COMPASS

perspectives & tools to benefit southern forest resources

Spring 2005

Silent Invaders of Our Southern Forests

When invasive plants take over our forests and communities...

Southern Research Station
USDA Forest Service

INSIDE... THE SCIENCE

Cover photo by John Asher (USDI Bureau of Land Management) shows the extent that nonnative plants in the South can invade a landscape. The use of nonnative species in a natural landscape invites unwanted weed species to invade our communities.

(more on p. 14)

Multiflora rose *(Photo by James H. Miller, USDA Forest Service)*

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DEPARTMENTS

COMPASS
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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.

SILENT INVADERS OF SOUTHERN FORESTS

by Zoë Hoyle

Most people don't see a threat to national security in a forest choked with invasive plants. But for **Jim Miller**, the analogy is not that much of a stretch. Miller, research ecologist with the Southern Research Station (SRS) **Forest Vegetation Management unit** in Auburn, AL, spends long hours on the road, spreading the word about the threats posed by these nonnative interlopers.

"For me, nonnative invasives are plant bioterrorists," says Miller. "They occupy our lands at will, making them useless for wildlife, native plants, and humans."

For almost 30 years, Miller has researched and developed effective controls for invasive plants in forest settings. Author of the guide *Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control*, Miller approaches the problem of these destructive imports with passion and vision.

Nonnative invasive plants invade an estimated 4,600 acres of U.S. land every day, with about half of those acres on public land. These alien weeds destroy native plant communities and limit plant and animal diversity. Largely unnoticed by the general public, nonnative invasives creep steadily deeper into millions of acres of southern forests along corridors formed by roads, trails, streams, and rivers.

Nonnative invasive plants invade an estimated 4,600 acres of U.S. land every day, with about half of those acres on public land.

How Did Plants Get To Be Such a Big Problem?

European settlers brought many of today's nonnative invasive plants over in the 1700s and 1800s. In the late 1800s, importing new plants for agricultural and other purposes became a national priority, and introductions continue today. Over 50,000 new plant species and varieties have been brought into the United States, and at least 4,500 now live outside cultivation. Kudzu (*Pueraria montana*), a relatively late introduction, was planted widely in the Southern United States to stabilize eroding soils and provide forage for livestock on depleted farmlands.

"Kudzu was one of many alien plants brought to the United States in an effort to heal overused lands and feed the population after the Great Depression and the droughts of the early 1900s," says Miller. "Many of these plants were chosen for their hardiness, and they continue to spread today."

Whether introduced accidentally or like most, brought in for ornamental use or livestock forage, these plants left an environment where they were kept in check by insects or diseases that had evolved with them. In a new environment with no natural enemies, they competed unfairly with native vegetation. Many of the plants introduced in the 1700s and 1800s did not become a problem until the late 1900s. The end of a long "lag" phase often corresponded with landscape disturbances from farming and forestry practices that helped clear the way for invasion.

"All invasives have a lag phase, followed by a rapid spread phase," says Miller. "Some of the plants the European settlers brought started

(continued on page 2)

Old World climbing fern *(Photo by Peggy Greb, USDA Agricultural Research Service)*

TERMS OF INVASION

Many of the terms for nonnative invasive plants are used interchangeably, but there are subtle differences. The words that follow are used throughout the articles in this issue:

exotic plant: a plant introduced by humans to a location outside its natural range—alien, nonnative, introduced.

invasive plant: a plant that grows and spreads rapidly, establishes over large areas, and persists in areas where it is not wanted.

native: belonging to or associated with a particular place.

naturalized: adapted to an environment that is not native; established and reproducing as though native.

nonnative invasive plant: an invasive plant introduced to a location outside its native range.

noxious weed: official designation for a weed that causes major economic damage.

ornamental: a plant cultivated for home and commercial landscaping purposes.

threat: an agent that can significantly alter a natural habitat, displace a native species, affect genetic integrity, or otherwise damage native ecosystems.

weed: a plant growing where it is not wanted, judged to be a nuisance.

SILENT INVADERS

(continued from page1)

out in a lag phase of 80 to 100 years while they adapted to new environments. For various poorly understood reasons, they began expanding rapidly."

Chinese privet (*Ligustrum sinense*) was introduced in 1852, and was in a lag phase until 1962, when some change—hybridization or some other factor—caused it to take off. Today, Chinese privet is a force to be reckoned with. It currently occupies an estimated 20 million acres of southern forestland.

"I don't know if we can live with Chinese privet," says Miller. "It can actually stop hardwood regeneration, and prevent forests from forming. You end up with a solid shrub thicket where once you had a forest."

A Particular Danger to Forests

In the South, many of these plants—privet, tall fescue (*Lolium arundinaceum*), cogongrass (*Imperata cylindrica*), to name a very few—have reached an explosive stage. Cogongrass, accidentally introduced into the Mobile, AL, area in 1917, now infests over 1.25 million acres in Alabama, Mississippi, and Florida. Most of the land invaded by cogongrass is forestland, where wildlife habitat has been destroyed. Cogongrass is also highly flammable, so it increases the threat of wildfire. Continued incursions of invasives such as cogongrass that burn with unusually high intensity and others such as Japanese climbing fern (*Lygodium japonicum*) that form "fire ladders," could eventually reduce the diverse forests of the region to savanna forests.

Cogongrass, privet, Nepalese browntop (*Microstegium vimineum*) and garlic mustard (*Alliaria petiolata*) literally choke southern forests. But they're not the only ones. Landscape plants, many still for sale to homeowners and professional landscapers, have moved out of the garden and into the woods.

"Many people are not aware of the problems that ornamental plants such as Bradford pear, burning bush, and English ivy cause," cautions Miller. "Most nonnative invasive plants are perennials and form extensive roots and runners. They take over quickly and once established, are difficult to remove."

With their rapid early growth and dense infestations, invasive plants alter the ecology of forests, affecting water and soil quality and causing declines in both the numbers and diversity of native species. Nonnative imports literally overrun native plants, creating unique new habitats amenable to yet more invasives. Vines climb over native vegetation, blocking sunlight and even breaking small trees.

English Ivy *(Photo by Chuck Bargeron, University of Georgia)*

Grasses form dense, impenetrable mats.

Nonnative plants often interbreed with their native relatives. For example, oriental bittersweet (*Celastrus orbiculatus*) can cross, or hybridize, with the native American bittersweet (*C. scandens*). As a result, American bittersweet is increasingly rare in Southern Appalachia and may disappear completely.

Some invasives are worse than others. Japanese honeysuckle (*Lonicera japonica*) infests roughly half of southern forestland, but is not a pressing problem.

"Honeysuckle is somewhat of a team player," says Miller. "It participates in forest communities and is only unruly in special situations and locales."

Kudzu, the South's most infamous invader, is another matter. Preliminary results from a new invasive plants survey by the SRS Forest Inventory and Analysis unit estimates that over 3 million acres of forest had been replaced by kudzu.

"I've been in a death lock with kudzu for over 25 years," Miller says. "I still answer hundreds of emails and phone calls each year about kudzu control alone."

The Southeast is also under attack from species moving down from the Northeast—mile-a-minute weed (*Polygonum perfoliatum*), burning bush (*Euonymus alata*), and Chinese silvergrass (*Miscanthus sinensis*)—and from species moving up from Florida such as tropical soda apple (*Solanum viarum*), cogongrass, and Japanese climbing fern.

Search and Destroy

Preventing the incursion of invasive plants requires constant vigilance.

"Effectively controlling nonnative invasive plants relies on the constant surveillance of the road and streamsides they spread along," said Miller. "Eradicating these plants is much easier and less costly when they first appear, so it is important to be able to identify them in both growing and dormant seasons."

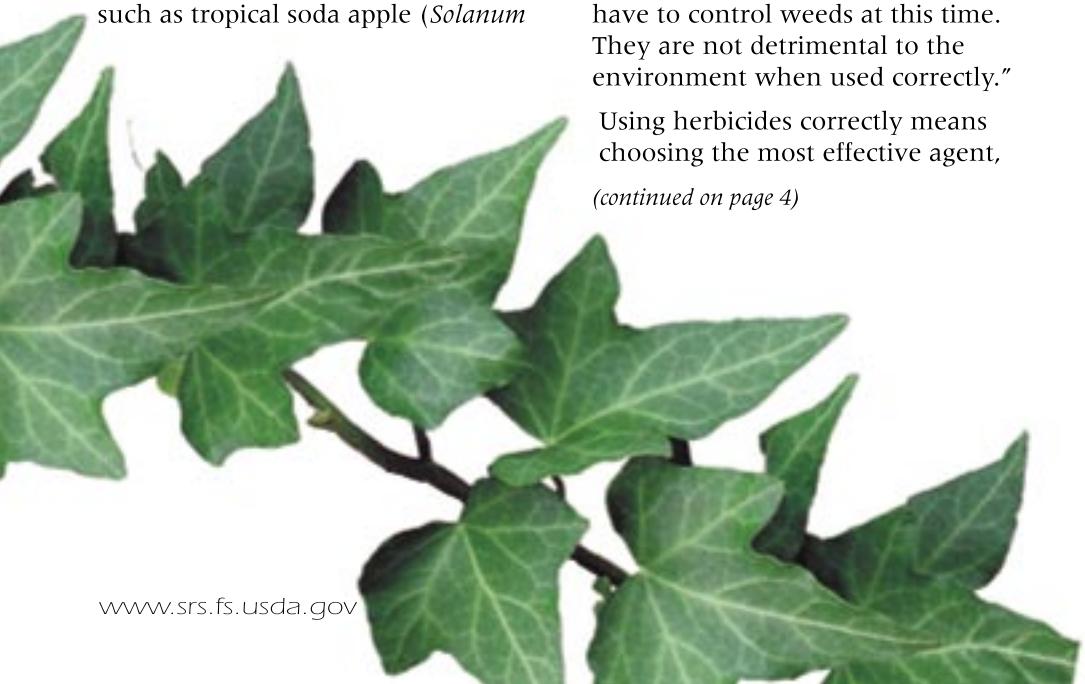
There are no easy ways to control the spread of invasive plants once they break out of the lag phase. With so many species spreading onto millions of acres, Miller is adamant about using every tool available, including mechanical treatment (usually brush-hogs and shredder mulchers), prescribed burning, herbicides, and biological control.

Herbicides—Many people would prefer to use anything but herbicides. Miller himself started out avoiding them, taking the herbicide course in graduate school "because I had to." Now he insists that the new, targeted herbicides are the best tools we have.

"I have come to see that herbicides are often the most ecologically safe choice," says Miller, whose own research has focused on the most effective ways to use herbicides to kill nonnative invasives while protecting natives. "The new herbicides are not toxic to humans and animals, and are the most sophisticated way we have to control weeds at this time. They are not detrimental to the environment when used correctly."

Using herbicides correctly means choosing the most effective agent,

(continued on page 4)



Forest Plants of the Southeast Revised

"Southeastern forests have for long periods been molded by strong natural and human influences. Much of the current forested area has been cleared and cultivated in the past, often followed by an extended period of open range grazing and repeated burning. Old field and natural forest succession followed, with episodes of increasingly intensified logging and decreases in burning frequency. With human migrations and occupations came introductions of nonnative plants, which continue today. Nonnative plants are increasingly replacing native flora."

—Jim Miller, *Forest Plants of the Southeast*

Jim Miller's passion for stopping the invasion of nonnative plants rises in part out of his appreciation for the richness and diversity of the forest plants native to the Southeastern region of the United States. In May 2005, the University of Georgia Press, in cooperation with the Southern Weed Science Society, published the revised version of his award-winning guidebook *Forest Plants of the Southeast and Their Wildlife Uses*. Karl Miller, professor of wildlife ecology and management at the University of Georgia, coauthored the book. Ted Bodner took most of the photographs in collaboration with Jim Miller, with valued image contributions by many others.

The guide focuses on the importance of southeastern forest plants to wildlife, birds, and butterflies. Enhanced by 650 color photographs and describing over 330 native and nonnative species, *Forest Plants of the Southeast and Their Wildlife Uses* is designed as a resource for forest landowners, game biologists, students, and anyone with an interest in how plants and wildlife interact in southern forest ecosystems.

For ordering information:
go to the University of Georgia Web site http://www.ugapress.uga.edu and search for the title.

Using Herbicides Effectively

Most nonnative invasive plants are perennials, and have extensive tough roots and runners. For these plants, effective herbicide applications offer the best means of containment or eradication, because herbicides can kill roots without baring the soil for reinvasion or erosion. To successfully use herbicides:

- Use the most effective herbicide for the species.
- Follow the application methods prescribed on the label.
- Choose the optimum time period to apply treatments; for foliar-applied herbicides, this is late summer to early fall, and not later than a month before expected frost.
- Adhere strictly to all label prohibitions, precautions, and Best Management Practices during herbicide transport, storage, mixing, and application.
- Remember that some herbicides require up to a month before their activity is detected as yellowing foliage or leaves with dead spots. Be patient, and allow the herbicides to work before resorting to other treatment options.

SILENT INVADERS

(continued from page 3)

using the correct methods of mixing and application, and timing applications correctly.

Biocontrol—the use of one living organism to control another, is probably the most environmentally benign and sustainable approach to invasive plants. Scientists search the world for new biocontrol agents—generally insects, pathogens, and fungi—to keep nonnative invasives in check.

Biocontrol demands extensive research to make sure the agents themselves do not become problems. Five to ten years of research are usually needed to find and test a group of biocontrol agents; research on a single agent can cost up to $10 million. Although this is not a high price to pay when compared to the loss of biodiversity on lands infested by nonnative invasive plants, the high price definitely limits the number of control agents researched.

"In the best of all possible worlds, we would have safe biocontrol agents for every invasive plant. Since we don't, we must continue to use the methods we have developed and tested—mechanical control, herbicides, and prescribed burning—while we promote the development of more biocontrol options," says Miller. "It is important to realize that eradicating infestations of invasive plants usually takes several years of treatment and many more of surveillance and retreatment."

Miller stresses that actual eradication is just one phase of integrated vegetative management, an approach consisting of four activities that take place continuously—detection, containment, eradication, and rehabilitation.

Rehabilitation should begin as soon as invasive plants are eradicated, but is often left out of plans altogether. Though restricting control to hand pulling is very attractive to some groups, it can actually promote the growth of new invasive plants if the soil is not immediately stabilized by planting.

"The rehabilitation phase is extremely important. To protect and stabilize the soil, fast-growing native plants that can outcompete and outlast any surviving nonnative plants must be promoted from the seedbed or planted soon after eradication."

Guide to Nonnative Invasive Plants in Third Printing

In February 2005, the Southern Research Station reprinted Jim Miller's guide, *Nonnative Invasive Plants of the Southern Forests: A Field Guide for Identification and Control*, for the third time. Issued first in May 2003, the guide has already been distributed to nearly 50,000 individuals across the Southeast, many involved in garden clubs, weed teams, and other groups committed to working locally to stem the destructive tide of nonnative invasive plants.

Miller designed the book to help people easily identify the most serious invasive plants in southern forests and to aid in region-wide surveys. The guide covers 33 plant groups, highlighting over 40 separate species. The identification section includes a complete written description of each plant, its ecology, history, and use. Detailed color photographs show how each plant looks in different seasons of the year.

Miller's book also offers both general and specific information on controlling the spread of nonnative invasive plants. The guide provides illustrated directions for applying herbicides to target nonnatives while avoiding damage to desirable plants, as well as suggestions for burning, hand pulling, and mechanical treatments. Prescriptions for specific plants follow the general guidelines.

Miller views the publication as a first step for managers and landowners in identifying and controlling the damage invasive plants do to forests, farm lands, recreational areas, and waterways across the Southeast.

The guide can be viewed and downloaded at http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=5424. You can also request free copies of the publication (GTR–SRS–062) from pubrequest@srs.fs.usda.gov or by calling 828–257–4830.

Growing Native

People swayed by the attractive purple flowers of princess tree (*Paulownia tomentosa*), the red leaves of burning bush, or the scarlet-orange berries of oriental bittersweet may want to add these plants to their own yards. Educating the public about the danger of these and other nonnative invasive plants is of the utmost importance to maintaining the diversity of southern forests.

"It's important that we help people to open their eyes. When you see how these plants take over, how they can literally wipe out the lush natural undergrowth of southern forests, you begin to see the invaders everywhere," says Miller. "You may even develop a passion for eradicating them."

He stresses that not all nonnative plants are invasive, and that there are many native and nonnative substitutes for the invasive ornamentals.

"People will always want to add exciting new plants to their gardens," says Miller. "We need to continue to promote native substitutes for invasive ornamentals. We also need to work with the horticulture industry to test nonnative cultivars for their invasiveness and fertility."

Research on the conditions that promote the invasion of plants is critical, as is the ability to identify invaders in the lag phase, when they can be more easily controlled. Basic genetic research could help managers rate the ability of invaders to cross with natives and to colonize new habitats.

"We need a systematic assessment of all major invasive species in the United States, and projections for those poised to enter," says Miller. "The resulting information should be entered into a database that, in turn, can be used to inform comprehensive regional planning."

It All Comes Down to Us

Invasive plants do not respect boundaries. They are opportunists that spread out along highways and rivers and emanate from misguided plantings. They are very well adapted to the fragmented landscape of the Southern United States. Large programs of eradication can be very effective, but when it comes down to it, we all need to be part of the solution.

"It really is a social problem as much as it is a biological one," says Miller. "Successfully fighting this invasion depends on personal choice and group action. It's as simple as that."

"It really is a social problem as much as it is a biological one..."

Miller proposes a process of "adaptive collaborative restoration" that works across land ownerships.

"The process is adaptive because we are learning as we go. We have to constantly adapt to new and changing situations, and to learn from what we do on the ground," says Miller. "The process must be collaborative. We need to coordinate efforts with everyone who manages land."

Invasive plant councils such as the State Exotic Plant Pest Councils have taken the lead in developing grassroots organizations to educate and organize weed-killing activities at the local level. Their Web sites and others can be used to help citizens monitor infestations and organize initiatives.

Miller believes that we must act now, and that we all must be involved in protecting our ecosystems from plant invaders.

