



Middle Rio Grande Basin Research Report 2008

A progress report from the Middle Rio Grande Ecosystem Management
Research Unit, U.S. Forest Service Rocky Mountain Research Station



The Middle Rio Grande.
Photo: David M. Merritt

U.S. Forest Service Research: Understanding, Conserving, and Restoring Southwestern Ecosystems

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An ecosystem is rarely static. A natural system composed of plants, animals, and microorganisms interacting with an area's physical factors, an ecosystem is always fluctuating and evolving. But sometimes, often at the hands of humans, ecosystems change too much. Such is the case with many of the ecosystems of the Middle Rio Grande Basin of New Mexico.

For thousands of years, the ecosystems of the Middle Rio Grande Basin (which includes the river environment and the associated upland watersheds) evolved under the influence of natural factors such as shifting landforms, floods, drought, wildfire, and climate fluctuations. More recently — since 1540, when the first Spanish settlers arrived — human activities have had an enormous impact on the area's environment. Factors such as urbanization, drought, grazing, timber harvesting, water demands, flood control measures, fire suppression, hunting, and the introduction and spread of exotic (non-native) species have all contributed to many ecosystems that are altered at best and severely degraded at worst.

Clearly, the Middle Rio Grande Basin no longer looks like it did back in the 1500s. Evidence of environmental degradation can be found throughout the area today:

in the river itself, in the riverside bosque (cottonwood) ecosystems, and in the nearby upland ecosystems of grasslands, shrublands, and forests. For example:

- Many fish and wildlife habitats have been significantly altered in structure and composition and reduced in size and quality.
- Two species, the Rio Grande silvery minnow (*Hybognathus amarus*) and the southwestern willow flycatcher (*Empidonax traillii extimus*), have been placed on the federal endangered species list; others, such as the gray wolf (*Canis lupus*), have not been seen in the area for decades.
- At least half of the fish species once found in the middle Rio Grande drainage are no longer found there.
- Exotic tree species such as Russian olive (*Elaeagnus angustifolia*) and saltcedar (*Tamarix ramosissima*) have invaded

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“To restore and maintain the health of the ecosystem in the area, we first need a better understanding of what is here.”

- DEBORAH FINCH, PH.D.

A bobcat (*Lynx rufus*) at Valles Caldera National Preserve.
Photo: Marc Chipault

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river habitats, taking over where native species such as cottonwoods (Rio Grande cottonwood [*Populus deltoides* subsp. *wislizeni*] and Fremont cottonwood [*Populus fremontii*]) used to flourish, reducing water supplies, increasing fuel loads and fire risk, and impeding wildlife and human travel.

- The native riverside ecosystems — the marshes, willows, and cottonwoods found adjacent to the river — have been greatly reduced in size, distribution, and health.
- Shrubs and small tree species have moved into areas that were once grasslands.
- Upland forests and woodlands have become increasingly subject to wildfires and bark beetle infestations.
- The Rio Grande itself has changed from a braided river that moved across the floodplain and regularly flooded its banks, and was associated with abundant wildlife populations, to one that is now largely constrained and not meandering, and has reduced flows.

Conservation Efforts

Efforts to conserve and protect the natural resources of the Southwest date back to the 1800s, when the U.S. Department of the Interior and the U.S. Bureau of Forestry were created, and some local forest reserves were set aside. Those early efforts were followed by more federal laws in the 1960s and 1970s, such as the Clean Water Act and the Endangered Species Act.

More recently, local conservation efforts have focused on restoring and maintaining the health and diversity of Middle Rio Grande Basin ecosystems — the forests, grasslands, and shrublands, and the species that inhabit them.

Many organizations, including federal, state, municipal, tribal, and private entities, have contributed to these efforts, with some success. For example, the Middle Rio Grande Endangered Species Act Collaborative Program and the Middle Rio Grande Bosque Initiative have been very successful in generating public interest and support for river and bosque restoration and recovering endangered species.

Too often, however, proposed solutions for restoring Basin ecosystems are based on incomplete knowledge of the conditions that led to the problems. Solutions are put together without a thorough understanding of how factors such as drought, grazing, and fire interact with each other and can affect restoration efforts.

The Forest Service’s Research Program

To support and contribute to the ongoing conservation efforts, and to build a sound scientific basis for future efforts, the Middle Rio Grande Ecosystem Management Research Unit, a local unit of the U.S. Forest Service’s Rocky Mountain Research Station, embarked on an ambitious long-term research program in 1994.

“To restore and maintain the health of the ecosystems in the area, we first need a better understanding of what is here,” explains Deborah Finch, Ph.D., the program’s Team



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Leader. "We need to understand the structural components of the ecosystems and how they function and interact, particularly in response to factors such as population growth and extreme climate variability.

"We also need to know more about the effectiveness of various restoration methods, as well as how to best balance restoration plans with human needs and priorities."

The research program is built around three broad areas: 1) understanding how perturbations such as drought and fire affect ecosystems; 2) understanding how management practices affect ecosystems; and 3) ensuring that scientific information about the area is available to the people — from many backgrounds — who will be making decisions about how the Middle Rio Grande Basin is managed in the future.

The individual research studies affiliated with the program are not all done by Forest Service research scientists. An annual funding program sponsors studies conducted by many outside researchers, such as university faculty and graduate students, and each research proposal is closely evaluated for how it fits into the larger research program. Each study alone might seem like it covers just a tiny piece of the puzzle. But taken together, over several years, these studies are uncovering the big picture of what we need to do to take care of the Middle Rio Grande Basin.

Research Area 1: Effects of Drought and Other Perturbations

It's no surprise to anyone that water availability is one of the most important factors influencing the environment of the Southwest. Water — or the lack of it during a drought — affects where people live, where species live, the makeup of plant and animal communities, agricultural operations, how people make their living and recreate, and much more. Long-term drought can also influence

chain reactions of disturbances, such as insect outbreaks, extinction of native species, flourishing exotic species, catastrophic wildfires, and changes in human social, cultural, and economic stability.

In addition to water supply, other important perturbations are over-grazing, fire exclusion, climate change, and plant and insect invasions.

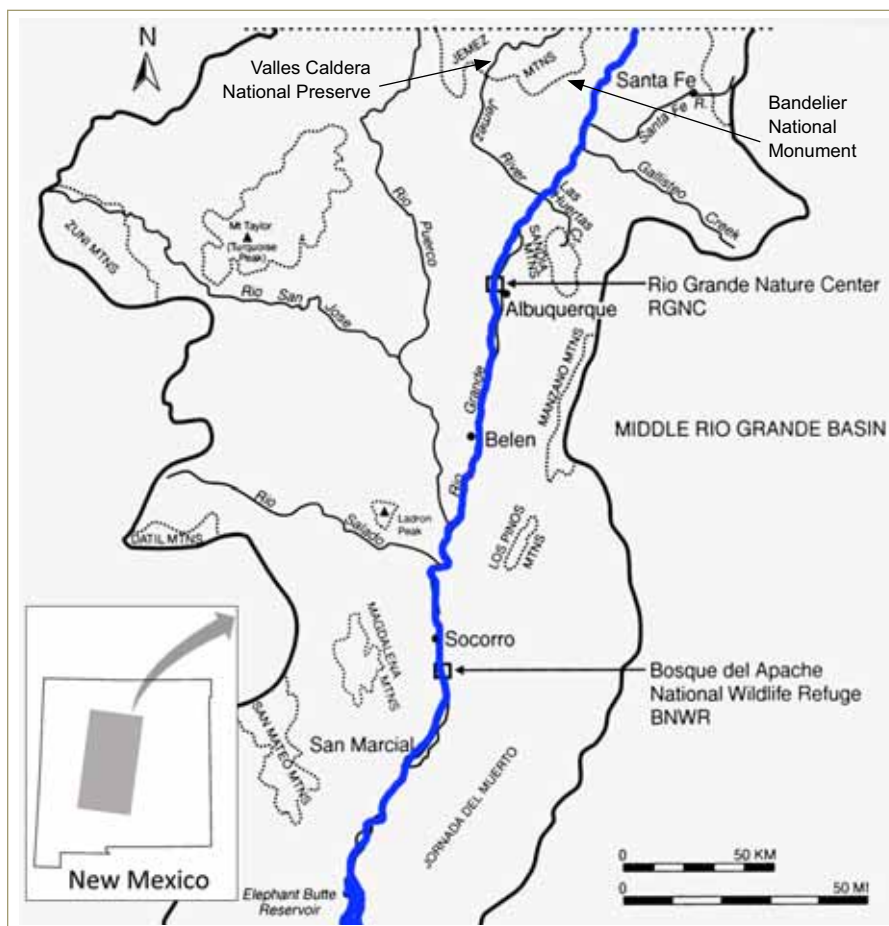
"For land managers to be good stewards, they need to understand how the Middle Rio Grande Basin ecosystems react to these disturbances, both currently and historically, as well as how all of these factors interact with each other and with humans," says Finch. "Knowing how this all influences the dynamics, stability, productivity, biological diversity, and sustainability of local

ecosystems forms the scientific basis for adaptively managing habitats, conserving species, and providing ecosystem services to humans.

