Integration of Science and Community-Based Conservation in the Mexico/U.S. Borderlands

CHARLES G. CURTIN

Arid Lands Project, Box 29 Animas, NM 87501, U.S.A., email ccurtin@earthlink.net

Abstract: *Ranchers, conservationists, and researchers in the Mexico-United States borderlands have implemented a community-based conservation program that relies on monitoring and peer-reviewed science. Their collaboration with the Malpai Borderlands Group supports large-scale, long-term studies, but—perhaps more importantly—it helps assure that science effectively addresses local concerns. Conservation programs are organized around understanding and maintaining the processes that sustain arid landscapes, including fire and herbivory (by both cattle and native species), and understanding how they interact with climate. Sustaining ecosystem processes in the face of climatic variability requires a sound foundation of monitoring and research and a good working relationship between people and organizations with diverse goals and interests. This collaboration between ranching, research, and conservation communities demonstrates that these groups, working together for mutual benefit, can reach scientific and conservation goals unobtainable by any one group on its own.*

Integración de la Ciencia y la Conservación Basada en la Comunidad en las Tierras de la Frontera Entre México y Estados Unidos

Resumen: *Los Rancheros, conservacionistas e investigadores de México de las tierras de la frontera entre México y Estados Unidos han implementado un programa de conservación basado en la comunidad que depende del monitoreo y de la ciencia. Su colaboración con el grupo de las tierras fronterizas de Malpai apoya estudios a gran escala de largo plazo, pero quizá aún más importante es que ayuda a asegurar que la ciencia se dirija de manera efectiva hacia los intereses locales. Sus programas de conservación están organizados alrededor del conocimiento y mantenimiento de los procesos que sostienen los paisajes áridos, incluyendo los incendios y la herbivoría (tanto por el ganado como por las especies nativas), y el conocimiento de la manera en que estos interactúan con el clima. Los procesos que apoyan a un ecosistema de cara a la variabilidad climática deben estar fundamentados en un monitoreo e investigación sólida y de buenas relaciones de trabajo entre la gente y las organizaciones que tienen metas e intereses diversos. Esta colaboración entre ganaderos, la investigación y las comunidades conservacionistas demuestra que el trabajo conjunto de estos grupos en busca de un beneficio mutuo permite lograr metas científicas y de conservación inalcanzables por cada grupo por separado.*

Introduction

Community-based conservation, in which local citizens and groups take responsibility for conservation efforts, has expanded globally in recent years (Western et al. 1994) but is still relatively uncommon in North America (D. Western, personal communication). A North American example of the utility of this approach is the collaboration between the Malpai Borderlands Group (MBG) and conservationists and researchers in the Mexico-United States borderlands.

The MBG is a coalition of ranchers who organized in the early 1990s to protect biological resources and to sustain local agrarian livelihoods in a roughly million-acre ecosystem spanning southeastern Arizona, southwestern New Mexico, and adjoining Chihuahua and Sonora, Mexico (McDonald 1998). The MBG may be regarded as an

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outgrowth of the traditional grazing association in which ranchers worked together toward the mutual goals of sustaining the local community through cooperative management of the land and marketing of livestock (Remley 2000). What makes the MBG's efforts distinct is that they invited members of conservation organizations, federal agencies, and research scientists to participate.

This interaction between the ranching community and outside individuals and organizations has added to the conventional goal of sustaining local agrarian livelihoods the aim of protecting the structure and function of the landscapes within which their community and culture are imbedded. The efforts of these ranchers and collaborators to conserve open space have been widely documented in the press (Klinkenborg 1995; Stevens 1996; Page 1997; Stolzenburg 2000), but little attention has been given to the important role science can play, as a community-building tool, in sustaining community-based conservation. My review of the research and monitoring programs in the Malpai borderlands illustrates how local communities and researchers can work together to sustain open landscapes and functioning ecological systems for mutual benefit.

Research and Restoration in the Malpai Borderlands

The conservation and research programs in the Malpai Borderlands are based on the premise that understanding the underlying processes that maintain southwestern landscapes is essential to sustaining biological and cultural diversity. In particular, their work focuses on reintroducing and sustaining fire and herbivory, two of the fundamental processes in southwestern ecosystems (Hastings & Turner 1965; Bahre 1991; McPherson & Weltzin 2000; Webster & Bahre 2001), and on understanding how these processes interact with climate to structure southwestern landscapes (e.g., Schlesinger et al. 1990; Swetnam & Betancourt 1998; Curtin & Brown 2001).

