Bosque Ecosystem Monitoring Program (BEMP): First Annual Supplement: 2001

Kim D. Eichhorst, Mary C. Stuever, Mary M. Dwyer, Daniel C. Shaw,
and Clifford S. Crawford

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First Annual Supplement: 2001

By Kim D. Eichhorst[1], Mary C. Stuever[2], Mary M. Dwyer[3], Daniel C. Shaw[4], and Clifford S. Crawford[5]

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[1] Data manager, Department of Biology, University of New Mexico, Albuquerque, NM 87131; kime@sevilleta.unm.edu

[2] Education co-coordinator, Seldom Seen Expeditions, P.O. Box 474, Placitas, NM 87043; sse@nmia.com

[3] Education co-coordinator, 1605 Rita Dr. NE, Albuquerque, NM, 87106; dwyermc@unm.edu

[4] Education co-coordinator, Bosque School, 4000 Learning Rd. NW, Albuquerque, NM 87120; dshaw@bosqueschool.org

[5] Program director, Department of Biology, University of New Mexico, Albuquerque, NM 87131; ccbosque@juno.com

Errata

Corrections for Bosque Ecosystem Monitoring Program (BEMP): First Report: 1997-2000

Typos and additional acknowledgments can be found on the on-line version of the First Report on the BEMP website. The following corrections have not been made to the on-line version:
Table 1 and Figure 11: all ARAD from Lemitar should be BOAR (Table 1) and PSSC8 should be changed to PSSC6 (Table 1).
In addition, please note the change in scale for litterfall data (Figures 12& 14) and cottonwood diameter at breast height (Figure 15).

Cover photo by Michael Boles

Additional information about BEMP can be accessed at: http://www.bosqueschool.org/BEMP/bemp.htm

Copies of this report can be purchased by writing to:
Cliff Crawford, Director, BEMP
Department of Biology, University of New Mexico,
Albuquerque, NM 87131

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Executive Summary

The Bosque Ecosystem Monitoring Program (BEMP) continues its long-term ecological research with the cooperation of volunteers. Monitoring key indicators of structural and functional change in the Middle Rio Grande riparian forest, or "bosque," is a critical way to determine ecosystem integrity and biological quality, as recommended in the Middle Rio Grande Ecosystem: Bosque Biological Management Plan (Crawford et al. 1993). Students from the kindergarten level through upper-level university are increasing their understanding and appreciation of science and the bosque through this program. The data are already proving useful to the U.S. Corps of Engineers, the U.S. Geological Survey, the Middle Rio Grande Conservancy District, the City of Albuquerque Open Space Division, and the Bosque Education Guide. These data collected by students and scientists will only gain value as monitoring continues.

Funding continues from various sources, including the U.S. Fish and Wildlife Service, Bosque School, and the Sevilleta Long-Term Ecological Research Schoolyard Education Program (funded by the National Science Foundation). In 2001 BEMP added two new sites, one at the National Hispanic Cultural Center and one at the Pueblo of San Juan, although collections did not start until 2002. Nine sites (north to south: Pueblo of San Juan, Pueblo of Santa Ana, Alameda, Bosque School/Savannah, Rio Grande Nature Center, National Hispanic Cultural Center, Los Lunas, Belen, and Lemitar) now span approximately 280 km of the Rio Grande. Sites are monitored by public, private, and home school students ranging from kindergarten through high school, with the help of university student interns.

Quality controlled BEMP data are available to agencies, organizations and individuals with bosque concerns. BEMP precipitation, depth to water table, and vegetation transect data have already been used by different official groups, while a variety of other datasets have been used by students.

Annual precipitation was averaged across all BEMP sites to more easily compare patterns within and across years. 2001 had below average levels of precipitation (4.93 inches, 125 mm), especially at Alameda, the Nature Center, Los Lunas, Belen, and Lemitar. This had no significant impact on herbaceous vegetation, though there were twice as many increases than decreases in herbaceous cover.

Correlating BEMP water table data with USGS Rio Grande flow data seemed to confirm Belen as a site with strong connectivity to the river. Alameda appeared to be far less connected than previously thought, though it still appeared to be influenced by river flow. The Nature Center, Savannah, Los Lunas, and Lemitar all appeared to be somewhat-to-greatly disconnected from the Rio Grande. Any or all of these sites may be influenced by nearby drains, many of which contain water year-round; these channels are being added to the regular monthly monitoring.

Plant species diversity was relatively high at Lemitar, Savannah, Los Lunas and Belen. The Nature Center and Alameda had intermediate species diversity while Santa Ana had relatively low species diversity. All sites had greater numbers of native plants than exotic plants, but both Savannah and Santa Ana had higher exotic species diversity than native species diversity due to the evenness of exotic plants present. True to statements made in the First Report, the dominant

vegetation at Belen continues to shift, with Russian olive competing for dominance with cottonwoods and willows.

Vegetation data, collected by botanists, continue to validate litterfall data collected by students. The consistency between the datasets is clearer when graphed as percentages, but even the graphs presented in this supplement report (in meters and in grams per meter squared) show the relationship between cover and leaf fall. Litterfall data also show that while most trees drop the majority of their leaves beginning in October or November, Russian olives consistently begin dropping leaves as early as May or June, with between 12 to 25% of the leaves falling each month from August to December.

BEMP data provide information about the overall age and health of bosque sites, change in the amount of exotic or native vegetation, accessibility of groundwater, precipitation levels, and the potential for restoration of native cottonwoods and willows. As the datasets grow, more correlations will be made between abiotic and biotic factors, increasing our understanding of bosque function in the Middle Rio Grande valley.

Introduction

Welcome to the First Annual Supplement to the 1997-2000 Report of the Bosque Ecosystem Monitoring Program (BEMP). The supplement updates BEMP's activities during the 2001-2002 school year and data collected during 2001, and will be followed by yearly supplements that do the same. Our goal is to document ecological and hydrological change, taking place over time and space, in the riparian "bosque" forest bordering the increasingly regulated middle Rio Grande (which for purposes of this supplement lies approximately between Otowi Bridge and Elephant Butte Reservoir).

The central objectives of BEMP remain unchanged. They are 1) to involve citizens in monitoring key variables reflecting bosque ecosystem structure, functioning, and biodiversity at sites with different flooding histories; and 2) to track environmental trends in the bosque and make this information available to resource agencies and others with interests in the ecosystem.

The present document continues with roughly the same format as the original report. It begins with an outreach section, under which we profile a special feature: the Bosque Internship course we teach every semester in the University of New Mexico Biology Department. As the topic of materials and methods remains unchanged, it is skipped here. The remaining sections address BEMP data collection, interpretations, and concluding remarks, in that order.

New Sites

In the last months of 2001, BEMP arranged for two new monitoring sites, although they were not set up until 2002. We describe them here to inform readers how they will extend BEMP both geographically and culturally.

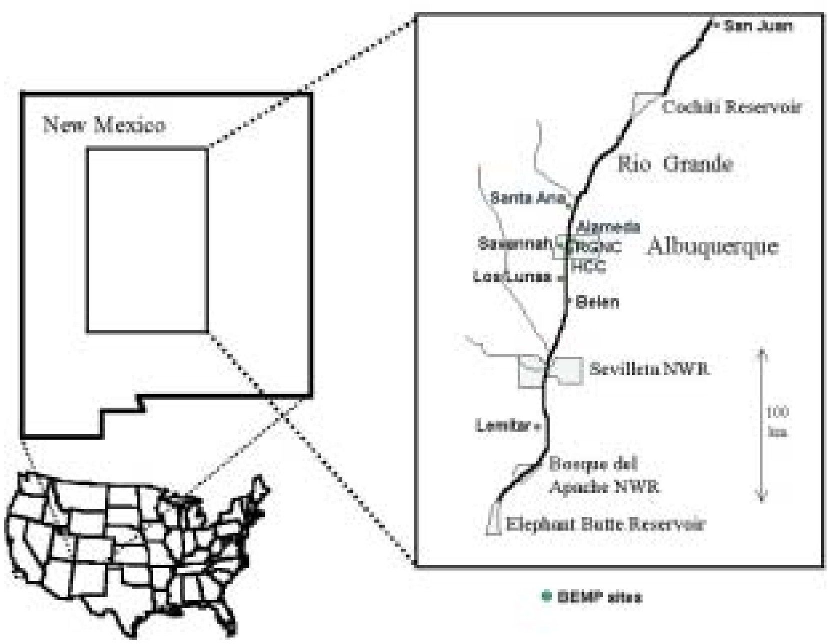


Figure 1. Map of BEMP sites along the Rio Grande, including the two new sites at the National Hispanic Cultural Center (HCC) and the Pueblo of San Juan.

Through the good offices of U.S. Fish and Wildlife Service Rio Grande Bosque Coordinator, Cyndie Abeyta, contact was made in 2001 with Carlos Vasquez of the National Hispanic Cultural Center of New Mexico in Albuquerque regarding establishing a BEMP site in the bosque adjacent to the center. Earlier, that location had undergone considerable clearing of dead, down, and non-native trees by City of Albuquerque Open Space. With the support and encouragement of the center, and the hard work of School on Wheels teacher Vince Case and his students, a BEMP site was established in the fall of 2001 and completed by April 2002. It is located just south of the Barrelas Bridge on the east side of the Rio Grande. Initial monthly collections were somewhat disrupted by jetty jack removal activity in August, but are now back on track.

Students collect litterfall at the National Hispanic Cultural Center BEMP site.

During the summer, Maceo Martinet, a University of New Mexico graduate student in biology, coordinated the center's Jardines del Bosque project, directed by Carlos Vasquez. The project, using summer interns recruited by the center, emphasizes education, research, ecology, and bosque restoration on the center's 12 acres, which include the new BEMP site. Vince Case remains site representative, and his students have become very knowledgeable about the bosque.

In late 2001 the Pueblo of San Juan, through environmental consultant David Morgan and the pueblo's environmental director, Charles Lujan, asked BEMP to set up a monitoring site on its land north of Española. The site was to be part of a wetland restoration project funded by the Environmental Protection Agency (EPA). It was established in March 2002, with the able assistance of students and teachers at the pueblo's Ohkay Owingeh Community School. Giselle Piburn, a Santa Fe resident employed by Mr. Morgan, was responsible for coordinating the operation and continues on as site representative. She works closely with principal Albert Garcia, and teachers Francis Harney and David Trujillo.

The new BEMP site is located in a recently burned cottonwood bosque about 100 m from the Rio Grande. Its well-separated large trees grow in cobble and gravel soils, and experience a shallow water table influenced in summer by nearby irrigation flow. A small part of the site is inundated by newly restored ponds and wetland. Recently cleared of a dense Russian olive understory, by midsummer the site was covered with dense herbaceous vegetation, some of which consisted of wetland plants. During the summer, the site was monitored by members of the Youth Conservation Corps. Community School students who did the spring monthly data collections are now back at "their" site, repeating their good work.

View of large cottonwoods and lush undergrowth at the San Juan BEMP site.

Outreach and Education

A key component of The Bosque Ecosystem Monitoring Program (BEMP) is making the process of collecting data an educational experience for those involved. Although our efforts are primarily focused on school-aged students, adult education is also a priority. By participating in monthly collections, data processing in the lab, and discussions on data analysis, students master state and national educational standards in science and other subjects.

Involvement in BEMP is a major commitment in time, resources, and energy for educators. Although each site varies in terms of actual collection time requirement, most students participate in 9 to 15 trips to the bosque during the school year. This naturally limits the number of groups, classes, or schools that can participate in the program.

As the reputation of BEMP grows, there are more requests to establish BEMP sites, as well as requests from schools and groups who wish to participate in the collection of data. Additionally, outside agencies with monitoring needs have increasingly evidenced an interest in BEMP. It is now BEMP staff funding that limits the number of sites that can be established and administered, and the number of classes that can participate.

Short-term Outreach Opportunities

For many area teachers, the commitments of time constrain their participation in BEMP data collection operations. However, many educators would like their students to have at least an introduction to BEMP, even though participation year round would be difficult. We have responded to these concerns by establishing opportunities for classes to visit certain BEMP sites, participate in collecting data, help process those collections, and observe how data are processed into the entire data set.

In the 2000-2001 school year we completed our first field test of this progress by hosting five 5th grade classes from Hubert H. Humphrey Elementary School at the Savannah and Alameda sites. Leaf litter labs were then held in their classrooms. Bosque School continued to support the visits of the 5th grade HHHES program in the 2001-2002 school year, but we also implemented an outreach program for them at the Rio Grande Nature Center site (RGNC). The homeschooling group that collected data at the RGNC for the previous two years had taken on other activities, and we felt the center was an excellent location to host one-time visits.

In the fall of 2001, students from Albuquerque Public School's alternative high schools, School on Wheels and Freedom High, and Albuquerque Country Day School collected data at RGNC. This program requires staff or experienced volunteer time, which was supplied by UNM intern Aleta Harroun, RGNC docents Doug Shaw and Dean Tooley, and by BEMP staff. Due to the heavy involvement of volunteer and staff time, the decision was made to let Freedom High maintain the site for the remainder of the school year.

Bosque School received a grant from Public Service Company of New Mexico (PNM) to support the outreach program based at Bosque School, so the concept of using the RGNC site as an outreach site was abandoned, and the site was assigned to S.Y. Jackson Elementary School's gifted program in the fall of 2002.

This "BEMP introductory approach" exposes more students to BEMP than does the usual arrangement, although these students do not experience the same in-depth understanding of the process and data as do students who participate throughout the school year.

