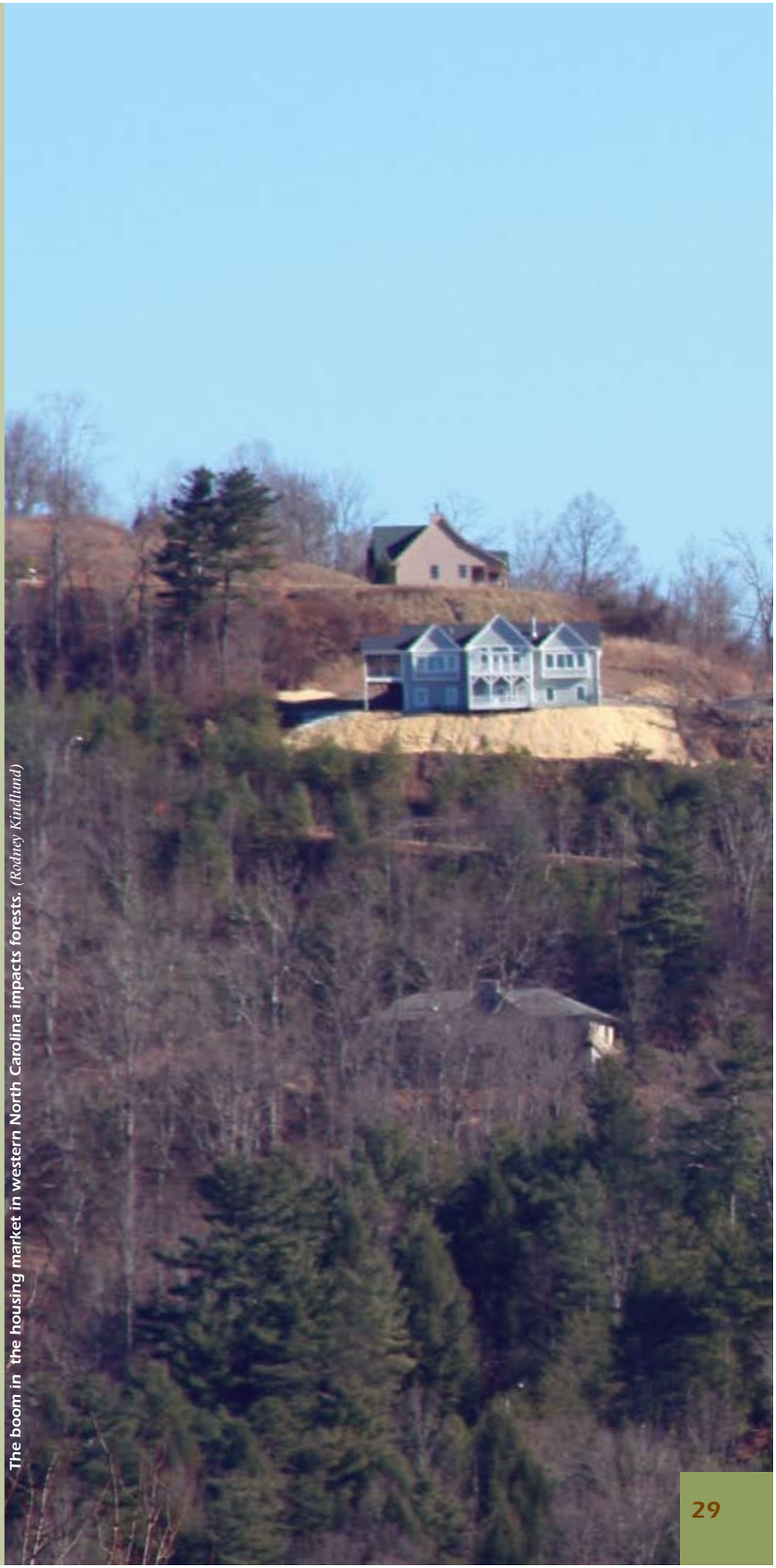
The Forest Health Monitoring Program's 2002 national technical report presents results of forest health analyses from a national perspective. This annual report focuses on "Criterion 3—Maintenance of Forest Ecosystem Health and Vitality" from the "Criteria and Indicators of Sustainable Forestry of the Santiago Declaration" as the reporting framework. The report provides background information about Forest Health Monitoring, details about the conceptual approach to the report, and details about data used in the analyses. The first indicator section focuses on abiotic, biotic, and anthropogenic disturbances, including drought, hurricanes, tornadoes, fire, insects and diseases, introduced species, and land development. The second