"What we do in the next decade will determine forever the extent and severity of the changes to our natural communities wrought by invasive plants," says Miller. "If we don't move quickly, many of the ecosystems we treasure will not be around for future generations. Together we can stem the tide, combat the invasion, and give our native ecosystems the chance for a future."

Selective Herbicide Application Methods

- **Directed foliar sprays:** herbicide-water sprays aimed at plant foliage to cover all leaves to the point of runoff, usually applied with a backpack sprayer (use low pressure, drift retardants, and spray shields to avoid drift)
- **Stem injection (including hack-and-squirt):** herbicide concentrates or herbicide-water mixtures applied into downward incision cuts spaced around woody stems made by an ax, hatchet, machete, brush ax, or tree injector
- **Cut-treat:** herbicide concentrates or herbicide water mixtures applied to freshly cut stumps (outer circumference) or stems (entire top surface) with a backpack sprayer, spray bottle, wick, or paint brush
- **Basal sprays:** herbicide-oil-penetrant mixtures sprayed or daubed onto the lower portion of woody stems, usually applied with a backpack sprayer or wick applicator
- **Soil spots:** application of Velpar® L herbicide as metered amounts to the soil surface around target woody stems or in a grid pattern for treating many stems in an area; usually applied with a spot gun or with a backpack sprayer equipped with a straight-stream nozzle

Adapted from: Jim Miller. 2004. *Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control*. USDA Forest Service, Southern Research Station, Gen. Tech. Rep. SRS–62.

Golden bamboo (*Photo by James R. Allison, Georgia Department of Natural Resources*)

(Photo by Kim Barto, USDA Forest Service)

SNAPSHOT
From the Field

A Lifetime in the Weeds

Jim Miller, research ecologist at the Southern Research Station unit at Auburn, AL, has worked on vegetation management for the Forest Service since 1977. His research ranges from developing effective herbicide treatments and equipment for hands-on use to examining the long-term effects of vegetation management on native plants, soil sustainability, and forest stand development. In June 2001, Miller received the USDA Honor Award in recognition of his leadership in furthering plant conservation and diversity, and for his considerable contributions to the management of nonnative invasive plants. In 1999, he was named Scientist of the Year by the Southern Weed Science Society. Over the last two decades alone, Miller authored or coauthored over 120 publications on strategies for conserving forest plants and controlling invasive plants.

Where did you grow up?

My family's home was not far from downtown Oklahoma City, so I grew up as a city boy. As children, we had the freedom to wander into vacant lots with plants and dirt, and into industrial junk piles where we found the components for secret devices and machines. I went to what might have been seen as an "underprivileged" school, where dedicated teachers instilled in me interests in community, science, and mathematics. I grew up in the sputnik/H-bomb era that drove the need for America to do better and protect itself with science. I got caught up in this, and in the idea that science could both defend and feed us. On most summer weekends, my family ran away from the city to a campsite in southern Oklahoma, where the cold streams were our habitat and hiking and swimming our fun.

When did you become interested in science?

Most of us are probably born inquisitive—I certainly was—and then have it wrung out of us by people saying "don't." Fortunately, I was allowed to explore and experiment with few people saying "don't." I had my laboratory in the family garage, with all types of solvents and fluids lying around to mix and attempt to ignite using my chemistry set. A series of great teachers formed the ladder that lifted my interest and understanding. It was actually failure as a scholarship engineer student at the University of Oklahoma that led me to the workstudy program and to a young plant physiologist who gave me glassware in abundance to wash, a lab, and responsibilities to initiate techniques—and who steered me towards studying forest ecology.

What was your first experiment?

I guess it was testing whether I could fly from the roof of the garage using a cape as wings when I was about 5 years old. The results prepared me for a career in science and facing reviewers. Then by age 7, I was concocting my first pesticide on a stove at my friend's house and using his chemistry set to make gun powder from a recipe in the encyclopedia. My friend's mother was a marvelous research manager, much like **Charles McMahon** (recently retired project leader of the Auburn vegetation management unit). Both allowed me a lot of room to both make mistakes and achieve success.

What was your first job?

My first real "work" was in the family garden starting around age 7—turning the soil, planting the rows, and hoeing. As many others who see the vast benefits of herbicides, I had a lot of early experience with a hoe. Then there were summers mowing grass with a pushmower—more reinforcement for the idea that there had to be better ways for humans to manage plants.

Where was the most exciting place you worked?

After I earned my Ph.D. in forest ecology from Oregon State, I traveled with my wife, Anne, and two young daughters to the three-story tropical rainforests of West Malaysia, where I started teaching silviculture, ecology,

and ecophysiology. A forest engineer and I, with our Malay dean, struggled to start the first bachelor of science-level forestry program in Malaysia and the entire region. We taught all the courses and erected a building patterned after the School of Forestry at Oregon State. By my third year, we had 15 returning faculty, which taught me that a lot can be done in a short time with few resources if people are committed. I also saw first hand how forest communities and land can be used to depletion.

What led you to your work on invasive plants?

When I arrived in Auburn to start my Forest Service career, it was hard to ignore kudzu, although dealing with pest plants was not part of our unit's mission at that time. I started getting phone calls about kudzu, and then several letters from distraught widows who, with no husbands to fend off the vine, were afraid that kudzu was going to engulf their homes. I decided to start a small project to test available herbicides. (In the 1970s, all herbicides were advertised as effective for eliminating kudzu, but I had my doubts.)

At that time, the Georgia Forestry Commission had one of the most highly funded, progressive research programs in the region. My early results caught their attention and they invited me to expand my research. We did so in a large way, testing 15 herbicides at 6 locations along major highways. Each location included public information signs and treatment information. We soon exposed the false claims made by some herbicide manufacturers and gained the respect of people needing the information.

I have tried to continue in this tradition. For over 20 years I have answered about 200 email, telephone, and letter requests for help every year. I have helped organize over 100 workshops, and have given over 400 presentations in the last 25 years on how to stop invasive plants. I could not have done this without the help of **Erwin Chambliss**, who has been my research associate for 27 years, and contributes to all aspects of the research in a tireless and dedicated manner.

What would you want people to know about your work?

As much as they need to help them.

What invasive plant do you dislike the most and why?

Cogongrass is a plant that I thought I had left behind in Malaysia, part of its home range. I grew to hate this plant because it literally displaced so many people in Asia and Africa from their lands. It was quite a shock to discover that cogongrass had been in the Southern United States since 1911, and was invading our region at an alarming rate. Cogongrass is the world's worst invasive plant of forests. We cannot tolerate this plant, because it will turn our rich forests into savannas.

When did you start to kayak? What do you love about it?

I bought my first kayak 20 years ago so I could more easily explore streams and rivers. These are the places in the landscape that I find most dynamic, where I can watch the eternal interplay of water, soil, rock, and plants. I enjoy the challenge of running difficult water, the fun of surfing waves and "holes." I am refreshed by time apart in nature, and by the company of my partners on the river. It just doesn't get much better than that.

Kudzu seeds *(Photo by Ted Bodner, Southern Weed Science Society)*

RESPONDING AT THE GROUND LEVEL: EXOTIC PEST PLANT COUNCILS IN THE SOUTHEAST

by H. Daniel Brown

We are under attack by invasive exotic plants—not only in the Southeast, but all across the United States. This has been happening for hundreds of years, but has increased dramatically over the past few decades.

In the United States today, an estimated 3,500 exotic plant species have naturalized, meaning they thrive and reproduce without cultivation. Approximately 350, or 10 percent, are invasive, and about 200 of these are present in the Southeast. An estimated 100 million acres in the United States are already affected by invasive exotic plants, with about 2 million additional acres affected every year. Every day, roughly 4,600 new acres are invaded on public lands alone. Economic impacts to agriculture, natural areas, and gardens are estimated to be $35 billion a year.

In 1994, melaleuca infested an estimated 490,000 acres of south Florida; within 4 years control efforts had reduced that acreage by 100,000.

State Exotic Pest Plant Councils

In 1999, in response to mounting concern about invasive exotic plants, President Clinton signed Executive Order 13122 on invasive species, which resulted in the establishment of the National Invasive Species Council. The council's first action was to publish a national management plan—the first attempt to address the invasive exotic plant issues affecting natural areas at the national level.

At the State and regional levels, efforts had been underway several years prior to President Clinton's signing of the Executive order. In 1984, Florida established the first Exotic Pest Plant Council (EPPC) in the Southeast—and in the United States. The council began as a coalition of agencies fighting the spread of melaleuca (*Melaleuca quinquenervia*), a tree native to Australia, in the Everglades. Members of the coalition realized the importance of getting the cooperation of all agencies owning public land in the area surrounding the Everglades to work together if they were going to have a reasonable chance of controlling melaleuca.

The Florida EPPC continues to be a leader in building public awareness about the serious threat invasive exotic plants pose to native ecosystems, and in developing integrated management and control methods for preventing the spread of these plants. The Florida EPPC also demonstrates the success of using the pest council structure to work across administrative boundaries. In 1994, melaleuca infested an estimated 490,000 acres of south Florida; within 4 years control efforts had reduced that acreage by 100,000.

The EPPC concept began to flourish outside of Florida in the early 1990s. Tennessee EPPC was established in 1996 (the fourth EPPC after California and the Pacific Northwest). During its first 10 years, Tennessee EPPC has become a strong voice

What Do We Mean by Exotic and Invasive Plants?

An exotic plant is a plant introduced by humans to a location outside its natural range. It is often from another continent, but it can be from another ecosystem or from a different habitat within the same ecosystem.

An invasive plant is a plant that grows and spreads rapidly, establishes over large areas, and persists. Usually it poses major economic and environmental threats, especially in natural areas. Invasiveness is characterized by abundant vegetative growth, high reproductive rate, abundant seed production, high seed germination rate, and longevity.

Not all exotic plants are invasive. In the United States, some of our most common and economically valuable plants—corn, wheat, and rice, for example—are exotic. And not all invasive plants are exotic. In fact, approximately two-thirds of the invasive plants in the United States are native. In the Southeast, native invasive plants include poison ivy (*Toxicodendron radicans*), coralberry or buckbush (*Symphoricarpos orbiculatus*), and pokeweed (*Phytolacca americana*).

An interesting and important point about native invasives is that though they can be opportunistic—quickly invading a newly burned or cleared area—they usually persist for a period and then are replaced by other plants.

RANKING EXOTIC INVASIVE PLANTS

The Tennessee Exotic Pest Plant Council (EPPC) ranks exotic pest plants in one of three categories, based on invasive characteristics:

Rank 1—severe threat: exotic plant species that possess characteristics of invasive species and spread easily into native plant communities and displace native vegetation

Rank 2—significant threat: exotic plant species that possess characteristics of invasive species but, are not presently considered to spread as easily into native plant communities as those species listed as rank 1

Rank 3—lesser threat: exotic plant species that spread in or near disturbed areas, but are not presently considered a threat to native plant communities

The purpose of ranking is: (1) to help resource managers detect invasive exotics early, so that they can respond rapidly to prevent them from becoming established and spreading; and (2) to encourage the general public and resource managers to avoid using invasive exotics in landscaping, restoration, and enhancement projects.

Several other States use a similar three-category ranking. Florida, however, uses a two-category system. Category I lists nonnative plants known to have invaded Florida natural areas and to displace native plants, or at least to disrupt the natural community. Category II lists plants that have a real potential to become category I but are not yet known to be disrupting natural area communities.

In addition to the rankings, Tennessee EPPC has developed two watch lists. The first lists exotic plants that naturalize easily and may become a problem in the future. Two examples are butterflybush (*Buddleja davidii*) and Bradford pear (*Pyrus calleryana*). The second lists exotic plant species that are severe problems in surrounding States, but have not yet been reported in Tennessee. An example is mile-a-minute weed (*Polygonum perfoliatum*), which is causing serious problems in the Northeastern United States.

Tennessee EPPC Lists: http://www.tneppc.org/Invasive_Exotic_Plant_List/The_List.htm

Cogongrass *(Photo by Charles T. Bryson, USDA Agricultural Research Service)*

addressing the critical issue of invasive exotic plants. The council has developed a ranking system and watch lists to help resource managers and the public work to control exotic invasive plants; they also publish educational materials and hold numerous workshops.

Since 1996, several other Southeastern States have organized EPPC chapters, including Kentucky, North Carolina, South Carolina, Georgia, Mississippi, and Alabama. In 1999, the regional Southeast EPPC was formed, in part to assist States in organizing new chapters, and to facilitate coordination among chapters within the Southeast and elsewhere in the United States.

The State EPPC chapters, as well as the Southeast EPPC, have a similar mission to:

- Raise public awareness about the spread of invasive exotic plants into natural areas
- Facilitate the exchange of information about the management and control of invasive exotic plants
- Share information on invasive exotic plants with all interested parties through venues such as meetings, workshops, and an annual symposium
- Serve as an educational, advisory, and technical support council on all aspects of exotics
- Initiate actions to prevent future introductions

About half the members of a typical EPPC are professionals, with representation from botany, weed science, and land industry. Other members are primarily private individuals interested in protecting the environment, ranging from college students to retired persons. All EPPCs are nonprofits, with no salaried officers or employees. Funding is through annual dues, proceedings from an annual symposium, and donations.

(continued on page 10)

TREE-OF-HEAVEN, AILANTHUS


James H. Miller

(All Southern States)

Tree-of-heaven or ailanthus (*Ailanthus altissima*) is a deciduous tree to 80 feet tall with long pointed leaves, gray slightly fissured bark, and large clusters of greenish flowers in early summer. Flowers and other parts of the plant have a strong odor. Tree-of-heaven was introduced as an ornamental in 1784. It spreads by root sprouts, which can grow to 14 feet a year for 4 or more years; and prolific wind- and water-dispersed seeds, which can grow 3 to 6 feet in the first year.

SILKTREE, MIMOSA


Ted Bodner

(All Southern States)

Silktree or mimosa (*Albizia julibrissin*) is a small deciduous tree 10 to 50 feet tall. It has feathery leaves, smooth light-brown bark, and showy pink blossoms that yield dangling flat pods. Silktree was introduced from Asia in 1745. It spreads by root sprouts and abundant animal- and water-dispersed seeds. Seedpods float and seed remain viable for many years.

PRINCESSTREE, PAULOWNIA


James R. Allison

(All Southern States)

Princesstree or paulownia (*Paulownia tomentosa*) is a deciduous tree to 60 feet tall with large fuzzy heart-shaped leaves, showy pale-violet flowers, and pecan-like nuts in clusters that contain many tiny winged seeds. Stump sprouts and root sprouts may eventually emerge after main stems are deadened. Paulownia was introduced from Asia in the early 1800s, and has been widely planted both as an ornamental and in scattered plantations for export of wood to Japan. It spreads from old home sites, roadsides, and stream banks by root sprouts and wind- and water-dispersed seeds, especially after forest fires and logging operations.

TALLOWTREE, POPCORNTREE


Ted Bodner

(Alabama, Arkansas, Carolinas, Florida, Georgia, Louisiana, Mississippi, Tennessee, Texas)

Tallowtree or popcorntree (*Triadica sebifera*, formerly *Sapium sebiferum*) is a deciduous tree growing to 60 feet tall with heart-shaped leaves that turn scarlet in fall, long drooping flowers in spring, and bundles of white waxy "popcorn-like" seeds in fall and winter. Three-year-old plants can produce viable seed and small seedlings can be easily hand pulled. Burning results in abundant seedlings. Tallowtree has been imported from China since the 1700s as an ornamental, a honey plant for beekeeping, and source of raw materials for oil production and candle

making. It spreads by prolific root sprouts and bird- and water-dispersed seeds on freshwater- and saline-saturated soils.

Ted Bodner

SILVERTHORN, THORNY OLIVE

(Alabama, Arkansas, Carolinas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Tennessee, Virginia)

Silverthorn or thorny olive (*Elaeagnus pungens*) is an evergreen, densely bushy shrub, 3 to 25 feet in height, that can climb into trees. It has long limber projecting shoots, scattered thorny, dense leaves silver scaly in spring on both top and bottom becoming dark green above and silvery beneath by midsummer. Oblong red and scaly brown fruit appear in spring. Silverthorn was introduced from China and Japan in 1830 as an ornamental, for hedgerows, and highway right-of-ways; use continues for landscaping. It spreads by prolific stem sprouts and animal-dispersed seeds.

James H. Miller

WINGED BURNING BUSH

(Carolinas, Georgia, Kentucky, Oklahoma, Tennessee, Virginia)

Winged burning bush (*Euonymus alata*) is a deciduous bushy shrub to 12 feet in height with multiple ridged stems, many branches, and a broad and leafy canopy. It has small leaves, green turning bright scarlet to purplish red in fall. Many orange fruit appear in pairs and turn purple in fall. Winged burning bush was introduced from Asia in the 1860s as an ornamental and for highway beautification. It spreads by root suckers and animal-dispersed seeds.

Ted Bodner

CHINESE PRIVET, EUROPEAN PRIVET

(All Southern States)

Chinese privet (*Ligustrum sinense*) and European privet (*L. vulgare*) are difficult to distinguish except at flowering. Both are aggressive evergreen to semi-evergreen, thicket-forming shrubs to 30 feet in height and have multiple stems that are soft and woody, long leafy branches, and leaves less than 2 inches long. Showy clusters of small white flowers in spring yield clusters of small oval, dark-purple berries during fall and winter. Both privets were introduced in the early to mid-1800s as ornamentals. They spread from bottomland fencerows to forests, fields, and right-of-ways by root sprouts and abundant seeds dispersed by birds and other animals.

RESPONDING AT THE GROUND LEVEL

(continued from page 9)

Here are just a few examples of EPPC activities in the Southeast:

- A State Department of Transportation commissioner was encouraged to plant native wildflower seed mixes along the highway instead of nonnative mixes.

- A Chinese yam (*Dioscorea oppositifolia*) eradication project started in the Murfreesboro, TN, area. Federal, State, city, local groups, and EPPC are now working together to map, remove, treat, and monitor the plant. Native plants are being grown to replace the invasive exotic species.

- In Gainesville, FL, 880 volunteers gathered 17,415 pounds of air yams (*D. bulbifera*) from 25 different sites during the 6th Annual Great Air Potato Round Up.