Brief Site Reports

- The Alameda BEMP site continues to be collected by students from Bosque School.

- Century High School was unable to continue their monitoring of the Los Lunas BEMP site, so several faculty members and students continued to help make collections on their own time, ensuring that, with the support of UNM interns and BEMP staff, there would be no losses in data collection points.

- Rio Grande Elementary School continued its 2nd and 5th grade program at the Belen BEMP site. Approximately 90 students visit the educational center, located at the former Willie Chavez State Park, on the third Tuesday of each month. The students rotate BEMP collection responsibilities, with six pairs of older and younger students making the collection each month. Other students are involved in additional bosque education activities during the field visit. This year marked the first time where the 5th graders in the program had participated previously as 2nd graders. In the fall of 2002, both the Environmental Education Association of New Mexico and the New Mexico Riparian Council recognized Rio Grande teacher Molly Madden as an "Outstanding Educator" for her work coordinating this program.

- The Dream Warriors, a Native American club from Bernalillo High School, made the majority of the collections at the Santa Ana BEMP site during the school year. Matt Farley's Rio Rancho High School biology class made the April collection. In the summer, Youth Conservation Corps members collected the data. The Dream Warriors no longer collect the data, but the Pueblo of Santa Ana's Department of Natural Resources staff, with the support of BEMP staff, make sure that no data sets are missed. The Pueblo's after-school program will be taking over the site soon.

- The Savannah BEMP site is located adjacent to Bosque School, and is collected by the sixth grade program there, or by students visiting the school through an outreach program described above.

- Students from Sarracino Middle School in Socorro collected data at Lemitar during the first part of the school year under the direction of teacher Brian Crawford. When the school was no longer able to continue the program, a few parents, Joan Stone in particular, took over the site and brought their own children. Along with BEMP staff and UNM interns, data were and are still being collected, but the search continues for a school group to adopt the site.

Additional outreach summary

Participation in existing outreach options, regular BEMP monitoring groups, and various summer programs in the 2001-02 school year involved between 350 to 400 students in BEMP monitoring. This amounts to over 2,000 student visits to the bosque, and over 6,000 hours of volunteer field monitoring in one year. This does not include lab time, or advanced and associated research projects conducted by students such as Thomas Nichols of Bosque School and the River Rangers. Thomas was recognized with the Prudential Spirit of Community Award as New Mexico's top middle school volunteer and received the award at a ceremony at the White House for his work in protecting cottonwood and beaver populations. He learned about the particular threats to the Middle Rio Grande Cottonwood ecosystem through his participation in BEMP.

BEMP students and others have made a number of public presentations about BEMP. These include giving poster and oral presentations, staffing booths, and providing information at various water and natural resource fairs, conferences, and events. This year's activities included presentations to the Governor's Blue Ribbon Water Committee; the Middle Rio Grande Bosque Initiative – Bosque Improvement Group conference at the National Hispanic Cultural Center; the Desert Science Teacher's Workshop in Las Cruces, New Mexico; the Rachel Carson Writing Workshop in Boothbay Harbor, Maine; the Ecological Society of America meeting in Madison, Wisconsin; Albuquerque's Dia del Rio fair; the American Water Resources Association meeting in Albuquerque; and the EPA Region 6 Environmental Education Roundtable in Dallas, Texas. A complete list of BEMP outreach activities for 2001 and early 2002 is listed in Appendix B. Through these kinds of activities, BEMP reaches an additional 500 to 1,000 people each year.

The Bosque Education Guide is a program enabling teachers and youth leaders to learn to use the bosque as an educational resource. BEMP staff provided support for revision of these program materials. The 2nd edition of the guide will contain many references directly related to BEMP. Four BEMP teachers provided essays for the guide, a new activity on pitfall trapping using

BEMP techniques was developed, and a restoration activity on monitoring was introduced using BEMP as a model. The updated BEMP plant species list (Appendix A) is being used by the Bosque Education Guide to provide a more comprehensive list of species found in the bosque. Cliff Crawford provided the preface to the new edition of the guide.

BEMP is working to make data available to agencies and organizations with bosque concerns. For example, BEMP rainfall data were considered by officials from the city of Albuquerque Open Space Division and the Middle Rio Grande Conservancy District in determining when to lift fire closure restrictions. BEMP groundwater data were supplied on request to the U.S. Geological Survey and U.S. Corps of Engineers to use in creating a model of groundwater flow and seepage in the Rio Grande valley.

Special Feature: The BEMP Intern Program

by Mary Stuever

It is the first day of a fall semester course, and the students are gathered around a tan, felt blanket on the classroom floor in UNM's biology building. One of four instructors asks them to take off their shoes, and stick them under the blanket to create mountains and a valley. Soon the students are walking about in stocking feet, laying strips of blue cloth on the blanket to represent a meandering, braided river. They place paper cottonwood trees, marshes, grassland, and shrubs along the river, learning in a hands on way how the river today differs radically from the river of two million years ago.

This three-semester-hour class is unlike any other course these graduate and upper-division college students have ever taken. In the next sixteen weeks, they will participate in a wide variety of activities. They will spend days in the field collecting long-term ecological data for an on-going monitoring project, often assisting younger students from second grade through high school with the task. They will learn about the bosque through lectures, discussions, and guest speakers. They will visit the younger students' classrooms to assist with labs for data processing or other environmental education opportunities. They will read and write about relevant scientific papers in biology and environmental education. They will keep field notebooks and be responsible for data sheets. They will assist with program management that might include grant writing, presentation making, equipment maintenance, or data collecting and processing. By the end of the semester, they will look back on the experience with a sense of awe and accomplishment. Few may even enroll in the same class again because "there is just so much more to learn."

This is the twelfth semester of the BEMP Intern Course. In Spring 2002, UNM listed the course with its own course numbers (BIOL 408/508), thereby awarding the class with a stamp of approval and permanence in the Biology Department. Although often dominated by biology majors, the class is a favorite among education majors as well, especially students from the university's environmental education program. Anyone is welcome however, and often the class attracts working professionals, including natural resource managers, teachers, and environmental educators.

For the biology students, the biggest challenge is often learning to work with younger students. Yet, when they graduate and land their first jobs, these same biologists are better prepared for the "outreach" aspect of employment. Education majors, on the other hand, frequently state that their biggest obstacle in the class is their own fear of science. The hands-on approach, and the involved discussions on background information and data interpretation usually help these students overcome their fears. After graduation, these educators find themselves looking for ways to involve their own students in real-science applications.

The BEMP intern class originally evolved out of a need for a quality assurance/quality control aspect to the newly-established monitoring program. Program managers were looking for ways to ensure that data were systematically and accurately collected and recorded. With a growing number of BEMP sites, the staff wanted to instruct more people in the collection process, to supervise the effort. Being a university-sponsored program, the obvious source of people-power was students. Quickly, the class developed into an enriching experience for both students and the program.

The first intern class was a more-or-less self study course involving three students in the fall of 1998. By the spring of 1999, it was meeting formally, with nine students. One of the original course assignments included a final report in which students were urged to make recommendations to improve the class or the program. An intense course curriculum has evolved today based on successive student recommendations. Field trips, lab exercises, essays on readings, and special projects have all been added to the class at the urging of past students. Over the years, course handouts have grown, and this semester, students were greeted on the first day of class with an Intern Handbook containing over 200 pages of instructions, readings, site maps, data results, and other program related information.

The class textbook stands out as an oddity among the bulk of biology texts on the University Bookstore shelves. The trade paperback, The Geography of Childhood, by Gary Nabhan and Stephen Trimble, is a collection of essays on why children need to spend time in the outdoors. In the classroom, intern course students discuss with an experienced schoolteacher the value of having kids learn in outdoor settings.

The class has been held every semester, except for the summer of 2000, when severe fire conditions limited site access and staff availability. Class size ranges from 4 to 18 students, with an optimum class size of around a dozen. Each season offers its own variations to the experience. Fall interns receive a strong emphasis on program instruction because the secondary students they work with are also new to the program. Vegetation transects offer field opportunities for students to work alongside trained botanists. Spring students add cottonwood sexing to their experience, as interns are sent out to identify male and female trees based on catkin morphology. The course is somewhat compressed for the summer students, who get less hands-on experience working with younger children because many of the school groups are out of session.

The teaching team includes Professor Emeritus Cliff Crawford, forest ecologist Mary Stuever, environmental educator Mary Dwyer, data manager Kim Eichhorst, and schoolteacher Dan Shaw. Course participants have both formal and informal access to a wide berth of ideas and perspectives on the bosque.

In addition to becoming a core part of the Bosque Ecosystem Monitoring Program, the BEMP Intern Course offers an incredible opportunity for biology students to develop outreach experiences, and for education majors to learn to incorporate real science in their teaching programs. The course is an exciting way for any adult to learn more about the bosque and long-term monitoring efforts.

BEMP Collection Data

The majority of the BEMP data presented here are from the year 2001. New graphs for precipitation, groundwater, and Russian olive leaf fall are given for multiple years. Collections at the National Hispanic Cultural Center and the Pueblo of San Juan did not start until 2002, so data from these sites will be in the next annual supplement.

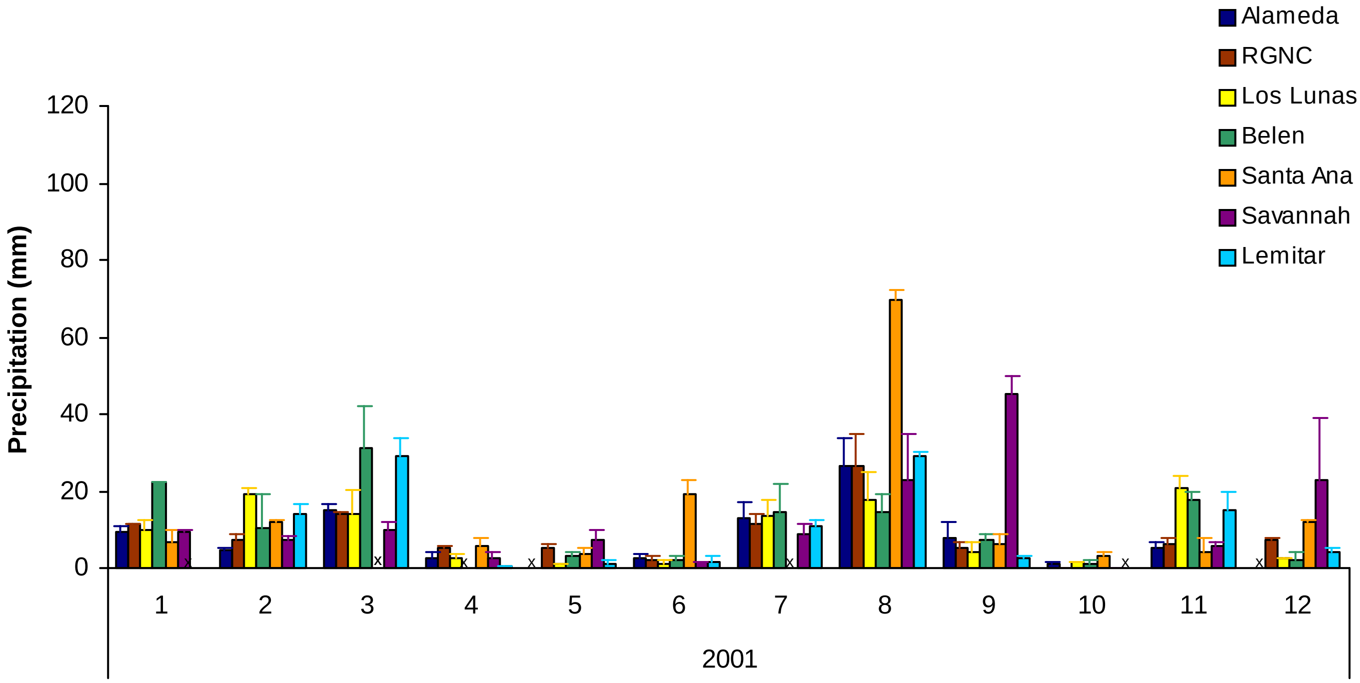


Figure 2. 2001 average monthly precipitation (mean of canopy and open rain gauges) with vertical standard error bars for sites. "x" denotes missing data, not a value of "0". Precipitation is given in millimeters.