The borderlands science program includes a number of key partners in addition to the ranching community. Early on, community leaders approached The Nature Conservancy (TNC) for assistance, the ranchers and TNC representatives in turn contacted ecologists familiar with the borderlands ecosystems to aid in the organization of the science program. This input from scientists was crucial in giving the efforts of the Malpai Borderlands Group a systems-based approach that emphasized conservation of natural processes rather than simply focusing on the management of single species or particular resources, as is typical of many conservation programs.

Federal agencies are another important partner. The U.S. Forest Service Rocky Mountain Research Station (RMRS) has provided substantial financial and logistical support, and the Natural Resources Conservation Service (NRCS) provided their first representative in the United States to work across administrative boundaries within two states to facilitate the implementation of management and restoration projects.

In addition, local nonprofit organizations have contributed heavily to the synthesis of conservation and science in the borderlands. The Animas Foundation, which owns and manages the 133,867-ha (502-square-mile) Gray Ranch, has been a leader in establishing conservation programs and monitoring plots, coordinating fire management, and setting aside large-scale research areas for field studies. The Arid Lands Project (ALP) coordinates the Malpai Borderlands Research Program, organizes scientific meetings, and manages a student internship program that involves local high school and college students from around the country in research.

To assure accountability to the scientific, conservation, and land-management communities, the MBG has over the past 6 years relied on a 10-member science advisory board to review their science program. The scientists and land managers of the board represent varied perspectives, including those of federal agencies, academic institutions, and nonprofit organizations. Individuals serving on the board are selected for their scientific credentials and commitment to conservation in the borderlands. Fewer than half of these scientists have a history of working with ranchers or the cattle industry. Instead they represent disciplines ranging from botany and environmental history to forestry, landscape ecology, and zoology. Since 1999, the MBG and ALP have hosted an annual science symposium where reports on local research projects are presented. The symposia have brought leading scientists and conservationists from around the globe to the borderlands. These efforts not only bring a wide range of perspectives to conservation in the borderlands but also provide national credibility. This credibility is essential to sustaining long-term conservation efforts because if local people wish to play a leadership role in preserving their landscape, they must demonstrate through independent peer-reviewed science that their efforts are scientifically defensible and ecologically sustainable.

Inventory, Monitoring, and Restoration

Since the 1950s, researchers have used repeat photography to document changes in vegetation in the Mexico-U.S. borderlands (Hastings & Turner 1965; Humphrey 1987; Bahre 1991). This research has been augmented by analysis of chronosequences of aerial photos (Brown et al. 1997; Curtin et al. 2000; Curtin & Brown 2001), which, when coupled with remote sensing and geographic information system maps of current and historical vegetation in the region, provide detailed information on landscape change across a range of spatial and temporal

scales. These studies demonstrate that significant increases in woody species and declines in grasslands have occurred throughout the last century, changes that have accelerated over the last 25 years (Muldavin et al. 1998, Rich et al. 1999, Curtin & Brown 2001).

Since 1993, the MBG and collaborators have established more than 200 monitoring plots. This standardized protocol involves 100-m vegetation transects that provide information on directional and relative vegetation change within different habitats and land-management areas (Fig. 1). Since 1994, studies by geologists at the Arizona Geological Survey, the U.S. Geological Survey, and the University of Arizona have provided information on the landforms of the borderlands (Gottfried et al. 1999). Geological information is crucial to understanding environmental and economic processes within these arid landscapes.

In 1999, the ALP and MBG began documenting the location of weather stations and the slope, aspect, elevation, and land use of current monitoring areas to determine where gaps exist in the monitoring program. This was the first phase of a long-term effort to integrate monitoring plots of borderlands vegetation into a single, coordinated research program. Over the next few years, the ALP and MBG hope to add livestock exclosures and rainfall gauges to many of the monitoring sites and to expand the program to address deficiencies identified in the monitoring-site analysis. These additions will facilitate more-precise determination of the relative effects of climate and herbivory across a range of sites throughout the borderlands region. They can also help integrate the different aspects of the science program by providing, at a regional scale, tests of the hypotheses examined experimentally at smaller scales.