- State and Federal agencies worked with EPPC to put on a hands-on invasive weed workshop, with emphasis on identification, control, and native plant alternatives. The statement most frequently heard by the five instructors was "I didn't know that!"

What Do We Do Now?

Sometimes we don't think about choices until we no longer have them. We could wait until invasive exotic plants have literally taken over our natural areas and many of our favorite native plants and animals have disappeared.

Obviously, some people have chosen not to wait, but too many people know too little about this problem. We need to educate others about this problem, letting them know the good things about native plants and the bad things about invasive exotic plants.

We can learn to identify the most important invasive exotic plants, especially those in our geographic area. We can learn about how to prevent them from taking root in our area and how to control them when they do. We who are knowledgeable in this area can leave the choir loft and go out onto the streets and tell others what we know.

For example, we can explain that the fast-growing tree with the pretty violet flowers they see along the highway is an invasive from East Asia called princesstree (*Paulownia tomentosa*). Another tree along the highway is called, strangely enough, Tree-of-heaven (*Ailanthus altissima*); it has yellowish-green flowers and large compound leaves. We can tell people that both of these trees are spreading at an alarming rate, crowding out native plants and trees throughout the Southeast, growing through and damaging retaining walls along the highway. We can explain how to get rid of them.

We can also become active in our local EPPCs. EPPC members are sincere and dedicated people who know about invasive exotic plants and want to get that information out to the public. Through the EPPCs, we can work with other organizations that are involved in fighting invasive exotic plants, such as native plant societies, weed science societies, and botanic gardens and arboreta.

Contact your local EPPC, join up and get involved! It's a win-win relationship.

H. Daniel Brown is retired from the USDA Forest Service, where, as forest pathologist, he worked on a wide range of issues, including nonnative invasive plants. He is past president of the Southeast Exotic Pest Plant Council and is currently a member of the board of directors for the Tennessee Exotic Pest Plant Council.

MEASURING INVASIONS

Alligator weed *(Photo by Gary Buckingham, USDA Agricultural Research Service)*

by Claire Payne

Invasive plant species damage forest resources and transform ecological processes. Kudzu (*Pueraria montana*) is perhaps the most striking example, due to its rapid growth, complete ground coverage, and ability to reach and damage even mature trees. Like other invasive species that invade forests, kudzu modifies habitat for native wildlife, replaces native forest species, reduces species diversity, alters soil properties, and causes rapid accumulation of litter on the forest floor that increases the risk of wildfire.

There is a crucial need to locate, quantify, and track nonnative plant invasions of forests. Satellite imagery, aerial photography, and ground data are available toward this end. Southern Research Station (SRS) **Forest Inventory and Analysis (FIA)** crews survey all the forestland in the Southern United States at intervals of 3 miles. FIA's scientific sampling plan provides a systematic quality to information about invasive species that has been lacking in other plant surveys. FIA data also represent a much larger area, with revisits to the same locations over time intervals ranging from 5 to 7 years in the Eastern United States. The accumulated information can inform strategic decisions regarding conservation and management resources and activities.

A recent survey by SRS researchers in Athens, GA shows the largest extent of kudzu infestation occurs primarily in the Southern United States, with extensive populations in Alabama and adjacent States. This does not minimize the seriousness of the kudzu problem in other regions. FIA data show that infestations are severe wherever kudzu is found.

Looking only in the South's forestland, however, FIA data show that the most significant nonnative invasive plant

(continued on page 12)

JAPANESE PRIVET

James H. Miller

(Alabama, Carolinas, Florida, Georgia, Louisiana, Mississippi, Tennessee, Texas, Virginia)

Japanese privet (*Ligustrum japonicum*) is an evergreen to 35 feet in height, with an upward spreading canopy. It has thick leathery leaves 2 to 4 inches long. Leaves and stems are hairless. Clusters of small showy white flowers in spring yield small round dangling green-to-purple fruit. This privet was introduced from Korea in 1794 and Japan in 1845 as a widely planted ornamental. It spreads in lowlands by root sprouts and abundant seeds dispersed by birds and other animals.

SACRED BAMBOO, NANDINA

James H. Miller

(Alabama, Carolinas, Florida, Georgia, Louisiana, Mississippi, Texas, Virginia)

Sacred bamboo or nandina (*Nandina domestica*) is an evergreen erect shrub to 8 feet in height, with multiple bushy stems resembling bamboo, glossy green or reddish leaves. Early summer terminal clusters of tiny white-to-pinkish flowers yield dangling clusters of red berries in fall and winter. Nandina was introduced from Asia and India in the early 1800s and is still available for sale as an ornamental. It spreads by root sprouts and animal-dispersed seeds under forest canopies and near forest edges.

NONNATIVE ROSES

James H. Miller

(All Southern States)

Multiflora rose (Rosa multiflora), Mccartney rose (R. bracteata), Cherokee rose (R. laevigata), and other nonnatiive roses are all evergreen except multiflora. They are erect, arching, or trailing shrubs to 10 feet in height with frequent curved or straight thorns. The leaves have three to nine leaflets. The clustered or single white to pink flowers in early summer yield red rose hips in fall to winter. Nonnative roses were introduced from Asia as ornamentals, living fences, livestock containment, and wildlife habitat. They climb into trees and spread into right-of-ways and new forests by prolific sprouting, stems that root, and animal-dispersed seeds.

ORIENTAL BITTERSWEET

James H. Miller

(Alabama, Arkansas, Carolinas, Georgia, Kentucky, Tennessee, Virginia)

Oriental bittersweet (*Celastrus orbiculatus*) is an attractive but very invasive deciduous, twining, and climbing woody vine to 60 feet with drooping branches in tree crowns, forming infestations in thickets and arbors. It has elliptic to rounded leaves 1.2 to 5

inches long. Its dangling clusters of inconspicuous yellowish flowers yield green spherical fruit that split to reveal three-parted showy scarlet fleshy covered seeds, which remain through winter. Bittersweet was introduced from Asia in 1736 as an ornamental and is a popular material for wreath-making. It spreads by prolific vine growth and seeds dispersed by birds, other animals, and discarded wreaths.


Fred Nation

CLIMBING YAMS

(All Southern States)

Air yam (*Dioscorea bulbifera*), Chinese yam or cinnamon vine (*D. oppositifolia*), and water yam (*D. alata*) are high climbing vines to 65 feet that cover shrubs and trees in infestations. They have twining and sprawling stems with long-stemmed smooth heart-shaped leaves and dangling potato-like fruits. Climbing yams were introduced as a possible food source in the 1800s—air yams from Africa and the others from Asia—and cultivated first by unsuspecting gardeners intrigued by the dangling yams and most recently as medicinals. They spread underground and by forming new plants from the dropped yams, making control difficult.


James H. Miller

ENGLISH IVY

(All Southern States)

English ivy (*Hedera helix*) is an evergreen vine climbing to 90 feet that forms dense ground cover. When young, it has thick dark-green whitish-veined leaves that are heart-shaped with three-to-five pointed lobes, later becoming broadly lance-shaped. Flower clusters in summer yield dark-purple berries in winter and spring. English ivy was introduced by European settlers and is still available for sale as an ornamental and for varnish resin, dyes, and tanning substances. It spreads by trailing and climbing vines that root at nodes and bird-dispersed seed; once released into forests it increases the chance of windthrow by amassing on trees and decreasing vigor and carries bacteria that infest the leaves of oaks, elms, and maples.


Chuck Bargeron

JAPANESE HONEYSUCKLE

(All Southern States)

Japanese honeysuckle (*Lonicera japonica*) is a semi-evergreen-to-evergreen woody vine, high climbing and trailing to 80 feet, branching and often forming arbors in forest canopies and ground cover under canopies. Japanese honeysuckle was introduced in the early 1800s as an ornamental and for deer browse and erosion control; use continues for wildlife feeding plots. It spreads by rooting at the nodes of long woody underground stems that sprout frequently and by animal-dispersed seeds, overwhelming and replacing native plants in all forest environments.

MEASURING INVASIONS

(continued from page 11)

species are Japanese honeysuckle (*Lonicera japonica*), Chinese and European privet (*Ligustrum* spp.), and Chinese tallowtree (*Sapium sebifera*).

Data for Mississippi and Oklahoma are not yet available, and the State of Florida ranks invasive plants differently because so many species are limited to that area. For example, melaleuca (*Melaleuca quinquenervia*) covers hundreds of thousands of acres in Florida. Native to Australia, where it is valued as an ornamental, melaleuca has become a terrestrial and aquatic pest in Florida since its introduction 50 years ago. Known also as punktree or paperbark tea tree, melaleuca has invaded the Everglades.

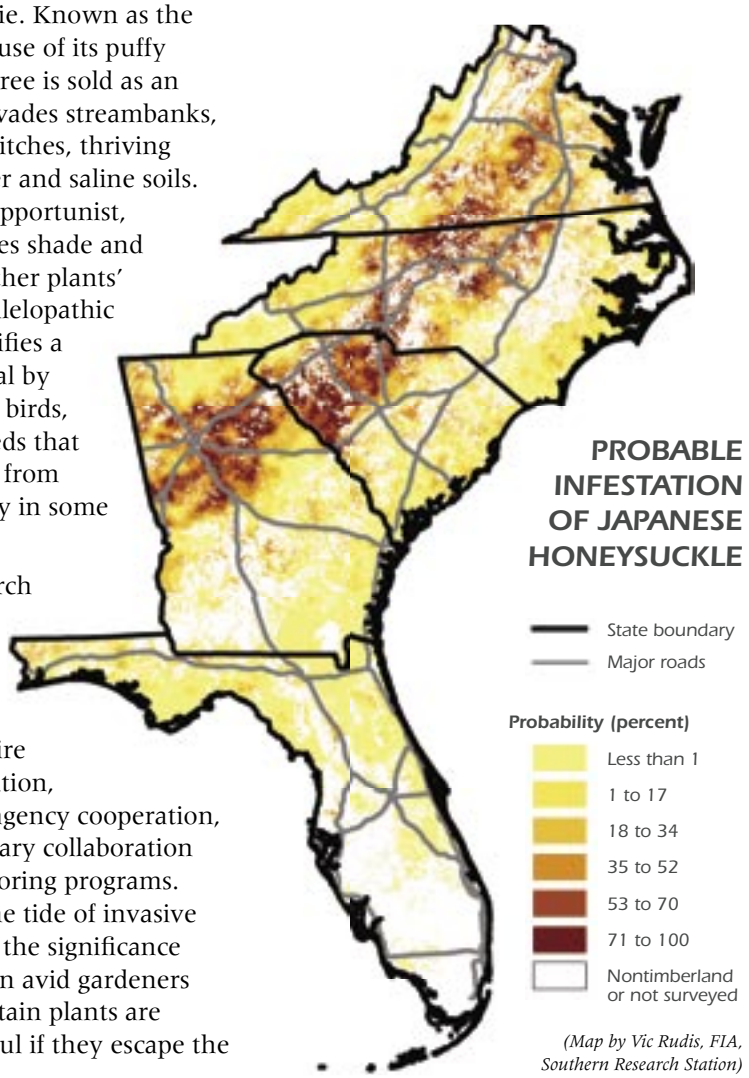
Other invasive plant species in the South fail to limit their range to dry land. Chinese tallowtree is invading the wetland prairie. Known as the popcorntree because of its puffy white seeds, the tree is sold as an ornamental. It invades streambanks, riverbanks, and ditches, thriving in both freshwater and saline soils. An almost ideal opportunist, tallowtree tolerates shade and flood, prevents other plants' growth with its allelopathic qualities, and typifies a showy ornamental by attracting people, birds, and bees with seeds that can stay attached from August to January in some geographic areas.

Vic Rudis, research forester with the **SRS FIA unit**, stresses that risk assessments require national coordination, augmented interagency cooperation, and interdisciplinary collaboration with other monitoring programs. People fighting the tide of invasive plants emphasize the significance of education. Even avid gardeners do not realize certain plants are potentially harmful if they escape the garden. Nurseries sell a large volume of invasive plants, which comprise a significant portion of wholesale and retail sales. Chinese/European privet and Chinese and Japanese wisteria (*Wisteria sinensis* and *W. floribunda*) are old southern trademarks, intertwined with the culture.

As ecological damage is becoming clearer, however, some States are banning the sale of certain plants. In Texas, Chinese tallowtree is one of the few trees that changes color in the fall, so it is highly prized as an ornamental. However, its invasive nature led the State to ban it last year.

Invasive plants injure not only agricultural and urban lands but also forests, especially at the forest edge. The 1997 survey of Georgia's

Sample FIA risk assessment map



(Map by Vic Rudis, FIA, Southern Research Station)

Amur honeysuckle *(Photo by Chuck Bargeron, University of Georgia)*

timberland revealed that 9 percent contained forest-nonforest edges. The odds of an infestation by Japanese honeysuckle were two times greater, for privet three times greater, and for kudzu seven times greater at the forest edge than in forest interior locations. Forested areas may be particularly vulnerable to invasion if they are close to extensive human activities.

According to **Bill Burkman**, **SRS FIA program manager**, the benefits of monitoring nonnative invasive species include:

- Definition of a better distribution area of nonnative invasive plants—within a single system, on a State level, or at a regional scale
- Opportunity to determine whether invasive plants are spreading, since FIA crews survey plots over time
- Ability to assess if forest conditions facilitate the spread of invasive plants—for example, forest fragmentation, other disturbances, or fire suppression

"Collecting data about nonnative invasive plants today equals investing in information uses for the future," says Burkman. "Information about invasive plants has been inconsistent among States and largely anecdotal. It is difficult to plan strategically without knowing present and evolving conditions on the ground."

FIA crews began collecting data about invasive plants across the South about 4 years ago, working in a regional effort without a national mandate. Field personnel survey throughout the year, so they see plants in all stages—with buds, flowers, and fruit. In the dormant stage, crews can measure relative density compared to other species, percentage of plot cover, and amount of shade imposed.

For more information:
Vic Rudis at 865–862–2009 or vrudis@fs.fed.us

VINCAS, PERIWINKLES

Chris Evans

(Alabama, Arkansas, Carolinas, Georgia, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas, Virginia)

Common periwinkle (*Vinca minor*) and bigleaf periwinkle (*V. major*) are evergreen to semi evergreen somewhat woody, trailing or scrambling vines to 3 feet long and upright to 1 foot that form dense ground cover. They have lance- to heart-shaped leaves and pinwheel-shaped violet single flowers with five petals. Viable seed appear to be produced only rarely. Periwinkle was introduced from Europe in the 1700s and is still available for sale as an ornamental. It spreads from old home sites to dense canopied forests where it forms mats and extensive infestations.

CHINESE WISTERIA, JAPANESE WISTERIA

Ted Bodner

(Alabama, Arkansas, Carolinas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Tennessee, Texas, Virginia)

Chinese wisteria (*Wisteria sinensis*) and Japanese wisteria (*W. floribunda*) are deciduous high climbing, twining, or trailing woody vines to 70 feet with long pointed leaves and showy spring flowers ranging from violet to lavender to white. Chinese and Japanese wisterias are difficult to distinguish due to possible hybridization. Wisteria was introduced in the 1800s as an ornamental porch vine. It spreads runners that root at nodes when covered by leaf litter and by water-dispersed seeds.

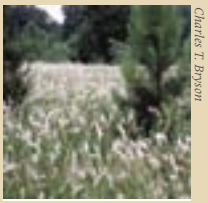
TALL FESCUE

James H. Miller

(All Southern States)

Tall fescue (*Lolium arundinaceum*) is an erect, tufted cool-season perennial grass, 2 to 4 feet in height. It has whitish-eared areas where leaf blades connect to the stem, and the stem has swollen nodes. Dark-green seedstalks and leaves appear in late winter, usually flowering in spring. This grass is dormant in midsummer. Most plants carry a fungus that reduces livestock weight gains and fertility, and compromises songbird and Canada goose nutrition. Tall fescue was introduced from Europe in the early to mid 1800s and is distributed throughout the world for turf, forage, soil stabilization, and wildlife feeding plots. It spreads by expanding rootcrowns into new forest plantations, roads, openings, and high-elevation balds.

COGONGRASS



Charles T. Bryson

(Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, Texas)

Cogongrass (*Imperata cylindrica*) is an aggressive, colony-forming dense erect

KUDZU—OUT OF ECOLOGICAL PLACE AND TIME

by Claire Payne

Nonnative invasive plants are by definition outside of their endemic ecosystems, removed from their natural predators and competitors. If sufficiently invasive, they may interrupt native succession and eventually displace an entire native ecosystem.

Kudzu (*Pueraria montana*) certainly belongs in this category—it now covers between 4 and 7 million acres in the Southeastern United States; 3 million of these acres are in forests. Where it takes hold, kudzu eventually eliminates all other vegetation, including trees, as it climbs and competes for light. Like the velociraptor in Michael Crichton's *Jurassic Park*, kudzu has been recreated out its ecologic and geologic time by an ill-conceived human experiment.

Kudzu has not lived up to the beneficial results anticipated when it was introduced in this country at the Philadelphia Centennial Exposition of 1876. Around the same time, David Fairchild, a plant explorer for the USDA, observed extensive acreage of the vine used as food for livestock in Japan. In 1902, he planted kudzu seedlings around his Washington, DC, home. Fairchild soon became disenchanted with the plant as it overtook the bushes and pines in his yard, smothering and bending them to the ground. He issued a warning about the invasiveness of the plant, but by the time it was published in 1938, the vine had been widely planted in the South.

In 1907, kudzu baled into hay was exhibited at a fair in Jamestown, VA, where Florida farmer C.E. Pleas first encountered the plant's potential as a bountiful food source for his farm animals. By 1910, Pleas had 35 acres in the vine, and was doing a brisk business selling fodder. He was a strong advocate for kudzu, and sold root cuttings through mail-order catalogs until he died in 1954.

In the 1930s and 1940s, the Soil Conservation Service promoted kudzu as a means of controlling erosion on the gullies created by the deforestation of the South. Kudzu was planted especially heavily in the Piedmont regions of Alabama, Georgia, and Mississippi. The Soil Erosion Service paid farmers $8 per acre to grow kudzu. This subsidized program resulted in more than 1.2 million acres being planted.