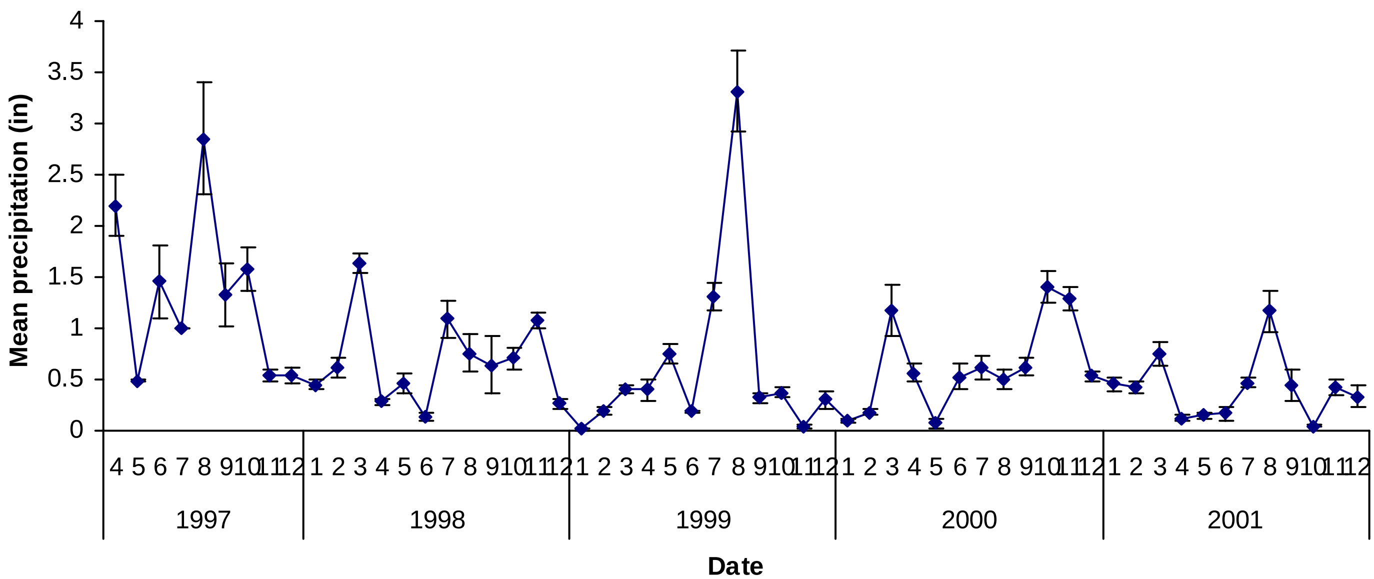
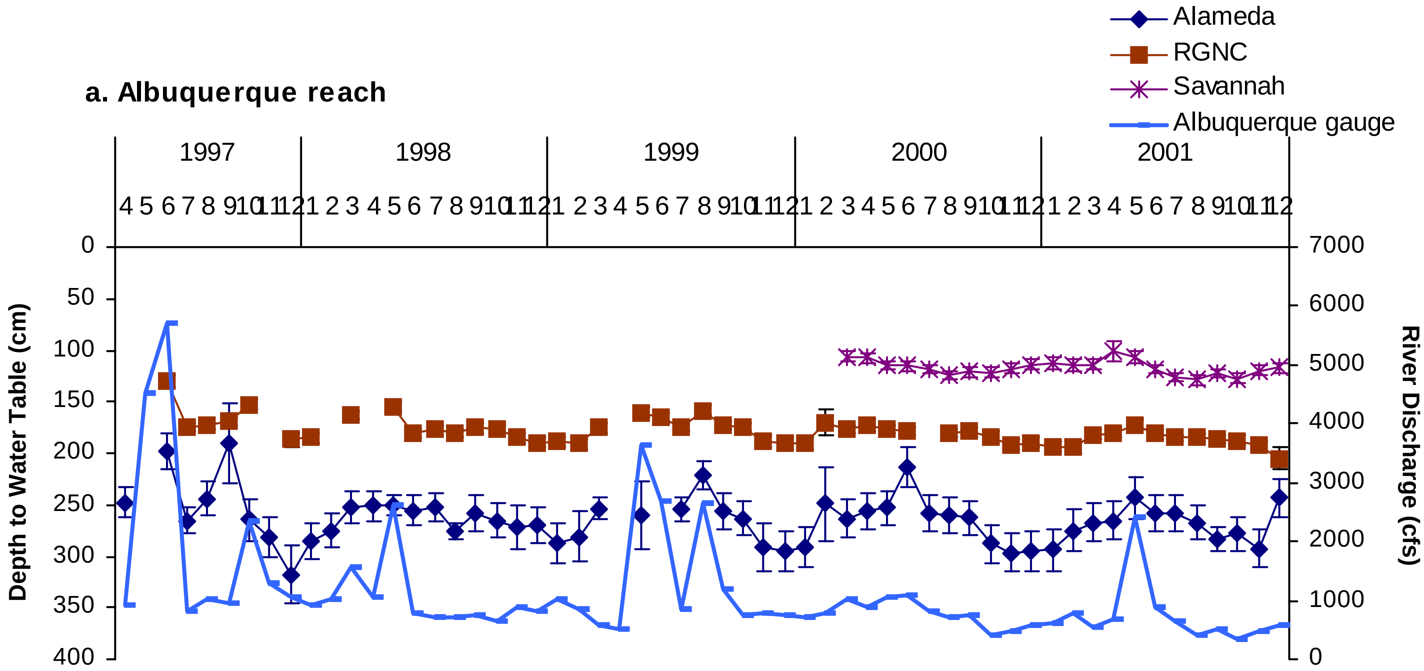


Figure 3. Mean monthly precipitation averaged across all BEMP sites with vertical standard error bars. Precipitation is given in inches, from 0 to 4.



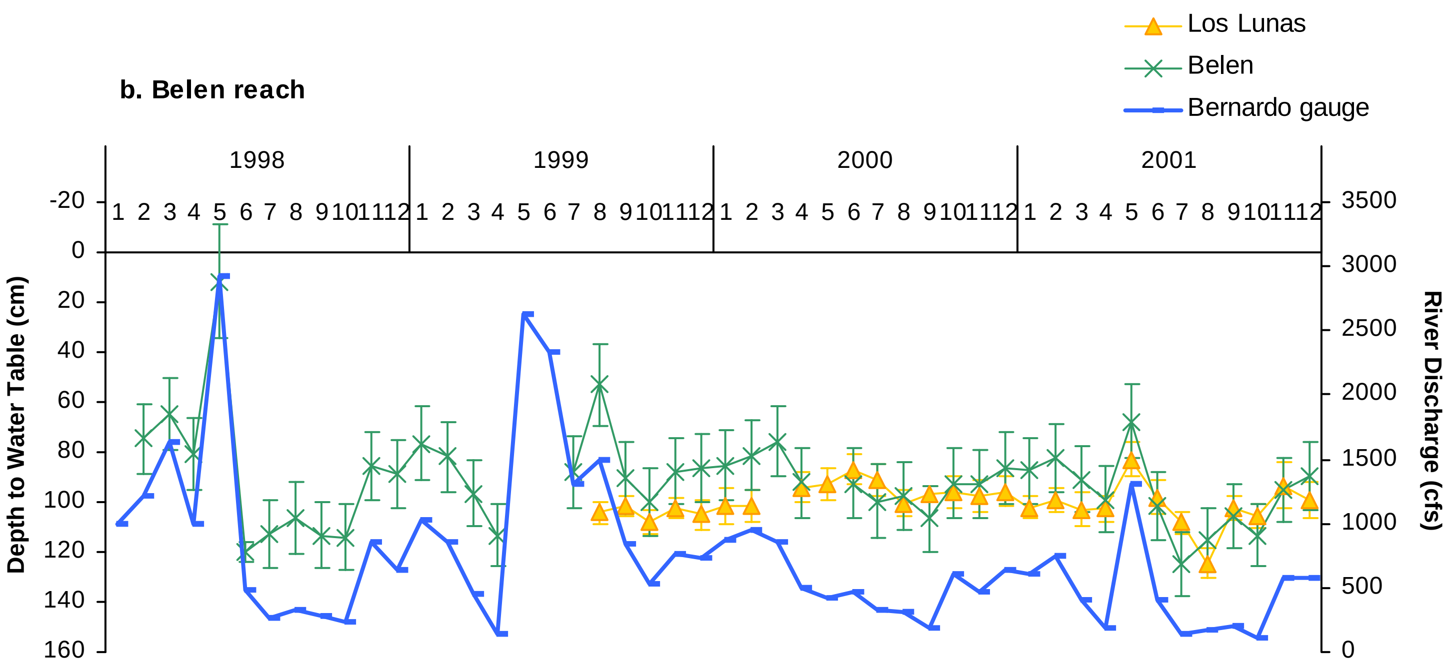


Figure 4. Average depth to groundwater from ground surface (primary y-axis) from April 1997 through December 2001, contrasted with Rio Grande discharge in cubic feet per second (secondary y-axis). a. Albuquerque reach: Alameda, Rio Grande Nature Center, and Savannah with USGS Albuquerque Gauge river data. b. Belen reach: Los Lunas and Belen with USGS Bernardo Gauge river data (1/98–12/01). Note different scale for depth to water table (0-140 cm).

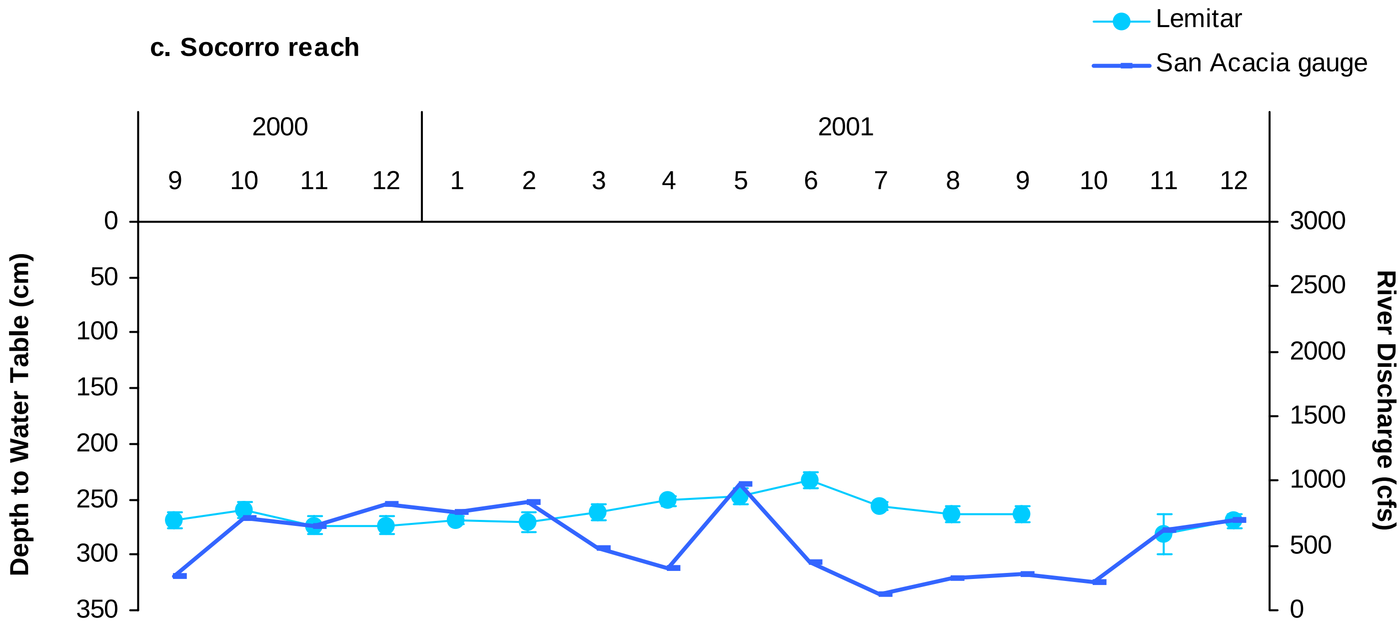


Figure 4 (continued). c. Socorro reach: Lemitar with USGS San Acacia Gauge river data. Note dates range from September 2000 to December 2001 only.

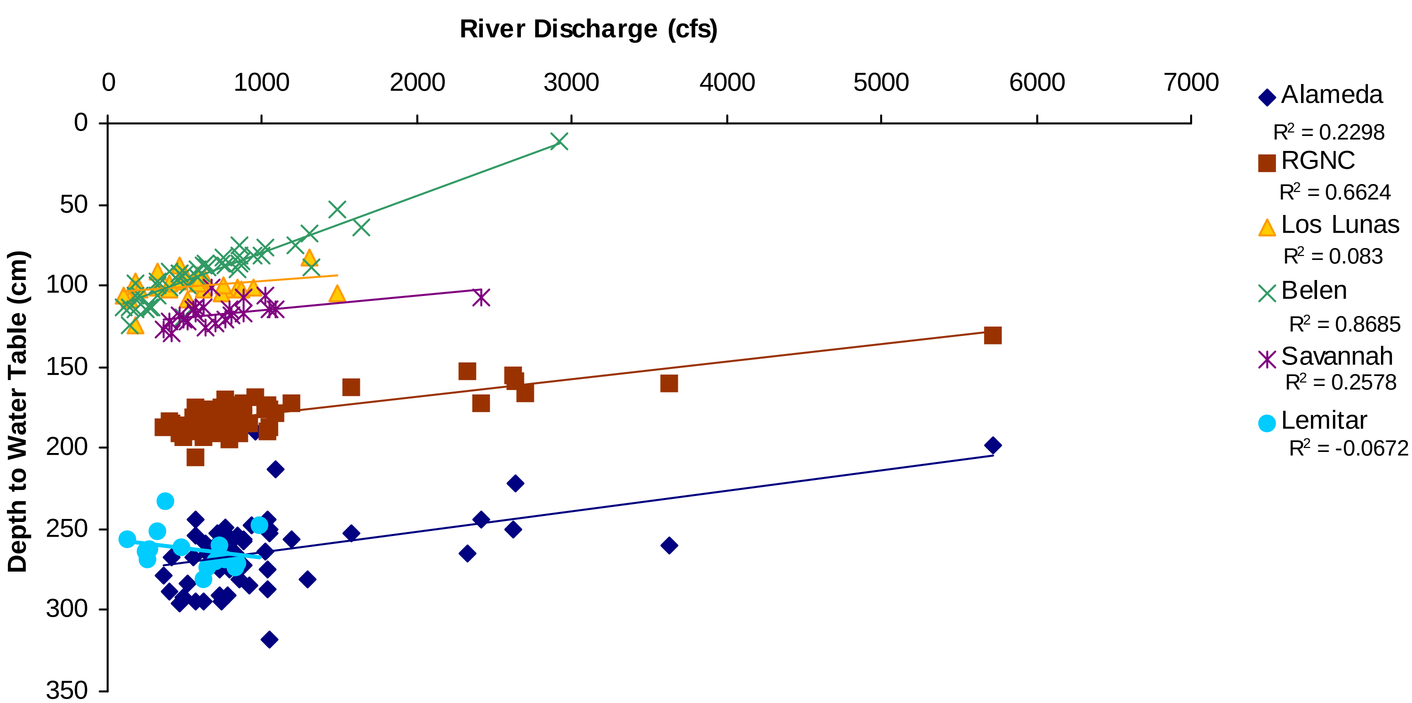


Figure 5. Correlations of water table depth at each site to the nearest Rio Grande stream flow gauge.

