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7

Cultural Landscapes and Biodiversity

The Ethnoecology of an Upper Río Grande Watershed Commons

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The Upper Río Grande watershed is a thirty-four-thousand-square-mile area stretching from the Rocky Mountains in southern Colorado and northern New Mexico to the Juarez Valley, across the border from El Paso, Texas (Hay 1963:491). The northernmost third of the watershed encompasses a seven-county area in northern New Mexico and southern Colorado with a predominantly Chicano population of Spanish-Mexican origin.[1] This area is the principal headwaters bioregion of the Upper Río Grande but includes important tributaries of the Arkansas watershed. It consists of a series of high-altitude valleys that drain forested, snow-covered mountains.[2] At the end of the sixteenth century, coming north from Mexico, a diverse people began to settle in the intermontane valleys of the watershed.[3] The settlers established agropastoral villages that have been widely praised as examples of sustainable human adaptation to high-altitude, arid-land environments.[4] At the heart of these farm and ranch communities is the watershed commons. The high mountain peaks provide water, timber, pasture, medicinal plants, and wildlife for use in common by the villagers.

Watersheds have traditionally defined the boundaries of self-governing communities in the Upper Río Grande. This invention of political jurisdiction as derivative from a type of hydrographic unit was probably first described by John Wesley Powell in 1890. Writing on the possibilities for sustainable human settlement in the arid-land environments of the intermountain West, Powell observed:

> The people of the Southwest came originally, by way of Mexico, from Spain, where irrigation and the institutions necessary for its control had been developed from high antiquity, and these people well understood that their institutions must be adapted to their industries, and so they organized their settlements as pueblos, or "irrigating municipalities," by which the lands were held in severalty while the tenure of the waters and works was communal or municipal. . . . [The goal of this irrigation tradition was] to establish local self-government by hydrographic basins. (Powell 1890:112–14; see also Worster 1994:1–28)

The organization of acequia-based farms and ranches of the Chicano upland villages of northern New Mexico and southern Colorado is an important example of this watershed commonwealth form of self-governance. The association of acequia members *(parciantes)* is a community of irrigators with shared responsibility in the care, maintenance, and use of the ditch networks. The irrigating municipality is a deeply rooted tradition for effective, local self-management of water and land. The ultimate responsibility of the acequia associations is the management of water rights and stewardship of the watershed commons. This tradition of local self-governance is only now being recognized as a viable alternative in the debate over the future of the commons in the intermountain West (see Wilkinson 1988, 1992). Moreover, acequias are themselves innovations on the rhythms and patterns of the watershed, a type of disturbance ecology that, like beaver works, increases biodiversity by creating wildlife habitat and movement corridors.[5]

Ethnoecology of the Culebra Microbasin

The San Luis Valley in southern Colorado is a high-altitude, cold-desert environment. The valley is topographically and climatically similar to the high steppes of central Asia. The valley has an average elevation of eight thousand feet above sea level and is surrounded by the fourteen-thousand-foot peaks of the Sangre de Cristo Mountains to the east and the San Juan Mountains to the west. The bioregion receives very little rain (with average annual precipitation of seven to eight inches). However, the high mountain peaks on average receive more than one hundred inches of snow during the long seven-month winter season. The moisture from the snow pack is what makes agriculture possible in the valley. The valley is the northernmost headwaters basin of the Río Grande, collecting stream flow from some fifty tributary creeks of the river that originate in the high peaks. One of these tributaries is the Río Culebra, with headwaters in the Culebra Range, the southernmost extension of the Sangre de Cristo Mountains in Colorado.[6]

The Culebra Microbasin

The Culebra microbasin is home to some of the oldest agricultural communities in the state of Colorado. The Chicano villages of the Culebra were settled between 1850 and 1860 by *pobladores* (village colonists) invited by the heirs of the Sangre de Cristo land grant (issued in 1844).[7] The microbasin includes nearly every major life zone in North America, from alpine tundra above timberline (at twelve thousand feet and above) to Upper Sonoran cold desert (at eight thousand feet and below). Montane and subalpine fir forests located at nine to twelve thousand feet are the heart of the watershed. The forest canopy protects the winter snow pack. During the spring and summer the gradual melting of the snow is the primary source of water for irrigation in the microbasin.