By the 1950s, kudzu was recognized as a weed and removed from the list of species acceptable for use under the Agricultural Conservation Program. In 1998, the U.S. Congress listed kudzu as a Federal noxious weed.

Impacts on the Ecosystem and the Economy

Kudzu has altered the southern landscape, affecting biodiversity and the cultural and economic framework of the region. In 2002, Coleman Dangerfield, University of Georgia forest economist, estimated that productive forestland overtaken by kudzu represented an economic loss of approximately $48 per acre per year. At that time, the net value of an average stand of pines grown on cutover land for 25 years in the Southeast was approximately $650 per acre, while kudzu control costs exceeded $200 per acre per year for 5 years. Clearly, costs exceeded potential profit.

Southern Research Station (SRS) plant ecologist Jim Miller, who has researched herbicides for kudzu control for the last 20 years, estimates power companies alone spend at least $1.5 million per year battling kudzu. The loss of homes, barns, and fields overtaken by kudzu is immeasurable

Kudzu *(Photo by John D. Byrd, Mississippi State University)*

in terms of lost socioeconomic opportunities for farming, homesteading, and gardening.

Biodiversity is a hallmark of the South, an ecological trait imprinted on natives and attractive to visitors from this country and around the world. As Richard J. Blaustein noted in 2001, the South retains remnant populations of many species pushed south from the Upper Midwest and Northeast by the glacier that retreated 18,000 years ago. Kudzu is smothering native plants, grasses, and trees, replacing them with a leguminous woody vine that, once established, can grow almost a foot a day.

Kudzu Combat

Kudzu spreads very little by seed, due to predation by spiders and insects. However, its roots thrive in disturbed soil, and the continuing development boom in the South gives the opportunistic vine the avenue it needs—land displaced by construction or agriculture.

The plant sets deep roots rich with carbohydrate reserves capable of withstanding repeated mowing or herbicide applications. Kudzu's hairy, woody runners include roots at nodes, enabling large storage tubers to develop along the vine's pathway. An old and uncut plant can have a single root weighing more than a hundred pounds, so killing the plant by digging up the roots is a daunting, if not impossible task.

In China, kudzu is not a pest, possibly because all arable land is cultivated to produce food, not allowing the plant an opportunity to spread. The Chinese dig up the starchy kudzu roots and use them for food and medicinal purposes. Additionally, more than 100 insect species prey on kudzu seeds in China; however, most also feed on plants that produce beans, making them unsuitable as potential biocontrol agents in the United States. Kudzu's closest relative in the United States is the soybean, which complicates the search for a biocontrol agent considerably.

When forest pathologist Kerry Britton served as project leader for the SRS unit in Athens, GA, she began collaborating with Jianghua Sun, researcher at the Institute of Zoology, Chinese Academy of Sciences, Beijing, China, and entomologist David Orr, North Carolina State University, Raleigh, NC. Looking for ways to control the kudzu infestation in the Southern United States, the team undertook a systematic survey for biocontrol agents in China.

In May 1999, the team selected four survey sites with climatic characteristics similar to the Southeastern United States, focusing on the Anhui Province in Southeastern China, where the climate is similar to Atlanta, GA. Because kudzu grows mostly in mountainous regions in China, the researchers also established a survey site further south in the Guangdong Province. In 2000, a fifth survey site was established in Shaanxi Province, which includes most of the middle stretch of the Yellow River. The climate in the southern part of Shaanxi Province is subtropical and humid with rainy summers.

The researchers chose five sample vines from each site, observing insect feeding, mating, and egg laying behavior at 10-day intervals, May through November. They collected and preserved representative insects and plant specimens of their feeding damage. Defoliation was visually estimated in five 1-foot square areas on each vine. The main vine and branches were monitored for feeding damage and gall formation.

Before an insect imported for potential biocontrol purposes can be released in the United States, researchers conduct extensive tests in U.S. quarantine facilities to ensure that it does not prey on any other American plants. The USDA Animal Plant Health and Insect Service independently analyzes test results to determine whether the insect can be released safely. For the kudzu project, initial tests to determine which insects

(continued on page 16)

perennial grass 1 to 5 feet in height. It has tufts of long leaves, yellow-green blades (each with an off-center vein and finely saw-toothed edges), and silver-plumed flowers and seeds in spring, arising from sharp-tipped branching underground stems. Burning results in abundant seedlings. Cogongrass was introduced from Asia in the early 1900s for soil stabilization and forage. It spreads underground and by wind-dispersed seeds into right-of-ways, new forest plantations, open forests, old fields, and pastures. Infestations become more difficult to control with aging.

NEPALESE BROWNTOP

(Alabama, Arkansas, Carolinas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Tennessee, Texas, Virginia)


Ted Bodner

Nepalese browntop (*Microstegium vimineum*) is a sprawling, dense, mat-forming annual grass, 6 inches to 3 feet long with stems growing to 1 to 3 feet in height, often bending over and rooting at nodes to form extensive infestations. It has lance-shaped leaf blades to 4 inches long with off-center veins and thin seed heads in late summer and fall. Nepalese browntop was first identified near Knoxville in the early 1900s. It spreads by prolific seeds—up to a thousand per plant—dispersed by flood waters and carried on hikers' clothes and boots.

CHINESE SILVERGRASS

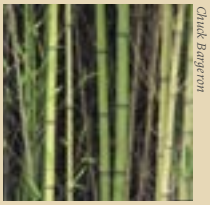
(Alabama, Carolinas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Tennessee, Virginia)


James H. Miller

Chinese silvergrass (*Miscanthus sinensis*) is a tall, densely tufted, perennial grass, upright to arching, 5 to 10 feet in height. It has long, slender, and upright-to-arching leaves with whitish upper veins. Flowers are numerous and loosely plumed, turning silvery to pinkish in fall. Silvergrass was introduced from Asia and is still widely sold and increasingly planted as an ornamental although it is a highly flammable fire hazard. It spreads from older ornamental plantings to roadsides, forest edges, and sites that have been subjected to burning and other disturbances.

BAMBOOS

(All Southern States)


Chuck Bargeron

Golden bamboo (*Phyllostachys aurea*) and other nonnative bamboos (*Phyllostachys* spp. and *Bambusa* spp.) are perennial infestation-forming grass-like plants 16-to-40 feet in height. They have jointed cane stems and bushy tops of lance-shaped leaves in fan clusters on grass-like stems, often golden green. Bamboo was introduced from Asia and is still in use as an ornamental and for building fishing rods. It spreads underground from old home sites.

Ted Bodner

JAPANESE CLIMBING FERN

(Alabama, Arkansas, Carolinas, Florida, Georgia, Louisiana, Mississippi, Texas)

Japanese climbing fern (*Lygodium japonicum*) is a climbing and twining, perennial vine-like fern to 90 feet, often forming mats of shrub- and tree-covering infestations. It has lacy finely divided leaves along green-to-orange-to-black wiry vines. A native of Japan and Australia, Japanese climbing fern was introduced from Japan in the 1930s and is still available for sale as an ornamental. It spreads underground and wind-dispersed spores from right-of-ways around bridges to open forests and the sides of roads, streams, and swamps. It is similar to the Old World climbing fern, a major invasive in southern Florida.

J. Jeffrey Mullahey

TROPICAL SODA APPLE

(Alabama, Carolinas, Florida, Georgia, Louisiana, Mississippi, Tennessee)

Tropical soda apple (*Solanum viarum*) is an upright, thorny perennial sub-shrub or shrub, 3 to 6 feet in height, characterized by remaining green year-round in most southern locations and by a sweet smell that is attractive to livestock and wildlife. It has oak-shaped leaves, clusters of tiny white flowers, and golf-ball size fruit that are mottled green-white turning to yellow in late summer to fall. Tropical soda apple was introduced from Argentina and Brazil in the 1980s. It spreads by seeds dispersed by livestock and wildlife and carried in hay, sod, and machinery. Report infestations to county agents for treatment under a federally sponsored eradication program.

Leslie J. Mehrhoff

GARLIC MUSTARD

(Arkansas, Carolinas, Georgia, Kentucky, Oklahoma, Tennessee, Virginia)

Garlic mustard (Alliaria petiolata) is an upright biennial that grows in colonies under forest canopies, and is characterized by its garlic odor when crushed. The broadly arrow-shaped leaves with wavy edges in the first year give rise to a 2 to 4 foot high flower stalk and clusters of four white petaled flowers in the second year. The plant produces long slender seed pods after June in the second year as the plant dies. Garlic mustard was introduced from Europe in the 1800s as a medicinal. It emits chemical that kill surrounding plants and microbes and spreads by seeds that can lie dormant for 2 to 6 years after being dispersed ballistically (up to 10 feet) and carried by humans, animals, or water.

Plant descriptions for this section were taken from Jim Miller's book, Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control, *reissued in February 2005.*

OUT OF ECOLOGICAL PLACE AND TIME

(continued from page 15)

feed on kudzu were conducted in China, where quarantine facilities are not required for native insects. **Project leader** and entomologist **Jim Hanula** of the **Insects and Diseases of Southern Forests unit** in Athens, GA, has continued working with Jianghua Sun on the project in China. Also involved in the research are Richard Reardon, the Forest Service's Forest Health Technology Enterprise Team; Gary Mann, USDA Forest Service, International Programs; and Judy Hough-Goldstein, an entomologist at the University of Delaware.

Hough-Goldstein and her graduate students are testing a leaf eating insect from China (*Gonioctena tredecimmaculata*) in quarantine facilities at the USDA Agricultural Research Center's Beneficial Insects Introduction Research laboratory in Newark, DE. This summer the team will zero in on whether the soybean is a specific host for the Chinese leaf beetle, which belongs to the family Chrysomelidae. If the insect eats soybeans, testing will be discontinued.

Nathan Schiff, SRS entomologist with the **Center for Bottomland Hardwoods** in Stoneville, MS, coauthored an identification of kudzu for the 2004 edition of CAB International's *Crop Protection Compendium*. Schiff is a proponent of biocontrol, in which a plant's natural predators are used to keep it under control.

"Biocontrol can be a wonderful success," says Schiff. "If you can find a bug that eats the plant you want to kill, eats nothing else, and reproduces, it's self sustaining." He notes that a host-specific bug that flies is even better, eliminating the problem of distributing the killer to the host.

A classic example of biocontrol success is the demise of cottony cushion scale in California in 1910. The disease was decimating citrus crops. The Vedalia beetle (*Rodalia cardinalis*) from Australia was introduced, wiped out the scale, and citrus remains one of California's largest industries.

Chemical treatment to eradicate kudzu is labor intensive and expensive. Until biocontrol is available, grazing sheep are landowners' best bet for keeping kudzu under control. Though cattle do not like to eat trampled vegetation, goats and pigs do not share that aversion. But it takes skill, logistics, and money to keep grazing animals fenced, herded, and protected. And kudzu climbs, while grazing animals do not.

Kudzu and Culture

Perhaps because of the South's milder climate, numerous rivers, streams, and lakes, and historical ties to agricultural and forest-based job markets, people feel a deep connection to the land. While millions of acres of the southern landscape have been lost to kudzu, the aggressive plant also inspires a significant amount of regional humor and innovation. Southerners enjoy kudzu festivals, where they dance to bands playing bluegrass or country music, eat fried kudzu, and buy baskets woven from the vines. So while scientists and managers work to find the key to controlling the invasion—whether the tool is chemical, sheep, or biocontrol insects—people driving down the road wonder whether anything's being done about "this stuff" while enjoying the scent of grape soda.

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Kudzu flower *(Photo by Ted Bodner, Southern Weed Science Society)*

KUDZU CONTAINMENT

by Zoë Hoyle

Kudzu (*Pueraria montana*) is an aggressive vine that forms a dense mat, and in the South, now covers areas as large as 100 acres. The plant spreads by rooting from the nodes where the vine comes in contact with the ground—these roots enlarge to form crowns that increase in size with age and can be difficult to remove. Kudzu vines can quickly grow up to 100 feet in length and 10 inches in diameter.

Mechanical control of kudzu, digging up the entire plant, is only effective for small vines, since the roots of mature vines are often over 4 feet long. Cutting the vines and runners just above ground level every 2 weeks will contain the spread of kudzu, but does not kill the roots. To totally eradicate a kudzu patch, every root must be killed. Because of its rapid growth (runners can grow up to a foot a day in summer), a single surviving kudzu plant can spread and reinfest a site within a few years.

Land managers are often advised to use prescribed fire in the spring to clear young plants and reveal holes and other hazards before summer applications of herbicides. To determine the age of the patch, evaluate the root crowns (the tops of primary roots). If these are 2 inches or more in diameter, the patch is over 10 years old and will require multiple years of herbicide treatments.

The following are specific herbicide recommendations from Jim Miller's book *Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control*:

Thoroughly wet all leaves (until runoff) with one of the following herbicides in water with a surfactant:

- During July to October for successive years when regrowth appears—Tordon® 1011 2 as a 3-percent solution (12 ounces per 3-gallon mix) or Tordon® K[1] [2] as a 2-percent solution (8 ounces per 3-gallon mix), either by broadcast or spot spray. Spray climbing vines as high as possible.

- July to September for successive years—Escort®[1] at 3 to 4 ounces per acre in water (0.8 to 1.2 dry ounces per 3-gallon mix)—or when safety to surrounding vegetation is desired, Transline®[3] as a 0.5-percent solution in water (2 ounces per 3-gallon mix). Spray climbing vines as high as possible or cut vines that are not controlled after herbicide treatment.

- For partial control, repeatedly apply Garlon® 4 or a glyphosate herbicide as a 2-percent solution in water (8 ounces per 3-gallon mix) with a surfactant during the growing season. Cut large vines and immediately apply herbicide to the cut surfaces. To control vines < 2 inches in diameter, apply Garlon® 4 as a 20-percent solution in commercially available basal oil, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to large vines as a basal spray (January to April).

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[1] Nontarget plants may be killed or injured by root uptake.

[2] When using Tordon® herbicides, rainfall must occur within 6 days after application for needed soil activation. Tordon® herbicides are restricted use pesticides, and require a special permit for purchase and use and a licensed applicator.

[3] Transline® controls a narrow spectrum of plant species.

KUDZU AND BEYOND: AN INTERVIEW WITH KERRY BRITTON

by Zoë Hoyle

A close look at your own environment will likely reveal some exotic organism invading your favorite place. I predict that the more you look, the more you will see. I urge you to take action, at whatever level you can. Organize local efforts to increase awareness of the biological pollution threat. Support ongoing efforts by joining organizations such as The Nature Conservancy or Exotic Plant Pest Councils. Kill the exotic weeds in your own back yard. Choose a skirmish and begin to fight back, for the outcome of this war depends on each of us. —Kerry Britton, *Biological Pollution*

Before she took the job as **Forest Health Protection (FHP)** national pathologist in 2003, **Kerry Britton** spent 8 years leading the Southern Research Station (SRS) unit in Athens, GA. "As project leader of the **Insect and Diseases unit** in Athens, I started looking ahead for areas we could grow into as a unit," says Britton. "Weeds are recognized as a major problem across land uses, but the costs of managing them can be prohibitive in forestry. I thought we could contribute by developing a weed biocontrol program for forest invasives."

Biocontrol involves matching one or more prey organisms to a particular invasive pest with containment, rather than complete eradication, as the desired result. Britton chose kudzu, well known to the public as a major menace in the South, as a good "poster child" for biocontrol research.

"If we could find a good model for the biocontrol of kudzu, then we could start on other weeds such as Chinese privet, Japanese honeysuckle, and oriental bittersweet that actually have more impact on forests, but are a harder sell to the public," says Britton.

With funding from FHP and Forest Service International programs, Britton set out to search for insects and other organisms that feed on kudzu in China, the native range of the plant. Collaborating Chinese scientists helped choose survey sites in an area where the climate is most similar to that of the area around Atlanta, GA. Numerous insects and fungal pathogens that prey on kudzu have been identified since the program began—the most promising are being tested in China to ensure that they will not prey on plants other than kudzu.

"Biological control is an expensive solution. Years of research are essential to ensure that the biological control agent will not have unintended effects of its own," writes Britton in her 2004 book *Biological Pollution*, "but where eradication is no longer possible, biological control may be a better long-term investment than continuing to fight these invaders with chemical weapons. In many situations, an integrated pest management program that uses both biological and pesticide weapons may be needed."

Who Will Stop the Invasion?

In *Biological Pollution*, Britton states the essence of the problem with exotic invasives: "These organisms, sometimes called invasive exotic pests, threaten our crops, our forests, and perhaps our very existence. Once biological pollutants are imported, they grow, adapt, multiply, and spread on their own unless people take direct, vigorous, and often costly actions to stop them."

The most economical approach is to focus on early detection and rapid response. To help managers of State and private lands, FHP offers to pay 50 percent of the cost of eradicating invasive plants on their lands. This strategy recognizes that biological pollution is a cross-boundary issue, and must be addressed through a network of local initiatives. In the South, where more than 80 percent of lands are privately owned, this involves working hands-on with people who may have had little direct contact with the Forest Service.

"Invasive plant control is a very good issue for bringing together traditional and nontraditional partners and for working with those who usually don't work with us," says Britton. "This is an excellent way to involve the public and let them know about the other things we are doing."

Britton remains passionate about invasive plant control, but as national pathologist for FHP, she now focuses most of her time on introduced pathogens such as sudden oak death, white pine blister rust, and root disease.

LOOKING IN CHINA FOR KUDZU BIOCONTROL

Kudzu (*Pueraria montana*) is arguably the most famous exotic plant to invade the Southeastern United States. Introduced from Asia in 1876, kudzu vines with their grape soda-scented blossoms cover millions of acres of disturbed land, forming dense mats over everything, including mature trees. Kudzu is prohibitively expensive to control chemically. Southern Research Station scientists and collaborators are searching in the plant's native range in China for insects that feed on kudzu. So far, they have identified 110 species of insects that feed on kudzu, and are conducting preliminary tests in China on some of the most promising candidates.

Oriental bittersweet *(Photo by James H. Miller, USDA Forest Service)*

ORIENTAL BITTERSWEET: A PATIENT INVADER

by Zoë Hoyle

For some, it means a rustic wreath of red-orange berries from the mountains, a little cheer on a gray winter day. For others, the very name oriental bittersweet evokes an endless battle with a wily invader. How could such a pretty vine cause such disparate reactions?