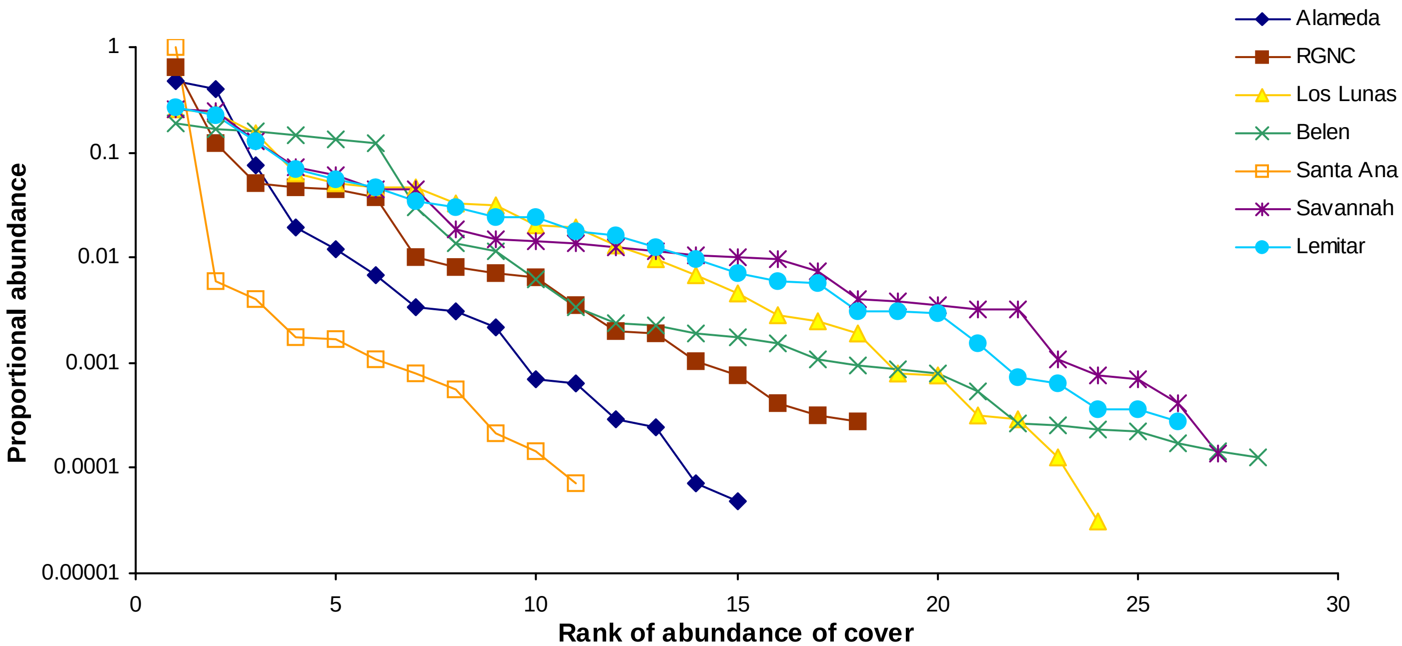


Figure 6. Plant species diversity presented in rank abundance curves for BEMP sites. The X-axis shows the number of species at each site, in order of most abundant to least abundant. The Y-axis presents the proportion of each species present, indicating the evenness of species at each site. Each point represents a single species.

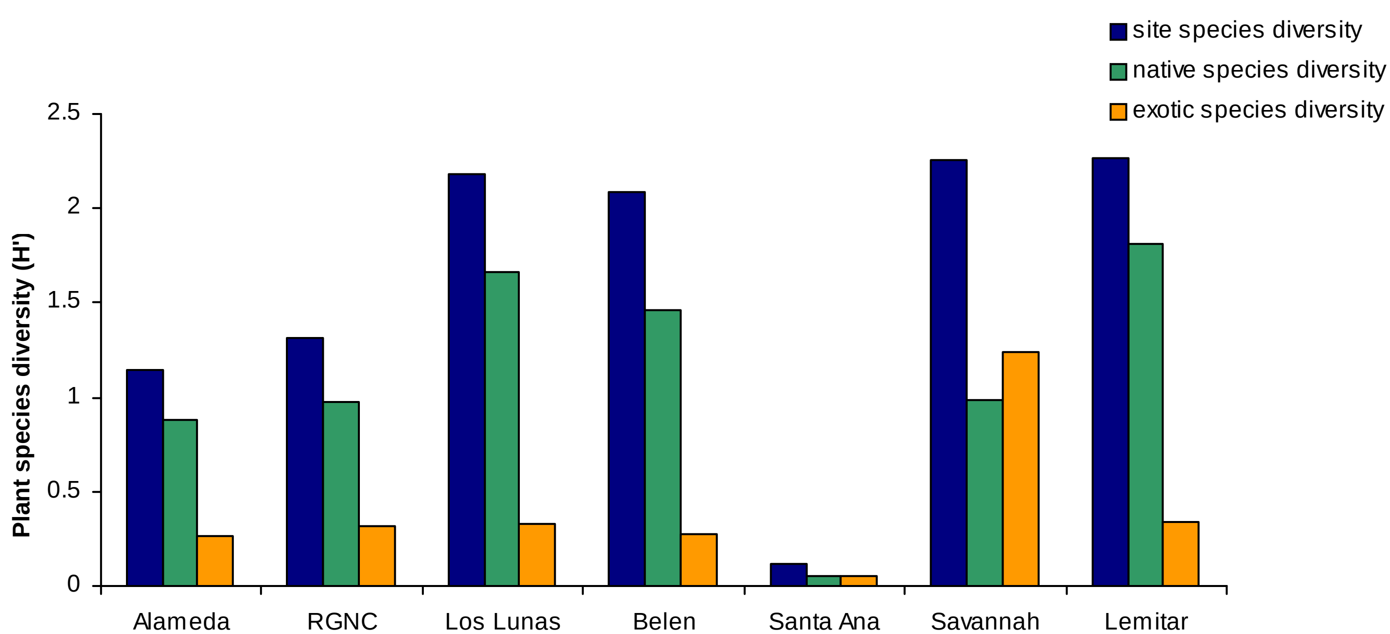


Figure 7. Total site plant species diversity, native plant species diversity, and exotic plant species diversity, measured using the Shannon-Wiener index (H'), which emphasizes both number of species and evenness of species at each site.

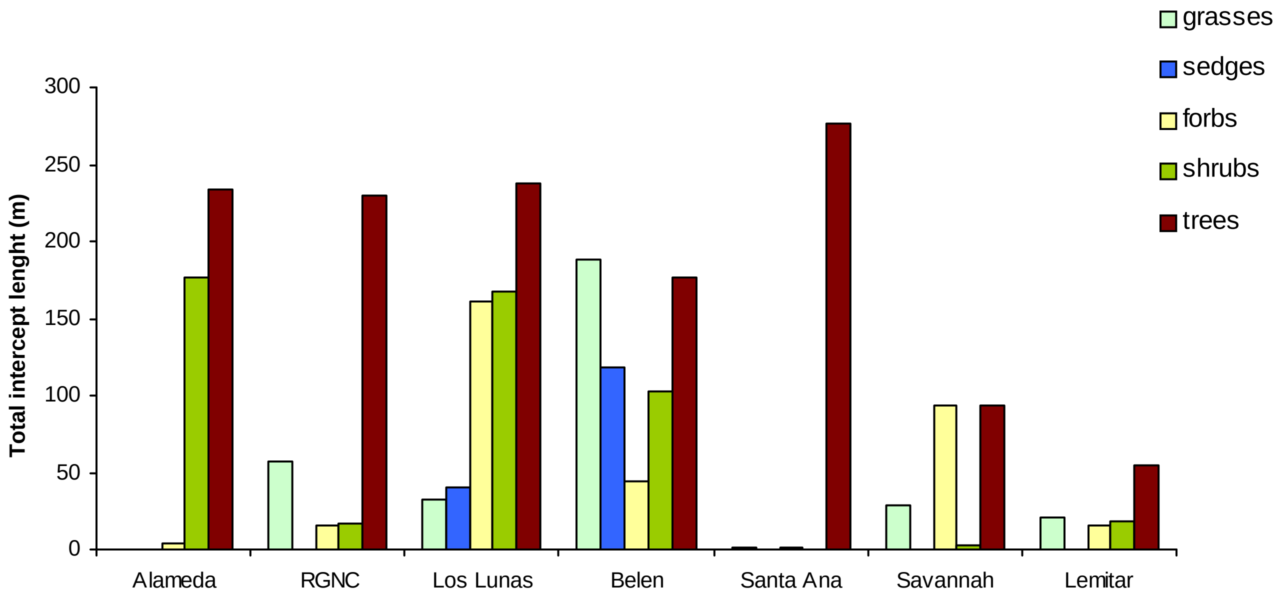


Figure 8. 2001 vegetation cover divided into plant growth form. Y-axis is total intercept length summed across all ten 30-m transects, indicating patch size of each vegetation type.

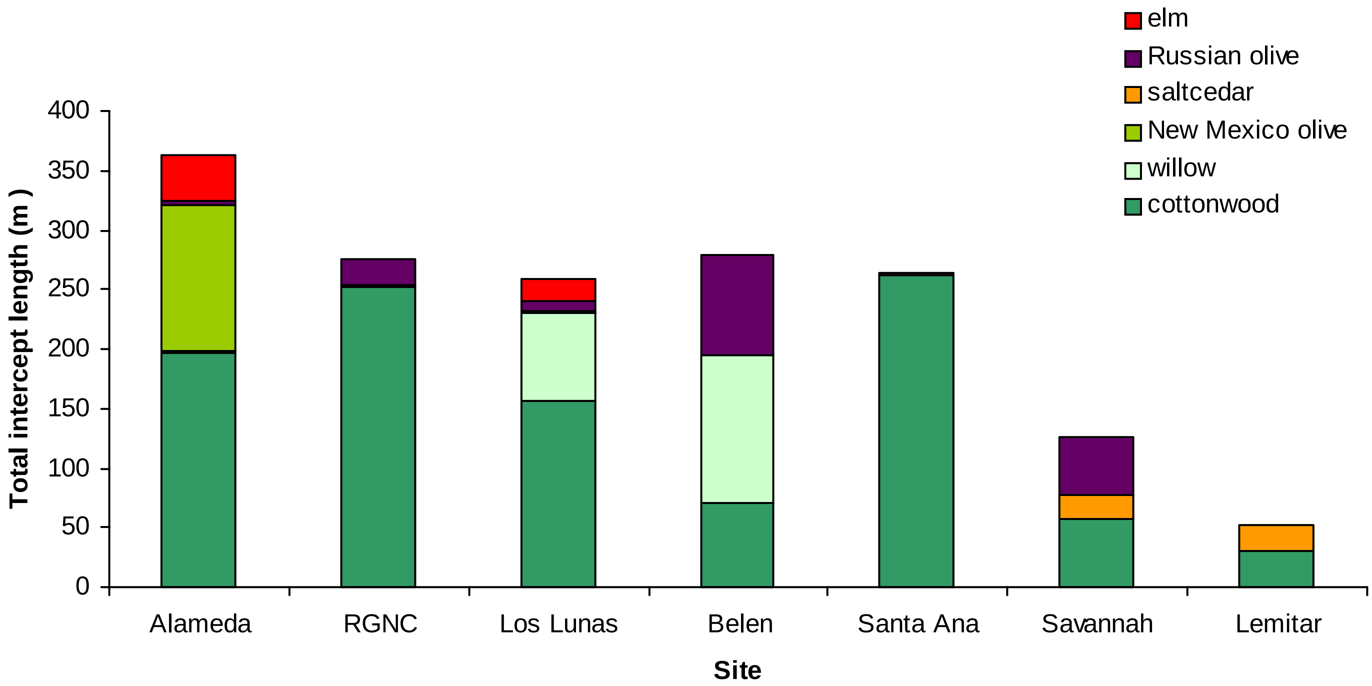


Figure 9. 2001 tree cover at each site. X-axis shows predominant trees. Native trees: *Populus deltoides* ssp. *wislizenii* (cottonwood), *Salix exigua* and *S. gooddingii* (willows), and *Forestiera pubescens* var. *pubescens* (New Mexico olive). Exotic trees: *Tamarix chinensis* (saltcedar), *Elaeagnus angustifolia* (Russian olive), and *Ulmus pumila* (Siberian elm). Y-axis is total intercept length summed across all ten 30-m transects.