"This knowledge will help us to develop the best restoration methods, avoiding quick fix solutions that might not work long term."

Research in this area includes studies on: 1) the relationship between drought, bark beetle outbreaks, and pinyon pine (*Pinus edulis*) mortality; 2) the interactive effects of drought, tree thinning, grazing, fuel removal, and prescribed fire in various ecosystems; 3) decision-support tools for managing the consequences of biological invasions; and 4) understanding how humans respond socially, culturally, and economically to these and other issues.

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The Middle Rio Grande Basin includes the Rio Grande (in blue) from Bandelier National Monument in the north to the upper end of Elephant Butte Reservoir in the south, as well as the area surrounding the seven major tributaries that contribute to the river: Santa Fe River, Galisteo Creek, Jemez River, Las Huertas Creek, Rio Puerco, Rio San Jose, and Rio Salado.

Research Area 2: Effects of Management Practices

The second area of research looks at what happens when we try to manage or “fix” various ecosystems. Many methods can be used, for example, to control fire risk, remove exotic plants, or restore some aspect of a complex ecosystem. Some work better than others. Some can have unintended, negative outcomes.

“We need to understand how the many components of the Middle Rio Grande Basin ecosystems — the water quality, soil quality, plant growth rates, fish habitat, nesting birds, and many other components — respond to various management practices,” says Finch.

For example, the bosque ecosystem, which long flourished along the Rio Grande, has been massively altered in the past century. Much of the bosque was converted into agricultural or urban areas. And many of the natural processes that the bosque needs for survival, such as spring floods that remove woody debris and disperse seeds, were disrupted after the river was channelized. Consequently, exotic plants, including saltcedar and Russian olive, have invaded the bosque, and woody debris has increased substantially. Various agencies have been using a number of tools, such as herbicides and chainsaws, to try to remove the exotic plants and restore the bosque. But the long-term impacts and effectiveness of these activities are largely unknown.

Similarly, disturbances such as drought, habitat fragmentation, and invasive species can cause ecosystems to deteriorate, resulting in higher fire risk, loss of species, and other ill effects.

When land managers try to manage or restore these disturbed areas,

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Restoring the Rio Grande: Finding the Best Methods



The Middle Rio Grande in fall.
Photo: MarbleStreetStudio.com

“Maintaining the remnants of the ribbon of green that the Rio Grande forms through the Southwest is key to the ecological and social health of this region.”

- DAVID M. MERRITT, PH.D.

Their intentions were good, but their efforts led to many problems. The plant species that relied on floods to regenerate, such as cottonwoods and willows, declined. The exotic trees, such as saltcedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*), thrived and became dominant in the bosque, forming dense dry thickets that could easily burn. Fish that were once abundant disappeared; two species are believed extinct, while another, the Rio Grande silvery minnow (*Hybognathus amarus*), is on the federal endangered species list. Woody debris and other plant litter, no longer washed away by floods, accumulated in the bosque, changing the landscape and the habitats, and setting the stage for potentially catastrophic fires. Such fires could cause even further damage; they could destroy the remaining native cottonwoods, clearing the way for even more exotic plants. Indeed, fire could completely eliminate the largest remaining bosque in the Southwest.

After so much change, and with so many demands on the river’s water, restoring the entire river to its original state is not possible. But researchers and land managers are looking at ways to return large portions of it to a more natural, ecologically healthy state. For the last seven years, Deborah Finch, Ph.D., Team Leader, and others have been exploring various methods for rehabilitating the bosque ecosystem.

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Finch and her colleagues began by selecting 12 experimental sites along the river, stretching from Albuquerque south to Bosque del Apache National Wildlife Refuge, some 90 miles down the river. Each site was about 50 acres in size, and was characterized by a cottonwood overstory (including Rio Grande cottonwood [*Populus deltoides* subs. *wislizeni*] and Fremont cottonwood [*Populus fremontii*]), an understory of native and exotic woody plants, and a high fuel load (lots of flammable debris). Three different restoration methods were chosen: 1) mechanical removal of dead, downed, and exotic woody plants (using chainsaws, wood chippers, and hauling), plus treatment with an herbicide; 2) mechanical removal and herbicides, plus a prescribed fire; and 3) mechanical removal and herbicides, plus revegetation with native plants (mostly shrubs). Each treatment plan would be applied to three of the sites; three others would act as controls and receive no treatment.

During the first three years of the study, no treatments were applied to the sites. The researchers established the sites, tested their monitoring methods, and collected data on the current conditions and resident species. At each site, they developed a detailed picture of what was there, measuring and plotting rainfall, air temperature, soil salinity and

nutrients, groundwater levels, plant species and density, bird counts and nesting sites, bat activity, and the abundance of moths, beetles, reptiles, and amphibians. They collected thousands of points of data.

That baseline monitoring was followed by two years of active treatment: removal of plants, herbicide treatment, prescribed fires, and replanting. After the treatments were done, monitoring was done to track the ecological responses. The researchers again measured the numbers and species of trees, birds, bats, and other bosque denizens.

What did they find? *All* of the treatments were successful in significantly altering the sites. Overall, the treated areas have a more open understory, with fewer exotic trees, fewer branches on the ground, and less litter.

“The sites changed from having dense thickets of exotic plants and piles of debris to a more open, or park-like understory,” says Heather Bateman, Ph.D. Bateman, who is now a U.S. Forest Service wildlife biologist, led the portion of the study that focused on reptiles and amphibians while she was a graduate student at the University of New Mexico, working with her supervisor, Alice Chung-MacCoubrey, Ph.D.

Effects on Vegetation

Early analysis shows that the treatments were successful in getting rid of the exotic plants and decreasing fuel loads. Mortality rates of the exotic species overall was 84 percent. Their re-sprouting rates were acceptably low: about 16 percent overall (Russian olive was the lowest, at 3 percent, while Siberian elm [*Ulmus pumila*] was highest, at 50 percent, indicating it needs more intense treatment). Moreover, the native species that were planted as part of the treatments — such as pale wolfberry (*Lycium pallidum*), skunkbrush (*Rhus trilobata*), and screwbean mesquite (*Prosopis pubescens*) — survived well. Across the various species, 60 to 100 percent of them survived.

So far, however, the diversity of the native plant species has not increased, and the cottonwoods, overall, have not shown higher growth rates (as measured by their annual growth rings). Nor have the cottonwoods increased the amount of canopy they provide. It was expected that the cottonwoods would be reinvigorated once they were no longer competing with the exotic trees (an event known as “competitive release”). It could be, however, that both native and exotic trees had adequate water before the treatments, and so the cottonwoods were already growing at normal rates.

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A variety of methods were used to restore the bosque ecosystem, including mechanical removal of dead and exotic plants, herbicides, and prescribed fires (far left). The restored areas (left) have a more open understory.