"Most people don't notice oriental bittersweet until it is pointed out to them, yet the plant poses a bigger threat than kudzu to forest trees and plants in the Southern Appalachian Mountains," says **Katie Greenberg**, research ecologist at the Southern Research Station **Bent Creek unit** in Asheville, NC. Recent experiments by Greenberg and university cooperators confirm the plant's destructive capabilities and explain how it actually spreads.

Oriental bittersweet (*Celastrus orbiculatus*), a woody vine with rounded leaves and small yellowish-green flowers, was introduced into the United States from Asia as early as 1736. Like many other nonnative invasive plants, it was brought over as a garden ornamental. Its bright orange berries, produced in the fall, also made the plant popular for wreaths and winter flower arrangements. But over the centuries, the pretty vine has become a pest, spreading steadily out from old home sites into surrounding forests. Oriental bittersweet can now be found in more than 33 States, ranging from Maine south to Georgia and west to Iowa.

Until recently, the highlands of the Southern Appalachian region were relatively free of the vine. Then during the late 1980s, infestations were found in the Great Smoky Mountains National Park, the Blue Ridge Parkway, and the national forests of North Carolina and Tennessee. Nestled among public lands, Asheville, NC, has become a hub for oriental bittersweet invasion. The vine proliferates easily along forest edges and in openings created by disturbance, and spreads rapidly. From Asheville, the vine has moved out along roads and rivers into the national forests, where it poses a real threat to forest trees and plants.

Growing as high as 60 feet, with vines up to 4 inches in diameter, oriental bittersweet can collapse a tree with the weight of its vines. Understory plants are smothered or die from lack of light.

A Strategy Revealed

When brought to the United States, nonnatives are moved away from the insects and diseases that keep them in check in their home landscapes. This gives them an edge, but to proliferate they need to produce viable seed that can germinate in a wide range of soil and light conditions. They become invasive when they develop the ability to outcompete native vegetation.

Oriental bittersweet produces hundreds, even thousands of berries, depending on the size of the vine. The seeds are spread by the birds and animals that eat the fleshy berries, and by humans gathering the vine to decorate or sell. The plant can also expand through both aboveground and underground stems and by sending up shoots from roots. Greenberg's research has also shown that young vines are able to "sit and wait" for the best conditions to start growing rapidly.

Katie Greenberg, along with Lindsay Smith (University of Tennessee) and Douglas Levey (University of Florida), designed an elegant series of experiments that revealed the strategies that allow oriental bittersweet to spread so rapidly. The first experiment compared the

(continued on page 20)

PATIENT INVADER

(continued from page 19)

fruit fate—what happened to the fruit after it ripened—of oriental bittersweet and the native American holly (*Ilex opaca*), which also produces bright orange berries.

The researchers marked fruit along roadsides where both plants occurred within 30 m (98 feet) of one another. They found that similar amounts of fruit—over 75 percent—were removed from both bittersweet and holly, apparently by birds and small mammals. In the second experiment, the researchers found that the amount of bittersweet fruit taken by animals was similar whether the fruit was abundant or scarce within the area.

Greenberg and her fellow researchers next investigated the factors that might affect how well seeds germinated once they are dispersed. They found that bare seeds—those with the flesh removed—had the highest germination rate. The seeds of many plants have a hard seed cover that must be broken or scratched before germination can begin, a process called scarification. Some plant seeds must be "etched" by the gastrointestinal acids in the stomachs of birds and mammals.

"Although birds are thought to be the primary dispersers of oriental bittersweet, no one had looked at whether scarification contributed to germination," says Greenberg. "We fed seeds to captive birds, and were surprised to find no difference in germination rates between seeds that were scarified by the birds and seeds that were just removed from the berry. But seeds from intact berries did take longer to germinate, suggesting that the birds and mammals do help the seeds to germinate by removing the flesh."

Playing the Waiting Game

In a fourth set of greenhouse experiments, the researchers tested the effect of natural light intensity on bittersweet seed germination and growth by creating five different levels of shade. The results showed that light intensity did not affect the proportion of seeds germinating, time until germination, or seed survival. Seedlings with the greatest exposure to sun did grow more rapidly and produced more leaves, heavier shoots, and longer roots.

"We found a high level of germination over a wide range of conditions," says Greenberg. "Combined with our other experiments, our results confirmed that bittersweet seeds are dispersed in large numbers, and that the plant can readily establish and persist in low light under the forest canopy. When a new hole in the forest canopy allows light to reach the ground, the plants begin to grow rapidly."

Most invasive plants move into disturbed sites with high light and reduced competition from other plants. Oriental bittersweet's unusual "sit and wait" strategy allows the plant to slowly invade an intact forest, then quickly take advantage of disturbances that open the canopy and expose the forest floor to more direct sunlight.

These findings reinforce the need to focus control efforts on oriental bittersweet berries, keeping them from being dispersed by birds, mammals, or humans. This means cutting and treating vines early, especially the large vines that produce fruit in the tops of trees. This also means that, if vines are used for decoration, they must be disposed of in landfills rather than thrown into brush piles or compost heaps.

Better yet, find a more sustainable way to decorate.

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Pulling oriental bittersweet *(Photo by Zoë Hoyle, USDA Forest Service)*

SPREADING OUT FROM ASHEVILLE

While studying the unique "sit and wait" invasion strategy of oriental bittersweet (*Celastrus orbiculatus*), Katie Greenberg and fellow researchers Evelyn Konopik, Doug Levey, and Lindsay Smith set up plots along the19 miles of Blue Ridge Parkway that pass through the Asheville, NC, basin. In both north and south directions along the parkway, elevation increases with distance from Asheville. The plots ranged from 2,201 to 4,836 feet in elevation. The researchers counted the number of bittersweet stems by height in each plot, and noted the percent cover of native plant species in each plot.

As expected, the researchers found that the plots nearest Asheville had higher levels of oriental bittersweet. Though there was less bittersweet at higher elevations, distance from Asheville was a more compelling factor than increasing elevation. Vines were tall along road edges, but taller still towards the interior of the forest. Bittersweet was more likely to occur on north-facing than on south-facing slopes, and native plant diversity was significantly affected by the presence of oriental bittersweet.

The researchers found a large number of oriental bittersweet vines at the high elevation (6,542 feet) parking area at Mount Pisgah. The hiking trail at Mount Pisgah is one of the most highly visited sites along the Blue Ridge Parkway, and is only a few miles from Asheville. The researchers concluded that the presence of the vine at this high elevation confirmed their conclusions about the importance of distance from Asheville over elevation, and suggested that humans may play an important part in dispersing oriental bittersweet into recreational areas.

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PREDICTING WHERE ORIENTAL BITTERSWEET WILL SPREAD NEXT

To learn more about how oriental bittersweet (*Celastrus orbiculatus*) infests forests, **Henry McNab**, researcher forester with the Bent Creek unit, and Project Leader **David Loftis** looked at the relationships among variables such as landform and disturbance and the presence of the plant. They conducted their study in the **Bent Creek Experimental Forest**, on a site that had been selectively harvested and recently disturbed by hurricane-force winds. Testing a rapid survey method they designed for this and other risk-assessment studies, they found oriental bittersweet on 39 percent of the study area.

After analyzing the variables associated with the presence of the plant, McNab and Loftis developed and tested a model to predict the types of forests the vine preferred. They found that bittersweet was associated with forest type, disturbance of the soil, and sheltered, concave areas. It seemed to prefer moist areas with mature trees and few shrubs, but occurred less frequently where the forest canopy was dominated by oaks or where there was no bare soil exposed. Disturbance of the forest floor by animals or of the canopy by wind seemed to promote the presence of the vine, but disturbance associated with roads and harvest activities had little effect.

Unfortunately, very little is known about how to get rid of oriental bittersweet once it begins to invade a forest. McNab recommends that land managers start by aggressively controlling isolated patches of the vine as soon as they find them. He notes that although it is relatively easy to eradicate small infestations with herbicides, more solutions are needed for long-term control of bittersweet across large landscapes of varying ownerships and landowner priorities.

"Because of its ability to become established under a variety of conditions and for birds to disperse seeds widely, bittersweet is difficult to manage in Southern Appalachian forests, which are subject to a number of natural and human disturbances," says McNab.

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MONITORING ORIENTAL BITTERSWEET IN WESTERN NORTH CAROLINA

by Bill Hoffard

A new effort is underway in western North Carolina to monitor oriental bittersweet (*Celastrus orbiculatus*)—an aggressive introduced plant that threatens to overrun native plant communities. Since its introduction into the United States in the 1860s, the exotic vine has become naturalized in 21 of the 33 States in which it was planted, and is now found from Maine to Georgia and west to Iowa.

A reliable monitoring system is critical to any attempts to control the spread of oriental bittersweet. In 2004, **Paul Merten**, invasive plants specialist with the USDA Forest Service, **Forest Health Protection (FHP)** office in Asheville, NC, started driving the back roads of western North Carolina, taking his own "windshield" surveys of the presence of oriental bittersweet. Even as a casual observer, he was struck by how often he saw the plant and the speed at which it seemed to spread.

"I realized that we needed a more systematic and scientifically designed monitoring system than my windshield survey to accurately track oriental bittersweet in western North Carolina," says Merten.

With landowner volunteers and personnel from the National Park Service, FHP, and the National Forest System, Merten has formed a 12-person team to set up a network of

(continued on page 22)

MONITORING ORIENTAL BITTERSWEET

(continued from page 21)

monitoring plots. Merten notes a characteristic of oriental bittersweet that makes it easily detectable, but means monitors may have to scramble for data."In the fall, oriental bittersweet retains its green foliage for weeks after most native plants have dropped their leaves, so it's easy to spot in the woods at that time," he says. "Unfortunately, this delay in foliage drop is brief, so we have only a limited window of opportunity to take our survey. With plots located in multiple counties, it can really pose some logistical challenges."

Still, Merten is confident that the team will come up with a workable plan to collect the data they need to show trends in growth, dispersal, and range extension of oriental bittersweet in western North Carolina. The network can also be used to monitor the effectiveness of control programs and provide a means of rapid detection of new infestations. The network will coordinate with other monitoring initiatives such as the National Forest Health Monitoring Program to provide better information about the spread of oriental bittersweet in western North Carolina and to alert resource managers to emerging problem areas.

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Bill Hoffard is an entomologist with Forest Health Protection in Asheville, NC.

Oriental bittersweet *(Photo by James H. Miller, USDA Forest Service)*

ORIENTAL BITTERSWEET: BOUNTIFUL CRAFT PLANT OR ODIOUS PLAGUE?

by Bill Hoffard

"Bittersweet." Perhaps there is no more aptly named plant in all of western North Carolina than oriental bittersweet (*Celastrus orbiculatus*). For some people, the name conjures up images of the widespread destruction of native ecosystems by a profligate introduced weed. For others, the word evokes a source of income that helps struggling mountain families to weather plant closings and economic upheaval. Introduced into the Asheville area in the 1880s, the oriental bittersweet vine soon became a favorite of gardeners because of its showy orange-red berries and the ease with which it could be grown. Over time, crafters began weaving the woody vines and bright berries into wreaths sold at farmers' markets and craft fairs across the South.

Unfortunately, oriental bittersweet, like so many other introduced plants, has run amok and threatens a wide range of native plants. Growing very rapidly, bittersweet vines quickly constrict and cover native vegetation. The damage goes far beyond killing native plants. Oriental bittersweet can alter the ecology of an area, causing unnatural change in animal as well as plant communities. A dangerous unnatural competitor, oriental bittersweet could cost the forest products industry millions in revenue. The vine also threatens the American ginseng (*Panax quinquefolium*) industry—a business that nets licensed collectors of the native medicinal plant some $3 million annually.

In 2003, the North Carolina Department of Agriculture (NCDA) added oriental bittersweet to the State Noxious Weed List, prohibiting the sale and distribution of the vine and products made from it in North Carolina. Crafters opposed the ban, claiming that the 18 counties of western North Carolina were already so infested with oriental bittersweet that the ban would have little effect and would adversely affect their livelihoods. Natural resource managers countered that the heaviest infestations are in the Asheville basin, with only small and controllable infestations in the outlying western North Carolina counties.

On October 19, 2004, the NCDA held a work session near Asheville to gather information from citizens and organizations about the status of oriental bittersweet in western North Carolina. The board voted to allow crafters to continue to sell the vine in the 18 western North Carolina counties.

Both sides understand that oriental bittersweet is a problem that will not go away. The Asheville Weed Team—a local citizens' group—has been meeting with crafters and representatives from NCDA and Federal agencies to develop labeling to warn consumers of the dangers of carelessly disposing of wreaths and berries. For example, consumers might be encouraged to bag the product in plastic and insure that it is properly disposed of in a landfill—and discouraged from throwing wreathes out in the yard or nearby woods, or into their own compost heaps. Meanwhile, the Asheville Weed Team continues to provide public education and to work directly to eradicate oriental bittersweet from the Asheville basin, which is recognized by all as a hub for the spread of the invasive vine out into nearby national forests.

The North Carolina Noxious Weed List, which includes oriental bittersweet and many other nonnative invasive plants, can be found at http://www.agr.state.nc.us/plantind/plant/weed/noxweed.htm

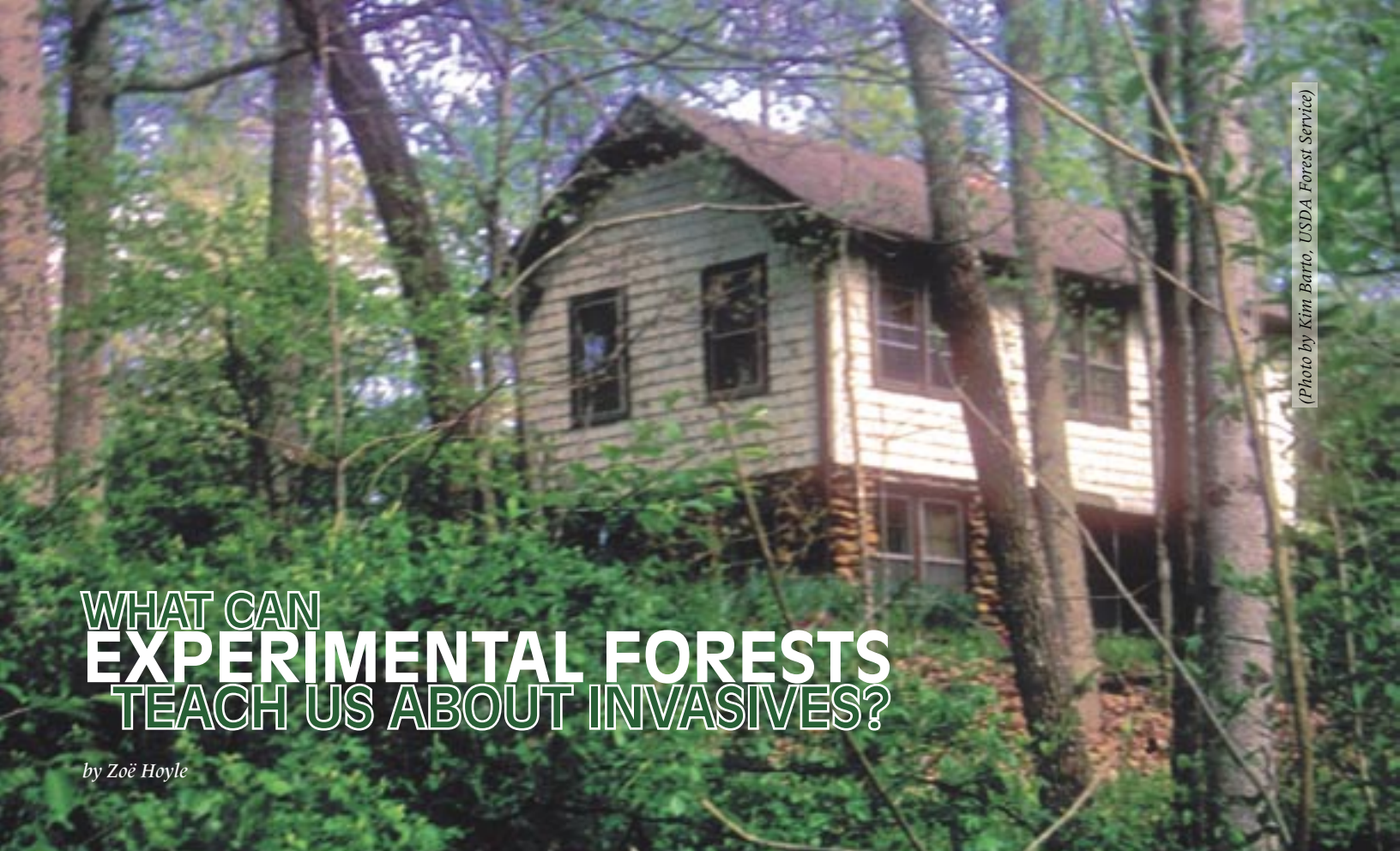
CONTROLLING ORIENTAL BITTERSWEET

As with kudzu, mechanical controls—pulling up the plants or clipping—are only effective for very small vines and in areas with very few stems. The root system for a 2-inch diameter oriental bittersweet vine can easily stretch over 10 feet. New sprouts rise quickly from roots left in the ground. Vines should be treated with herbicide when cut; if the vine is cut but not treated, sprouting from the root section will actually increase.

The following are specific herbicide recommendations from Jim Miller, *Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control*:

- Thoroughly wet all leaves with one of the following herbicides in water with a surfactant (July to October): Garlon® 4, Garlon® 3A, or a glyphosate herbicide as a 2-percent solution (8 ounces per 3-gallon mix).

- For stems or vines too tall for foliar sprays, apply Garlon® 4 as a 20-percent solution in commercially available basal oil, diesel fuel, or kerosene (2.5 quarts per 3-gallon mix) with a penetrant (check with herbicide distributor) to the lower 16 inches of stems. Or, cut large stems or vines and immediately treat the cut surfaces with one of the following herbicides in water with a surfactant added: Garlon® 4 or glyphosate herbicide was a 25-percent solution (32 ounces per 1-gallon mix).



