

# Research of the Rio Grande Ecosystem Management Program

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**Abstract**—This paper describes the mission, objectives, and preliminary results of the Middle Rio Grande Ecosystem Management Research Program managed at the Rocky Mountain Research Station's Albuquerque laboratory. This program was initiated in 1994 to address growing pressures to effectively manage the limited resources of the middle Rio Grande Basin. The program is divided into four problem areas: upland vegetation, links between uplands and rivers, fish and wildlife, and cultural resources. This paper describes the productivity and products of the program since its inception.

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Rio Grande Basin ecosystems have evolved under human influence for at least 12,000 years. Since 1540, the Middle Basin has experienced increasing environmental and socio-economic changes, including urban population growth, invasion of aggressive exotic plants, water development, changes in rural economic patterns, shifts in public values, and endangerment of riparian species. Primary goals of the Middle Rio Grande Basin Ecosystem Management Program sponsored by the Rocky Mountain Research Station (RMRS) are to generate and share knowledge and methods to maintain the ecological health and diverse cultural and economic values of native grasslands, shrublands, and woodlands in the space- and resource-limited ecosystems of the Middle Basin.

Working with over 30 Basin stakeholders, our program coordinates and implements research designed to solve environmental and sociocultural problems in the Basin with emphasis on sustaining rangeland health, riparian productivity, fish and wildlife populations, archaeological sites, and human values and needs. An initial literature assessment of status and issues of river and upland ecosystems in the Rio Grande Basin was published by our program in 1995 (Finch and Tainter 1995). Research updates and cooperative ventures of the Rio Grande program were most recently highlighted at a symposium held June 2-5, 1998 cosponsored by RMRS and the U.S. Fish and Wildlife Service. Research products were summarized in the symposium proceedings, *Rio Grande Ecosystem: Linking Land, Water, and People. Toward a Sustainable Future for the Middle Rio Grande Basin* (Finch and others 1999).

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## Environmental History and Cultural Dimensions

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To interpret current ecosystem dynamics and health in the middle Basin, it was first necessary to understand and describe the influences of past human land uses during critical periods of New Mexico's complex history (Finch and Tainter 1995). Therefore, a comprehensive environmental history was funded by the program and published last year (Scurlock 1998). This environmental history report documents land change during the following periods: American Indian (pre-1540), Spanish Colonial (1540-1821), Mexican (1821-1846), Territorial (1846-1912), and Statehood (1912-present). Another volume reviewing the history of irrigation in the Middle Basin was also funded and published by our program (Wozniak 1998). Members of the program (Roy Jemison and Carol Raish, RMRS, Albuquerque, NM) are in the process of editing a book about livestock grazing in the Southwest, including an evaluation of historical, social and economic considerations. This volume has been accepted for publication in Elsevier Press and is due to be printed in the year 2000. A pilot project assessing social and economic costs and benefits of Hispanic ranching on national forests has recently been implemented under the auspices of the Rio Grande Program and is described in a recent article by Raish (1999). For more information on the economic role of livestock, see Raish (1998).

To visually document prehistoric human influences, our program is developing three-dimensional GIS models of reconstructed past landscapes using archaeological, vegetational, and paleoenvironmental data from the Rio del Oso drainage of the Santa Fe National Forest (Richard Periman, RMRS, Albuquerque, NM). Landscape models will be produced for three time periods, including two Puebloan occupations (1200-1325 and 1325-1600) and the historic Hispanic occupations (see Periman 1999). In addition, a Ph.D. project on this topic is underway at the University of New Mexico (UNM), and a dissertation should be completed by the year 2001. A summary of cultural research implemented by members of the Rio Grande Program team is included in table 1.