Photos: David M. Merritt (far left); Heather L. Bateman (left)

David Merritt, Ph.D., a riparian plant ecologist with the Forest Service who led the plant studies, notes that the positive effects of exotic tree removal might not be detectable in the first years after treatment. "Ecosystem, community, and population responses may be realized only after several years of 'recovery,'" he says. "Many native plant species that provide food, nectar, nest materials, and habitat are present at most of the cleared sites, and are likely to become more abundant with time." Moreover, he notes, the study period included a severe drought, which may have hampered the recovery. Analysis of the vegetation data is continuing.

Effects on Animals

The treatments also changed the habitats available for many animal species. Finch studied the bird species found in the sites, focusing on the six most common species. Species that nest in tree cavities were mostly unaffected or showed a tendency to increase, probably because the exotic trees never suited them to begin with (most were multi-stemmed, with each stem being too narrow for nesting cavities). The treatments seemed to have little effect on the species that nest in the canopy, as well. Species that depend on the lower two-thirds of tree habitats, however,

did show a significant response. They declined in numbers after the treatments, particularly those species that had adapted to the presence of exotic plants by nesting in or under them. Black-chinned hummingbird (*Archilochus alexandri*), the most abundant nesting bird species, moved its nest sites from exotic plants to the remaining native trees, such as tall cottonwoods. However, those higher nests suffered greater predation than did nests built in shorter, multi-stemmed exotic trees.

Lizards, meanwhile, were found in greater abundance in the treated areas, says Bateman. Four of the six most common lizard species increased in numbers, probably because there were fewer trees and less downed wood in the restored areas. Amphibians saw significant increases as well, but that was due to a small flood event, rather than removal of the exotic plants, says Bateman. (For example, in 2005, the researchers found 45 times more toads as seen earlier, probably due to floods that created habitat where toads could lay eggs and tadpoles could develop.) Bats increased in activity, too; they were detected more often in areas that had less plant clutter than before, suggesting that exotic plant removal made it easier for bats to fly in the bosque.

Recommendations for Future Restorations

Several of the researchers are continuing their data analyses. They expect to learn more about the implications of bosque restoration in the near future, as species adapt to the restored conditions. In the meantime, however, they can recommend that land managers proceed with restoration efforts in areas where fuel loads are high, with some specific advice:

- Removing exotic woody plants will help to avoid or reduce fire risk

and intensity and so preserve the native trees.

- Replanting with native woody plants will improve plant species diversity and will help reduce the effects of restoration on animal species sensitive to loss of exotic plants.
- Species that prefer a less-cluttered, more open habitat will benefit from treatment.
- Where removal of invasive plants is necessary, it's best to stagger the treatments over time, to allow animals to adapt to changes in their habitats.
- It is critical for scientists to have both experimental sites and no-treatment control sites, as well as opportunities for pre-treatment monitoring, in order to evaluate the effects of plant removal both spatially and temporally.

"The middle Rio Grande will no doubt be the focus of ongoing efforts to restore the riparian forest habitat," says Bateman. "This research will help to identify species sensitivities to habitat changes and the abundances of those species currently inhabiting this semi-disturbed area."

"Maintaining the remnants of the ribbon of green that the Rio Grande forms through the Southwest is key to the ecological and social health of this region," adds Merritt. "But it's a formidable challenge given the ever-increasing human demands for water and the warmer, drier climate that is predicted for the coming years." 🌿

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A prairie lizard (*Sceloporus consobrinus*) in the middle Rio Grande bosque.

Photo: Heather L. Bateman

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Drought in the Southwest: How it Affects Ecosystems

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The southwestern United States is currently experiencing a severe drought, the likes of which has not been seen since the 1950s.

A drought is more than just a couple of hot, dry summers. It is an unusually long period of dry weather, and it can have substantial effects on ecosystems — dying trees, insect invasions, and heightened fire risks — that can last for years. Already, an estimated 10 to 20 percent of pinyon pines in the Four Corners states have died, with mortality up to 95 percent in some stands. And to make matters worse, scientists now believe that climate change will lead to even more frequent and severe droughts in the future.

Several studies funded by the Middle Rio Grande Ecosystem Management Research Unit are looking at drought-related issues, to help scientists better understand what is happening in various ecosystems as a result of the current drought, what might occur in the future, and what land managers might do on the ground to protect ecosystems and lessen future damage.

Two groups of researchers are focusing on the pinyon-juniper (*Pinus edulis-Juniperus monosperma*) woodlands, an ecosystem found in the Middle Rio Grande Basin uplands. In particular, they want to learn more about how drought and invasions of bark beetles (such as *Ips confusus*) may have contributed to the vast die-offs of trees that have occurred in the uplands in recent years.

The generally accepted theory is that drought leaves trees weakened and vulnerable, and insects such as bark



Gutters are used to simulate rainfall scenarios at a study plot.

Photo: Jennifer Plaut

beetles then take advantage of that state, infesting the trees and killing them. But what exactly happens in a tree during that cascade of events? What is killing the trees that show no sign of insects? And how are these changes affecting the larger pinyon-juniper ecosystem?

Drought's Effect on Water Transport

One research team, led by Nate G. McDowell, Ph.D., a staff member at Los Alamos National Laboratory, is studying the internal mechanisms that seem to leave the trees so weakened during a drought. They want to know more about the system by which plants normally transport water from the soil to their tissues above. Does this water transport system simply fail when water is scarce? Or does the risk of water transport failure in times of drought trigger other problems in the tree? For example, could the gas-exchange openings on leaves (the stomata) be shutting down to avoid dehydration, leading to a low uptake of carbon dioxide during photosynthesis and

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thus lowered carbon reserves to use in growth and insect defense?

McDowell and others are exploring these questions by manipulating rainfall at several pinyon-juniper study plots. Located at the Sevilleta Long Term Ecological Research site in central New Mexico, each study plot contains at least five mature and five young pinyon trees. The researchers installed a system of rain gutters and sprinklers over the plots, which they use to simulate rainfall scenarios. One site gets 50 percent less rain than occurs naturally, one gets 50 percent more rain, and the rest are used as controls. The researchers are now collecting data on what is happening in the soil and in the plants (such as transpiration and growth rates), which will allow them to better understand the water transport system and assess how the trees react to the simulated climates. The project is primarily funded by the U.S. Department of Energy Program for Ecosystem Research. The Middle Rio Grande Ecosystem Management Research Unit is funding the portion that looks at the ecosystem carbon cycle consequences of climate change. By attaching chambers to the soils or to the stems of the plants, the researchers will measure the carbon dioxide flux from those tissues, using an infra-red gas analyzer. This allows them to determine what happens to the carbon cycle during drought. Do these ecosystems lose more carbon during a drought? Or are they carbon emitters?

The study, which is ongoing, is expected to lead to a deeper understanding of the cascade of events that occur during drought and beetle invasion. Having such information could greatly help scientists to determine ideal tree stand densities (trees per acre), predict stand growth and carbon uptake, and also predict how future disturbances such as drought might affect the growth and survival of the pinyon-juniper woodlands.

Collaborating with McDowell are Michael G. Ryan, Ph.D., Rocky Mountain Research Station; William T. Pockman, Ph.D.,

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Several species of bark beetle are involved in the current outbreak, including the pinyon bark beetle (*Ips confusus*), right.

Photos: James Holland (pinyon pine); Darren Blackford, USFS, Bugwood.org (pinyon bark beetle)

What Is a Bark Beetle?



Bark beetles are a natural component of ponderosa pine (*Pinus ponderosa*) and pinyon-juniper (*Pinus edulis-Juniperus monosperma*) forests. Adult beetles (there are several species) infest trees by chewing through the bark and laying their eggs inside. When the larvae hatch, they feed on the inner bark of the tree, cutting off the flow of sap. The beetles also produce a characteristic "blue stain" fungus, which blocks the transport of water and nutrients through the tree. Eventually, the tree dies.