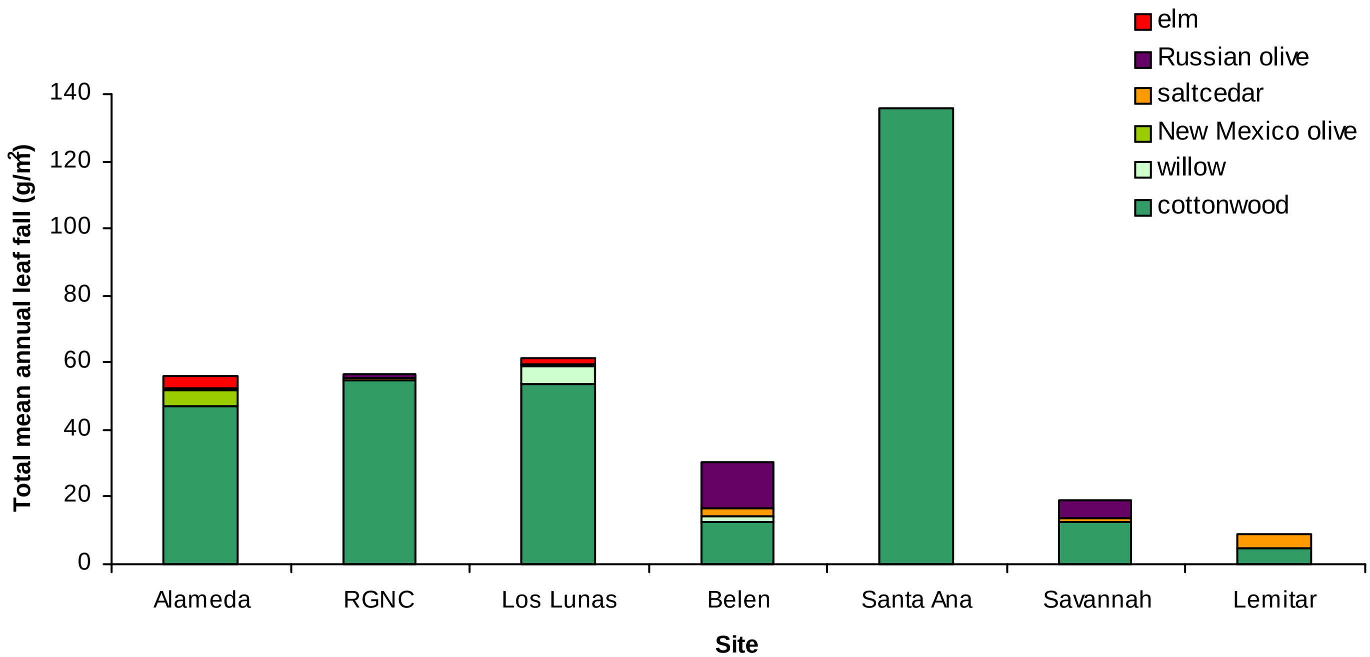
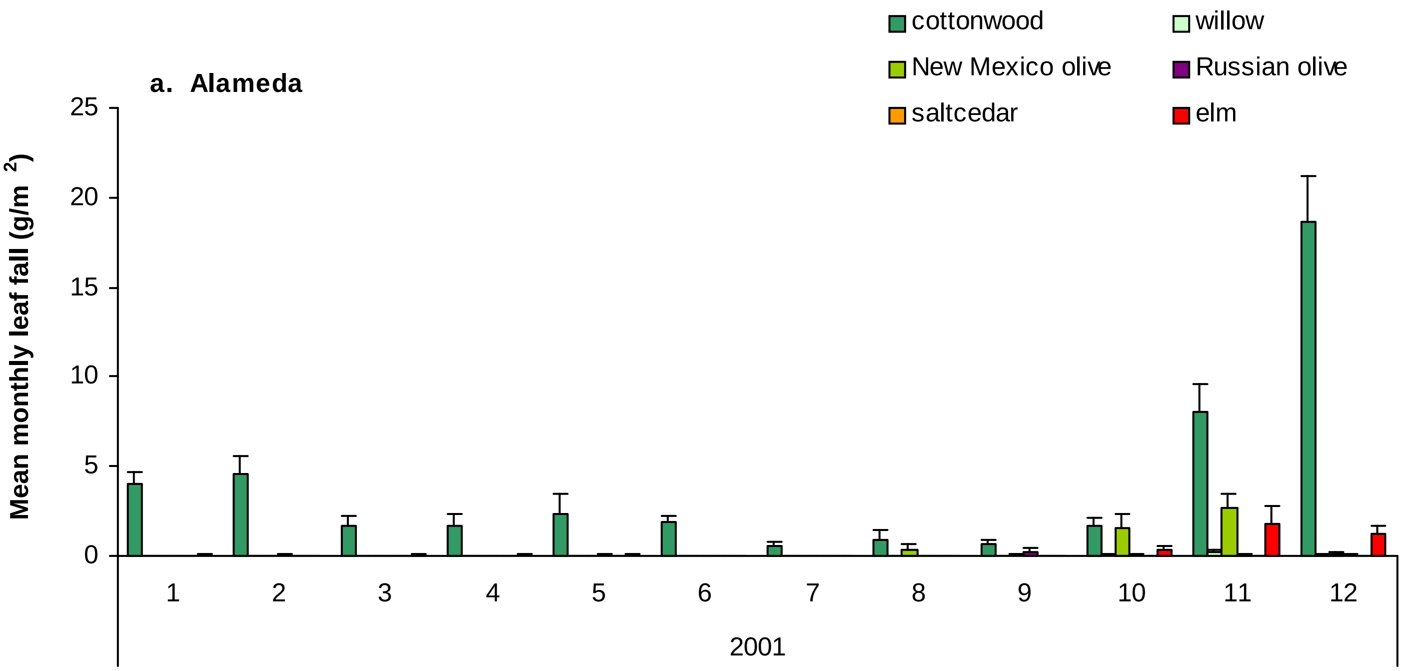


Figure 10. 2001 annual tree leaf fall. Y-axis is sum of monthly means for each site. Native species shown are cottonwood, willows, and New Mexico olive. Exotic species shown are saltcedar, Russian olive, and Siberian elm.



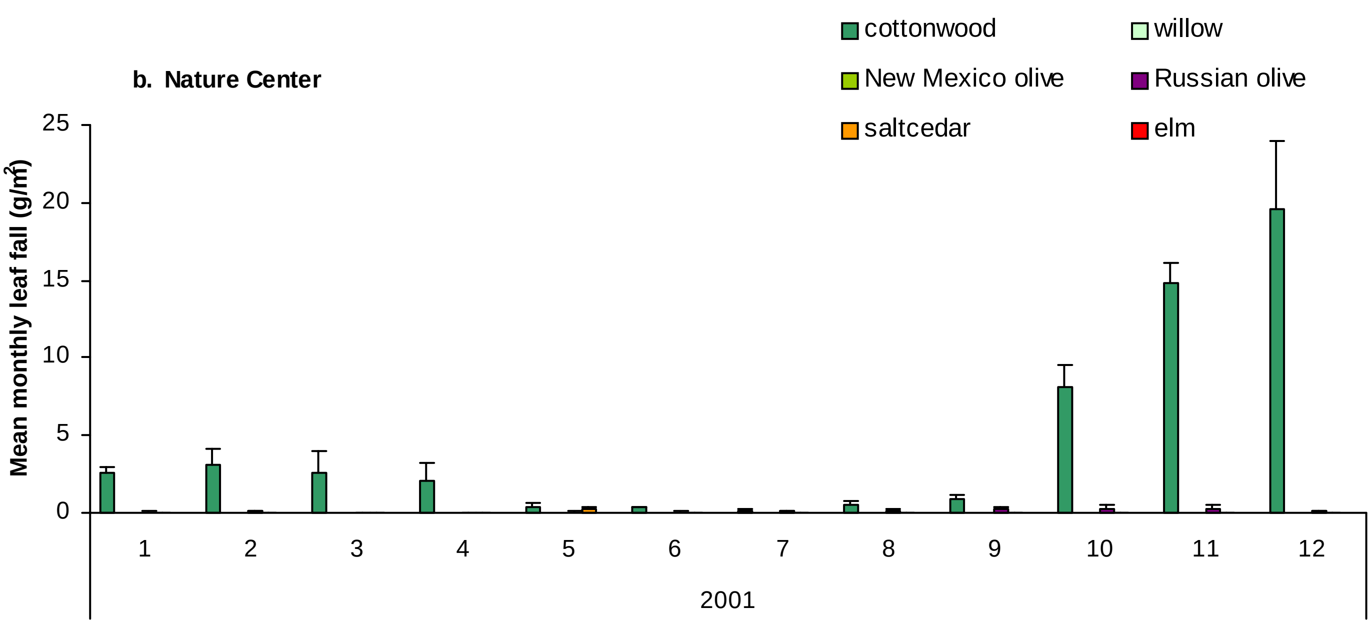
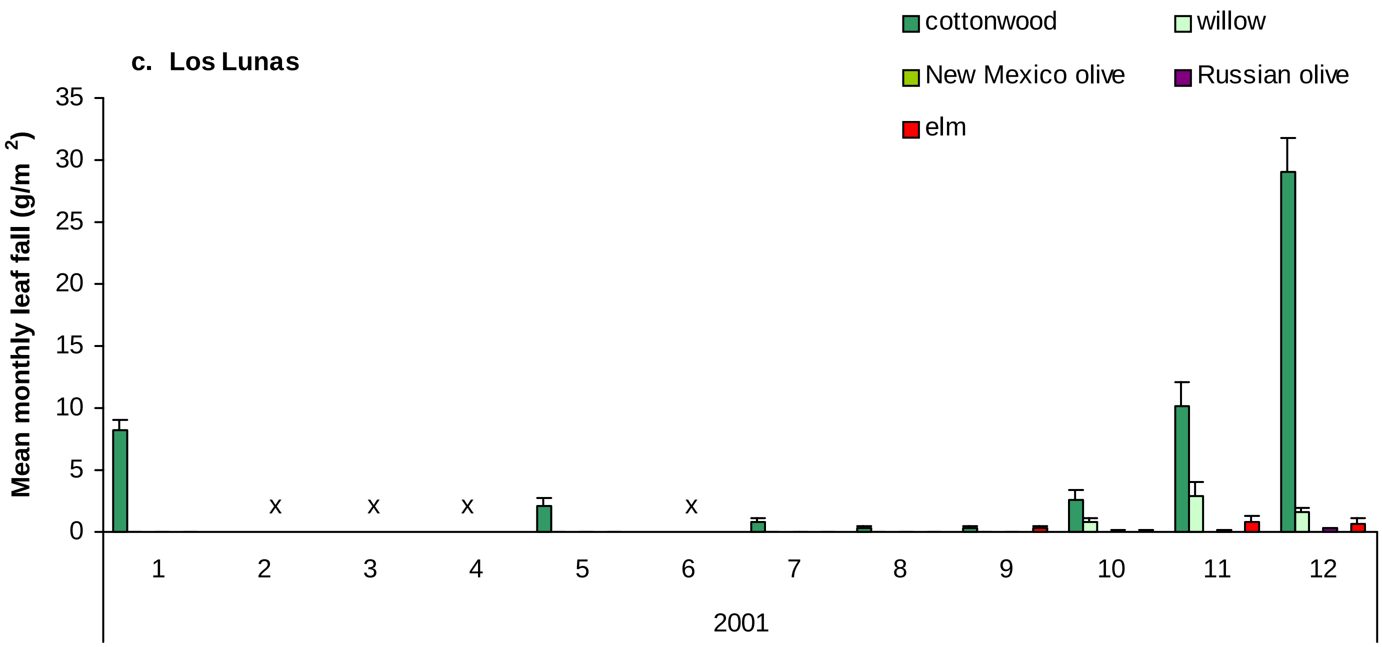


Figure 11. 2001 mean monthly leaf fall for cottonwood, willow, New Mexico olive, Russian olive, saltcedar, and elm, per site. Values are the means for 10 litter tubs at each site, with standard error bars. All are on a scale of 25 g/m^2 except for Los Lunas (35 g/m^2), and Santa Ana (70 g/m^2). 'x' denotes missing monthly data. Each legend contains only species with some input at that site. a. Alameda b. Rio Grande Nature Center