In addition to the vegetation monitoring program, the MBG and its cooperators have undertaken projects to document the ecology and restore populations of rare and endangered species (Gottfried et al. 1999). In one of the most significant examples of what can be achieved through partnerships between ranchers and researchers, Malpai-area ranchers have over the last several years worked with University of Arizona biologists to preserve habitat for the Chiricahua leopard frog (*Rana chiricahuensis*). This species appear to have undergone a

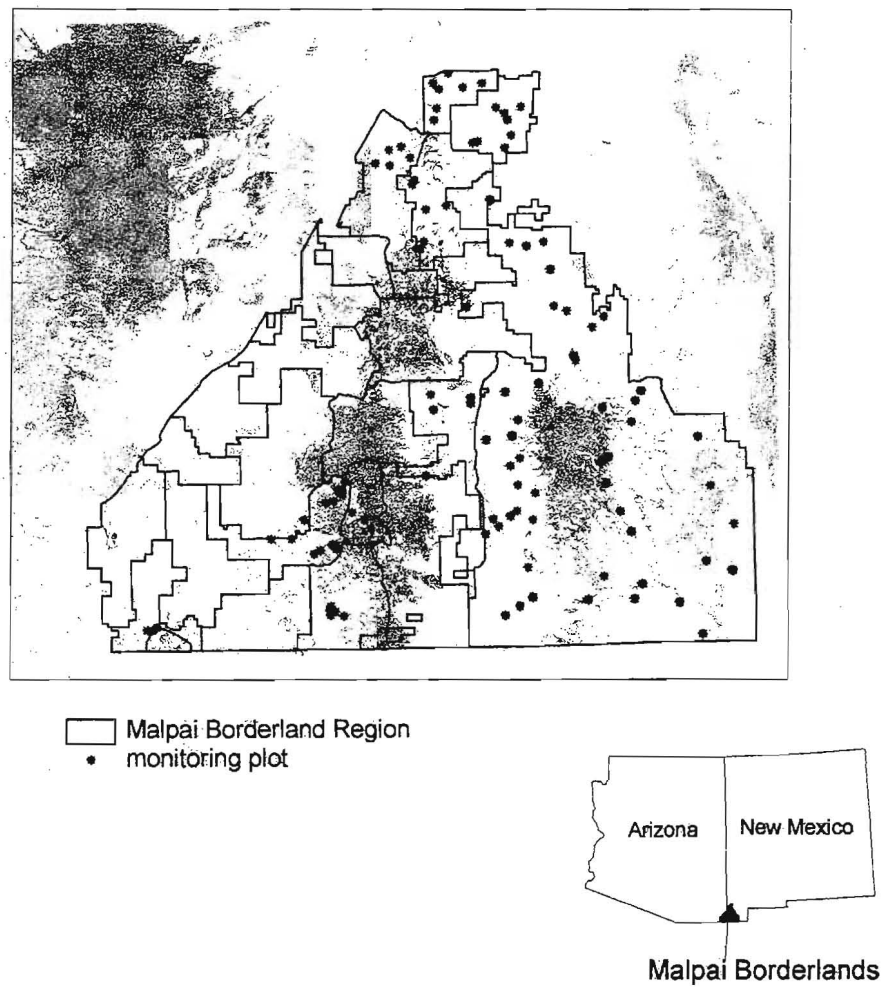

Figure 1. Map of the Malpai borderlands ecosystem depicting the location of the planning area and over 200 grazing and fire-monitoring plots (scale: 10 cm = 15 km).

steep decline over the last decade, and a stock pond on a local ranch was one of the frogs' few remaining refugia in the region. The ranching family, with support from the MBG, has maintained and restored this site and others to protect this species. This family and the MBG have also been instrumental in initiating a program with students from the local high school for propagating frogs in artificial ponds for reintroduction into the wild. In addition to preserving the species' local gene pools, this link with the local community has instilled an interest in conservation among young people and their families on both sides of the Mexico–U.S. border (in Douglas, Arizona, and its Mexican sister city of Agua Prieta, Sonora).