Under normal conditions, healthy trees defend themselves from a bark beetle infestation by pushing the insects out with sap. The beetles thus are usually

limited to attacking only a few diseased or weakened trees. Under drought conditions, however, trees are unable to produce those defensive resins, leaving many more of them vulnerable to attack.

The current bark beetle infestation began in 2002, in association with worsening drought conditions. Tens of millions of pinyon pines have already been killed in New Mexico, making this the worst infestation since an outbreak that occurred during a drought in the 1950s. (Juniper trees are not affected by the insects, and ponderosa pine deaths have been limited.) Those millions of dead trees may be setting the stage for potentially catastrophic fires.

Once a tree has been attacked by bark beetles it cannot be saved. For tips on protecting trees and disposing of dead trees, see the U.S. Forest Service Southwestern Region bark beetle site, www.fs.fed.us/r3/resources/health/beetle/index.shtml.



University of New Mexico; Richard H. Waring, Ph.D., Oregon State University; Nicholas C. Coops, Ph.D., University of British Columbia; Sue A. White, University of New Mexico; and Robbie A. Hember, University of British Columbia.

Drought's Effect on Tree Stands

The second team of researchers, led by Neil S. Cobb, Ph.D., is focusing on how drought — in combination with bark beetle outbreaks — affects the larger pinyon-juniper ecosystem. Cobb is director of the Northern Arizona University Merriam-Powell Center for Environmental Research and also curator at the Colorado Plateau Museum of Arthropod Biodiversity. He and his collaborators have been funded by the Middle Rio Grande Ecosystem Management Research Unit since 2005.

Cobb and his colleagues are working on several different studies that will 1) help to clarify how upland ecosystems at the plot level respond to the disturbances of drought and bark beetles; 2) assess the changes in tree stands and fuel loads in areas that have already seen large tree die-offs; and 3) determine how these disturbances have affected the overall Middle Rio Grande Basin tree stand structure. Working with Cobb are Paulette Ford, Ph.D., Rocky Mountain Research Station; Robert J. Delph, Colorado Museum of Arthropod Biodiversity; Michael Clifford, Merriam-Powell Center for Environmental Research; and Monique Rocca, Ph.D., Colorado State University.

The researchers set up a large number of study plots throughout the Basin, in areas where many trees had died (high-mortality areas) and also where they had not (low-mortality areas), and carefully measured what was found in each plot. They recorded data such as basal trunk



An estimated 10 to 20 percent of pinyon pines in the Four Corners states have died, with mortality up to 95 percent in some stands.

Photo: William M. Ciesla, Forest Health Management International, Bugwood.org

diameter, foliage density, canopy height and depth, litter depth, percentages of shrubs, grasses and forbs, the amount of dead and down woody debris, and the abundance of more than 300 species of insects, spiders, and other arthropods. Among the questions they have asked: What has changed in the pinyon-juniper ecosystem because of the drought and bark beetle disturbances? Have invasive plant species moved in? Have dead trees provided habitats that will support more arthropods? Have decaying trees changed the soils with a flush of added nutrients? Are downed trees raising the risk of fire? What has happened to stand structures regionally?

By comparing the data from the various sites, the researchers have so far found some significant changes in the upland ecosystem:

- Understory vegetation was changed, with increases in a more drought-tolerant grass species in high-mortality areas.
- A loss of canopy cover reduced litter depth in high-mortality areas, but soil composition did not change.
- Some classes of fuel loads (the amount of woody debris of a

certain diameter) increased in quantity, but others did not, and while fire dynamics were altered, the probability of a catastrophic fire due to high levels of dead trees is low.

- Somewhat surprisingly, the overall abundance of arthropods was not found to be significantly different between high- and low-mortality areas. This could be because most of the dead trees have not fallen to the ground yet, and so have not increased habitat complexity for these species.
- Arthropod community composition was different between high- and low-mortality areas, with 25 percent indicating preferences for either high- or low-mortality habitats. This indicates that ground-dwelling arthropod communities are changing as a result of drought.
- Perhaps the most interesting finding was that the density of trees in a stand did not affect tree mortality levels. This contradicts the popular theory that trees in dense stands are more stressed and so tree thinning will reduce susceptibility to drought-bark beetle outbreaks.

While the changes to the pinyon-

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juniper ecosystem are not yet considered drastic, the forests will continue to change over the coming years, as more of the dead trees fall down. Indeed, the full extent and impacts of the current drought are not likely to be known for decades or even centuries, and several aspects of these studies will be continuing in the future. But the changes noted so far are a clear indication that land managers must be prepared to deal with severe events like drought — not just average climate conditions — in the future.

“The future management of these woodlands needs to take into consideration predicted extreme climatic events,” says collaborator Michael Clifford. “Southwestern ecosystems, especially the semi-arid woodlands, are susceptible to these extreme events and may act as a barometer for climatic change.”

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Grazing and Fire: Studies in Valles Caldera National Preserve

Disturbances to natural ecosystems, such as fire and grazing, have long been a fact of life in the Southwest.

Sometimes these disturbances are due to human activities, sometimes not. Humans have been using the resources of the Middle Rio Grande Basin for some 10,000 years, and intense livestock grazing has been common for centuries. Elk (*Cervus canadensis*) have long grazed in the area as well, recently reaching historically large populations. And fires occurred naturally for at least 9,000 years, until they were largely suppressed in the late 1800s.



Grazing elk are common in Valles Caldera National Preserve.

Photo: Marc Chipault

Although such disturbances are common, scientists do not have a complete understanding of how they can affect the landscape. What long-term impacts might livestock and elk have on grasslands, forests, rivers, and riparian areas? How might they affect fish populations, aquatic invertebrates, or water quality? How do ecosystems respond when a fire burns through an entire valley?

With the creation of the Valles Caldera National Preserve in 2000, there is a great need for such information. The preserve's land managers are now focusing on restoration of ecosystems, reduction of forest and grassland fuels to prevent catastrophic fires, and sustainable use of the forests, wildlife, and livestock. In addition, some streams in the preserve are considered possible sites for reintroduction of the Rio Grande cutthroat trout, (*Oncorhynchus clarki virginalis*), a native species and New Mexico's state fish. Two ongoing U.S. Forest Service-funded research projects in the preserve may help those managers to make decisions on these and other issues in the future.

The Effects of Grazing on Stream Systems

One collaborative, multi-agency study has focused on how grazing by livestock and elk might affect stream systems: the fish populations, aquatic invertebrate communities, water quality, terrestrial insects, vegetation, and stream bank morphology. It is being led by Robert R. Parmenter, Ph.D., chief scientist at the preserve, Colleen Caldwell, Ph.D., Assistant Leader, Cooperative Fish and Wildlife Research Unit, jointly of the U.S. Geological Survey (USGS) and New Mexico State University, and Robert DuBey, Ph.D., of New Mexico State University.

The researchers selected 18 multi-acre study sites along three different reaches of river in the preserve: the East Fork of the Jemez River, Jaramillo Creek, and the San Antonio River. Using fences of varying heights, they built three different types of study sites: “open treatments,” where cattle and elk could graze freely; “cattle treatments,” where elk could graze but cattle were excluded; and “elk and cattle treatments,” where no grazing was allowed.

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Since 2002, each site has been assessed in the spring and fall. The researchers have been collecting data on the physical, chemical, and biological effects of each treatment. The Valles Caldera researchers have focused on measuring the riparian vegetation, terrestrial insect populations, and stream channel geomorphology, while the USGS researchers have focused on habitat characteristics (stream width, substrate, water velocity, runs vs. pools), water quality, fish abundance and body condition, and the aquatic invertebrate communities.

The data collection is ongoing, but initial analyses have allowed the researchers to develop a better understanding of the watershed dynamics on the preserve. For example:

- There are large differences in the fish species present and in species' abundances from one river to the next.
- Vegetation data analysis has shown there were significant increases in plant biomass and (in dry years) plant diversity in riparian areas where livestock and elk were excluded.
- An initial analysis of the aquatic invertebrate community data has indicated improved stream-bottom conditions at the sites where grazing was excluded.
- Restoration of grasses in the non-grazing sites seems to have had a beneficial impact on the structure of the streams; they are becoming relatively deeper and narrower, which provides fish with better living conditions.