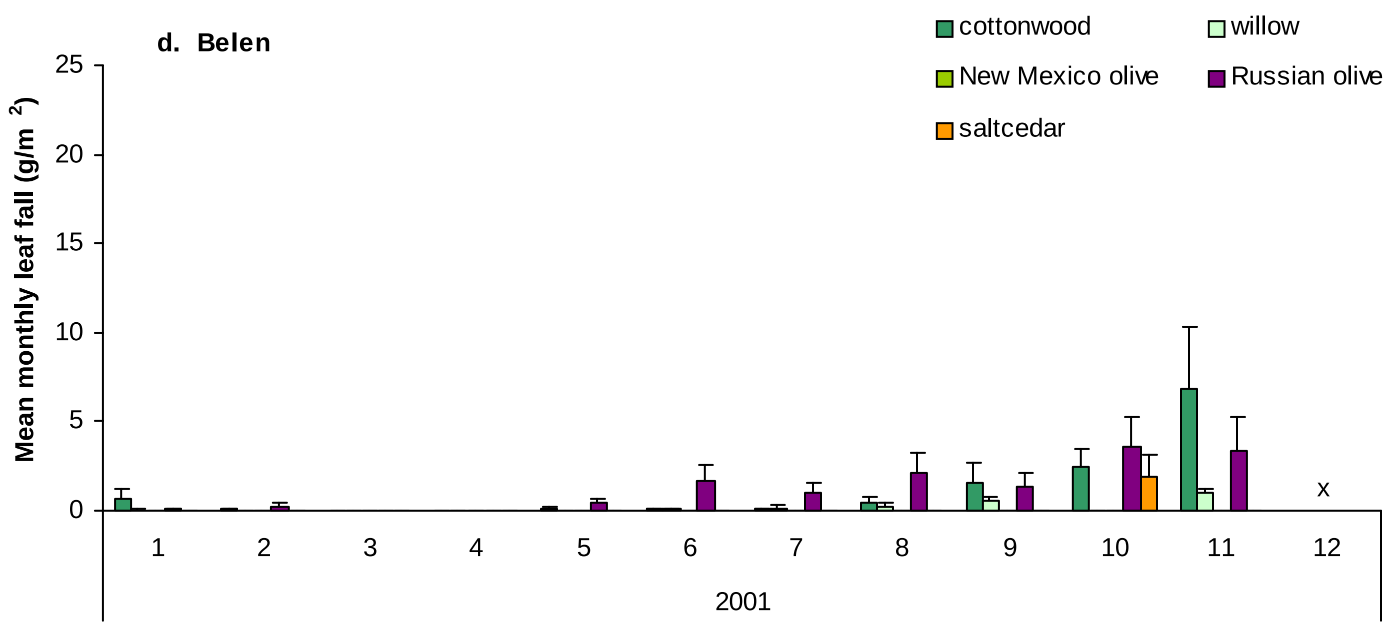


Figure 11 (continued). c. Los Lunas d. Belen

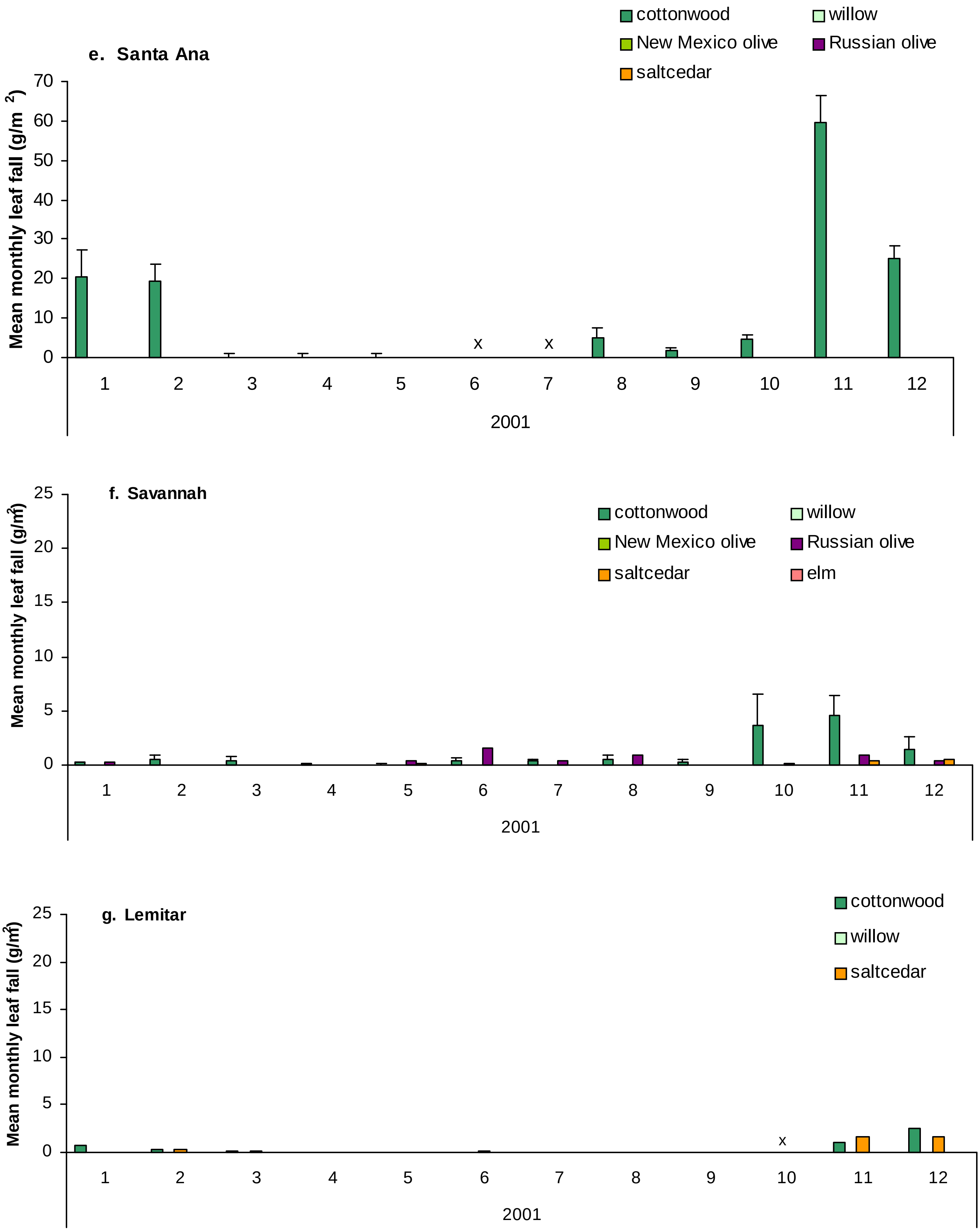
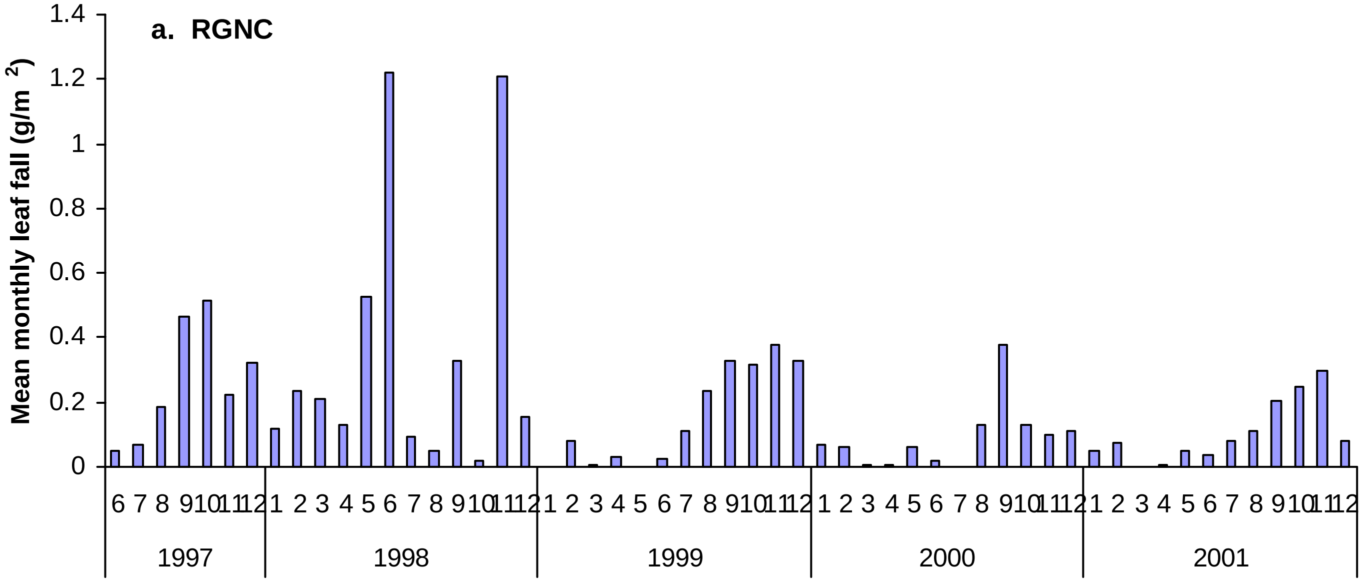


Figure 11 (continued). e. Santa Ana f. Savannah g. Lemitar



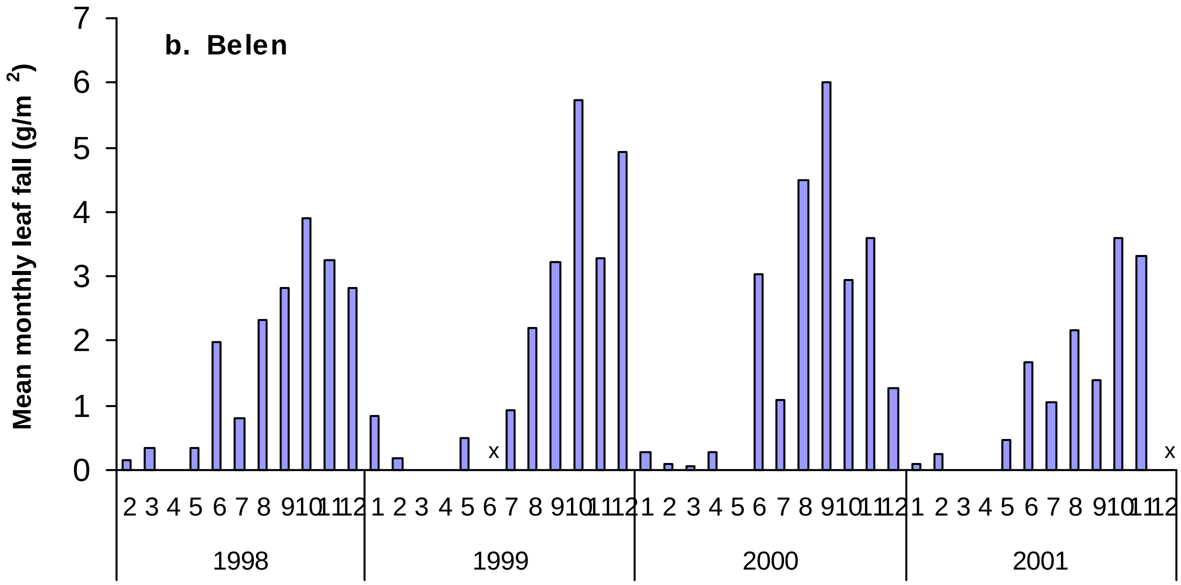


Figure 12. Russian olive leaf fall at a. Rio Grande Nature Center, and b. Belen. Values are the means for 10 litter tubs at each site.

Interpretations

This document is intended as a supplement to our first report, and we have tried not to be overly repetitious in the presentation of continuously collected data. However, many of the data sets are presented in new ways, while some graphs are formatted for direct comparisons to graphs in the First Report. Some of our previous interpretations have been restated, while others are cautiously refuted based on new data. We continue to capture variation between and within sites over time, improving our conception of the Middle Rio Grande bosque.

Abiotic Factors

Average monthly precipitation (Figures 2 & 3)

Timing and amount of precipitation are important factors affecting plant and animal abundance, survival and levels of activity at any site. Monitoring precipitation in the open and under the canopy at each BEMP site gives an overall view of surface-accessible water and its variation over time and location.

Mean monthly precipitation for 2001 can be compared directly to graphs from the First Report (Figure 2). August had the highest level of precipitation for the year, with an exceptional and verified high at the Pueblo of Santa Ana. Savannah's high was recorded in September, though it includes any rainfall at the end of August as well. The monsoon peak for 2001 was not as high as in previous years, especially at the Albuquerque and southern BEMP sites.

Average precipitation in the bosque was quantified by averaging monthly mean precipitation across all BEMP sites (Figure 3). This information is presented in inches for easier comparison with published historic rainfall data. It reiterates information from the previous report, showing a relatively even annual distribution of rainfall in both 1998 and 2000. Precipitation in 1999 was lower for most of the year, with a distinct peak in August. There were higher levels of precipitation in 1997, but still with a distinct peak in August. Although data are missing from January through March 1997, the rest for that year indicate above-average annual rainfall (April – December) totaled 11.98 inches. Total precipitation values for the BEMP sites in 1998, 1999, and 2000 were: 8.12", 7.60", and 7.57" respectively, close to the long-term average for the Middle Rio Grande valley. The annual precipitation for 2001 was 4.93", indicating a below-average dry year.

Depth to ground water (Figures 4 & 5)

Monitoring groundwater levels has given us a picture of how hydrologically connected or disconnected each site is to the river; in other words, monitoring shows how responsive the water table is to river flow. This connection to the river is reflected by the variation in the water table between months.

To more clearly show the level of hydrological connectivity of each site's water table to river flow, we compared groundwater depth with river discharge (Figures 4 & 5). The river flow data were obtained from the USGS website; the data point for each month is the daily average stream flow on the third Tuesday of the month, matching BEMP monitoring dates. BEMP sites were divided into reaches corresponding to the locations of specific USGS river gauges.

In 2001, Alameda had a mobile water table, ranging from approximately 2.4 m to almost 3 m below the surface (Figure 4a). The varying heights of the standard error bars indicate considerable variation of the water table within the site. The water table appears to track the changes in river flow (Figure 4a), supporting our earlier interpretation of high connectivity to the Rio Grande. However, a linear correlation yields an R^2 value of 0.23, which does not support our interpretation of strong connectivity (Figure 5). This low value may change with more years of data, supporting or falsifying our initial assumption of strong connectivity. We are now beginning to measure the water levels of the nearest drainage ditch to each site. By doing so we hope to determine if there are mitigating effects on water tables from the nearby ditch system at some of our sites.

The water tables at the Rio Grande Nature Center and Savannah sites remain consistent and stable at ~1.8 m and 1.1 m below the surface, respectively, and show little variation within the sites (Figure 4a). There appears to be a positive water table response to river flows over 2000 cfs at the Nature Center. This is reflected in the weak correlation ($R^2 = 0.66$) of the site's water table to river flow (Figure 5). Savannah has an R^2 of 0.26, but neither of these values is significant. The water levels of the nearest ditch may be a significant stabilizing factor at the Nature Center, which is closer to the ditch than to the Rio Grande.