## Ecological Disturbance and Restoration Research

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Watershed and biological studies were initiated in FY94 and FY95 in the middle Rio Grande Basin, defined as the reach between Cochiti Dam and Elephant Butte Reservoir, New Mexico (table 1). Current studies are assessing responses of soil nutrients, water, belowground flora and fauna,

**Table 1**—Summary of current research implemented by the Rio Grande Program.

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<b>Riparian and watershed disturbance and restoration</b>
Effects of drought, fire, and grazing on woodland-grassland interface
Landscape patterns in relation to lightning, precipitation, and vegetation
Cienega restoration in relation to road-engineering techniques
Methods for restoring grasslands using prescribed fire, vegetation manipulation, amendments, and grazing management
Classification of vegetation species composition and structure along the Rio Grande
<b>Wildlife and fish</b>
Status, distribution and ecology of Rio Grande cutthroat trout and other fish species
Maternal roost ecology of three bat species of concern
Arthropod-habitat relationships in the Rio Grande bosque
Stopover ecology of Neotropical migrants in the Rio Grande Valley
Migrant use of exotic and native vegetation
Willow flycatcher use of mowed channels and unmowed vegetation
Use of stable-isotope ratios in understanding bird migration
<b>Cultural Dimensions</b>
Economic, social, and cultural importance to Hispanic ranchers of livestock grazing on national forests
Ecology and current role of Anasazi cobblemulch gardens
Prehistoric and historic human influences on landscape development

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herbaceous and woody plants, and fish and wildlife populations to (1) disturbances by drought, fire and its suppression, grazing, and past human activities, and (2) restoration treatments to mitigate or reverse disturbance effects.

Drought, overgrazing, and fire exclusion are three of the major factors, interacting in concert, that have resulted in degraded upland and river ecosystems in the middle Basin (Finch and Tainter 1995). Several cooperative studies were implemented to evaluate effects of drought, grazing exclusion, fire suppression, and historic human influence. These studies have involved the use of dating tree rings (Betancourt and Swetnam), landscape analysis (Potter, Milne, UNM), experiments with cobble rocks (White, UNM, Loftin, RMRS and Los Alamos National Lab), excluding cattle from streams (Valett, Moyer, Dahm, UNM), and current and historic inventory data and photo records at Research Natural Areas (RNA) (Muldavin, Ladyman, UNM Natural Heritage Program). Ecological assessments have detected widespread shifts in grassland/shrubland/woodland boundaries (Baisan and Swetnam 1997; Kieft and others 1998; Johnson and others 1999), influences of early Puebloan cobblemulch gardens on current ecosystem functioning (White and others 1998), effects of grazing and hydrology on nutrient composition and retention in streams (Valett and others 1998; Moyer and others 1998), and influence of RNA protection on ecosystem health as indexed by plant age and densities, nutrient cycling, and extent of cryptogam crusts (Ladyman and Muldavin 1996).

Evaluations of the influence of the 1950's drought on pinyon (*Pinus* spp.) demography are underway by Julio Betancourt (U.S. Geological Survey Desert Ecology Lab, Tucson, AZ) and Tom Swetnam (University of Arizona, Tucson). Their most recent update was published in Journal

of Climatology (Swetnam and Betancourt 1999). In addition, the Rio Grande program sponsored a book about the 1950's drought in the Southwest that is being compiled and edited by Betancourt. A Ph.D. dissertation at UNM on the relationships between lightning strikes, precipitation, and landscape vegetation patterns was published in Landscape Ecology (Potter and others 1998).

A large number of cooperating agencies are involved in ecological disturbance and restoration research, in part because altered or degraded ecosystems are prevalent in the Basin, crossing organizational boundaries. Restoration ecology studies were designed to determine whether intervention with treatments will interrupt ecosystem degradation processes and re-establish natural ecological functioning (contacts: Carl White, UNM, Albuquerque, NM; Samuel Loftin, Los Alamos Research Lab, Los Alamos, NM; Roy Jemison, RMRS, Albuquerque, NM.). Recent results of amendment, road engineering, and prescribed fire studies have been published by White and others (1997), Pawelek and others (1999), Loftin (1999), and White and others (1999).