The data collection will continue through 2008. When the study is completed, it is expected to improve our understanding of the effects of grazing, as well as help the preserve's land managers to develop livestock range models for managing riparian habitat and native fish communities in

these watersheds. It will also provide data that may help to restore habitats that could aid in the recovery of the Rio Grande cutthroat trout.

The Effects of Fire Plus Grazing

The second study in the preserve is examining the effects of fire and grazing on grasslands and forests. Parmenter and colleagues selected two adjacent watersheds for study: Valle Toledo, which would be subjected to a prescribed fire, and Indios Creek, which would be a no-fire control site.

In 2005, the researchers established numerous study plots in the two watersheds and collected baseline data on many parameters, such as plant abundance and the species present. They also built fences to exclude cattle and elk from several of the study plots, so that plant responses to fire with and without grazing could be assessed. In late 2005, fire crews conducted a prescribed burn in Valle Toledo, burning about 1,800 acres of grassland and ponderosa pine (*Pinus ponderosa*) forest.

For two years after the burn, the researchers returned periodically

to take detailed measurements at the study plots. They assessed plant cover, soil nutrients, litter decomposition, soil erosion, and water quality, as well as the abundance and species of fish, terrestrial arthropods, and aquatic macroinvertebrates. To monitor how elk and cattle used the areas, they set up several cameras that automatically took pictures every 15 minutes.

Data collection continued through 2007, and analyses are now underway. But some interesting early results have been noted. In many of the areas studied, there were no major adverse effects seen due to the fire. Macroinvertebrate communities were mostly unaltered, as were fish populations. Stream water quality was not significantly changed. Soil erosion was non-existent. Plant communities were significantly reduced in canopy size and leaf height after one year, indicating that they likely need two or more years to recover. In contrast, plant nutritional characteristics were enhanced. There was more protein and mineral content, which provides better forage for wildlife and livestock. Not surprisingly, the elk significantly increased their use of the burned areas.

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A prescribed burn is set in Valle Toledo, Valles Caldera National Preserve.

Photo: Valles Caldera Trust Cultural Resources

It is expected that the final results from this study, too, will help Valles Caldera National Preserve managers to implement more effective restoration and conservation plans in the future. In addition, the study results will allow the public to learn more about the positive effects of fire, and will help to build public confidence in management decisions on the use of prescribed and natural fire. 🦋

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Photos top right: Valles Caldera Trust Cultural Resources (background fire); Ashok Khosla, seeingbirds.com (western bluebird)

How Do Birds React to Fire?



One long-accepted viewpoint in the Southwest is that decades of fire suppression, combined with logging and grazing practices, have led to tree stands that are very dense and at risk of fires that are unnaturally large and severe. With that in mind, many ecosystem restoration programs now aim to reduce tree stand densities, hoping that such changes will reduce the risk of severe fires and allow for the return of more controlled understory fires.

However, some researchers think this scenario might be oversimplified, noting that severe fires are not unheard of in southwestern history. Indeed, severe fires may be ecologically beneficial.

Natasha B. Kotliar, Ph.D., an ecologist with the U.S. Geological Survey (USGS), in Fort Collins, CO, proposed to look at this question by examining how birds react to fire conditions.

After the severe Cerro Grande fire of 2000, which burned 42,000 acres near Los Alamos, Kotliar launched a multi-year study of the birds in the region. She marked off 49 study plots in the hills near the 2000 fire, in burned as well as unburned areas. Each site was ranked in terms of how severely it was burned, and was then surveyed several times to see which bird species were found there. She also did surveys at nearby sites

that had been surveyed by a colleague a few years before the fire (1986-1990) and had also burned in 2000.

Statistical analysis was used to build a picture of the number of birds found in the various areas. Overall, the majority of species (71 percent) showed either a positive or neutral response to fire, as measured by their density in burned areas. And many showed positive responses even to the most severely burned areas. Western wood-pewee (*Contopus sordidulus*) and western bluebird (*Sialia Mexicana*), for example, were found almost exclusively in severely burned areas. Other species were found in areas of all burn severity, but were most often found in severely burned areas: hairy woodpecker (*Picoides villosus*), house wren (*Troglodytes aedon*), and broad-tailed hummingbird (*Selasphorus platycercus*).

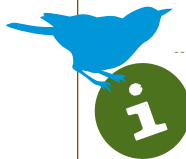
These results, says Kotliar, demonstrate that severe fires are important to the landscape. They create forest structures and elements, such as standing dead trees, that are not likely to be created by forest thinning and understory fires, but that are preferred by some species.

"Fire management that includes a range of variability, including severe fires, is more likely to preserve a broad range of ecological functions," she says.



A great blue heron (*Ardea herodias*) at Bosque del Apache National Wildlife Refuge in New Mexico. Photo: Dick Thompson

“Climate change cuts across virtually every major issue we face in forest management — fire and fuels, invasive species, water resources, forest health, endangered species, outdoor recreation, and more,” says Forest Service Chief Gail Kimbell.



For further discussion on climate change, see “Climate Change and the Nation’s Forests: Challenges and Opportunities,” a paper that recently appeared in the *Journal of Forestry*. Dale Bosworth, chief emeritus of the Forest Service, and Linda Joyce, a quantitative ecologist with the Rocky Mountain Research Station, are co-authors of the paper.

Bosworth, Dale; Birdsey, Richard; Joyce, Linda; Millar, Constance. 2008. Climate Change and the Nation’s Forests: Challenges and Opportunities. *Journal of Forestry*. 106(4): 214-221.

The U.S. Forest Service Takes on Climate Change

Is it getting warmer out there? After many years of debate, most scientists now agree that climate change is a reality, and the Earth is getting warmer. Last year, the Intergovernmental Panel on Climate Change (IPCC) reported that “warming of the climate system is unequivocal,” and that the warming was very likely due to human activities such as deforestation and the burning of fossil fuels.

Whether or not this warming is affecting environmental systems worldwide is no longer in question either. Scientists have observed significant declines in glaciers and snow cover, rising sea levels, increased precipitation in some parts of the world, and longer and more intense droughts in other areas. Climate change has also been correlated with an increased frequency in forest fires and insect outbreaks (including in the Southwest), earlier spring runoff peaks, and shifts in distribution and reproductive patterns of plants, fish, and wildlife. Moreover, these changes are very likely to accelerate in the future.

Still, there is much that is *not* known about climate change and its potential effects. Scientists and decisionmakers in the U.S. and elsewhere want to better understand how climate change could influence plants, animals, ecosystems, and disturbance patterns. They want to know more about how it could affect the products and services that ecosystems provide, such as timber, clean water, food supplies, biodiversity, flood protection, recreation, and aesthetic and spiritual benefits. And land managers are looking for information on how they can best manage their forests, grasslands, and other areas in the face of a changing climate.

The U.S. Forest Service is well-positioned to help provide those answers, as the agency has been conducting research on climate change for 20 years. As forest Service Chief Gail Kimbell noted at a recent conference on science, policy, and the environment, “climate change cuts across virtually every major issue we face in forest management — fire and fuels, invasive species, water resources, forest health, endangered species, outdoor recreation, and more.”

“The Forest Service has a strong scientific basis for addressing climate change in all of these areas,” she added.

The Agency’s Research and Development branch, which includes the Rocky Mountain Research Station (RMRS), has been studying issues related to climate change for many years. The organization’s climate change research priorities include 1) providing national leaders on policies, issues, and discussions, and 2) conducting extensive research on the effects of climate change. Such research includes adaptation science, which addresses how ecosystems respond under different climate scenarios, and how land managers can prepare for uncertain future conditions; and mitigation science, which looks at how forests, woodlands, and grasslands can sequester carbon, as well as related issues.