section addresses air pollution data, including nitrate and sulfate wet deposition data and ozone data. The third section contains analyses of tree health data including tree mortality, crown condition, and damage. The final data section is a multivariate analysis, providing an integrated presentation of the data used in the report.

14 Coulston, John W.; Ambrose, Mark J.; Riitters, K.H.; Conkling, Barbara L.; Smith, William D. 2005. **Forest health monitoring: 2003 national technical report.** Gen. Tech. Rep. SRS-85. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 97 p.

The Forest Health Monitoring Program's 2003 national reports present results from forest health data analyses focusing on a national perspective. The Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests are used as a reporting framework. Some indicators discussed include ozone bioindicator plants; changes in trees (crown condition, mortality, and stand age); and soils (forest floor depth). Other indicators or indicator groups use data about insects and diseases, and remotely sensed or ground-based data about distance to roads, forest edge, interior forest, drought, fire, and air pollution (sulfates, nitrates, and ozone). Identifying patterns and observing possible relationships is an important part of national level analysis and reporting. The report presents results of analyses designed to evaluate whether indicators discriminate between crowns in poor condition and crowns not in poor condition.

15 Zarnoch, Stanley J.; Turner, Jeffrey A. 2005. **Adjustments to Forest Inventory and Analysis estimates of 2001 saw-log volumes for Kentucky.** Res. Pap. SRS-38. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 4 p.



The boom in the housing market in western North Carolina impacts forests. *(Rodney Kindlund)*

The 2001 Kentucky FIA survey overestimated hardwood saw-log volume in tree grade 1 because too many trees were classified as grade 1 trees. Quality assurance data generated two types of adjustments, one based on the proportion of trees misclassified, and the other on the proportion of saw-log volume misclassified. Both methods significantly reduced estimated saw-log volume in tree grade 1. We believe that the saw-log volume approach is superior to the tree approach, but that both approaches generate improved estimates of tree-grade saw-log volumes. Standard errors are given for adjustment proportions, based on a cluster sampling design.

Large-Scale Assessment and Modeling

16 Brandeis, Thomas J.; Suárez Rozo, María del Rocío. 2005. **Effects of model choice and forest structure on inventory-based estimations of Puerto Rican forest biomass.** Caribbean Journal of Science. 41(2): 250-268.

This paper describes young, secondary tropical forest structure and carbon sequestration in the Río Grande de Arecibo watershed using forest inventory results from the USDA Forest Service's Southern Research Station's Forest Inventory and Analysis and University of Puerto Rico at Mayagüez Atmospheric Carbon Sequestration Project. Once heavily deforested, the watershed now holds relatively large, contiguous tracts of biologically diverse, secondary tropical forest, some of which is being considered for addition to the island's public forests. As primary forests are being lost, secondary forests are on the increase worldwide, and their role in global biogeochemical cycling needs to be better understood.

17 Matta, Jagannadha; Alavalpati, Janaki; Kerr, John; Mercer, Evan. 2005. **Agency perspectives on transition to participatory forest management: a case study from Tamil Nadu, India.** Society and Natural Resources. 18: 859-870.