The MBG has stimulated other innovative partnerships between ranchers and scientists. On the Post Office Canyon Ranch in the Peloncillo Mountains, introduction of desert bighorn sheep (*Ovis canadensis*) has been conducted in collaboration with the New Mexico Game and Fish Department. Ranchers in the San Bernardino Valley monitor jaguars (*Panthera onca*) by maintaining Arizona Game and Fish trip cameras at known jaguar passways. The MBG has also funded fieldwork on jaguars in Sonora, Mexico, south of the Malpai planning area.

The reintroduction of fire into the Malpai Borderlands has been a primary goal of the MBG since its inception, and over 83,333 ha (200,000 acres) have been burned since 1994. In addition to the landscape-level restoration project represented by the MBG's fire-reintroduction efforts, a number of smaller, discrete restorations have occurred. For example, at the Sycamore Canyon Ranch, reductions in ground cover and increases in woody species have resulted in accelerated erosion of an archeological site. Local archeologists and researchers from the University of Oklahoma surveyed the area for its cultural values. A stabilization project was then implemented, with local prison crews clearing the woody vegetation, followed by the local rancher and the NRCS employees seeding and mulching with native grasses.

Experimental Research

Although monitoring and inventory have been an important part of the MBG's research and restoration program over much of the past decade, the MBG is moving toward increased emphasis on replicated, landscape-level research coordinated by outside organizations. This approach recognizes the importance of keeping research independent of local stakeholders so as not to compromise its integrity. Yet by forming collaborative partnerships between researchers and rural communities, an understanding of natural and human processes can be gained that exceeds the problem-solving potential of either community alone. This interaction of researchers and communities also increases the applicability of the research to the local community (e.g., Ehrenfeld 2000) by giving local collaborators an appreciation for the methods of (and constraints on) scientists and by giving scientists a better understanding of the issues facing rural people.

The cornerstone of scientific research in the Malpai Borderlands is a series of experimental studies by ALP on the Gray Ranch, where a long-term, replicated study is being conducted to determine how fire, livestock grazing, climate, and herbivory by native species interact to structure arid grasslands. The study site includes four pastures of approximately 917 ha (2200 acres), of which each pasture contains a 1-km^2 research area (0.62 square miles) (Fig. 2). Each research area is divided into four different treatments, including fire and livestock grazing, fire and no livestock grazing, no fire and livestock grazing, and no fire or grazing. A 25% rainfall gradient across the pasture allows us to examine the interaction of climate with fire and herbivory. Within each research area, field crews that include a combination of professional biologists, local residents, and interns measure the distribution and abundance of birds, grasshoppers, lizards, small rodents, and vegetation. These guilds of organisms were selected to represent different responses to the variables of climate, fire, and grazing. Each represents a fundamental consumer group or, in the case of vegetation, the primary biomass within the system. In addition, there are smaller, 36-m^2 exclosures that exclude livestock; large native grazers including deer (Cervidae) and pronghorn (Antilocapridae); folivores, including rabbit (Leporidae) and javelina (Tayassuidae); and small granivorous rodents (primarily Heteromyidae, *Reithrodontomys*, and *Sigmodon*) from the grazed portion of the research areas. These exclosures allow a more precise determination of the relative effects of these organisms on grassland vegetation composition and the interaction of herbivory with fire.

In addition to the fire and grazing treatments, four reintroductions of black-tailed prairie dog (*Cynomys ludovicianus*) colonies have been conducted, one in each pasture, to compare the ecological effects of prairie dogs with those of fire and grazing. The ALP is developing collaborative studies with researchers from the Mexican National University in Mexico City, who are establishing a biosphere reserve and research center 50 km (31 miles) south of the study site within the Janos prairie dog complex in Chihuahua, Mexico. The contrast of replicated studies of reintroduced colonies with large natural colonies provides a rare opportunity to study the ecology of prairie dogs in arid grasslands and to directly assess the effects of prairie dogs on biodiversity and livestock operations (Fig. 3).