(Photo by Kim Barto, USDA Forest Service)

WHAT CAN EXPERIMENTAL FORESTS TEACH US ABOUT INVASIVES?

by Zoë Hoyle

The experimental forests and ranges established by the USDA Forest Service over the last century are some of the few places in the United States where long-term data is 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.

The Bent Creek Experimental Forest, established by the Forest Service in 1925, is the oldest experimental forest in the Eastern United States. Located just south of Asheville, NC, the 6,300-acre forest includes a campus of small offices and buildings built with hand-hewn chestnut timbers and handmade white oak shingles in the early 1930s by the Public Works Administration.

Early research at Bent Creek aimed to improve the degraded hardwood stands of an area that had been extensively tilled, grazed, and logged for decades. Current research is still focused on hardwoods, and informs efforts to manage and regenerate hardwood forests in the Southern Appalachian region, not only in North Carolina, but also across the Cumberland Plateau region that stretches from Kentucky south to northern Alabama. Bent Creek researchers are also using innovative approaches to classify the often unique ecologies of upland forests, charting the production of hard and soft mast over decades, and studying long-term changes to forests and their animal and plant populations as a result of disturbances ranging from hurricanes to fire. As the experimental forest becomes increasingly popular with area hikers and mountain bikers, researchers have started to look at how forest management can interface with recreational use.

In summer 2004, volunteers cleared a section of the experimental forest of oriental bittersweet in preparation for the expansion of the Bent Creek Demonstration Forest. Dedicated in 1990 to teach scientific forestry to land managers and interested publics in the Southern Appalachian region, the demonstration forest program uses long-term research sites to illustrate principles of hardwood forest ecology and management. Many of the demonstrations installed in 1991 have grown so vigorously that it is now hard to see the silvicultural systems they were intended to illustrate.

Seven new demonstration sites will encompass the wide range of silvicultural treatments suitable for managing the hardwood forests of the Southern Appalachian region, and will be available to serve the many university students and professors, scientists, local school districts, interest groups, and others who visit Bent Creek to learn about forests and how they can be managed for multiple uses.

Bent Creek Experimental Forest: http://www.srs.fs.usda.gov/bentcreek/

Maps: http://www.srs.fs.usda.gov/bentcreek/new_maps_on-line!.htm

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CONTROLLING ORIENTAL BITTERSWEET ON THE BENT CREEK EXPERIMENTAL FOREST

by Zoë Hoyle

Like many areas within the Asheville, NC, basin, the **Bent Creek Experimental Forest** is heavily infested with oriental bittersweet (*Celastrus orbiculatus*). In the heat of late summer 2004, volunteers worked alongside Southern Research Station (SRS) scientists and technicians to "sweep" oriental bittersweet from a section of the experimental forest where new demonstrations of forest management alternatives will be installed over the next few years. The section contained some of the oldest populations of bittersweet on the experimental forest, with vines up to 3 inches in diameter along the edges, and several large infestations in interior forest areas. Recognizing the threat of the invasive vine, the Environmental Assessment required for the latest experiments included the site-specific use of herbicides to control oriental bittersweet.

Forest management options planned for the tract include removing overstory trees. This creates the sunlit gaps that have been shown to promote the growth of oriental bittersweet, which can "sit and wait" in the shaded interior of forests. To minimize the effect of the noxious weed on research, **David Loftis**, project leader for the SRS **Bent Creek unit**, decided to try to eradicate oriental bittersweet from the new experimental plots, using the "sweep" as an opportunity to educate volunteers about the effects of invasive plants on forests.

Volunteers certified to use herbicides were given clearance to spray within the tract, except in areas along the several small creeks in the area, where oriental bittersweet sprouts were pulled by hand. Hand pulling revealed the frustrations of controlling oriental bittersweet. The roots of the plant can be very long and hard to pull up. If not completely removed, root fragments left in the ground will resprout. Volunteers in these areas vied to see who could pull up the longest root—the record was over 30 feet. Meanwhile, volunteers with backpack sprayers hoofed over a mile up a steep grade to douse a huge bittersweet infestation along a popular mountain bike trail.

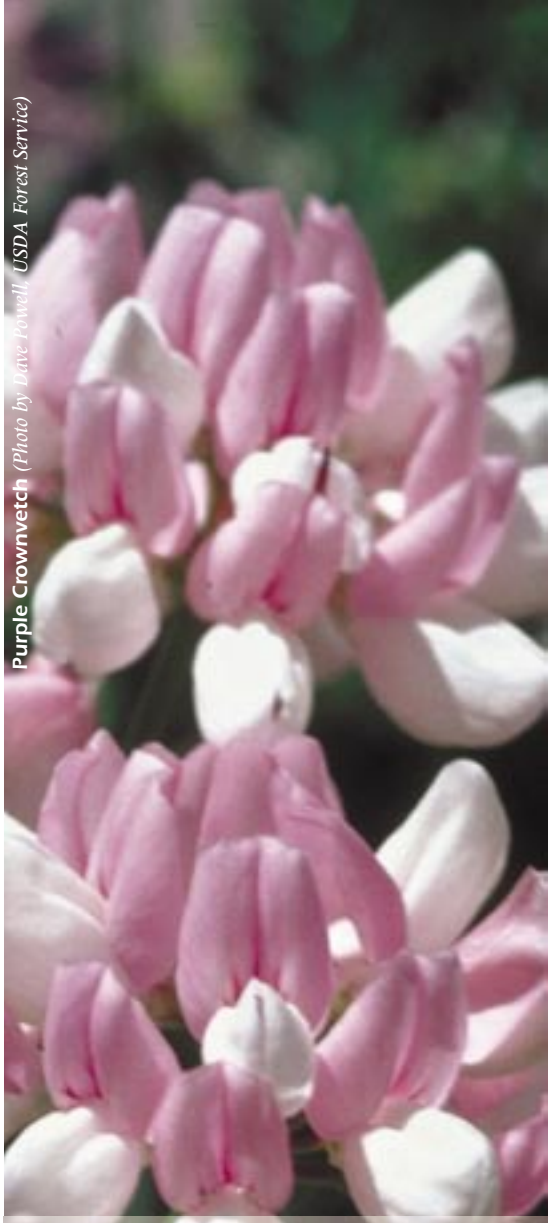
At each session, botanists, including **Gary Kauffman** from the National Forests in North Carolina, trained volunteers to identify about 20 invasive plants common to the Asheville area. Certified herbicide specialists, including **Tracy Roof** from the SRS Bent Creek unit, provided training on herbicide application and safety.

Volunteers included members of the Asheville Weed Team, the North Carolina Exotic Pest Plant Council, the North Carolina Arboretum, the National Forest System, Forest Health Protection, U.S. Fish and Wildlife Service, Southern Appalachian Man and the Biosphere, the Blue Ridge Parkway, the Audubon Society, the Western North Carolina Alliance, and students from Warren Wilson College.

For more information:
Tracy Roof at 828–667–5261 ext. 125 or troof@fs.fed.us

A THREAT TO ITS NATIVE COUNTERPART

Oriental bittersweet (*Celastrus orbiculatus*) easily outcompetes native plants of ecological and economic importance such as American ginseng (*Panax quinquefolium*) and goldenseal (*Hydrastis canadensis*). Another plant under direct threat is the native American bittersweet (*C. scandens*), which flowers and produces berries at the end of stems, while oriental bittersweet produces berries where the leaf and stem intersect. American bittersweet is neither aggressive nor invasive and is already difficult to find in the wild. Because it crosses so easily with oriental bittersweet, the genetic integrity of the native plant may be lost.



Purple Crownvetch *(Photo by Dave Powell, USDA Forest Service)*

Control Terms

biological control (biocontrol): control of a pest with a biological agent such as an insect or pathogen.

containment: preventing the spread of invasive species from infested to noninfested areas.

detection: the process of surveying or watching for infestations.

early detection and rapid response: method for finding and eradicating new infestations.

eradication: total elimination of an infestation.

herbicide: a chemical agent used to destroy or inhibit plant growth.

pesticide: general term for a chemical agent used to destroy a pest.

Landowner's TOOLBOX

Biological Control Virtual Information Center

http://cipm.ncsu.edu/ent/biocontrol/

The Biological Control Virtual Information Center is part of the National Integrated Pest Management Network and is maintained by the National Science Foundation Center for Integrated Pest Management and the Consortium for International Crop Protection.

Exotic Pest Plant Council (EPPC) Web Sites

Mid-Atlantic region: http://www.ma-eppc.org

Southeastern region: http://www.se-eppc.org

Alabama: http://www.se-eppc.org/states/alabama.cfm

Florida: http://www.fleppc.org

Georgia: http://www.gaeppc.org

Kentucky: http://www.se-eppc.org/states/kentucky.cfm

Mississippi: http://www.se-eppc.org/states/mississippi.cfm

North Carolina: http://www.se-eppc.org/states/northcarolina.cfm

South Carolina: http://www.se-eppc.org/states/southcarolinna.cfm

Tennessee: http://www.tn-eppc.org

Invasive and Exotic Species

http://www.invasive.org/

A joint project of the University of Georgia's Bugwood Network, USDA Forest Service, and USDA Animal and Plant Health Inspection Service, the site provides information on invasive and exotic species, biocontrol agents, and news updates. A comprehensive list of all plants considered invasive in the southern region can be viewed at **http://www.invasive.org/seweeds.cfm**.

Invasivespecies.gov

http://www.invasivespecies.gov

The gateway to Federal and State invasive species activities and programs, and a node of the National Biological Information Infrastructure, the site includes species profiles, geographic information, databases, grants and funding sources for invasive species management, outreach tools, and much more.

The National Institute of Invasive Species Science

http://www.niiss.org/cwis438/niiss/index.html

Formed by a consortium of agencies that conduct research on invasive species provides science-based information and Web site includes invasive species database with maps.

The Nature Conservancy Eastern Invasives Management Network

http://tncweeds.ucdavis.edu/networks/eastern/eastern.html

Web site includes invasive profiles and control methods, a weed information management system, a weed control methods handbook, and information about remote sensing.

Southern Appalachian Information Node Invasive Plants Literature Collection

http://sain.nbii.org/invasives/

Web site includes a comprehensive database of research on nonnative invasive species of the Southern Appalachian region listed by both common and scientific names.

USDA Animal and Plant Health Inspection Service Noxious Weeds List

http://www.aphis.usda.gov/ppq/weeds/

Web site covers the Animal and Plant Health Inspection Service noxious weeds policy, and includes current Federal noxious weed list, active biocontrol programs, guidelines for listing and delisting noxious weeds.

USDA Forest Service Invasive Species Portal

http://www.fs.fed.us/foresthealth/programs/invasive_species_mgmt.shtml

Portal includes management plans for invasive plants.

USDA Forest Service, Southern Research Station

http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=5424

URL directly links to Jim Miller's guide to nonnative invasive plants in the South. This guide can be downloaded or ordered from SRS in quantity.

USDA Natural Resources Conservation Service Invasive Plants

http://plants.usda.gov/cgi_bin/topics.cgi?earl=noxious.cgi

Web site includes State and Federal composite noxious weeds lists, invasive plants of the United States, introduced plants of the United States, each with links to more information.

RECOMMENDED READING

Measuring Invasions

Rudis, V.A. [and others]. [In press]. *Regional monitoring of non-native plant invasions with the Forest Inventory and Analysis program.* In: McRoberts, R.E. [and others]. *Proceedings of the 6th annual FIA symposium.* Gen. Tech. Rep. Washington, DC: USDA Forest Service. http://web.utk.edu/~vrudis/nnis/Rudis_MSTS2004.pdf

Kudzu—Out of Ecological Place and Time

Blaustein, R.J. 2001. *Kudzu's invasion into Southern United States life and culture.* In: McNeeley, J.A., ed. *The great reshuffling: human dimensions of invasive species.* Gland Switzerland and Cambridge, UK: World Conservation Union: 55–62.

Britton, K.O.; Orr, D.; Sun, J. 2002. *Kudzu*. In: Van Driesche, R. [and others]. *Biological control of invasive plants in the Eastern United States.* FHTET–2002–04. Morgantown, WV: USDA Forest Service, Forest Health Technology Enterprise Team: 325–330.

Miller, J.H. 2003. *Nonnative invasive plants of southern forests: a field guide for identification and control.* Gen. Tech. Rep. SRS–62. Asheville, NC: USDA Forest Service, Southern Research Station. 93 p.

Schiff, N.M.; Abbas, H. 2004. *Pueraria montana* var. *lobata*. In: *Crop protection compendium* [CD-ROM]. Wallingford, UK: CAB International.

Stewart, D. 2000. *Kudzu: love it—or run.* Smithsonian. 31(7): 65–70.

Kudzu Containment

Kudzu in Alabama: history, uses, and control http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=2341

Kudzu eradication and management http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=2341

Kudzu and Beyond

Britton, K., ed. 2004. *Biological pollution.* St. Paul, MN: The American Phytopathological Society Press. 113 p.

Oriental Bittersweet: A Patient Invader

Greenberg, C.H.; Smith, L.M.; Levey, D.J. 2001. *Fruit fate, seed germination and growth of an invasive vine - an experimental test of 'sit and wait' strategy.* Biological Invasions. 3: 363–372. Full text: http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=4495.

Predicting Oriental Bittersweet

McNab, W.H.; Loftis, D. 2002. *Probability of occurrence and habitat features for oriental bittersweet in an oak forest in the Southern Appalachian Mountains, USA.* Forestry Ecology and Management. 155: 45–54. Full text: http://www.srs.fs.usda.gov/pubs/viewpub.jsp?index=3193.

Tropical sodapple *(Photo by J. Jeffrey Mullahey, University of Florida)*

around the STATION...

ENVIRONMENTAL THREAT ASSESSMENT CENTER INITIATED IN THE SOUTH

by Bill Hoffard

Our forests are faced with a daunting array of threats. Native and nonnative invasive insects, plants, diseases, drought, fire, rapid development, air pollution, and possible climate change—all these factors and more combine to have profound and lasting effects on our Nation's forests. To better address these threats in the Southeast, the USDA Forest Service established the Eastern Forests Environmental Threat Assessment Center (EFETAC) in Asheville, NC, in spring 2005.

Although the center is administratively attached to the Southern Research Station (SRS), it will cover the entire Eastern United States, an area that encompasses 33 States and includes an estimated two-thirds of the Nation's population and many of its major cities. At the same time, the area is heavily forested, with much of the forested acreage held by private and industrial landowners. This intersection of often competing land uses has increased the susceptibility of eastern forests to damage from native pests and from invasion by nonnative insects, plants, and diseases.

EFETAC will coordinate the efforts of several Forest Service units to predict, detect, and assess environmental threats. SRS brings years of experience developing economic and computer models in areas such as forest fragmentation, future water availability, and climate change, while the Forest Health Protection unit offers over four decades of aerial insect and disease survey and assessment experience. Long-term data resources from the SRS Forest Inventory and Analysis unit provide the center with a solid base of statistics about forests in the South that stretches back to the 1930s.

Part of the mission of the center is to develop new and reliable warning systems that will allow land managers to take cost-effective preemptive action against impending

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

Garlic mustard *(Photo by Jody Shimp, Illinois Department of Natural Resources)*

threats. Organizers emphasize that EFETAC will provide highly practical tools for a wide range of land managers. For example, user-friendly Web sites will be developed to allow users anywhere to easily interact with powerful computer programs to get specific, timely information. One of the first products will be an addition to the SRS Forest Encyclopedia Network, which synthesizes scientific information to provide natural resource managers, land owners, researchers, students, and the interested public easy access to useful knowledge about southern forests.

Forest Encyclopedia Network: http://www.forestencyclopedia.net/

While administered by SRS, the threat center will draw upon multiple units and staffs. Funded jointly by State and Private Forestry, the National Forest System, and Research and Development, the center has already announced plans to collaborate with the National Aeronautics and Space Administration Stennis Space Center in Mississippi to develop the components of an early warning system for forest threats using remote sensing data from satellites. Findings and products will be shared with other Agencies such as the U.S. Department of the Interior, U.S. Department of Defense, U.S. Fish and Wildlife Service, and others. As the center grows, it will expand to provide research and sabbatical opportunities for scientists and students from universities, national laboratories, other Federal Agencies, and foreign institutions.

What Was It?

A kudzu bloom appeared on the back cover of the Winter 2005 issue of *Compass*. Dan Miller and Larry Jahn tied, responding with the correct answer on the same day. Each will receive a framed, first-edition poster of *Nonnative Invasive Plants of the South*, currently in production.

SRS Headquarters, Asheville, NC *(Photo by Rodney Kindlund, USDA Forest Service)*

NEW PRODUCTS

Southern Pine Ecosystems

1 Dickens, E.D.; Barnett, J.P.; Hubbard, W.G.; Jokela, E.J. 2004. *Slash pine: still growing and growing!* Proceedings of the slash pine symposium. Gen. Tech. Rep. SRS-76. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 148 p.

This volume presents the experiences of scientists and land managers over a 20-year period in managing southern pine ecosystems. In 17 research papers the authors explore a renewed interest in managing slash pine over its natural and expanded range, but particularly within the southeastern Coastal Plain, with a focus on that species' ability to produce high-grade, high-value lumber.

2 Sullivan, Brian T.; Fettig, Christopher J.; Otrosina, William J. [and others]. 2003. *Association between severity of prescribed burns and subsequent activity of conifer-infesting beetles in stands of longleaf pine.* Forest Ecology and Management. 185: 327-340.

A randomized complete block experiment was performed to measure the effect of prescribed, dormant-season burns of three different levels of severity (measured as fuel consumption and soil surface heating) on subsequent insect infestation and mortality of mature longleaf pine (*Pinus palustris* Mill.). Attacks of *Ips* and *Dendroctonus* bark beetles were apparent on nearly all dead or dying trees, and evidence suggested that root pathogens may have contributed to tree susceptibility to beetle attack and mortality. Our data indicate that selection of burn regimes that reduce or eliminate consumption of duff (e.g., favoring heading fires over backing fires) could significantly reduce mortality of longleaf pine managed for long rotations.

from the Southern Research Station...