This paper reports on surveys of foresters involved with implementing India's Joint Forest Management initiative to examine the impact of attitudes on the success of collaborative forest management. Despite foresters' motivation toward implementing this policy, uncertain incentives and institutional complexities make the task complex and difficult. While decentralized decision making in the Tamil Nadu Forest Department could help mitigate the situation, the department's culture limits feedback in the system and represents a strong barrier to organizational adaptation. Pragmatic strategies for promoting participatory forest management should focus first on improving the institutional conditions of foresters in order to develop a shared vision and a unified strategy.

18 Neale, Anne C.; Jones, K. Bruce; Nash, Maliha S. [and others]. 2003. **Application of landscape models to alternative futures analyses.** In: Rapport, David J.; Lasley, William L.; Rolston, Dennis E., eds. [and others]. Managing for healthy ecosystems. Boca Raton, FL: CRC Press LLC: 577-587. *[Editor's note: Southern Research Station scientist Kurt Riitters co-authored this publication.]*

Different models have been proposed and used to predict future conditions, but the basic premise is the same: (1) what land managers and the public want based on needs and values; and (2) biophysical constraints of the environment. This chapter describes a model to predict nitrogen loading, one aspect important to water quality of streams, from a suite of landscape metrics and then will apply this model to a series of alternative future landscapes. This example illustrates important issues to consider when developing models for future conditions. Although we will describe only the process for modeling nitrogen loading, the methods presented could easily be applied to other environmental end points.

(USDA Forest Service)

19 Prestemon, Jeffrey P.; Mercer, D. Evan; Pye, John M. [and others]. 2001. **Economically optimal wildfire intervention regimes.** In: Proceedings, 2001 American Agricultural Economics Association meeting. 18 p. http://agecon.lib.umn.edu/cgi-bin/detailview.pl?paperid=2872. [Date accessed: November 3, 2005].

Wildfires in the United States result in total damages and costs that are likely to exceed billions of dollars annually. Land managers and policy makers propose higher rates of prescribed burning and other kinds of vegetation management to reduce amounts of wildfire and the risks of catastrophic losses. Using data to quantify how wildfire responds to prescribed burning, we evaluate whether current rates observed in one county in Florida (Volusia) differ from what might be considered economically optimal. Results show that the optimal amount of annual prescribed fire is about 3 percent (9,000 acres/year) of the total forest area, which is very close to the actual average amount of prescribed burning (12,700 acres/year) observed in Volusia County between 1994-1999.

20 Riitters, Kurt H. 2005. **Downscaling indicators of forest habitat structure from national assessments.** Ecological Indicators. 5: 273-279.

Large-area assessments of forest spatial patterns for national and international reporting are only feasible when using relatively coarse data and indicators. More work is needed to enable more detailed and local interpretations of the national statistics. This paper identifies opportunities to incorporate local information, and demonstrates an application to forest habitat assessments in Oregon and New York.

21 Turner, James A.; Buongiorno, Joseph; Zhu, Shushuai; Prestemon, Jeffrey P. 2005. **The U.S. [United States] forest sector in 2030: markets and competitors.** Forest Products Journal. 55(5): 27-36.

The Global Forest Products Model was used to project international forest sector developments, conditional on the latest RPA Timber Assessment of future domestic changes in the United States. While the United States, Japan, and Europe were predicted to remain major importers of forest products out to 2030, the rapid economic growth of China would make it the world's largest market for raw wood, and intermediate and final forest products. Mexico and the Republic of Korea would also become important markets for solid wood and fiber products. The U.S. share of global exports of industrial roundwood and other paper and paperboard were predicted to increase out to 2030. In competition with the United States, it was predicted that Finland, Austria, Latvia, Chile, and New Zealand would increase their share of global sawnwood exports, and Austria and the Republic of Korea would emerge as exporters of printing and writing paper.

22 Zarnoch, Stanley J.; English, Donald B.K.; Kocis, Susan M. 2005. **An outdoor recreation use model with applications to evaluating survey estimators.** Res. Pap. SRS-37. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 15 p.