Acequias

The irrigation system in the Culebra microbasin is based on the acequia, or gravity ditch system. This irrigation tradition has independent roots in three continents: Africa, Europe, and North America (Peña 1993, 1998). The term acequia derives from the Arabic word *as-Saquiya*, which means the "water bearer" or "water carrier." Acequia irrigation systems are renowned around the world as culturally and ecologically sustainable technologies. They are notable for: (1) a renewable use of water that maintains the equilibrium of the local hydrological cycle through aquifer recharge and return to in-stream flows; (2) a renewable use of energy that relies on the force of gravity to move water; (3) a network of earthen-work ditches that increases biodiversity by creating wetlands and woodlands that serve as wildlife habitats and biological corridors; and, overall, (4) their contribution to the control of soil erosion and maintenance of water quality. The collective community management of the acequia ditches provides a cultural foundation and an institutional tradition for local self-governance and the reproduction of conservation ethics from one generation to the next (see Peña 1993, 1998; Peña and Martínez 1998; Rivera 1997).

To work effectively, acequias rely on the gradual melting of the winter snow pack in the mountains. Any disturbance of the watershed ecology can result in serious problems for acequias. For example, deforestation can lead to excessive sediment loading in the ditches, arroyo cutting, flooding, or lack

Table 7.1. Original acequias, in the Culebra microbasin.

Priority[a]	Ditch	Construction Date
1	San Luis Peoples	April 1852
2	San Pedro	April 1852
3	Acequia Madre	1853
4	Montez	August 1853
5	Vallejos	March 1854
6	Manzanares	April 1854
7	Acequiacita	June 1855
8	San Acacio	April 1856
9	Madriles	April 1856
10	Chalifu	April 1857
11	Cerro	November 1857
12	Francisco Sanchez	March 1858
13	Mestas	May 1858
14	San Francisco	May 1860
15	Trujillo	May 1861
16	Little Rock	1873
17	Garcia	1873
18	Torcido	May 1874
19	Abudo Martin	May 1874
20	Guadalupe Vigil	March 1880
21	Jack J. Maes	March 1881
22	Antonio Pando	April 1881
23	Guadalupe Sanchez	November 1882

[a]As defined by construction date.

of sufficient water during the irrigation season (Costilla County Conservancy District 1993; Curry 1995; Jones and Grant 1996).

In the Culebra microbasin, there are twenty-three historical acequias represented by *mayordomos* (ditchriders) for each of the ditches.[8] These acequias hold the oldest water rights in Colorado under the doctrine of prior appropriation (table 7.1). For example, the San Luis Peoples Ditch, which has the first priority, was constructed in 1852, decreed in 1862, and adjudicated in 1889. The acequias are collectively organized under the umbrella of the Costilla County Conservancy District (CCCD), which was established in 1976. The CCCD has played a major, largely unheralded role in Colorado environmental politics. During the 1970s, the conservancy district led the opposition in successfully opposing a plan by the San Marcos Pipeline Company to mine the local groundwater aquifer to operate a coal slurry line. Repeatedly since the 1980s, the CCCD has been a major force lobbying against the reclassification of farmlands by the Colorado state legislature. These legislative initiatives would change the tax structure so that small farm properties (for example, with fewer than twenty acres or less than $5,000 in annual sales) would lose their status as agricultural land. These initiatives have been thrice opposed by the CCCD because the proposed reclassification would undermine the ability of Chicano smallholders to continue the sustainable tradition of subsistence agropastoralism in the San Luis Valley.

In the late 1980s and early 1990s, the acequias, through the CCCD, led the opposition to the Battle Mountain Gold (BMG) strip mine and cyanide leach mill (see Peña and Gallegos 1993). As a result of the BMG struggle, the CCCD played a major role in a 1993 campaign to reform the Colorado Mined Land Reclamation Act (MLRA). Most recently, the CCCD has played a critical role in the establishment of La Sierra Foundation of San Luis, a community-based organization seeking the return of the Culebra Mountain Tract through a national fund-raising campaign for a community land trust (see Peña 1995a; Peña and Valdéz Mondragon 1997).