In addition to these landscape and ecosystem studies, a number of other research projects being conducted in the borderlands include ecological studies of arid grasslands near Portal, Arizona, conducted since the 1950s (Chew 1982); vegetation-monitoring programs on the Re-

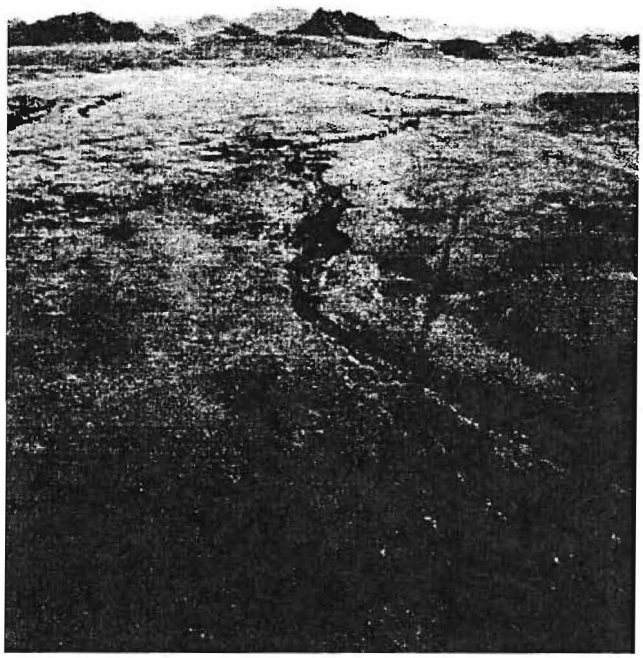

Figure 2. Aerial view of the 3668-ha (8800-acre) McKinney Flats research area on the Gray Ranch. The western and southern boundary of the northwest 1-km study block is visible in the foreground.

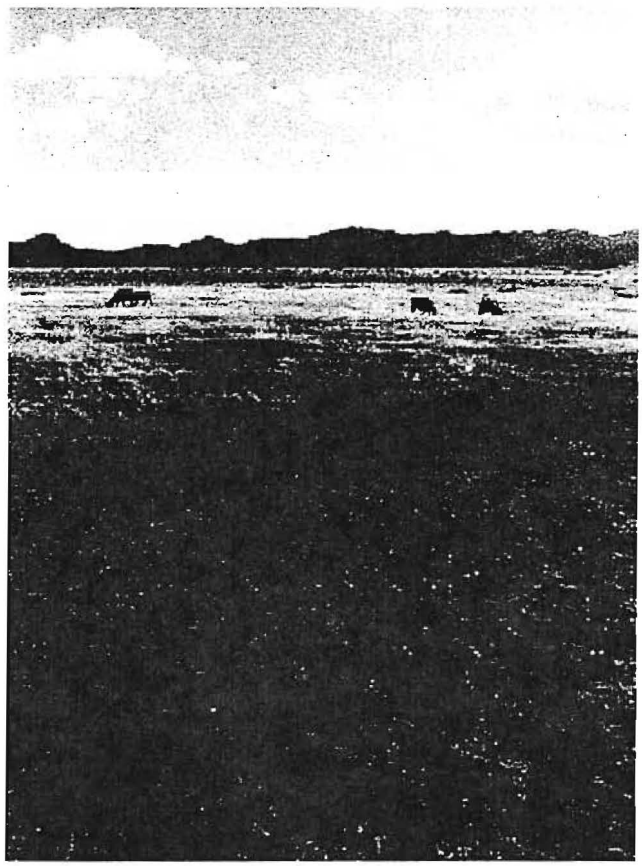

Figure 3. While it has been long noted that large ungulates are drawn to prairie dog towns, this pattern was particularly striking on the research pasture, where cattle travel several kilometers from water to graze in the vicinity of prairie dogs. Initial results from experimental studies of cattle and prairie dogs indicate that not only do cattle assist prairie dogs by reducing vegetation cover in the vicinity of towns, but that cattle accentuate the positive impact of prairie dogs on biodiversity by increasing heterogeneity near towns (C. Curtin, unpublished data).

search Ranch in the Peloncillo Mountains since the early 1970s (Moir 1979); and experimental studies of desert granivores near Portal, Arizona, since the late 1970s (Brown et al. 1986). Although not formally designed as an integrated part of the research program in the Malpai Borderlands, these projects provide important additional information on the ecology of the borderlands and in many cases have stimulated current work. Reviews of initial results of research in the borderlands are contained in Gottfried et al. (1999) and Curtin and Brown (2001).