An outdoor recreation use simulator (ORUS) has been developed to simulate recreation survey data collected by the USDA Forest Service, National Visitor Use Monitoring program's survey of national forests. Statistical distributions represent recreationists' behaviors, which include arriving times and last-exiting times, number of intermediate exits, times of exits, and trap shyness associated with the probability that recreationists will be captured by the interviewer. Functioning of the simulator is demonstrated with a simple example. The utility of ORUS in evaluating the bias and coefficient of variation of various survey scenario estimators of recreation use is also presented.


(Rodney Kindlund)

23 Wickham, James D.; Riitters, Kurt H.; Wade, Timothy G.; Jones, K. Bruce. 2005. **Evaluating the relative roles of ecological regions and land-cover composition for guiding establishment of nutrient criteria.** Landscape Ecology. 20: 791-798.

To protect aquatic resources, goals are commonly established for nitrogen and phosphorous concentrations in streams based on ecological zone maps that reflect gross differences in climate, topography, geology, and land use, all of which affect nitrogen and phosphorous dynamics. This research shows that land-cover maps are better than ecological zone maps when predicting nitrogen and phosphorus concentrations in streams, and, furthermore, that most differences among ecological zones are explained largely by differences in the types of land cover that they contain. The results suggest that land-cover maps could be used to help establish local nutrient goals for individual watersheds.

Wildland-Urban Interface and Urban Forestry

24 Butry, David T.; Prestemon, Jeffrey P. 2005. **Spatio-temporal wildland arson crime functions.** Selected paper presented at the 2005 American Agricultural Economics Association annual meeting. Providence, RI, July 24-27, 2005: American Agricultural Economics Association. 28 p. http://agecon.lib.umn.edu/cgi-bin/pdf_view.pl?paperid=16442&ftype=.pdf. [Date accessed: November 3, 2005].

Wildland arson creates damages to structures and timber and affects the health and safety of people living in rural and wildland-urban interface areas. For high-arson Census tracts in Florida, we develop six statistical models of daily wildland arson ignitions that incorporate information about recent and nearby suspected arson fires, in addition to measures of weather, forest fuels, law enforcement, and socioeconomic conditions. The number of wildland arson ignitions today in the Census tract is positively related to such ignitions in the same tract for up to the previous 11 days and in neighboring tracts for up to four days. Other variables showing significance include weather and wildfire activity in the previous six years. Prescribed fire and several variables that would indicate evidence consistent with an economic model of crime were less commonly significant.

25 Cho, Seong-Hoon; Newman, David H.; Bowker, J.M. 2005. **Measuring rural homeowners' willingness to pay for land conservation easements.** Forest Policy and Economics. 7: 757-770.

Population growth in the mountains of rural western North Carolina raises concerns over environmental quality and land-use policy. We examine the economic value of a conservation easement program designed to slow conversion of undeveloped land in Macon County. Although the county has struggled to adopt any land-use policy, our study shows a potentially high value for conservation easements. The estimated annual household willingness-to-pay to support an easement program ranges from $10.97 to $21.79 per year, depending on model assumptions. Added across all households, this value ranges from $109,825 to $360,772. At current prices, a range of 53–175 acres could be preserved annually. This would slow the rate of land conversion since 1987 by up to 46 percent.

26 Mercer, D. Evan; Prestemon, Jeffrey P. 2005. **Comparing production function models for wildfire risk analysis in the wildland-urban interface.** Forest Policy and Economics. 7: 782-795.

This paper evaluates and quantifies the roles that humans play in wildfire regimes in populated areas near and within fire prone areas. We use county level, time-series data from Florida to empirically estimate three broad classes of wildfire production functions: fire event (ignitions), fire aggregate extent, and a combination function of fire effect and aggregate

extent. Although higher population and poverty are correlated with more wildfire (acreage) and more intense wildfires, higher levels of unemployment and poverty are associated with fewer wildfire ignitions. The number of police in a county is correlated with fewer ignitions. Discussing possible reasons for these results, we suggest that managers and decision makers should be aware of socioeconomic impacts on wildfire and consider them in wildland fire management decisions. Our results also emphasize the importance of including such variables in statistical models of wildfire risk.