The Culebra Mountain Tract

The Sangre de Cristo land grant originally encompassed approximately one million acres. But the traditional commons of the Culebra bottomland villages consists of a 77,754-acre tract that locals know as *la sierra* (Mountain Tract). The Culebra Mountain Tract includes one peak of over fourteen thousand feet in elevation and eight of over thirteen thousand. Until 1995 the area was relatively undisturbed and roadless; there is a two-thousand-acre clear-cut in the southwestern corner of the tract.[9] According to Webb (1983) and Reynolds (1990), the Mountain Tract is historically habitat to nesting pairs of the endangered Mexican spotted-owl *(Strix occidentalis)*, and its creeks are stocked with the native Río Grande cutthroat trout (a rare and threatened species). Most of the Culebra Mountain Tract consists of montane and subalpine conifer forests with a mix of ponderosa, Douglas fir, and spruce. The higher elevations are characterized by alpine tundra, krummholz, and windswept rock lands that are under snow eight to ten months out of the year. Wet montane meadows and marshlands, aspen groves, piñon-juniper woodlands, riparian cottonwood and willow stands, and semidesert sagebrush prairies complete the variety of plant communities in the Mountain Tract.

Headwaters and Agroecology

An important feature of the ethnoecology of this microbasin is the relationship between the alpine and montane headwaters of the Culebra and the farms and ranches located below in the riparian bottomlands. Most local people strongly support the protection of wildlife and its habitat (Peña et al. 1993). Local farmers and ranchers are particularly strong in their support of wildlife conservation through habitat protection because they recognize that the conditions optimizing wildlife habitat also help maintain watershed integrity and water quality (Costilla County Conservancy District 1993). The processes that destroy wildlife habitat and disrupt the watershed are seen to affect farming and ranching negatively. These farms and ranches are notable for their reliance on acequias, use of perennial polycultures, preference for rare native landraces (regionally-adapted family heirloom crop varieties), and the clustering of wildlife habitats and farming landscapes. These farms and ranches are sustainable agroecosystems. A unique cultural-watershed landscape is endangered by industrial capitalist development and extractive activities affecting the ecosystem (Costilla County Conservancy District 1993; Peña and Martínez 1998).

Damage to the watershed presents a definite threat to the ecological basis of these farms and ranches. For example, logging operations destroy wildlife habitat and reduce biodiversity. And such activities also create soil erosion and channel aggradation, diminish water quality, and cause problems with sedimentation for downstream acequias. Deforestation creates flood-control problems with the potential to irreversibly damage the acequias. Deforestation also accelerates the rate at which snow pack melts into stream flow.[10] Too much water comes down too fast at the wrong time. The entire agro-hydrological cycle is thrown off balance.

In the case of the Culebra watershed, limited storage rights for the acequias and overextended storage capacity in structurally unsound reservoirs create the conditions for a hydrological crisis. Farmers and ranchers would not be able to manage the runoff and, lacking storage rights, most of the water for acequias would be lost to in-stream flows before the end of the irrigation season. The lack of sufficient water during the three- to four-month irrigation season would destroy the basis for sustainable agriculture in the microbasin.[11] A long-standing local struggle to restore communal ownership and use of the Culebra Mountain Tract stems from a desire by the irrigating community to prevent this sort of catastrophic damage.[12]

Chicano Agroecosystems: An Ideal-Type

Agroecology provides an interdisciplinary framework for the study of farming communities in environmental and sociohistorical contexts.[13] Agroecology begins with an elegant and seemingly paradoxical premise: Agriculture is, above all else, a human artifact; yet the farming system does not end at the edge of the field. The primary tenet of agroecology is that the farm is itself an ecosystem and part of a larger ecosystem (it is located within a broader bioregional context). Proceeding from the basic recognition of the ecological context of agriculture, this research tradition emphasizes four foundational principles: Agroecology (1) recognizes sense of place as a factor in the coevolution of culture and nature and in the adaptation of agroecosystems to the physical and biological nuances of localities (ontological dimension); (2) values the preservation of local knowledge over the imposition of universal mechanistic knowledge and recognizes the sustainability of traditional agroecosystems (epistemological dimension); (3) privileges the production strategies of traditional polycultures over modern monocultures as a way to correct inequities in agricultural research and extension services (ethical dimension); and (4) empowers farmers by favoring self-management of the natural conditions of production and promoting local control of political economic institutions (policy dimension). (For further discussion, see Altieri et al. 1987.)

Agroecological approaches have not been used in the study of Chicano farming systems. And yet, Chicano agriculture provides a living laboratory for the study of the interactions between cultural, social, economic, political, and ecological systems in a context characterized by limited resources and relatively low levels of mechanized technology. Our preference for the agroecological approach is based on our concern for understanding these practices in a more holistic manner. We also want to endorse an ethically grounded political perspective that supports local initiatives for land reform and democratization of impinging market and state institutions. Given current debates over the future of agricultural policy in the rural intermountain West, the nature of alternative and sustainable models must be made more salient. We must redefine the terms of this debate by outlining a comprehensive and interdisciplinary perspective of Chicano agricultural systems and studying their continuing evolution in contemporary practices.