Integrating Science with Local Communities

Given the emotionally charged atmosphere surrounding the debate over grazing and fire management in the western United States, the importance of scientific credibility in forwarding conservation goals cannot be overemphasized. Research also provides ranchers and public land managers with an ecological context for their management activities. An understanding of climatic effects is particularly important for understanding landscape change, because our research consistently shows that the climatic events that follow a management technique are often more important than the type of treatment per se, such as fire or grazing (Curtin et al. 2002; C.C., unpublished data). The success of a management action therefore rests on accounting for climatic variability, anticipating its impacts, and acting to take advantage of or mitigate its consequences. Adaptive management is the key to sustaining the ecological health of arid landscapes. This requires clear management goals, monitoring, and research to determine whether these goals have been or can be successfully attained.

The experimental research in the borderlands is beginning to provide land managers with information that allows them to predict more effectively the ecological implications of grazing and fire and their interaction with climate, and the monitoring program allows land

stewards to quantitatively assess trends in landscape change and the outcome of management actions. This integration of monitoring and research into ranching is a key part of the Malpai Group's activities, and those of other progressive land-management and ranching groups, and is a crucial component of ecologically sustainable landscape management or restoration (Curtin et al. 2002). Monitoring and research on the part of the ALP and MBG is conducted at the invitation of, and often with the assistance of, local ranchers. The results are made available to the public through reports, publications, and community meetings and workshops. Research and data pertaining to the Malpai borderlands region are being assembled in a regional photo and data archive at the Malpai Group offices at the Glenn Ranch near Douglas, Arizona. In addition to historical photos, recent matched photos, and rainfall and vegetation-monitoring data, the archive also houses all photographic records from the photo stations established as part of the Malpai region's vegetation monitoring program.

Lessons from Cooperative Science and Community-Based Conservation

The evolution of the ALP highlights the effectiveness of coupling community-based conservation and science. Initiated as a research organization, the ALP found that to assure the preservation of open space and access to large-scale, landscape-level research sites, it needed to work with local communities. This involvement in community-based conservation has contributed to rather than detracted from the initial goals of conducting experimental landscape-level research because it increased both the conservation and the research implications of the work. Most long-term large-scale research programs in North America, such as the National Science Foundation's Long Term Ecological Research Program (LTER), rely heavily on a pool of undergraduate and graduate student labor and are exclusively supported by federal funds. In contrast, research in the borderlands conducted by the ALP is essentially a private-sector LTER project. This means that, in addition to reducing the high overhead typically associated with the public funding of institutional grants, many of the research dollars stay in the local community, providing an important outreach tool that engages local people in the research process. Because of their vested interest in the research results and familiarity with the outdoors and work in the field, local students and community members are highly motivated and especially conscientious and reliable field assistants.

Cooperation and understanding between diverse groups is crucial to successfully linking community-based conservation and science. Key to sustaining these partnerships is an implicit understanding of the different cultures of conservationists, local people, and scientists. For example, the role of conservationists as community organizers and fundraisers often has direct benefits to local communities, whereas the benefits of involving scientists are often less immediate or tangible. The professional ethics of scientists require them, to the best of their ability, to objectively report their findings. Therefore, science can be a double-edged sword because it is essential to establishing credibility and guiding management, but its results may not always be consistent with the interests of the local community. Yet the experience of collaboration between scientists and the local community in the borderlands has demonstrated that the benefits to the local community of working with scientists outweigh the risks because they are essential to sustainable long-term landscape conservation (B. McDonald, personal communication).

Conservationists and scientists have increasingly recognized that to preserve biological diversity it is not enough to preserve land in parks and wilderness areas, but that inclusion of working landscapes within human communities is also essential to attaining long-term sustainable conservation (Western 2000, Brown & Curtin 2002; Curtin et al. 2002). Conservation and research efforts in the borderlands indicate that sustaining functioning ecological systems will require land mangers to work across boundaries not only to protect land from fragmentation but to preserve the processes that maintain functioning landscapes and ecosystems (Gottfried et al. 1999; Curtin & Brown 2001). I have reviewed one multiscale landscape approach that has sought to reveal pattern and process in arid landscapes; perhaps more important, I have demonstrated the value of having local communities and scientists work toward the mutual goal of sustaining unfragmented, functioning ecosystems.

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