Foundation Programs

27 Conrad, Robert F.; Gillis, Malcolm; Mercer, D. Evan. 2005. **Tropical forest harvesting and taxation: a dynamic model of harvesting behavior under selective extraction systems.** Environment and Development Economics. 10: 689-709.

A dynamic model of selective harvesting in multi-species, multi-age tropical forests is developed. Forests are predicted to exhibit different optimal harvesting profiles, depending on the nature of their joint cost functions and own or cross-species stock effects. The model is applied to the controversy about incentives produced by various taxes. The impacts of specific taxes are shown to depend on the composition of the forest stocks, growth rates, and joint cost effects. Therefore, specific taxes may create different incentives and impacts in Indonesia than in Brazil or Malaysia, for example, suggesting that no single uniform forest tax policy will be appropriate for all countries or all forests.

28 Wilson, A.D.; Lester, D.G.; Oberle, C.S. 2005. **Application of conductive polymer analysis for wood and woody plant identifications.** Forest Ecology and Management. 209: 207-224.

This paper describes an electronic aroma detection (EAD) technology known as conductive polymer analysis (CPA), developed to identify woody samples of hardwoods and conifers. CPA uses an electronic nose instrument that characterizes the aroma (smells) of vapors released from excised wood. Unique digital electronic fingerprints of wood aromas were obtained from woods of individual tree species. A reference library containing aroma signature patterns was developed and used to effectively identify unknown samples of individual tree species. Potential applications of CPA methods include research in ecology, forestry, plant taxonomy, and related disciplines. Other applications of this technology were discovered for the management of forested stands and ecosystems based on the identification of roles that wood-inhabiting organisms play in stand dynamics and long-term ecosystem functions.

29 Wilson, A. Dan. 2005. **Recent advances in the control of oak wilt in the United States.** Plant Pathology Journal. 4(2): 177-191.

Oak wilt, caused by Ceratocystis fagacearum, is the most destructive disease of oak trees (*Quercus* species) in the United States. The serious potential for damage prompted an increase in Federal funding for oak wilt research in the past 15 years. Benefits from this research have been extensive due to technological developments that have greatly improved our ability to manage this devastating disease nationwide. These improved methods for oak wilt control are reviewed and discussed in relation to current State forestry pest-control programs that have begun to implement these methods in their oak wilt suppression operations.

(USDA Forest Service)

(Rodney Kindlund)