As noted in the First Report, Belen is much more connected to river flow than Los Lunas (Figure 4b). Belen has more variation within the site than Los Lunas, and more closely tracks the monthly changes in river flow. This high connectivity of Belen's water table to river flow is reflected in the R^2 value of 0.87 (Figure 5). The water table at Los Lunas does respond to some of the river peak discharges, but is not consistent, as seen in the R^2 value of 0.08 (Figure 5). During times of high flow, Los Lunas does not overbank flood, but rather the water table rises, and seeps fill with water. A study of soils at Los Lunas may indicate less conductivity and longer retention times than soils at other sites.

Of all the BEMP sites, Lemitar continues to have the lowest water table, along with Alameda, between 2.5 to 3 meters below surface level. There is little spatial or temporal variation, and what variation there is between months does not correspond to river discharge (Figure 4c). There is no correlation between water table depth at Lemitar and Rio Grande flow as measured at San Acacia, as shown by an R^2 value of -0.07 (Figure 5). Again, the nearby ditch may prove to be better correlated with the water table at Lemitar.

Biotic Factors

Plant diversity (Figures 6, 7, 8 & 9; Appendix 1)

Plant cover, measured along the southern side of the ten vegetation plots (which represent 13.3% of total area for most sites) was divided into five main classes of vegetation: grasses, sedges, forbs, shrubs, and trees. Grasses (Poaceae) are a large family of herbaceous plants that grow in a wide variety of environments. Sedges, related to grasses but in their own family (Cyperaceae), grow in moist, wetland-type areas. Forbs are non-woody, flowering plants of many different families (e.g., asters, clover, tumbleweed). Shrubs are often classified as multi-stemmed, woody plants, while trees usually have one or two main trunks.

Plants were also classified based on whether they were native to the U.S. or introduced (exotics). In this southwestern riparian system, native trees and shrubs include cottonwood, willow, New Mexico olive and others. Many native plants, including some grasses, forbs, and sedges, are dependent on annual flooding for regeneration and survival. Exotic species, such as saltcedar, Russian olive, Siberian elm, and Russian thistle (tumbleweed) are able to invade and out-compete native vegetation in areas that are altered or otherwise disturbed and no longer experience the annual flood-pulse. Appendix 1 provides an updated list of the plant species identified at BEMP sites and includes the life forms for each of them, as well as the origin – native or exotic – of each species (Cox 2000, USDA 2001).

Plant species diversity is measured by both *species richness* (the number of species at a site) and *species evenness* (the relative abundance of species in a community) (Molles 2002). Species diversity is presented using rank-abundance curves, which plot the total number of species per site in order of most abundant to least abundant, against the proportion of each species at a site (Figure 6). The steepness of the line indicates the relative evenness of the species, which contributes to plant species diversity. Species diversity was also calculated using the Shannon-Wiener index (H') (Figure 7). The Shannon-Wiener index is calculated using the formula

$$H' = -\sum_{i=1}^{s} p_i \log_e p_i$$

wherein the proportion of each species is multiplied by its natural logarithm, the results for all species are summed, and the sign is reversed to obtain a positive number (Molles 2002).

Total plant species diversity, as measured by both number of species as well as the evenness between the species at a site, was highest at Lemitar and Savannah, followed closely by Los Lunas and Belen (Figures 6 & 7). Both Lemitar and Savannah had even, low abundances of a large number of species (Figure 6). Although total cover is low for both these sites (Figure 8), the species diversity remains high. Native plants made up the majority of the diversity at Lemitar, and the exotic plant diversity was due to only one or two species (Figure 8). There were more native plants at Savannah than introduced plants, but the evenness of the exotic species present gave a larger value to exotic species diversity (Figure 7).

Los Lunas and Belen had similar numbers of species with high evenness between the species present, though relatively less evenness than Lemitar and Savannah (Figure 6). Both sites were dominated by native species, with few exotic species and higher native species diversity than exotic diversity (Figure 7). The Rio Grande Nature Center and Alameda BEMP sites had relatively lower species diversity, with fewer total numbers of species, and less evenness between those species present (Figure 6). Species diversity at both these sites is comprised primarily of native species (Figure 7). Santa Ana had the fewest number of species (9 total) and the steepest slope, indicating unevenness between the dominant species, *Populus deltoides* ssp. *wislizenii*, and all other species (Figure 6). Although Santa Ana was dominated by the native species of cottonwood and had more native than exotic species, the evenness of the exotic species present gave a slightly higher H' value than the native species diversity value (Figure 7).

Trees and shrubs were the dominant cover at Alameda, with little cover provided by forbs and grasses (Figure 8). Again we point out that Alameda had a low water table, averaging approximately 2.7 meters below the surface (Figure 4a), suggesting herbaceous plants not well established would have been relatively more dependent on precipitation, which was low in 2001 (Figure 3). However, both grass and forb cover increased almost imperceptibly from 2000. The low water table was more available to the deeper growing roots of trees and shrubs. Almost one half of the cover was provided by cottonwoods (47%), followed by New Mexico olives (*Forestiera pubescens* var. *pubescens*) at 40%, elms (*Ulmus pumila*) 7%, and few Russian olives (*Elaeagnus angustifolia*) (Figure 9). In addition to the lack of readily available water, the thick cover of established plants would have made it difficult for new seeds, herbaceous or otherwise, to germinate.

Cover at the Rio Grande Nature Center was dominated by trees: 92% cottonwood, 7% Russian olive, and few saltcedar (*Tamarix chinensis*, previously *T. ramosissima*) (Figures 8 & 9). Grasses, forbs and shrubs provided 28% of the cover, and both grasses and forbs increased slightly from 2000 (Figure 8).

Total vegetation cover is highest at Los Lunas and Belen. Both sites were dominated by trees, 37% at Los Lunas, and 28% at Belen (Figure 8). These two sites also had rich understories, both with grasses, sedges and forbs, and shrubs (Figure 8). Forbs and shrubs were the dominant understory cover at Los Lunas, at 25% and 26% respectively, with sedges (*Carex* spp.) covering 6% (Figure 8). In Belen, grasses covered 30% of the site, sedges 19%, and shrubs 16% (Figure 8). The rich herbaceous aspect of these two sites may be the result of the high water tables (Figure 4b). Sedges also indicate moisture-rich sites. Grass cover increased at both sites from 2000, while forbs increased slightly and sedges decreased slightly at Los Lunas. At Belen, forbs decreased by half and sedges increased by a third since 2000. Cottonwoods dominated at Los Lunas, covering 25% of the site; willows (*Salix exigua* and *S. gooddingii*) covered 17% (Figure 9). Willows continued to dominate at Belen (16%), but were followed by cottonwoods at almost 15% (Figure 9). Previously, Russian olives covered more of the site than cottonwoods, but as of 2001, Russian olive cover was down to 13% (Figure 9).

Cottonwoods remained the dominant species at Santa Ana, which was previously cleared of its understory. Grasses, forbs, Russian olive and saltcedar made up less than 2% of the cover, though grasses and forbs both increased slightly since 2000 (Figures 8 & 9).

Cover at Savannah was dominated 43% by trees, and 42 % by forbs (Figure 8). The majority of those trees were cottonwood (24.7% of total cover), Russian olive, and few saltcedar (Figure 9). Savannah is a maintained grassland, mowed once a year; it is a disturbed environment favoring exotics such as tumbleweed (*Salsola kali*), which provided the largest amount of cover at Savannah (25.8%). While grass cover did decrease at Savannah since 2000, forb cover varied little.

Cover at Lemitar was dominated by trees, and consisted of a lower but relatively even distribution of grasses, forbs and shrubs (Figure 8). Total vegetation cover at this site is lower than at all other sites. Grass cover decreased slightly, but forb cover increased over seven times from 2000. There was almost an even amount of cover provided by cottonwood and saltcedar, 27% and 23% respectively (Figure 9).

Litterfall (Figures 10, 11, & 12)

Litterfall consists of all leaves, plant reproductive parts, and wood that fall to the ground. Leaf litter and reproductive parts (flowers and seeds) provide an overall indication of net primary production and reproductive effort of the trees. Woody debris falling to the forest floor often indicates plant die-back, or loss of twigs and branches due to storms.

Total annual leaf fall for the dominant tree species in 2001 provided a picture of the sites similar to that of the 2001 tree cover data (Figures 9 & 10). Discrepancies are expected when comparing cover based on line-transect data (m) to litterfall, measured in g/m^2. Some trends appear shifted between the two datasets, but comparisons provide validation for both the line-transect data (collected by botanists), and the litterfall data (collected by students).

Most sites were dominated by cottonwood leaf fall, with the exception of Belen (Figure 10). Although cottonwood cover increased at Belen, Russian olive leaf biomass continued to provide the majority of annual leaf fall, while willow leaf fall only accounted for 6% (Figure 10). New Mexico olive represented 8% of the leaf fall in Alameda, and elm 5% (Figure 10). The Nature Center leaf fall was almost solely cottonwood, with 2% Russian olive, and less of the other tree species. Willow constituted 8% of leaf fall in Los Lunas. Santa Ana had less than 0.01% leaf fall from species other than cottonwood. Savannah leaf fall was no longer dominated by Russian olive, at 27%. Lemitar also shifted from domination by exotic saltcedar, from 50% to 43%.

Predominant leaf fall occurs in autumn and winter, with old leaves sometimes continuing to drop until late spring, when new leaves are forming (Figure 11). Cottonwoods had some leaf fall year-round, but the true fall for cottonwoods started in October or November (Figure 11). New Mexico olive also began to drop leaves in October, with some leaf fall in August. Willow trees seemed to start leaf fall in August or September at Belen, and as late as October at other sites, but the majority of the biomass fell between October and December. Saltcedar started dropping leaves in November, and elm in October. In contrast to all these trees, Russian olive started dropping leaves in June, with increasing leaf fall through November or December (Figures 11 & 12). This trend is consistent with previous years and varying sites, from 1997 through 2001 (Figure 12). As much as 12% of the Russian olive leaves have come down as early as May, and over 28% one June (Figure 12). The general trend, with few exceptions, has been that 12% to 25% of the total Russian olive leaves fall each month from August to December.

Concluding Remarks

BEMP continues to provide quality education outreach to students from kindergarteners through university graduates, while at the same time collecting valid, long-term monitoring data on the bosque ecosystem. BEMP precipitation and groundwater data are proving useful to government agencies for a variety of purposes. Connection between groundwater and river flow is shown to be complex, varying between sites. Groundwater response to river flow is not strongly correlated to site proximity to the river, or to depth to water table. Monitoring of nearby ditches has begun, while questions about soil type still need to be addressed. Vegetation data collected by scientists continue to validate litterfall data collected and processed by students. New BEMP sites have been established, and requests for more from schools, groups, and agencies that are interested in monitoring, are being met. As BEMP grows, funding has become the most limiting factor for new sites and increasing involvement from new groups.

Additional Acknowledgements

As we are a growing program, we have additional acknowledgements to add to those in the First Report.

We would like to thank Bob Rogers, Steven Yanoff, Phil Tonne, Dena Odell, Maceo Martinet and the Youth Conservation Corps primarily for field work. We also thank Lisa Robert & Tom Eichhorst for editing this document.

Thanks to Ray Graham III for continued use of the Savannah BEMP site.

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The establishment of the Pueblo of San Juan BEMP site in late 2001 was made possible thanks to David Morgan, Charlie Lujan, Environmental Protection Agency funds, and Giselle Piburn. Thanks also go to principal Albert Garcia, teachers David Trujillo and Francis Harney, and their classes from the Ohkay Owingeh Community School.

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BEMP site representatives, their schools or agencies, and their BEMP sites during 2001 – 2002 school year are listed alphabetically as follows:

Leslie Barker	Los Lunas site
Vince Case	APS School on Wheels, Hispanic Cultural Center site
Brian Crawford	Sarracino Middle School, Lemitar site
Molly Madden	Rio Grande Elementary School, Belen site
Laura Pena	Pueblo of Santa Ana, Santa Ana site
Giselle Piburn	Okay Owingeh Community School, San Juan site
Roger Reese	Century High School, Los Lunas site
Dan Shaw	Bosque School, Alameda site
Cathy Bailey	Bosque School, Savannah site
Joan Stone	Lemitar site

There was no official site representative at the Rio Grande Nature Center, but we thank Aleta Harroun-Riggs and Jessica Sapunar-Jurskich for volunteer time. Schools hosted at RGNC BEMP site include School on Wheels, Freedom High School, and other charter schools.

Literature Cited

Crawford, C.S., A.C. Cully, R. Leutheuser, M.S. Sifuentes, L.H. White, and J.P. Wilber. 1993. Middle Rio Grande Ecosystem: Bosque Biological Management Plan. Robino, R.E. (tech coord) U.S. Fish and Wildlife Service. Albuquerque, New Mexico.

Cox, G.W. 2001. An inventory and analysis of the alien plant flora of New Mexico. The New Mexico Botanist. 17:1-8.

Eichhorst, K.D., M.C. Stuever, D.C. Shaw, and C.S. Crawford. 2001. Bosque Ecosystem Monitoring Program (BEMP): First Report: 1997-2000. Open-File Report 01-1. 43 pp.

Molles, M.C., Jr. 2002. *Ecology: Concepts and Applications*. New York: McGraw-Hill. 2nd edition.