In the first area, providing national leadership on the issues, Forest Service scientists and consultants are taking part in a number of national and international assessments: they are analyzing the extensive scientific literature on climate change in order to apply existing knowledge toward improving conditions, identify gaps

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in needed information, and make recommendations for future research. One of the most notable of these endeavors was the participation of several Forest Service researchers in writing the recent report from the IPCC, which was awarded the 2007 Nobel Peace Prize, along with former U.S. vice president Albert Gore.

In the second area, the research arena, RMRS scientists are now carrying out numerous scientific studies throughout the West, looking at issues such as the effect of temperature on trout habitat and the effect of snow cover on wolverine dens. In the Middle Rio Grande Basin area, scientists are focusing on issues of local concern, such as the effects of climate change in drought, outbreaks of insects such as bark beetles, non-native species distribution, and the risk of severe forest fires.

In addition, a strong emphasis on climate change issues in the RMRS's most recent strategic framework ensures that these issues will continue



A woman fishes on the Middle Rio Grande. Climate change could possibly affect how people, such as this angler, experience the outdoors.

Photo: Jeff Greenberg

to be a priority in years to come. Among the questions researchers will try to answer in the future are:

- What is climate's role in the major disturbances we are seeing now, specifically in aspen (*Populus tremuloides*) die-back and pinyon loss in pinyon-juniper ecosystems (*Pinus edulis-Juniperus monosperma*)?

- Can carbon sequestration rates be increased in forested lands?
- What does climate change mean for ecosystems thought to be natural or undisturbed, such as wilderness areas?
- How will climate change directly influence species at risk, such as wolverine (*Gulo gulo luscus*), wolf (*Canis lupus*), spotted owl (*Strix occidentalis caurina*), and grizzly bear (*Ursus arctos horribilis*), as well as migratory birds and aquatic species?
- How will a changing climate alter fire intensity, severity, and occurrence?

"We have made a start," in addressing climate change, says Forest Service Chief Kimbell. "However, climate change will remain a challenge for generations to come." 🌱

"Climate Change 2007," the IPCC report that won the Nobel Prize, is available at www.ipcc.ch/ipccreports/assessments-reports.htm.

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U.S. Forest Service Research: Understanding, Conserving, and Restoring Southwestern Ecosystems

they need to fully understand the ecological consequences of their decisions. For example, if exotic plants are removed from the bosque, will they re-sprout? How quickly? How much grazing can be allowed in a grassland while still protecting biological diversity? Will removing fuels in an upland watershed, such as with a prescribed fire or by thinning small-diameter trees, help to restore a productive environment?

And again, land managers also need more information on social concerns. How do these activities affect humans and their relationship with the environment? For example, misunderstandings can easily arise among residents, landowners, and recreationists if it appears that access to resources such as water or a forest may be limited.

Research in this area includes studies on: 1) understanding the effects of disturbances on aquatic habitats and fish populations; 2) understanding the effects of removing bosque exotic species and fuels; and 3) developing information to aid in resolving social concerns.

Research Area 3: Communicating Research Findings

The third area of research is intended to ensure that

information developed on Middle Rio Grande Basin ecosystems is easily and quickly made available to all interested parties. Scientists and others are being funded to develop publications, databases, computer programs, field trips, and conferences to help synthesize and make public their research findings.

A Long-Term Program

The questions raised by the Middle Rio Grande Ecosystem Management Research Unit won't be answered overnight. Research takes time; in some cases, years. But much work has already been done. For example, a comprehensive environmental history of the area has been published, as well as a history of irrigation in the area and a synthetic review of Basin ecology and issues. Many field researchers have been funded, and many of them have presented their findings at symposia and professional meetings and published noteworthy articles in peer-reviewed journals. Newer studies continue with multi-year research.

This report describes several of the research projects most recently funded by the Middle Rio Grande Ecosystem Management Research Unit. 🌱



Profile: Hira Walker, Ph.D. From Student to Professional

Growing up in California, Hira Walker had always been interested in birds. She delighted in watching the hummingbirds and doves that frequented the trees outside her bedroom window. In college at the University of California at Santa Cruz, she pursued degrees in biology and environmental studies. But it wasn't until a guest speaker — a professional ornithologist — spoke to her natural history class that she realized she could build an entire career around her love for birds.



Hira Walker with a greater roadrunner (*Geococcyx californianus*).

Photo: Susan Allerton

"It was the first time I realized I could be an ornithologist," Walker recalls. She hung around after class to talk with the guest speaker, and he offered her a volunteer position. Walker soon found herself working directly with birds, capturing them with mist nets and putting identification bands on their legs. Her career as an ornithologist was underway.

A few years later, Walker was pursuing graduate studies in Missouri when contact with another professional ornithologist — Deborah Finch, Ph.D., of the U.S. Forest Service — led to another big career move. After talking with Finch, Walker transferred to the University of New Mexico, where Finch was a research associate professor. In Albuquerque, Walker studied under Finch and also began working for the Rocky Mountain Research Station under the authority of the Student Temporary Employment Program and alternatively as a contractor. Her first job with the Station, in 1997, involved studying how neotropical migrant birds used different habitats at the Bosque del Apache National Wildlife Refuge.

Walker continued to work with the agency for the next ten years, while she worked on her Ph.D., and afterward, as a postdoctoral researcher. With Finch as her mentor, she held numerous part-time and full-time jobs with the agency, gaining experience in many aspects of ornithology, including vegetation and bird surveys, nest searching and monitoring, data collection techniques, supervision and training of biological technicians, study design and analysis, and preparation of progress reports and articles for peer-reviewed publications.

The "trust, support, and encouragement," she got from Finch was invaluable, says Walker. "She gave me a lot of independence and the opportunity to develop my own projects."

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"There is a desire to simplify things as 'non-native bad, native good.' But it's really much more complex. Is something bad just because it is exotic?"

- HIRA WALKER, PH.D.

Launching a Career with the U.S. Forest Service

In addition to Hira Walker (left), Heather Bateman ("Restoring the Rio Grande," page 4) and Hugo Magaña ("What Do Rio Grande Silvery Minnows Prefer to Eat?," page 17) also began their careers as students working for the U.S. Forest Service. Many other students around the country have also benefitted professionally from their associations with the Agency.

The Forest Service has several programs that can help students to launch a career in the natural resources. These programs may involve part-time positions during the school year, full-time jobs during vacation periods, internships, scholarships, and more.

Students are often hired first under the Student Temporary Employment Program (STEP). Students who show strong potential may be recruited for the Student Career Experience Program (SCEP), which often leads to permanent employment with the government. Students may also find opportunities in the national Student Volunteer Program, the U.S. Department of Agriculture (USDA) National Scholars Program, the USDA Summer Intern Program, local work-study programs, and research joint ventures with universities.

For information, see www.fs.fed.us/fsjobs/index.html, or contact your local Forest Service office.



As her studies and work experience progressed, Walker developed her own area of expertise: assessing how human activities, such as habitat destruction and the introduction of exotic plants, can affect migrating, breeding, and wintering birds. Her work has included research on a very timely issue in New Mexico — the proliferation of a common exotic plant, saltcedar (*Tamarix ramosissima*).

“Saltcedar is the predominant plant in some areas of the Southwest,” she says. Indeed, it is now the most common plant species in many local riparian ecosystems. By some estimates, saltcedar and other exotic plants could dominate southwestern riparian ecosystems within the next 50 to 100 years. Many agencies are in the midst of aggressive programs to remove the exotics and replant with native vegetation. But given that the saltcedar is here, Walker says, we need to look at how it affects birds. “Can it be a functional replacement for the native vegetation?” she wants to know. “Which birds use it and which ones are avoiding it?”

In her studies, Walker has found that some migrating bird species *do* make good use of saltcedar. “In certain circumstances, saltcedar vegetation can support higher numbers of bird species and individuals than native vegetation,” she says. “Not all saltcedar vegetation has equal value to birds, however. Their use of it depends on such factors as whether it is a young shrub or a mature tree, and whether it is intermixed with native plants.” Moreover, she reports, the “bad” exotic species might in fact be helping to stem declines in some bird populations, by providing a refugia

in landscapes where other woody vegetation is absent.