Research Work Units

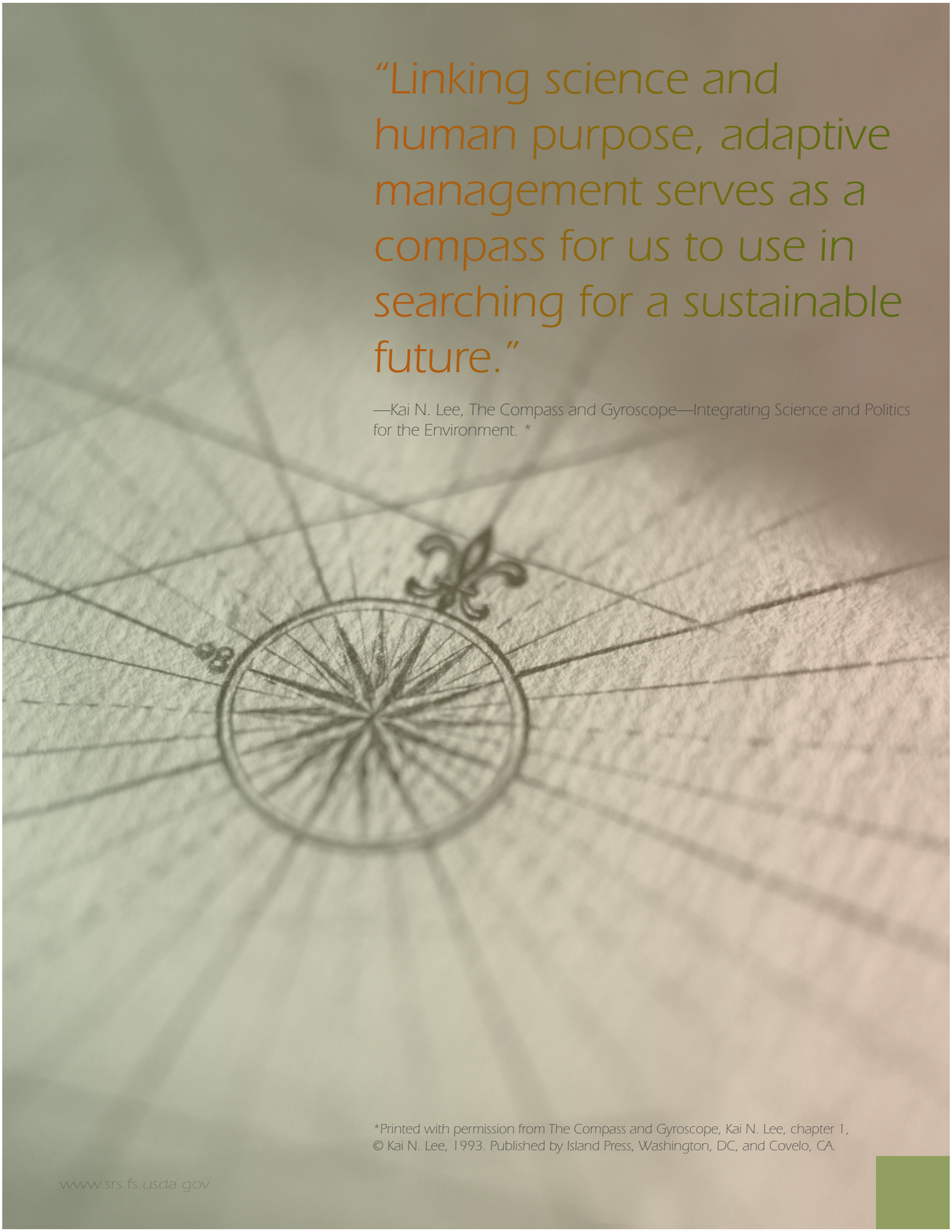
Location & Project Leader	Unit	Name & Web Site	Phone
Asheville, NC David Loftis	4101	Ecology and Management of Southern Appalachian Hardwood Forests www.srs.fs.usda.gov/bentcreek	828-667-5261
Asheville, NC Danny Lee	4853	Eastern Forest Environmental Threat Assessment Center	828-257-4854
Athens, GA John Stanturf	4104	Disturbance and the Management of Southern Pine Ecosystems www.srs.fs.usda.gov/disturbance	706-559-4315
Athens, GA Jim Hanula	4505	Insects and Diseases of Southern Forests www.srs.fs.usda.gov/4505	706-559-4285
Athens, GA Ken Cordell	4901	Assessing Trends, Values, and Rural Community Benefits from Outdoor Recreation and Wilderness in Forest Ecosystems www.srs.fs.usda.gov/trends	706-559-4264
Auburn, AL Kris Connor	4105	Vegetation Management Research and Longleaf Pine Research for Southern Forest Ecosystems www.srs.fs.usda.gov/4105	334-826-8700
Auburn, AL Robert Rummer	4703	Biological/Engineering Systems and Technologies for Ecological Management of Forest Resources www.srs.fs.usda.gov/forestops	334-826-8700
Blacksburg, VA Andrew Dolloff	4202	Coldwater Streams and Trout Habitat in the Southern Appalachians www.trout.forprod.vt.edu	540-231-4016
Blacksburg, VA Philip Araman	4702	Integrated Life Cycle of Wood: Tree Quality, Processing, and Recycling www.srs4702.forprod.vt.edu	540-231-4016
Charleston, SC Carl Trettin	4103	Center for Forested Wetlands Research www.srs.fs.usda.gov/charleston	843-727-4271
Clemson, SC Susan Loeb	4201	Endangered, Threatened, and Sensitive Wildlife and Plant Species in Southern Forests www.srs.fs.usda.gov/4201	864-656-3284
Franklin, NC James Vose	4351	Evaluation of Watershed Ecosystem Responses to Natural, Management, and Other Human Disturbances	828-524-2128
Gainesville, FL Ed Macie	4951	Southern Center for Wildland-Urban Interface Research and Information www.interfacesouth.org	352-376-3213