Wetlands, Bottomlands, and Streams

3 Adams, Susan B.; Schmetterling, David A.; Young, Michael K. 2005. *Instream movements by boreal toads* (Bufo boreas boreas). Herpetological Review. 36(1): 27-33.

Boreal toads (*Bufo boreas boreas*) are declining throughout much of their range in Western North America; documenting their movement patterns may prove integral to understanding and arresting the declines. Evaluating boreal toad travel via streams could enhance our understanding of home range size, dispersal distances and routes, and the effects of disturbance on dispersal. We evaluated instream movements of boreal toads to determine the prevalence, distance, and 24 hour timing of summer movements by juvenile and adult boreal toads in three western Montana streams.

4 Barton, Christopher D.; DeSteven, Diane; Kilgo, John C. 2004. *Mitigation bank promotes research on restoring Coastal Plain depression wetlands (South Carolina).* Ecological Restoration. 22(4): 291-292.

In 1997 the U.S. Department of Energy established a wetland mitigation bank to compensate for unavoidable wetland impacts on the Savannah River Site. This effort provided an opportunity to investigate wetland restoration techniques and ecological responses. Research and management staffs from the USDA Forest Service, Westinghouse Savannah River Corporation, the Savannah River Technology Center, the Savannah River Ecology Laboratory, and several universities developed a project to restore degraded depression wetlands on the Savannah River Site. The mitigation project seeks cost-effective methods to restore the hydrology and vegetation typical of natural depression wetlands, and so enhance habitats for wetland-dependent wildlife. We present a summary of this project and the research studies underway.

5 Conner, Richard N.; Dickson, James G.; Williamson, J. Howard; Ortego, Brent. 2004. *Width of forest streamside zones and breeding bird abundance in eastern Texas.* Southeastern Naturalist. 3(4): 669-682.

We evaluated breeding bird communities in forested streamside zones in eastern Texas to determine threshold widths of riparian forest associated with the addition of mature-forest-breeding birds and loss of shrub-breeding birds. We observed an association of shrub-breeding birds with narrow streamside zones and an increasing number of mature forest species within wider streamside zones. Streamside zones also provided song perches for many shrub breeding species. Our results provide important information to help forest managers balance the habitat requirements of both shrub-breeding and forest-breeding birds when they harvest timber in southern pine forests.

6 Grace, J.M., III; Skaggs, R.W.; Malcom, H.R. [and others]. 2003. *Increased water yields following harvesting operations on a drained coastal watershed.* In: Proceedings of the 2003 American Society of Agricultural Engineers international meeting; paper no. 03-2039. St. Joseph, MI: American Society of Agricultural Engineers: 25 p.

The impact of harvesting a 23-ha mature primarily hardwood forest watershed with poorly drained organic soils near Plymouth, NC was evaluated using a paired watershed approach. Event outflow, event peak flow, and number of flow days were significantly increased by the harvesting operation. Mean event outflow increased from 22.6 mm on the control to 47.3 mm on the harvested, which represents a 2-fold increase. Similarly, event peak flow and number of flow days from the harvested watershed were more than 50 percent greater than observed on the control. Daily outflow and water table depths observed on the harvested watershed were similar to those from the control.

7 Grace, J.M., III; Skaggs, R.W.; Malcom, H.R. [and others]. 2003. *Influence of thinning operations on hydrology of a drained coastal plantation watershed.* In: Proceedings of the 2003 American Society of Agricultural Engineers international meeting; paper no. 03-2038. St. Joseph, MI: American Society of Agricultural Engineers: 22 p.

Forest management activities such as harvesting, thinning, and site preparation can affect hydrologic behavior of watersheds on poorly drained soils. Effects of thinning on hydrology are presented for an artificially drained loblolly pine (*Pinus taeda* L.) plantation paired watersheds in eastern North Carolina. Thinning increased daily outflow, peak flow rates, and had no significant impact on water table depths. Mean daily outflow doubled and peak flow rates increased 40 percent on the thinned watershed in relation to the control. Differences in hydrologic behavior are primarily attributed to the thinning operation, which resulted in reduced evapotranspiration.

8 Harrison, Charles A.; Kilgo, John C. 2004. *Short-term breeding bird response to two harvest practices in a bottomland hardwood forest.* Wilson Bulletin. 116(4): 314-323.

Clearcutting is the preferred timber harvest method in bottomland hardwood forests because it is most likely to result in regeneration of preferred species. However, clearcutting generally has negative impacts on forest birds. Patch-retention harvesting may provide similar silvicultural benefits, but its effects on birds are unknown. We surveyed breeding birds in uncut control, clearcut, and patch-retention treatment areas (11-13 ha) for one season prior to harvest and two seasons postharvest in a bottomland hardwood forest in the Lower Coastal Plain of southeastern South Carolina. Based on density response, patch-retention harvesting appears to be less detrimental to forest birds than clearcutting. However, additional work is needed to determine whether retained patches influence avian survival and productivity.

9 Myszewski, Jennifer H.; Bridgwater, Floyd E.; Lowe, William J. [and others]. 2004. *Genetic variation in the microfibril angle of loblolly pine from two test sites*. Southern Journal of Applied Forestry. 28(4): 196-204.

We examined the heritability of microfibril angle (MFA) in loblolly pine, *Pinus taeda* L., and its genetic relationships with height, diameter, volume, and specific gravity. Analyses of variance revealed statistically significant genetic and environmental influences on MFA. Significant general combining ability (GCA), specific combining ability (SCA), and SCA × block effects indicated both additive and nonadditive genetic influences on MFA. Individual-tree, narrow-sense heritability estimates were variable. Genetic correlations between MFA, specific gravity, and growth traits were nonsignificant due to large estimated standard errors.

10 Peacock, Evan; Haag, Wendell R.; Warren, Melvin L., Jr. 2005. *Prehistoric decline in freshwater mussels coincident with the advent of maize agriculture*. Conservation Biology. 19(2): 547-551.

Freshwater mussels are particularly sensitive harbingers of modern-day ecosystem deterioration. Using data from prehistoric Native American shell middens, we examined prehistoric trends in abundance of freshwater mussels of the genus Epioblasma in North America during the last 5000 years. The relative abundance of Epioblasma declined steadily, which could be explained either by an increase in human impacts to streams or by long-term climatic changes unrelated to human activities. The rate of decline increased significantly, however, after the advent of large-scale maize agriculture in the Southeastern United States about 1000 years before the present. Results suggest that human land-use activities in prehistory caused changes in freshwater mussel communities lower in magnitude but similar in direction to changes caused by recent activities.

11 Phillips, Jonathan D.; Marion, Daniel A. 2005. *Biomechanical effects, lithological variations, and local pedodiversity in some forest soils of Arkansas*. Geoderma. 124: 73-89.

This study examines the potential biomechanical effects of trees and of lithological variations within parent material in explaining soil diversity in the Ouachita Mountains of Arkansas. Soils diversity on Ouachita sideslopes is high, and the soil series vary primarily in morphological properties such as soil thickness and rock fragment content. The pattern of variation in these properties indicates that the biomechanical effects of individual trees – as opposed to chemical and hydrological effects – and local lithological variations control soil type diversity. Results also suggest divergent evolution whereby the pedologic effects of trees are large and long-lived relative to the magnitude of the initial effects and lifespan of the plants.

Mountain and Highland Ecosystems

12 Clinton, Barton D.; Vose, James M.; Vroblesky, Don A.; Harvey, Gregory J. 2004. *Determination of the relative uptake of ground vs. surface water by* Populus deltoides *during phytoremediation*. International Journal of Phytoremediation. 6(3): 239-252.

The use of plants to remediate polluted groundwater is becoming an attractive alternative to more expensive traditional techniques. In order to adequately assess the effectiveness of the phytoremediation treatment, a clear understanding of water-use habits by the selected plant species is essential. We examined the relative uptake of surface water (i.e., precipitation) vs. groundwater by mature *Populus deltoides* by applying irrigation water at a rate equivalent to a 5-cm rain event. Examination of differences in isotopic signatures among irrigation water, groundwater, and xylem sap showed that water use by *Populus deltoides* is variable. Hence, studies addressing phytoremediation effectiveness must account for the relative proportion of surface vs. groundwater uptake.

13 Elliott, Katherine J.; Vose, James M. 2005. *Initial effects of prescribed fire on quality of soil solution and streamwater in the Southern Appalachian Mountains*. Southern Journal of Applied Forestry. 29 (1): 5-15.

Prescribed burning is being used in the Conasauga River watershed in southeastern Tennessee and northern Georgia by national forest managers to restore degraded pine/oak communities. Although burning might be an effective tool for restoring these stands to a shortleaf pine/mixed-oak/bluestem grass community type, it is not known whether these restoration burns will have a negative impact on water quality. Six subwatersheds (similar in vegetation, soil type, stream size and location, and disturbance history) were located within the Conasauga River watershed. Four of the sites were burned in March 2001, and two sites were designated as controls. Our results suggest that low-intensity, low-severity fires could be used as a tool to restore vegetation structure and compositions in these mixed pine-hardwood ecosystems without negatively impacting water quality.

14 Grace, J.M. III. 2004. *Sediment plume development from forest roads: how are they related to filter strip recommendations?* In: Proceedings of the 2004 American Society of Agricultural Engineers/Canadian Society of Agricultural Engineering international meeting; paper no. 04-5015. St. Joseph, MI: American Society of Agricultural Engineers: 11 p.

Sediment movement downslope of forest road systems is a concern because these sediments have the potential to reach stream systems. Filter strips and streamside management zones are recommended and implemented to minimize sediment delivery to stream systems. This paper reports the findings of an investigation to assess sediment travel distances downslope of forest roads and characterize the factors influencing these distances. A total of 235 forest road turn-outs (lead-off ditches) and visible sediment plumes were randomly selected and measured on national forests in Alabama and Georgia. This paper also examines how the study results relate to suggested Best Management Practices for forest operations below forest road turn-outs in Alabama and Georgia.

15 Grace, J.M. III. 2005. *Factors influencing sediment plume development from forest roads*. In: Environmental Connection 2005, Proceedings of the meeting of the International Erosion Control Association. Steamboat Springs, CO: International Erosion Control Association: pp. 221-230.

Design and development of Best Management Practices to control sediment movement from the forest road prism requires a better understanding of

the factors influencing sediment transport distances downslope. Relationships developed specifically for national forests will give managers additional planning and evaluation tools for roads and can be used to assess the potential for environmental impacts on existing forest roads. Data from a study to evaluate factors influencing sediment plume development were used to develop a prediction equation based on site specific road characteristics. Road section length and road width had the greatest influence on sediment travel distances. Generally, visible sediment plume development extended less than 90 m.

16 Greenberg, Cathryn H.; Miller, Stanlee. 2004. *Soricid response to canopy gaps created by wind disturbance in the Southern Appalachians*. 3(4): 715-732.

We used drift fences with pitfall traps to compare soricid abundance, richness, and demographic parameters among intact multiple-tree windthrow gaps, salvaged gaps, and mature forest in a xeric Southern Appalachian forest type during 1997-1999. We also tested whether capture rates were correlated with rainfall, and whether similar-sized species did not co-occur as predicted by multi-species assemblage rules. We captured six species: northern short-tailed shrew, least shrew, masked shrew, smoky shrew, pygmy shrew, and southeastern shrew. Results suggest that forest management that mimics conditions created by multiple windthrows in xeric forest of the Southern Appalachians is unlikely to affect shrew communities adversely, at least in the short term.

17 Greenberg, Cathryn H.; Tanner, George W. 2004. *Breeding pond selection and movement patterns by eastern spadefoot toads (*Scaphiopus holbrookii*) in relation to weather and edaphic conditions*. Journal of Herpetology. 38(4): 569-577.

Eastern spadefoot toads (*Scaphiopus holbrookii*) require fish-free, isolated, ephemeral ponds for breeding, but otherwise inhabit surrounding uplands, commonly xeric longleaf pine (*Pinus palustris*) and wiregrass (*Aristida beyrichiana*) ecosystem. Fire suppression in the Florida sandhills has the potential to alter upland and pond suitability through increased hardwood densities and resultant higher transpiration. In this paper, we explore breeding and

Water Hyacinth *(Photo by David R. Worley, Florida Department of Environmental Protection)*

metamorphic emigration movements in relation to weather, hydrological conditions of ponds, and surrounding upland matrices. Explosive breeding occurred during nine periods and in all seasons. Our results suggest that spadefoot toads are highly adapted to breeding conditions and upland habitat heterogeneity created by weather patterns and fire frequency in Florida sandhills.

18 Greenberg, Cathryn H.; Tanner, George W. 2005. *Spatial and temporal ecology of eastern spadefoot toads on a Florida landscape*. Herpetologica. 61(1): 20-28.

Effective amphibian conservation must consider population and landscape processes, but information at multiple scales is rare. We explore spatial and temporal patterns of breeding and recruitment by eastern spadefoot toads (*Scaphiopus holbrookii*), using nine years of data from continuous monitoring with drift fences and pitfall traps at eight ephemeral ponds in longleaf pine-wiregrass sandhills. We conservatively estimated a 7-year lifespan. Adult "population" trends clearly reflected breeding effort rather than numbers *per se*; capture rates fluctuated dramatically among years, but showed no overall trends during the 9-year study. Our paper provides empirical information that can be used to generate realistic metapopulation models for *S. holbrookii* as a tool in conservation planning.

19 Miller, Daniel R.; Schlarbaum, Scott E. 2005. *Acorn fall and weeviling in a northern red oak seedling orchard*. Journal of Entomological Science. 40(1): 2005.

In 2000, we determined levels of damage by acorn weevils (*Curculio* spp.) and patterns of acorn fall in a northern red oak (*Quercus rubra* L.) seedling orchard in eastern Tennessee. Trees were selected in the spring of 2000 based on abundance of acornets. The floating method for assessing sound acorns overestimated acorn damage by 36 percent. Weevils accounted for approximately 66 percent of all damage. The percentage of weeviled acorns was negatively correlated to total acorn production per tree. The rate of acorn drop was higher in October and November than in September. However, the percentage of acorns damaged by weevils was higher for acorns falling in September.

Inventory and Monitoring

20 Bentley, James W.; Howell, Michael; Johnson, Tony G. *Arkansas' timber industry—an assessment of timber product output and use, 2002*. Resour. Bull. SRS–99. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 43 p.

In 2002, roundwood output from Arkansas' forests totaled 680 million cubic feet. Mill byproducts generated from primary manufacturers were 326 million cubic feet. Almost all plant residues were used primarily for fuel and fiber products. Saw logs were the leading roundwood product at 342 million cubic feet; pulpwood ranked second at 213 million cubic feet; and veneer logs were third at 94 million cubic feet. The number of primary processing plants was 288 in 2002. Receipts for those mills totaled 721 million cubic feet.

21 Bentley, James W.; Johnson, Tony G. 2004. *Eastern Texas harvest and utilization study, 2003*. Resour. Bull. SRS-97. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 28 p.

In 2003, a harvest and utilization study was conducted on 81 operations throughout eastern Texas. There were 2,072 total trees measured, 1,557 or 75 percent were softwood, while 515 or 25 percent were hardwood. Results from this study showed that 87 percent of the total softwood volume measured was utilized for a product, while the other 13 percent was left as logging residue. Seventy-six percent of the total hardwood volume measured was utilized for a product, while 24 percent was left as logging residue.

22 Johnson, Tony G.; Howell, Michael; Bentley, James W. 2005. *Oklahoma's timber industry—an assessment of timber product output and use, 2002*. Resour. Bull. SRS-100. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 34 p.

In 2002, roundwood output from Oklahoma's forests totaled 126 million cubic feet. Mill byproducts generated from primary manufacturers totaled 50 million cubic feet. Almost all plant

Cogongrass *(Photo by David Teem, Auburn University)*

residue was used primarily for fuel and fiber products. Saw logs were the leading roundwood product at 64 million cubic feet; pulpwood ranked second at 49 million cubic feet. There were 109 primary processing plants operating in Oklahoma in 2002. Receipts totaled 123 million cubic feet.

23 Oswalt, Sonja N. 2005. *Forest resources of South Carolina's national forests, 2001*. Resour. Bull. SRS-98. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 35 p.

This bulletin describes forest resources of the Francis Marion and Sumter National Forests in the State of South Carolina. It is based on sampling from the eighth forest inventory conducted by the U.S. Department of Agriculture, Forest Service, Southern Research Station, Forest Inventory and Analysis Research Work Unit. Findings suggest that South Carolina's national forests are recovering from destruction caused by Hurricane Hugo in 1989. This bulletin addresses forest area estimates; timber growth, removals, and mortality; forest health; and trends across 23 years.

24 Zarnoch, S.J.; Bentley, J.W.; Johnson, T.G. 2004. *Determining sample size for tree utilization surveys*. Res. Pap. SRS-34. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 11 p.

The Forest Service has conducted many studies to determine what proportion of the timber harvested in the South is actually utilized. We describe the statistical methods used to determine required sample sizes for estimating utilization ratios for a required level of precision. The data used are those for 515 hardwood and 1,557 softwood trees harvested in east Texas and classified into 5 product types. Two-stage sampling was used to collect the utilization data. The primary units were the logging operation locations, and the secondary units were the trees within locations.

Large-Scale Assessment and Modeling

25 Coulston, John W.; Riittters, Kurt H. 2005. *Preserving biodiversity under current and future climates: a case study*. Global Ecology and Biogeography. 14: 31-38.

The conservation of biological and genetic diversity is a major goal of reserve systems at local, regional, and national levels. The International Union for the Conservation of Nature and Natural Resources suggests a 12 percent threshold (area basis) for adequate protection of biological and genetic diversity of a plant community. However, thresholds based on area may protect only a small portion of the total diversity if the locations are chosen without regard to the variation within the community. The objectives of this study were to demonstrate methods to apply a coarse-filter approach for identifying gaps in the current reserve system of the *Psuedotsuga menziesii* (Douglas-fir) forest type group based on current climatic conditions and a global climate change scenario.