“There is a desire to simplify things as ‘non-native bad, native good,’” she says. “But it’s really much more complex. Is something bad just because it is exotic?”

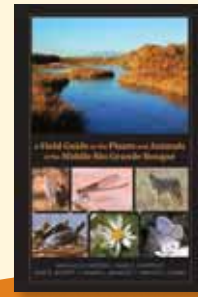
Walker is not opposed to efforts to eradicate exotic plants, but based on her research, she advises that land managers take precautions to protect bird species. “If you are going to remove saltcedar, you have to do it in stages,” she says. “Otherwise, what are the birds going to do in the meantime?” She suggests that eradication programs first target habitats that are less diverse (and that support fewer species), and that replanting after exotics are removed is made a priority. Walker reports she is pleased to see that many programs are now taking such tactics, selectively removing exotics, and leaving some in place until native plants are restored.

Walker recently started a new job, working as an endangered species ornithologist for the New Mexico Department of Game and Fish. Her work with the Forest Service was invaluable in helping to land that position, she says. “I had a Ph.D. and ten years of experience,” she notes. “It made a significant difference.”

Her advice for other aspiring ornithologists and biologists? “Align yourself with people who support and promote you, and push yourself to take on challenges whenever opportunities arise,” she says. 🌱

PUBLICATION

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A New Field Guide to the Middle Rio Grande Bosque

- What large insect lives underground for five to ten years, emerging only as an adult?
- What local herb was often used in folk medicine, even though its sap is toxic, and was also used to make ropes?
- In what species do the males get together as a chorus to serenade females?

(See answers below)

A new field guide to the plants and animals of the middle Rio Grande bosque and nearby areas will soon provide those answers, as well as details on 700 other local species.

A Field Guide to the Plants and Animals of the Middle Rio Grande Bosque features information on how to identify each species, its taxonomy, where it lives, how common it is, and interesting details about its natural history.

“Our goal is to help sensitize the next generation of New Mexicans to our natural heritage,” says co-author Jean-Luc E. Cartron, a former postdoctoral employee with the Rocky Mountain Research Station (RMRS), Albuquerque Laboratory, and now with the Drylands Institute.

Cartron’s co-authors are local natural history experts David C. Lightfoot, Jane E. Mygatt, Sandra L. Brantley, and Timothy K. Lowrey. *The Field Guide* is the result of a collaboration between the Drylands Institute and the University of New Mexico Museum of Southwestern Biology, with sponsorship by many organizations, including RMRS. All proceeds will be used to buy copies of the guide for classrooms and educational programs.

Answers:

- Giant cicada (*Tibicen marginatus*)
- Indian-hemp (*Apocynum cannabinum*)
- Several toad species, including the Woodhouse’s toad (*Bufo woodhousii*)

Woodhouse’s toads are known to serenade female toads. Photo: Jean-Luc E. Cartron





What Do Rio Grande Silvery Minnows Prefer to Eat?

Restoring or protecting an endangered or threatened species is a complex task. What sort of habitat does it need? What does it eat? What caused its demise in the first place: habitat loss, pesticides, an invasive species that displaced it or preyed on it, or something else? Field managers often need the answers to these and other questions before they can take meaningful steps to help populations of a species recover.

Such is the case with the Rio Grande silvery minnow (*Hybognathus amarus*). This tiny fish species, once the most abundant fish in the Rio Grande Basin, is now found in only five percent of its historic range. It was placed on the federal endangered species list in 1994, and resource managers are now working on a recovery plan.

Many likely causes of the fish's decline have been cited, including water quality problems, water impoundments along the river, and the effects of cattle grazing. But little research had been done on the species' food preferences. Hugo A. Magaña, Ph.D., now a research fisheries biologist with the Rocky Mountain Research Station in Albuquerque, decided to explore that question as part of his Ph.D. work at the University of New Mexico. Magaña's salary was sponsored by the Scientist Recruitment Initiative of the U.S. Forest Service, and his research was sponsored by the Middle Rio Grande Ecosystem Management Research Unit, as well as by the U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers.

Magaña set up a series of feeding trials to look at several questions, such as which diatom (algae) species the fish prefer, and whether they could learn to respond to offered food. He cultured samples of 15 different diatoms, placed some young hatchery-produced fish in a series of fish tanks, and systematically offered them food sources. To determine their food preferences, he documented on videotape how long it took the fish to find the food, how often they returned to the food source, and how much time they spent sampling it.

His results showed that Rio Grande silvery minnows do indeed have some dining preferences: they clearly preferred two diatoms, *Nitzschia palea* and *Nitzschia paleacea*, over other species. And they *could* be conditioned to eat; fish that had earlier been offered a food source were much quicker to feed upon it when it was offered a second time.

Magaña's results suggest that it might be possible for hatchery-produced Rio Grande silvery minnows to be trained to forage for food, before they are released into the wild as part of reintroduction efforts. "Given that 95 percent of all hatchery fish die from predation or starvation within weeks of their release," he says, "instilling such skills in Rio Grande silvery minnows before their release could greatly increase their ability to survive in the wild. It could help them come back from the brink of extinction." 🐟



The Rio Grande silvery minnow has been on the federal endangered species list since 1994.

Photo: Joel Lusk, USFWS

The Middle Rio Grande Ecosystem Management Research Unit

The Middle Rio Grande Ecosystem Management Research Unit (Research Work Unit 4652), which provided funds for the research projects described in this report, is part of the Grassland, Shrubland, and Desert Ecosystems Research Program of the U.S. Forest Service's Rocky Mountain Research Station (RMRS).

The RMRS, headquartered in Fort Collins, Colorado, administers and conducts research throughout a 14-state area, covering the Great Basin, the Southwest, the Rocky Mountains, and part of the Great Plains. Its scientists investigate issues related to wildlife and fish, fire and fuels, invasive species, forest and rangeland inventory, recreation, resource management and use, and water and air quality at numerous research stations and other locations. This vast research organization is comprised of seven programs and a wilderness institute, which produce and deliver scientific information to help land managers, planners, and other specialists make wise decisions about our nation's forests, rangelands, and grasslands. RMRS is one of six research stations that are part of the U.S. Department of Agriculture Forest Service Research and Development organization, the largest natural resources research organization in the world.

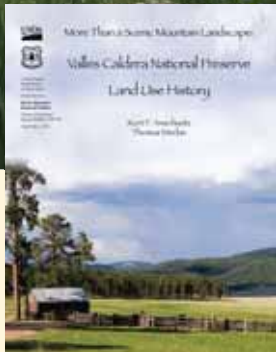
All research funded by the Middle Rio Grande Ecosystem Management Research Unit falls within the strategic framework focus areas established by RMRS: fire, water, terrestrial ecosystems, climate change, and human connections.

See www.fs.fed.us/rmrs/research/programs for more information on these programs.





More Than a Scenic Landscape: A New Report on the History of Valles Caldera National Preserve



More Than a Scenic Mountain Landscape

is available free of charge from:

USDA Forest Service
Rocky Mountain Research
Station
240 West Prospect Rd.
Fort Collins, CO 80526-2098
rschneider@fs.fed.us
970-498-1392
www.fs.fed.us/rm/pubs/rmrs_gtr196.html

Also of interest:

State of the Preserve 2002-2007, a report published by the Valles Caldera Trust, which identifies collaborative studies with Rocky Mountain Research Station and others.

Available from:
Valles Caldera Trust
PO Box 359
Jemez Springs, NM 87025
www.vallescaldera.gov/about/trust/docs/trust_SOPDecember2007ExecSum.pdf

Valles Caldera National Preserve
Photo: Marc Chipault

Valles Caldera National Preserve was established in 2000, when the U.S. Congress authorized the purchase of the historic Baca ranch located just west of Los Alamos, New Mexico.