(USDA Forest Service)

(Rodney Kindlund)

Research Work Units (Continued)

Location & Project Leader	Unit	Name & Web Site	Phone
Huntsville, AL Greg Ruark	4551	National Agroforestry Center www.nac.gov	256-372-4540
Knoxville, TN Bill Burkman	4801	Forest Inventory and Analysis www.srsfia2.fs.fed.us	865-862-2000
Monticello, AR James Guldin	4106	Managing Upland Forest Ecosystems in the Midsouth www.srs.fs.usda.gov/4106	870-367-3464
Nacogdoches, TX Ronald Thill	4251	Integrated Management of Wildlife Habitat and Timber Resources www.srs.fs.usda.gov/wildlife	936-569-7981
New Orleans, LA Rodney Busby	4802	Evaluation of Legal, Tax, and Economic Influences on Forest Resource Management www.srs.fs.usda.gov/4802	504-589-6652
Pineville, LA James Barnett	4111	Ecology and Management of Even-Aged Southern Pine Forests www.srs.fs.usda.gov/4111	318-473-7215
Pineville, LA Kier Klepzig	4501	Ecology, Biology, and Management of Bark Beetles and Invasive Forest Insects of Southern Conifers www.srs.fs.usda.gov/4501	318-473-7232
Pineville, LA Les Groom	4701	Utilization of Southern Forest Resources www.srs.fs.usda.gov/4701	318-473-7268
Raleigh, NC Steven McNulty	4852	Southern Global Change Program www.sgcp.ncsu.edu	919-513-2974
Research Triangle Park, NC Kurt Johnsen	4154	Biological Foundations of Southern Forest Productivity and Sustainability www.srs.fs.usda.gov/soils/soilhome.htm	919-549-4092
Research Triangle Park, NC William Bechtold	4803	Forest Health Monitoring http://willow.ncfes.umn.edu/fhm/fhm_hp.htm	919-549-4014
Research Triangle Park, NC David Wear	4851	Economics of Forest Protection and Management www.srs.fs.usda.gov/econ	919-549-4093
Saucier, MS Dana Nelson	4153	Southern Institute of Forest Genetics	228-832-2747
Starkville, MS Terry Wagner	4502	Wood Products Insect Research www.srs.fs.usda.gov/termites	662-338-3100
Stoneville, MS Ted Leininger	4155	Center for Bottomland Hardwoods Research www.srs.fs.usda.gov/cbhr	662-686-3154



"Linking science and human purpose, adaptive management serves as a compass for us to use in searching for a sustainable future."

—Kai N. Lee, The Compass and Gyroscope—Integrating Science and Politics for the Environment. *