USDA, NRCS. 2001. The PLANTS Database, Version 3.1 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490, USA.

USGS, NWISWeb Data for New Mexico. Department of the Interior, U.S. Geological Survey, USGS Water Resources of New Mexico (http://waterdata.usgs.gov/nm/nwis/).

Appendices

Appendix A: Current list of plant species identified on vegetation transects at BEMP sites. Plant code, scientific name, and common name are given, along with life form and origin of each species (native or exotic/introduced). Life form codes: G = grass or sedge, F = forb (flowering, non-woody plants), S= shrub, T= tree. Native species represent 63% of all species shown, and exotics, 16%. Unknowns, representing 21% of the species list, are most typically plants identified only to genus.

Plant code	Scientific name	Common name	Life form	Native to U.S.
ACHY	*Achnatherum hymenoides*	Indian rice grass	G	Native
AIAL	*Ailanthus altissima*	tree of heaven	T	Exotic
ALIN	*Allionia incarnata*	trailing windmills	F	Native
AMFR	*Amorpha fruticosa*	desert false indigo	S	Native
AMORP	*Amorpha* sp.	false indigo	S	
AMPS	*Ambrosia psilostachya*	Cuman ragweed	F	Native
ANCA10	*Anemopsis californica*	yerba mansa	F	Native
APCA	*Apocynum cannabinum*	Indianhemp	F	Native
ARFI2	*Artemisia filifolia*	sand sagebrush	S	Native
ARPU9	*Aristida purpurea*	purple threeawn	G	Native
ASCLE	*Asclepias* sp.	milkweed	F	
ASLAH2	*Aster lanceolatus*	white panicle aster	F	Native
ATCA2	*Atriplex canescens*	fourwing saltbush	S	Native
BASA	*Baccharis salicina*	Great Plains false willow	S	Native
BOAR	*Bouteloua aristidoides*	needle grama	G	Native
BOBA2	*Bouteloua barbata*	sixweeks grama	G	Native
BRINI	*Bromus inermis* ssp. *inermis*	smooth brome	G	Exotic
CAREX	*Carex* sp.	sedge	G	
CHGE2	*Chamaesyce geyeri*	Geyer's sandmat	F	Native
CIRSI	*Cirsium* sp.	thistle	F	
CIVU	*Cirsium vulgare*	bull thistle	F	Exotic
COAR4	*Convolvulus arvensis*	field bindweed	F	Exotic
COCA5	*Conyza canadensis*	Canadian horseweed	F	Native
DAGL	*Dactylis glomerata*	orchardgrass	G	Exotic
DALA3	*Dalia lanata*	woolly prairie clover	F	Native
DIWI2	*Dimorphocarpa wislizeni*	spectaclepod	F	Native
ELAN	*Elaeagnus angustifolia*	Russian olive	T	Exotic
ELCA4	*Elymus canadensis*	Canada wildrye	G	Native
ELEL5	*Elymus elymoides*	squirreltail	G	Native
ELYMU	*Elymus* sp.	wildrye	G	

EQLA	*Equisetum laevigatum*	smooth horsetail	F	Native
EQUIS	*Equisetum* sp.	horsetail	F	
ERAGR	*Eragrostis* sp.	lovegrass	G	
EUOC4	*Euthamia occidentalis*	western goldentop	F	Native
FOPUP	*Forestiera pubescens* var. *pubescens*	New Mexico olive	S	Native
FORB		unidentified forb	F	
GAVI2	*Gaura villosa*	woolly beeblossom	F	Native
GLLE3	*Glycyrrhiza lepidota*	American licorice	F	Native
GRASS		unidentified grass	G	
GUSA2	*Gutierrezia sarothrae*	broom snakeweed	S	Native
HEAN3	*Helianthus annuus*	common sunflower	F	Native
HECI	*Helianthus ciliaris*	Texas blueweed	F	Native
HOJU	*Hordeum jubatum*	foxtail barley	G	Native
IPLO	*Ipomoea longifolia*	pinkthroat morning-glory	F	Native
JUMO	*Juniperus monosperma*	oneseed juniper	T	Native
KOSC	*Kochia scoparia*	summer cypress	F	Exotic
LASE	*Lactuca serriola*	prickly lettuce	F	Exotic
LONIC	*Lonicera* sp.	honeysuckle	S	
LYAM	*Lycopus americanus*	American water horehound	F	Native
MACA2	*Machaeranthera canescens*	hoary tansyaster	F	Native
MACHA	*Machaeranthera* sp.	tansyaster	F	
MAPIP4	*Machaeranthera pinnatifida* ssp. *pinnatifida* var. *pinnatifida*	lacy tansyaster	F	Native
MEOF	*Melilotus officinalis*	white sweetclover	F	Exotic
MEOL	*Mentzelia oligosperma*	chickenthief	F	Native
MINT		unidentified mint	F	
MOAL	*Morus alba*	white mulberry	T	Exotic
MUAS	*Muhlenbergia asperifolia*	scratchgrass	G	Native
NAHI	*Nama hispidum*	bristly nama	F	Native
OEELH2	*Oenothera elata* ssp. *Hookeri*	primrose	F	Native
OEPA	*Oenothera pallida*	pale evening-primrose	F	Native
OPPH	*Opuntia phaeacantha*	tulip pricklypear	S	Native
PANIC	*Panicum* sp.	panicgrass	G	
PAOB	*Panicum obtusum*	vine mesquite	G	Native
PAQU2	*Parthenocissus quinquefolia*	Virginia creeper	F	Native
PASM	*Pascopyrum smithii*	western wheatgrass	G	Native
PHYSA	*Physalis* sp.	groundcherry	F	
PODEW	*Populus deltoides* ssp. *wislizenii*	Rio Grande cottonwood	T	Native
POHA5	*Portulaca halimoides*	silkcotton purslane	F	Native

PORTU	*Portulaca* sp.	purslane	F	
POTEN	*Potentilla* sp.	cinquefoil	F	
PSSC6	*Psorothamnus scoparius*	broom dalea	S	Native
RHTR	*Rhus trilobata*	skunkbush sumac	S	Native
RIAU	*Ribes aureum*	golden currant	S	Native
SAEX	*Salix exigua*	narrowleaf willow	S	Native
SAGO	*Salix gooddingii*	Goodding's willow	T	Native
SAKA	*Salsola kali*	Russian thistle	F	Exotic
SEFL3	*Senecio flaccidus*	threadleaf ragwort	F	Native
SELE6	*Setaria leucopila*	streambed bristlegrass	G	Native
SETAR	*Setaria* sp.	bristlegrass	G	
SEVI4	*Setaria viridis*	green bristlegrass	G	Exotic
SOAR2	*Sonchus arvensis*	field sowthistle	F	Exotic
SOEL	*Solanum elaeagnifolium*	silverleaf nightshade	F	Native
SPAI	*Sporobolus airoides*	alkali sacaton	G	Native
SPAN3	*Sphaeralcea angustifolia*	copper globemallow	F	Native
SPCO4	*Sporobolus contractus*	spike dropseed	G	Native
SPCR	*Sporobolus cryptandrus*	sand dropseed	G	Native
SPFL2	*Sporobolus flexuosus*	mesa dropseed	G	Native
SPGI	*Sporobolus giganteus*	giant dropseed	G	Native
SPHAE	*Sphaeralcea* sp.	globemallow	F	
SPORO	*Sporobolus sp.*	dropseed	G	
SYFAC	*Symphyotrichum falcatum* var. *commutatum*	white prairie aster	F	Native
SYMPH4	*Symphoricarpos* sp.	snowberry	S	
TACH	*Tamarix chinensis*	saltcedar	T	Exotic
ULPU	*Ulmus pumila*	Siberian elm	T	Exotic

Appendix B: BEMP Executive Committee activities for 2001 and 2001-2002 school year

2001

January 30 – Teacher training for Hubert Humphrey Middle School 5th grade teachers (Stuever)
February 14 – BEMP featured in the New Mexico Museum of Natural History's syndicated Television series "Way Out West: The Electronic Bridge" (New Mexico distribution with nationwide distribution sometime in 2002)
February 10-11– Presentation on BEMP and monitoring techniques, Cottonwoods and Cranes Natural History Weekend, Sevilleta LTER Field Station (Stuever)
March 20 – Hosted Hubert Humphrey Middle School 5th grade class at Alameda site (Dwyer and Shaw)
March 21 – Hosted Hubert Humphrey 5th grade class at Savannah site (Dwyer and Shaw)
March 28 – Conducted leaf litter lab for Hubert Humphrey teachers at Bosque School (Dwyer)
April 20 – *BEMP Annual Student Congress* at Bosque School
May 3 – Hosted Hubert Humphrey 5th grade class at Alameda site (Shaw)
May 4 – Hosted Hubert Humphrey 5th grade class at Savannah site (Shaw)
May 11 – Participated in New Mexico Watershed Watch Congress, NM Dept. of Game and Fish (Stuever)
June 18 – Presentation on "Ecological Monitoring and BEMP" at the Teachers Science Academy, UNM College of Education (Stuever)
June 20 – Tour of BEMP Lemitar site with Pueblo of Santa Ana YCC crew (Stuever)
August 8 – Poster "Long Term Ecological Research Network K-12 Education Partnership: Students and Teachers Experiencing LTER" by Sprott, Baker, Krasny, Elser, Rohanan, & Eichhorst, Ecological Society of America meeting, Madison, WI (Eichhorst)
September 8 – 4th Annual BEMP Teachers Workshop at Bosque School.
September 22 – BEMP Presentation at Arizona Association of Environmental Education Annual Conference, Flagstaff, AZ (Dwyer)
October 3 –BEMP booth at NM Museum of Natural History Teachers Open House (Dwyer)
October 20 – Presentation at Dia del Rio fair, Albuquerque, NM
October 30 – Presentation on "The Bosque Ecosystem Monitoring Program (BEMP)" at the annual meeting of the Institute of Wetland Science and Public Policy of the Association of Wetland Managers, Albuquerque (Eichhorst, Stuever, Shaw, Crawford)
November 12 – Presentation on "The Bosque Ecosystem Monitoring Program on the Middle Rio Grande" at the annual meeting of the American Water Resources Association (Eichhorst)

2002

January 18 – Presentation at Environmental Education Association of New Mexico (EEANM) luncheon, Open Space Visitor Center (Crawford, Dwyer, Stuever & Eichhorst)
January 26 – BEMP field trip (Stuever)
February 11 – Program at RGNC with Adamson Academy (Stuever)
February 28 – Program on BEMP at San Juan Pueblo (Stuever)
March 6-8 – Submitted *Summary and Information Sheet of Biological Targets and Restoration Goals for the Middle Reach of the Rio Grande* at the Rio Grande Restoration Vision Workshop in Albuquerque, sponsored by World Wildlife Fund and the Alliance For The Rio Grande Heritage (Crawford)
March 12 – Presented BEMP to EPA region 6 Environmental Education Roundtable, Dallas, Texas. 15 Adults (Dwyer)

March 18 & 19 – Long Term Ecological Research Schoolyard Program conference, Sevilleta LTER, NM (Eichhorst & Dwyer)
March 26 – BEMP display at Santa Ana Career Day at Bernalillo High School (Stuever)
April 17 – Program at Santa Ana with Matt Farley's Biology Class, Rio Rancho High School (Stuever)
April 18 – Program at Alameda on sexing cottonwoods with Hubert Humphrey Elementary School students. 25 students (Shaw & Stuever)
April 18 – Presentation on BEMP to the Governor's Blue Ribbon Task Force on Water Committee at Bosque School. 10 attending. (Shaw, Crawford, & Eichhorst)
April 25 – Hubert Humphrey leaf litter lab. 25 students (Shaw & Dwyer)
April 29 – Program for Van Buren Middle School along river near Alameda. 150 students (Shaw)
April 30 – Program for Van Buren Middle School along river near Alameda. 150 students (Shaw)
May 2 – Leaf litter lab with San Juan Pueblo students (Stuever)
May 9 – Collect pitfall traps with Hubert Humphrey elementary. 22 Students (Dwyer)
May 9 – Host BEMP program at RGNC with 21st Century Academy. 15 Students (Dwyer)
May 14 – Presentation on BEMP at the Middle Rio Grande Bosque Initiative/Bosque Improvement Group Conference, National Hispanic Cultural Center of New Mexico (Crawford)
May 16 – Litterfall lab at Hubert Humphrey Elementary, with teachers Montoya and Boswell. 53 Students (Dwyer)
June 6 – Short presentation on BEMP, Desert Science Teacher Workshop, Las Cruces (Stuever)
June 13 – Galisteo Watershed program using BEMP as a model. Galisteo, NM. 25 Adults (Dwyer)
June 13 – Short presentation on BEMP at Rachel Carson Writing Workshop (Stuever)
June 18 – Young Explorers, Museum of Natural History hosted at Alameda. 13 attending (Shaw)
June 19 – BEMP presentation at the Citizens Wetland Monitoring meeting in Park City, Utah. 30 Adults (Dwyer)

August 28 – Tour of RGNC BEMP site to Jill Turner of Teton Science School

Publication in which BEMP is described

Ellis, L.M., Crawford, C.S., and M.C. Molles, Jr. 2002. The role of the flood pulse in ecosystem level processes in Southwestern riparian forests: a case study from the Middle Rio Grande. Pp 51-107 in Middleton, B.A. (ed.) *Flood Pulsing in Wetlands: Restoring the Natural Hydrological Balance*. John Wiley & Sons, Inc., New York.