The sustainability and dynamic character of Chicano agropastoralism is an intriguing possibility, both as a historical legacy and a viable future option.

But Chicano agriculture, as a set of living cultural ecological practices, has until now remained relatively unstudied at the level of specific historical research sites.[14] The remainder of this chapter is the first in a series of reports focusing on multigenerational Chicano family farms and ranches that we have designated as historical research sites for an ongoing, long-term study of the cultural and environmental history of the Greater Río Grande watershed.[15] I chose these farms and ranches because they have remained in the same families for five or more generations and continue to be operated as profitable commercial agricultural enterprises.

Chicano agroecosystems in the Culebra microbasin are characterized by several prominent features that are hallmarks of sustainable and regenerative agriculture: (1) a riparian long-lot cultural geography characterized by multiple life zones and ecotones, (2) the use of acequia irrigation systems, (3) the clustering of wildlife habitats and farming landscapes, (4) a tradition of local and regional landraces, (5) the use of natural pest and weed controls with beneficial effects for soil fertility and erosion control, (6) the simultaneous production of several kinds of crops and livestock and an integrated approach to soil conservation and range management, (7) a preference for polycultures and rotational intercropping, (8) the adoption of new soil, pasture, and water conservation practices, (9) a low level of mechanization and a preference for human and animal power, (10) the increasingly common practice of restoration ecology, (11) a tendency toward autarkic prosumption (that is, the production of goods for home and local use and exchange), (12) the maintenance of access to traditional common lands, and (13) an increasingly self-organized and complex set of relationships with a variety of market and governmental institutions.

I present these features—discussed more fully in subsequent sections—as characteristics of an ideal-type. Note that I am not calling this "traditional" agropastoralism. My point of view is that many changes have occurred in Chicano agriculture and that these thirteen features embrace both traditional and more modern practices. Nor am I suggesting that all Chicano agropastoralists are engaged in these practices. Many are not, but these features are prominent enough in most Upper Río Grande microbasins (both historically and contemporaneously) to warrant their inclusion in an ideal- type model. Where possible I have sought to compare and contrast Chicano agroecosystems with mechanized agroindustrial monocultures in order to highlight the sustainability of the agropastoral model.

Riparian Long-Lot Cultural Geography

Agropastoralism in this bioregion depends on a unique and endangered cultural landscape known as the riparian long-lot (fig. 7.1). After passage of the Land Ordinance of 1785, the United States established a national land survey program based on the township-and-range system. According to Donald Worster, this system "divided the country from the Appalachian Mountains to the Pacific Coast into a rigid grid of square parcels one mile on a side, subdivided into quarter sections of 160 acres" (Worster 1994:12). The square-grid system is incompatible with the topographical features and hydrographic boundaries of ecosystems in the intermountain West; it is inconsistent with the lay of the land, water, and native human communities. Anglo-Americans, coming from the East to settle in this region, adopted the square-grid topography of the 1785 land ordinance. This land-use pattern homogenized natural and cultural landscapes by requiring the removal of woodlands, forests, wetlands and other natural and cultural features that were considered obstacles to the mechanized economies of scale favored by the Anglo-Americans.

Instead of the square-grid settlement pattern adopted by neo-European farmers and ranchers from temperate climates, Chicanos utilized the upland Franco-Iberian (and originally Roman) tradition of the riparian long-lot.[16] The long-lot represents a type of cultural landscape compatible with the biogeographical properties of high-altitude, arid-land environments. The cultural ecological advantage of the long-lot is that it provides every family with access to most of the life zones in the locality. Ideally, every family has access to the piñon-juniper woodlands on the mesa tops and foothills for fuelwood and construction; dry land grass prairies for pasture; riparian bottomlands for access to water, fish, cottonwoods, and wetlands; and irrigated bench land meadows for the planting of row crops, pastures, orchards, and subsistence gardens. The riparian long-lot is not just a boundary-setting tradition. It is an ecosystem with multiple life zones and ecotones (transition zones). Many observers have commented that this agricultural settlement pattern is ecologically sustainable and well adapted to the arid land of the Upper Río Grande watershed.[17]

In Spanish, this agricultural landscape is known as an *extensión*. In some areas of the Upper Río Grande it is called a *vara* strip and in other areas it is known as a *suerte*.[18] In the Lower Río Grande Valley of South Texas the long-lot is called a *porción*. The riparian long-lot is a ribbonlike strip of land that extends many miles through varied topographical and biotic zones. The