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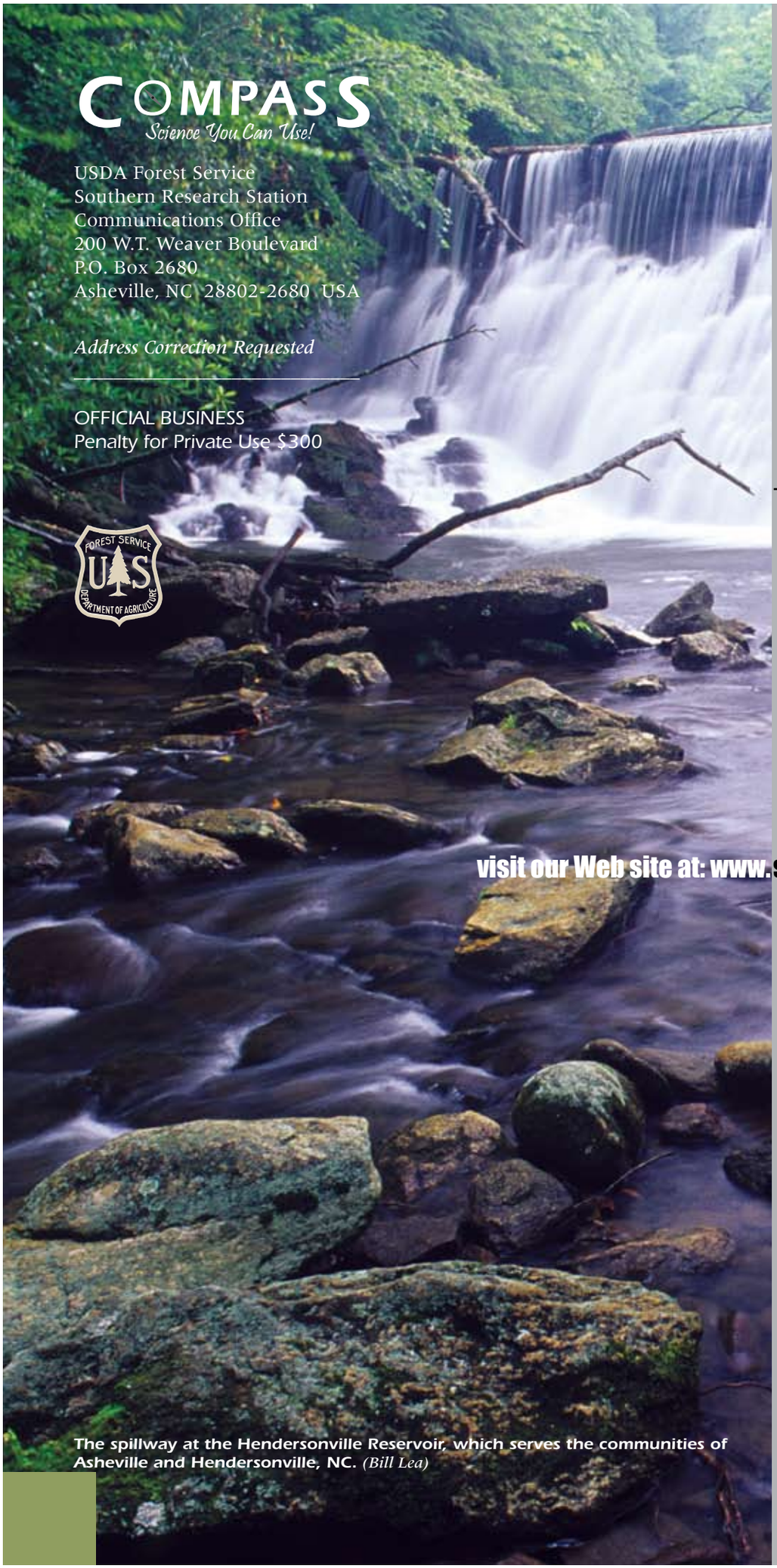

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The spillway at the Hendersonville Reservoir, which serves the communities of Asheville and Hendersonville, NC. *(Bill Lea)*

Next Issue...

In this issue, we touched briefly on the benefits, or ecosystem services, forests provide us. One of the most important of these is water: in the Southeast, both water quality and quantity are insured by forests under multiple ownerships—public, industrial, and private. In our next issue, we will look more closely at how forests actually clean water, how management activities affect stream quality, and the future of water supplies in the Southeast.

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