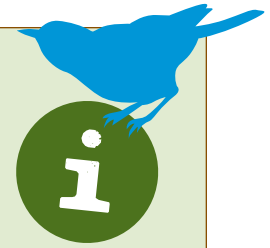
The 88,900-acre preserve is known for its scenic beauty; it features 11,000-foot mountain peaks, coniferous forests, broad open meadows, geothermal hot springs, and wildlife ranging from prairie dogs (*Cynomys gunnisoni*) to black bears (*Ursus americanus*) and bald eagles (*Haliaeetus leucocephalus*). Many of today's visitors to the preserve believe it to be pristine, untouched wilderness. But in fact, for more than 100 years the area supported intense sheep grazing, cattle ranching, timbering, and mineral and geothermal exploration by Anglo-Americans, activities that deeply affected the area's appearance.

The area was used by earlier people, as well. Archaeological evidence shows that the earliest visitors to the area, some 11,000 years ago, were hunters who passed through while looking for mammoth (*Mammuthus jeffersonii*) and bison (*Bison antiquus*). The area was not home to those animals, but it offered the hunters obsidian, which they used to refurbish their hunting gear, as well as other resources they needed for their journeys. Following those early hunters, countless generations of Native Americans visited the area to hunt deer and elk, gather plants for food and other uses, and collect obsidian for tools. By the time the Spanish explorers arrived in New Mexico in the 16th century, the area was well-known and important to the region's many and diverse indigenous people.

A new U.S. Forest Service report, *More Than a Scenic Mountain Landscape: Valles Caldera National Preserve Land Use History*, explores the nature and intensity of all the human impacts on the area. Focusing primarily on the past four centuries of Spanish, Mexican, and U.S. governance, the study details how the land was used, the social organizations of the times, and the communities and major actors involved. It traces how this remarkable landscape changed from an area that was shared by many to being the private property of a few individuals (who often competed fiercely with each other to control the land), and was finally returned to public ownership. The study also includes an archaeological review of human use of the area before Spanish colonization, describing traditional Native American land-use practices and associations.

Overall, the report provides a thorough record of the economic, social, and ideational relationships that Native Americans (including Pueblo, Navajo, Apache, and Ute), Hispanics, and Anglo-Americans have had with the area.

The report will be of interest to land managers and researchers as they assess the ecological history of the area and develop management plans for the future. It will also be of interest to history buffs who are intrigued by the area. It was written by Kurt F. Anschuetz, an archaeologist and anthropologist, and program director of the Rio Grande Foundation for Communities and Cultural Landscapes, and Thomas Merlan, a historian and historic preservation specialist. 🌿



To Our Partners: Thank You!

Few research programs are done in isolation. Most are collaborative efforts that are funded by several organizations and carried out by many staff members, outside researchers, students, and volunteers. The organizations below have all contributed to the efforts to understand, protect, and restore the ecosystems of the Middle Rio Grande Basin. The Forest Service gratefully acknowledges all of their kind efforts.

Armendaris Ranch
Bandelier National Monument
Bosque del Apache National Wildlife Refuge
Cibola National Forest
City of Albuquerque Open Space Division
Drylands Institute
Intel Corporation
Joint Fire Science Program
Middle Rio Grande Bosque Initiative
Middle Rio Grande Conservancy District
National Fish Hatcheries
National Partnership-Whirling Disease Initiative
Natural Resources Conservation Service
The Nature Conservancy
New Mexico Collaborative Forest Restoration Program
New Mexico Cooperative Fish and Wildlife Research Unit
New Mexico Department of Game and Fish
New Mexico Environment Department
New Mexico Highlands University
New Mexico State Forestry Division
New Mexico State University
Northern Arizona University
Pueblo de Cochiti
Rio Grande Foundation for Communities & Cultural Landscapes
Rio Grande Nature Center
Santa Fe National Forest
Save Our Bosque Task Force
Sevilleta Long Term Ecological Research
Sevilleta National Wildlife Refuge
Daniel B. Stephens & Associates
SWCA Environmental Consultants
Texas A&M University
Tree New Mexico
University of Arizona
University of New Mexico Department of Biology
University of New Mexico Museum of Southwestern Biology
University of New Mexico Water Resources Program
University of Oklahoma
U.S. Army Corps of Engineers, Albuquerque District
U.S. Bureau of Indian Affairs
U.S. Bureau of Land Management
U.S. Bureau of Reclamation
U.S. Fish & Wildlife Service
U.S. Forest Service Southwestern Region
U.S. Geological Survey
Valles Caldera Trust

Learn More About It

For more information on Middle Rio Grande research projects and Forest Service research partners, as well as local recreation areas, volunteer programs, species of concern, and more, see these websites.

Backyard conservation tips

www.nrcs.usda.gov/feature/backyard

Bark beetle outbreaks

www.fs.fed.us/r3/resources/health/beetle/index.shtml

Bird checklists: New Mexico

www.npwrc.usgs.gov/resource/birds/chekbird/r2/35.htm

Bosque del Apache National Wildlife Refuge

www.fws.gov/southwest/refuges/newmex/bosque/index.html

City of Albuquerque Open Space Division

www.cabq.gov/openspace

Climate change and western ecosystems

www.fs.fed.us/rmrs/climate-change

Climate research, Los Alamos National Laboratory

<http://climateresearch.lanl.gov>

Drylands Institute

www.drylandsinstitute.org

Endangered species

www.fws.gov/endangered

Fire management in the West

www.fs.fed.us/fire/index.html

The Friends of The Bosque del Apache National Wildlife Refuge

www.friendsofthebosque.org

Friends of the Rio Grande Nature Center State Park

www.rgnc.org

Joint Fire Science Program

www.firescience.gov

Merriam-Powell Center for Environmental Research, Northern Arizona University

www.mpcer.nau.edu

Middle Rio Grande Bosque Initiative

www.fws.gov/southwest/mrgbi

Middle Rio Grande Conservancy District

www.mrgcd.com

Middle Rio Grande Endangered Species Act Collaborative Program

www.fws.gov/mrgesacp

New Mexico Cooperative Fish & Wildlife Research Unit

<http://fws-nmcfwru.nmsu.edu>

New Mexico Department of Game and Fish

www.wildlife.state.nm.us

New Mexico Energy, Minerals and Natural Resources Department

www.emnrd.state.nm.us

New Mexico Forest and Watershed Restoration Institute

www.nmhu.edu/nmfwri

New Mexico State University

www.nmsu.edu

Sevilleta Long Term Ecological Research

<http://sev.lternet.edu>

Sevilleta National Wildlife Refuge

www.fws.gov/southwest/refuges/newmex/sevilleta

The University of New Mexico

www.unm.edu

U.S. Fish & Wildlife Service Southwest Region

www.fws.gov/southwest

U.S. Forest Service jobs and student and volunteer opportunities

www.fs.fed.us/fsjobs/about.html

U.S. Forest Service Rocky Mountain Research Station

www.fs.fed.us/rmrs

U.S. Forest Service Southwestern Region

www.fs.fed.us/r3

Valles Caldera National Preserve

www.vallescaldera.gov

Water Resources Program, University of New Mexico

www.unm.edu/~wrp



Scientist Hira Walker published an article in a recent issue of *The Auk*. She also painted the cover art, which depicts a Wilson's warbler (*Tamarix pusilla*) and MacGillivray's warbler (*Oporornis tolmiei*) on coyote willow (*Salix exigua*).

Cover Art: Copyright 2008 Hira Walker, published in *The Auk* 125.3 by the University of California Press, on behalf of the American Ornithologists' Union.

PUBLICATIONS SUPPORTED BY THE MIDDLE RIO GRANDE ECOSYSTEM MANAGEMENT RESEARCH UNIT

The scientists funded by the Middle Rio Grande Ecosystem Management Research Unit share their findings by publishing papers in scientific journals, making presentations at scientific meetings, and producing technical reports. In so doing, they are making a significant contribution to the body of scientific knowledge about the Southwest. Many of these efforts are listed with the articles in this report. Other recent efforts are listed below.

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A cottonwood tree beside the Middle Rio Grande. Photo: Keith Coronel