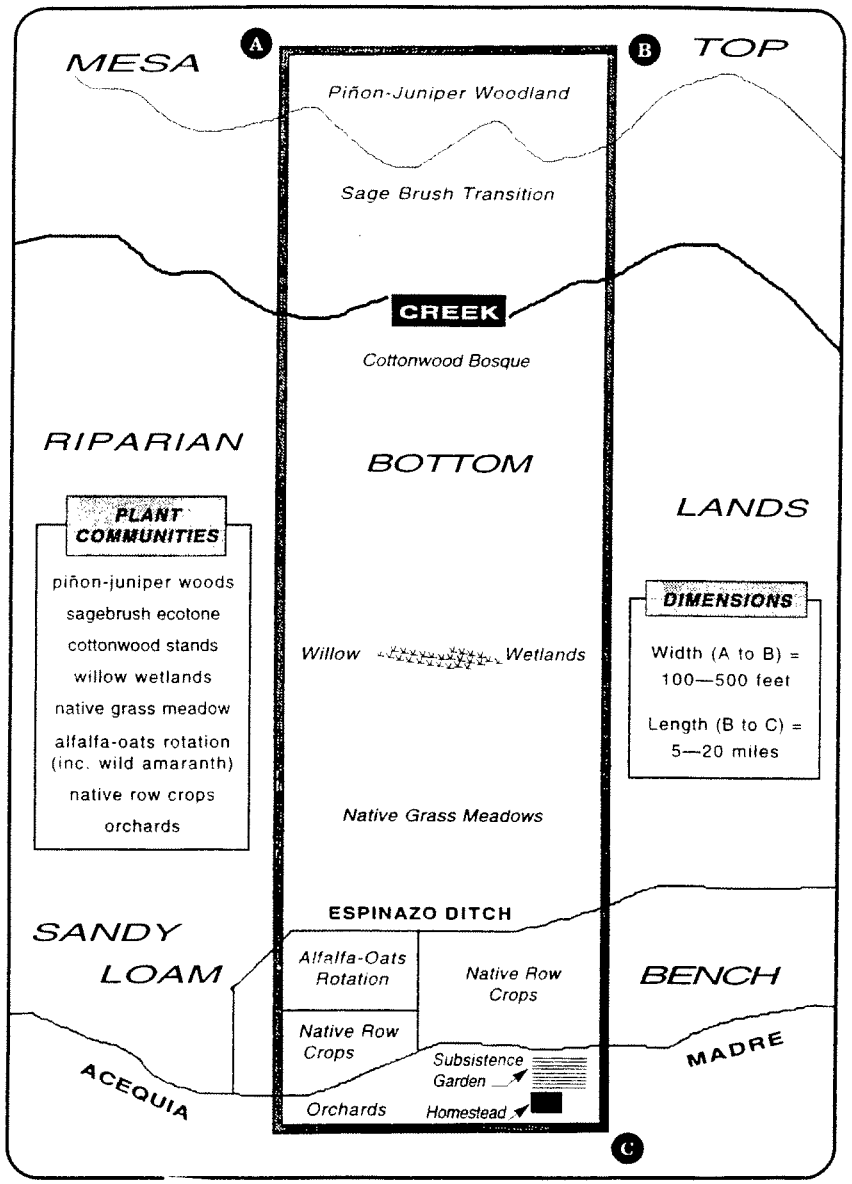

Figure 7.1. The riparian long lot.

size and shape of a long-lot can vary tremendously, depending on microbasin topography, the socioeconomic class standing of the owner(s), patterns of inheritance within families, and the effects of the enclosure of local common and private lands. The width of a long-lot can range from a little less than one hundred to as many as five hundred varas (one vara is equal to 33.3 inches).[19] The length of the long-lot is the significant factor in this cultural landscape. Estimates on the traditional length of historical long-lots vary: five to six miles, as suggested by Wilson and Kammer (1990), fifteen to twenty miles according to Stoller (1993), and ten miles in Carlson (1967).