26 Li, Harbin; Wu, Jianguo. 2004. *Use and misuse of landscape indices*. Landscape Ecology. 19: 389-399.

High expectations for landscape analysis to improve understanding and prediction of ecological processes have largely been unfulfilled. We identified three kinds of critical issues: conceptual flaws in landscape pattern analysis, inherent limitations of landscape indices, and improper use of pattern indices. Many landscape analyses treat quantitative description of spatial pattern as an end itself, failing to explore relationships between pattern and process. Landscape indices and map data are sometimes used without testing ecological relevance, which may not only confound interpretation of results, but also lead to meaningless results. In addition, correlation analysis with indices is impeded by the lack of data. We examine the underlying problems of these challenges and offer some solutions.

27 Mercer, D. Evan. 2004. *Policies for encouraging forest restoration*. In: Stanturf, J.A.; Madsen, Palle, eds. Restoration of boreal and temperate forests. Boca Raton, FL: CRC Press: 97-109.

Throughout the 20th century, many countries created national parks, forests, nature reserves, and sanctuaries to provide benefits that are underproduced on private lands. Private lands are now especially valuable for providing ecological services that public lands cannot provide, due to the increasing demands for all uses and the political and economic conflicts associated with allocating public lands between competing uses (e.g., recreation, watershed protection, biodiversity conservation, wildlife habitat, and commodity production). In many countries, the supply of public lands may not be adequate to ensure desirable flows of beneficial ecosystem services. Furthermore, because many ecological processes cross ownership borders, enhancing the flow of benefits requires management at a broader, landscape scale and with the participation of both public and private landowners.

28 Miller, Karl V.; Miller, James H. 2004. *Forestry herbicide influences on biodiversity and wildlife habitat in southern forests*. Wildlife Society Bulletin. 32(4): 1049-1060.

A shift to the Southeast in North American timber supplies has resulted in increased forest management intensity. Current site-preparation techniques rely on herbicide combinations, often coupled with mechanical treatments, and 21 years of post-planting applications. This near-total control of associated vegetation likely will affect plant diversity and wildlife habitat quality. Mitigation methods will be required to minimize vegetative and wildlife impacts. More uncertain are long-term impacts of increasing invasive plant occupation and projected increase in herbicide use needed to reverse this worsening situation. The potential of herbicides to meet wildlife management objectives in areas where traditional techniques have high social costs (e.g., prescribed fire) should be fully explored.

29 Park, Timothy; Bowker, J.M.; Leeworthy, Vernon R. 2002. *Valuing snorkeling visits to the Florida Keys with stated and revealed preference models*. Journal of Environmental Management. 65: 301-312.

Coastal coral reefs, especially in the Florida Keys, are declining at a disturbing rate. Marine ecologists and reef scientists have emphasized the importance of establishing nonmarket values of coral reefs to assess cost effectiveness of coral reef management and remediation programs. We develop a travel cost—contingent valuation model of demand for trips to the Florida Keys, focusing on willingness to pay (WTP) to preserve current water quality and health of the coral reefs. Snorkelers engage in a relatively focused set of activities, suggesting that they may not shift expenditures to other sites or other recreation activities in the Florida Keys when confronted with increased access costs for the snorkeling experience.

30 Selgrade, James F.; Roberds, James H. 2003. *Equilibrium and nonequilibrium attractors for a discrete, selection-migration model.* Canadian Applied Mathematics Quarterly. 11(2): 195-211.

This study presents a discrete-time model for the effects of selection and immigration on the demographic and genetic compositions of a population. Under biologically reasonable conditions, it is shown that the model always has an equilibrium. Although equilibria for similar models without migration must have real eigenvalues, for this selection-migration model we illustrate a Hopf bifurcation which produces long-term stable oscillations in allele frequency and population density. The interplay between the selection parameters in the fitness functions and the migration parameters is displayed by using migration parameters to reverse destabilizing bifurcations that occur as intrinsic density parameters are varied. Also, the rich dynamics for this selection-migration model are illustrated by a period-doubling cascade resulting in a pulsating strange attractor.

31 Turner, J.A.; Buongiorno, J.; Zhu, S.; Prestemon, J. 2004. *Global context for the United States forest sector in 2030*. In: Alavalapati, J.; Carter, D.R., eds. Proceedings of the annual meeting of the Southern Forest Economics Workers. [Place unknown]: [Publisher unknown]: 6-15.

The purpose of this study was to identify markets for, and competitors to, the United States forest industries in the next 30 years. The Global Forest Products Model was used to make predictions of international demand, supply, trade, and prices, conditional on the last RPA timber assessment projections for the United States. It was found that the United States, Japan, and Europe would remain important markets out to 2030, but China would grow into the world's largest importer of roundwood and manufactured products. Mexico would become an important importer of sawnwood and papers, and the Republic of Korea would become an important importer of wood panels and pulp. The United States' share of exports of industrial roundwood and paper and paperboard would increase, while its exports of sawnwood would decline, replaced by exports from Canada, Finland, Austria, Chile, and New Zealand. Besides Finland and Austria, Indonesia, Malaysia, and Thailand would remain the main competitors to United States' exports of wood-based panels.

32 Wagner, Robert G.; Newton, Michael; Cole, Elizabeth C. [and others]. 2004. *The role of herbicides for enhancing forest productivity and conserving land for biodiversity in North America*. Wildlife Society Bulletin. 32(4): 1028-1041. [Editor's note: Southern Station scientist James H. Miller co-authored this publication.]

Over the past 60 years, forest managers have prescribed herbicides to increase reforestation success and long-term timber yields. Wildlife managers and others interested in conserving biodiversity, however, have often viewed herbicide use as conflicting with their objectives. Meeting future demands for wildlife habitat and biodiversity conservation will require that society's growing demand for wood be satisfied on a shrinking forestland base. Increased fiber yields from intensively managed plantations, which include the use of herbicides, will be a crucial part of the solution. If herbicides are properly used, research indicates that negative effects on wildlife usually are short term and that herbicides can be used to meet wildlife habitat objectives.

33 Wear, David; Pye, John; Riitters, Kurt. 2004. *Defining conservation priorities using fragmentation forecasts*. Ecology and Society. 9(5): 4. http://www.ecologyandsociety.org/vol9/iss5/art4. [Date accessed: April 19, 2005].

Methods are developed for forecasting effects of population and economic growth on the distribution of interior

Sacred bamboo *(Photo by James H. Miller, USDA Forest Service)*

forest habitat in the Southern United States. Forecasts are displayed by ecological section and province and by metropolitan statistical area. Loss of interior forests is expected to be especially high in certain ecological sections, including the Southern Appalachian Piedmont in North and South Carolina, the Gulf prairies and marshes in Texas, and the Florida coastal lowlands. Sixty-six percent of loss of interior forests will be in urban counties, which highlights the conservation importance of the urbanizing fringe. Forecasts provide a mechanism for assigning priorities and targeting areas for more detailed study and for conservation efforts.

Foundation Programs

34 Britton, Kerry O.; Orr, David; Sun, Jianghua. 2002. *Kudzu*. In: Van Driesche, R.; and others. Biological control of invasive plants in the Eastern United States. FHTET-2002-04. Morgantown, WV: USDA Forest Service, Forest Health Technology Enterprise Team: 325-330. http://www.invasive.org/eastern/biocontrol/25Kudzu.html. [Date accessed: April 12, 2005].

Kudzu, a plant native to Japan, China, and Korea, is a perennial, semi-woody, climbing leguminous vine introduced into the United States in 1876. In this country, kudzu causes ecological and economic damage by rapidly covering fields, trees, and buildings. Kudzu blocks sunlight, eliminating other vegetation and wildlife habitat. Heaviest infestation is in the States of Alabama, Georgia, and Mississippi. Kudzu spreads primarily by its large tuberous roots. Scientists are researching biological control pathogens to control this nonnative invasive species.

35 Britton, Kerry O.; Sun, Jiang-Hua. 2002. *Unwelcome guests: exotic forest pests*. Acta Entomologica Sinica. 45 (1): 121-130.

Exotic forest pests cost China and the United States billions of dollars each year. Regulatory systems worldwide are overwhelmed with the increasing volume of international trade. Nursery stock, wood products, and pallets are the most common means of transport. Pests such as chestnut blight, gypsy moth, Dutch elm disease, and Asian longhorned beetle have caused major changes in the structure and function of American forests and urban landscapes. China's natural resources are likewise under attack, and many of the pests come from the United States, such as the pinewood nematode and the red turpentine beetle. The authors discuss the biological basis of the invasiveness of exotic pests and what can be done about them.

36 Grace, J.M. III. 2004. *NPS pollution related to forest management activities in Southern States*. In: Proceedings of the 2004 American Society of Agricultural Engineers/ Canadian Society of Agricultural Engineers international meeting; paper no. 04-5019. St. Joseph, MI: American Society of Agricultural Engineers: 17 p.

Nonpoint source pollution (NPS) has been identified as the Nation's largest source of water quality problems. Forest activities have been identified as activities influencing NPS pollution in the South. However, results of studies in the 13 Southern States investigating the effect of forest operations on water quality are highly variable. The results taken collectively indicate that forest operations have little impact on the quality of water draining from forests in the South. Forestry Best Management Practices show the potential to protect water quality; however, accurate assessments of the overall effectiveness of BMPs are not possible because the benefits of BMPs on different scales are relatively unknown.

37 Jewett, D.K.; Jiang, C.J.; Britton, K.O. [and others]. 2003. *Characterizing specimens of kudzu and related taxa with RAPDs*. Castanea. 68(3): 254-260.

Kudzu is a perennial, semi-woody, climbing legume in the tribe Phaseoleae Benth., subtribe Glycininae Benth. It is native to China, where an abundance of natural enemies and its cultivation prevent kudzu from becoming either an important economic or environmental liability. Kudzu was introduced to the United States as an ornamental during the middle of the 19th century. During the first half of the 20th century, approximately 134,760 ha were planted throughout the Southeastern United States to feed livestock and for erosion control. During 1998, kudzu was included by legislators in the United States Congress on a growing list of invasive, exotic plants recognized under the Federal Noxious Weed Law. Presently, it costs commercial forests

Mimosa *(Photo by Ted Bodner, Southern Weed Science Society)*

approximately $119/ha annually, it compromises the integrity of valuable natural resources, and dense infestations have interfered with exercises on military bases in North Carolina, South Carolina, and Virginia. Three varieties of kudzu exist, and the plant may hybridize with related taxa. Distinction among varieties in the field is difficult, proving an obstacle to development of an integrated management program. Of particular concern is selecting potential biological control agents because insects and pathogens cannot be reconciled with identity of the plants from which they were collected. Using genetic markers for more convenient identification of specimens may be possible. Randomly amplified polymorphic DNAs (RAPDs) have been used successfully to characterize genetic composition and reveal variation among genomic DNA of many important cultivated plants, including wheat, soybean, and tea. The objective of this study is distinguishing between kudzu and its related taxa using RAPDs.

38 Miller, James H. 2003. *Nonnative invasive plants of southern forests: a field guide for identification and control*. Gen. Tech. Rep. SRS-62. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 93 p.

Nonnative invasive plants in southern forests infest under and beside forest canopies and dominate small forest openings, increasingly eroding forest productivity, hindering forest use and management activities, and degrading diversity and wildlife habitat. They occur as trees, shrubs, vines, grasses, ferns, and forbs. This book provides information on accurate identification and effective control of the 33 nonnative plants and groups invading the forests of the 13 Southern States, showing both growing and dormant season traits. It lists other nonnative plants of growing concern, control strategies, and selective herbicide application procedures. The book also recommends measures for preventing and managing invasions to maintain forest vigor with minimal disturbance, constant surveillance and treatment of new arrivals, and rehabilitation following eradication.

39 Miller, James H.; Albritton, Tim. 2004. *Privet is a plague: you can help stop it.* Alabama's Treasured Forests. Spring: 20-21, 26.

Privet is that rampant small-leaved shrub that stays green in winter and can be seen growing along many fencerows and forest edges, as well as invading interior forests. Three species of privet exist, but Chinese privet (*Ligustrum sinense*) is most invasive. Privet can be controlled with concerted efforts and by using methods proven to be effective: prescribed burning; tractors with rootrakes and shredder-mulcher heads; brushsaws; pulling and digging plants; and safe and effective herbicides. The right combination depends on the extent of your infestation, the size of the privet, your objectives, and your budget.

40 U.S. Department of Agriculture, Forest Service, Southern Research Station. 2005. *Forest Science in the South, 2004*. Science Update SRS-007. Asheville, NC: 56 p.

Forest Science in the South, 2004 reports Southern Research Station accomplishments for fiscal year 2004, which includes the period from October 2003 through September 2004. The document summarizes budget allocations to resource categories and research units, and a list of collaborators receiving financial support. The document includes a directory of research units, a list of experimental forests, and highlights of administrative activities. A CD-ROM provides a list of research products.

41 Good Nature Publishing Company. 2005. *Nonnative invasive species of the South.* [Poster]. Seattle: Good Nature Publishing Company. (**A limited number of posters are available from the Southern Research Station.)**

The poster features 22 nonnative invasive species in a southern garden. A key identifies each plant. A sample of the poster is included as a centerfold in the Spring 2005 issue of *Compass*. The poster can be ordered from Good Nature Publishing Company, 1904 Third Avenue Suite 415, Seattle, WA 98101 or call toll-free 1-800-631-3086 or call (206) 622-9522.

Research Work Units

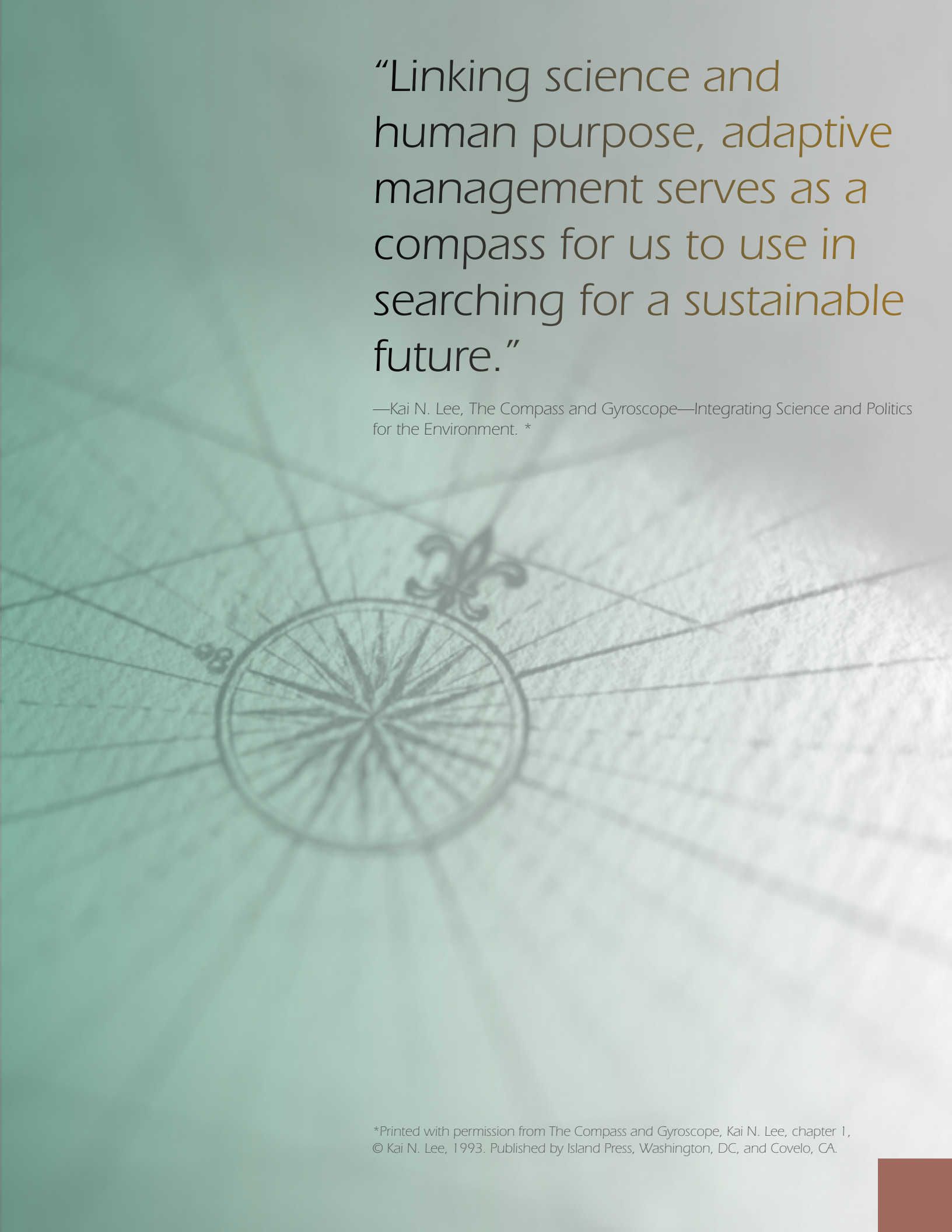
Location & Project Leader	Unit	Name & Web Site	Phone
Asheville, NC David Loftis	4101	Ecology and Management of Southern Appalachian Hardwood Forests www.srs.fs.usda.gov/bentcreek	828-667-5261
Athens, GA John Stanturf	4104	Disturbance and the Management of Southern Pine Ecosystems www.srs.fs.usda.gov/disturbance	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
Huntsville, AL Greg Ruark	4551	National Agroforestry Center www.nac.gov	256-372-4540

Chinese Silvergrass *(Photo by James H. Miller, USDA Forest Service)*

Purple Loosestrife *(Photo by Bernd Blossey, Cornell University)*

Research Work Units (Continued)

Location & Project Leader	Unit	Name & Web Site	Phone
Knoxville, TN Bill Burkman	4801	Forest Inventory and Analysis www.srsfia2.fs.fed.us	865-862-2073
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 James Granskog	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 Borys Tkacz, Acting	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



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What is it?

The photo (left) relates to the focus for the next issue of Compass*—longleaf pine ecosystems in the South.* ***Can you name this endangered species whose habitat is longleaf pine forests?*** *The first person with the correct answer will receive a special gift from the Southern Research Station. Please email cpayne@srs.fs.usda.gov or fax your answer to 828-259-0520.*

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