## Biological Diversity Research

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Understanding Basin ecosystems and cultures cannot be achieved without an understanding of the importance of the Rio Grande and its associated tributaries (Finch and Tainter 1995). The river itself has historically been and still is a major focal point for human settlement, water development, farming and irrigation, and pollution from local and upland sources. Despite threats from growing human populations, the Rio Grande and associated tributaries and streams continue to be important reservoirs for biological diversity in the Southwest. To understand the contributions of river and stream habitats to biological diversity, we implemented mapping and survey assessments and experimental studies of Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*), Rio Grande Sucker (*Catostomus plebeius*), and Rio Grande Chub (*Gila pandora*) (Bob Calamusso, New Mexico State University, Las Cruces and John Rinne, RMRS, Flagstaff); Neotropical migratory birds (Deborah Finch, Jeff Kelly, and Wang Yong, RMRS, Albuquerque); and endangered species (Southwestern Willow Flycatcher, *Empidonax traillii extimus*) (Deborah Finch, Scott Stoleson, Jeff Kelly, RMRS, Albuquerque) (table 1). Recent results have been published on fish status and distribution (Calamusso and Rinne 1999), stopover ecology of migratory landbirds (Yong and Finch 1997a; Kelly and others 1999), willow flycatcher migration (Yong and Finch 1997b; Finch and Kelly 1999), and brown-headed cowbird (*Molothrus aler*) distribution (Schweitzer and others 1998).

After further consultations with various agencies and stakeholders, studies of bat "Species of Concern" in upland ecosystems were added to the program in 1995 (Alice Chung-MacCoubrey, RMRS, Albuquerque), and some preliminary results have been published (Chung-MacCoubrey 1996). Because the Southwest has higher levels of species endangerment than most other areas of the United States or Canada, we deemed it critical to develop methodology for detecting population problems and solutions for recovering sensitive species. Given the influence of the Endangered Species Act on how forest, rangelands, and rivers in the

Southwest and in the middle Rio Grande Basin are managed, our faunal studies play a key role in supplying scientific information to a large and diverse group of Basin stakeholders.

## Milestones and Graduate Studies

The following milestones have been achieved by the Rio Grande Program:

- 1994 Rio Grande Ecosystem Management Grant funded and chartered.
- 1995 Rio Grande Basin Assessment published and first riparian symposium hosted.
- 1996 Proceedings, desired future conditions for riparian ecosystems published.
- 1997 ARC-INFO vegetation classification maps for the Rio Grande produced.
- 1998 Symposia Rio Grande Ecosystems (RGE) hosted.
- 1999 Proceedings, RGE and Environmental History published.

Five graduate students sponsored by the Rio Grande Program have completed their theses or dissertations:

- S. Hofstad. Sediment and nutrient loss following prescribed fire in semiarid grasslands: the potential for resource impairment. M.S. thesis. UNM, Albuquerque.
- R. Calamusso. Distribution, abundance, and habitat of the Rio Grande sucker on the Carson National Forest. M.S. thesis. NMSU, Las Cruces.
- D. Potter. Spatial relationships among lightning, precipitation, and vegetative cover in watersheds of the Rio Puerco Basin. Ph.D. dissertation. UNM, Albuquerque.
- M. J. Mund-Meyerson. Arthropod abundance and composition on native and exotic trees in the middle Rio Grande riparian forest as related to avian foraging. M.S. thesis. UNM, Albuquerque.
- D. Moyer. Influence of livestock grazing and geologic setting on morphology, hydrology and nutrient retention in four southwestern riparian-stream ecosystems. M.S. thesis. UNM, Albuquerque.

Several graduate studies are continuing or have recently been initiated:

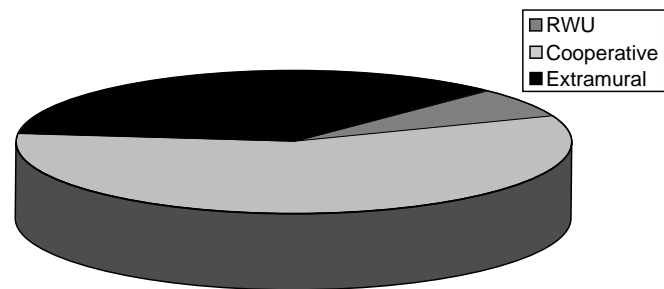
- R. Periman. Ph.D. Human influences on landscape development. UNM.
- Chung-MacCoubrey. Ph.D. Roost ecology of bat species of concern. UNM.
- H. Walker. Ph.D. Use of salt cedar by stopover migrants. UNM.
- R. Calamusso. Ph.D. Rio Grande cutthroat trout habitat use and distribution. NMSU.

## Publication Output

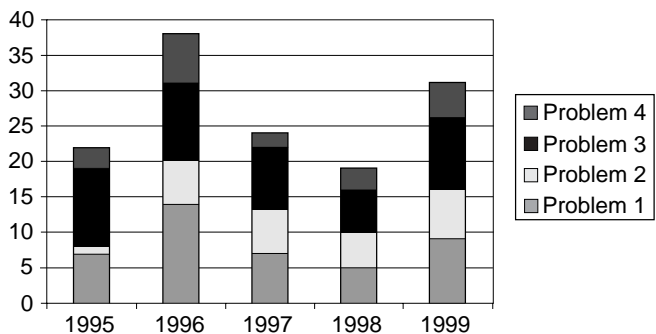
Over 130 publications, including journal articles, general technical reports, and symposium proceedings, have been produced since the inception of the Rio Grande program. Over half of the program's publication output between

October 1995 and September 1998 was accomplished through cooperative agreements between RMRS scientists and collaborators from universities or other institutions (fig. 1). Extramural research through contracts and research joint ventures have also contributed importantly to the productivity of the program. No permanent RMRS scientists are currently assigned to the Rio Grande program, but two RMRS postdoctoral scientists (Sam Loftin and Jeff Kelly) were hired by the Rio Grande Program and have published papers in the Research Work Unit (RWU) category.

Annual output of program publications has varied somewhat by year (fig. 2). High productivity in 1996 corresponds to the issuance of the proceedings of the 1995 symposium, *Desired Future conditions for Southwestern riparian ecosystems: Bringing interests and concerns together* (Shaw and Finch 1996), sponsored by RMRS, Region 3 of the U.S. Forest Service, and the New Mexico Riparian Council. With the publication of the proceedings of the Rio Grande Ecosystems symposium, the year 1999 is well on its way to being very productive (fig. 2).



**Figure 1**—Percent of total research publications (1995-1998, N = 103) by output category—Research Work Unit (RWU), cooperative, and extramural—for the Rio Grande Ecosystem Management Program.



**Figure 2**—Total number of Rio Grande program publications (N = 134) through July 1999 by year and problem area. The total count for 1999 is incomplete. Problem 1 = understanding upland ecosystems; Problem 2 = understanding watersheds and rivers; Problem 3 = understanding riparian ecosystems; and Problem 4 = understanding cultural dimensions.

## Emerging Priorities

The Rio Grande program is responsive to changes in research priorities over time. Team members convened in July 1998 to review status of the program and identify new directions. Emerging research priorities in the Basin based on input from federal, state, municipal and private interests include:

- Understanding the influence of exotic plant invasion on ecosystem health.
- Determining methods for conserving and recovering threatened and endangered fish and wildlife species.
- Developing methods for restoring water, native plants, wildlife and proper functioning condition to rivers and watersheds.
- Understanding ecosystem dynamics in the urban-wildland interface.
- Understanding long-term human influences on riparian ecosystems of the Rio Grande.
- Developing conflict-resolution techniques to bridge gaps between environmental groups and traditional land users.
- Studying growing conflicts over species protection issues and rural economic uses and needs.

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