Acequia Irrigation Systems

As we have seen, acequias (gravity-driven, earthen-ditch irrigation systems) are an integral part of rural Chicano communities, but they are also part of complex agroecosystems. In addition to delivering water to the irrigated fields and pastures, acequias fulfill a variety of ecological functions. What is most striking to us about the ditches is that they fulfill human objectives while simultaneously meeting the needs of wild plants and animals. This is an intrinsic conservation feature of Chicano agroecosystems that is often misrecognized by water engineers and environmentalists as an inefficient and wasteful use of water (see Peña 1995a; see also Gallegos 1998; García 1998; Peña 1998). Because the earthen ditches leak water into the land around them, they are associated with the water-loving phreataphytes (trees and shrubs with extensive root systems like cottonwoods and willows). This means that acequias increase biodiversity by contributing to the creation of wildlife habitats and biological corridors.

From the vantage point of agricultural energy systems, acequias are perhaps the most efficient of all arid-land irrigation technologies (Hall et al. 1979: 29–44). Unlike the mechanical center-pivot sprinkler systems favored by agribusiness monocultures, gravity-ditch systems do not require fossil fuel inputs. Mechanical irrigation systems utilize a great deal of energy yearly, mostly in the form of diesel fuel to power the deep-well pumps that deliver groundwater to the sprinklers. Annual fuel costs for these mechanized systems can run as high as $10,000. In contrast, annual fuel costs for acequias are close to zero.

Another aspect of energy comparison is the nature of trophic and nutrient cycles. The combination of the riparian long-lot with the acequia system contributes to the maintenance of the trophic complexity of the ecosystem by encouraging an optimum mix of relationships among livestock, wildlife, crops, weeds, trees, shrubs, insects, and pathogens. The mechanized system, in

contrast, disrupts the trophic webs by homogenizing the landscape and eliminating habitat niches and biological corridors. The acequias actually enhance the flow of energy circuits through the expanded interaction of land, water, flora, and fauna. Mechanized irrigation interrupts these trophic circuits by imposing uniform monocultures on naturally diverse landscapes. Finally, the long-lot/acequia complex also reduces energy inputs by relying on relatively self-enclosed nutrient cycling—that is, all nutrient requirements are met by in situ components of the soil and biota. The mechanized irrigation systems are characterized by open-nutrient cycling: They require high inputs in the form of agroindustrial chemical supplements (fertilizers, herbicides, pesticides, and the like).

Clustering of Wildlife Habitats and Farming Landscapes

The riparian long-lot cultural landscape is characterized by an extraordinary level of biological diversity. The landscape itself, because it includes different life zones, is supportive of an incredible variety of wild plants and animals. In this form, the vara strip agricultural landscapes serve as wildlife habitats and biological corridors linking diverse habitat islands in a given microbasin. One characteristic of Chicano agroecosystems is the existence of amorphous boundaries between natural and cultural landscapes. The boundaries between pastures and wildlife habitat are less definite in this system. In contrast, mechanized monocultures reduce biodiversity because they homogenize and separate the natural and cultural landscapes.

The significance of this landscape clustering feature of Chicano agroecosystems is implied in observations made by a variety of conservation biologists. For example, Reed Noss, a key figure in the field of island biogeography, notes:

> The only success stories in real multiple-use conservation are a handful of indigenous peoples who have somehow been able to coexist with their environments for long periods without impoverishing them. Some indigenous cultures have even contributed to the biodiversity of their regions . . . suggesting that humans have the potential to act as a keystone species in the most positive sense. The beaver provides a good model of how humans could contribute to native biodiversity by creating habitats used by many different species. (Noss 1994:37)

I would like to suggest that Chicano agroecosystems, based as they are on the riparian long-lot/acequia complex, constitute one such example of an indigenous cultural practice that contributes to biodiversity through the protection of the natural landscape integrity of the watershed ecosystem.

Heirloom Crops

Chicano agroecosystems are also characterized by the farmers' preference for native, locally adapted crops. Few Chicano farmers produce hybrid crops. There is an extraordinary range of landraces grown, which are also usually family heirloom crop varieties. The use of landraces means that Chicano farmers are conserving the genetic diversity of food crops and encouraging the adaptation of these varieties to local climatic conditions. This also means that Chicano farmers do not have to utilize high-cost inputs like agroindustrial chemical fertilizers, herbicides, or pesticides. These native plant species are naturally resistant to pathogens and, in some cases, drought. Moreover, because the plants produce fertile seeds, the farmers do not have to rely on seed merchants for their annual seed stocks. The average Chicano farm has a considerable amount of native crop biodiversity (table 7.2). This crop biodiversity eliminates the need for chemical inputs, provides for natural pest and weed controls, and encourages intercropping practices that are beneficial to the soil and its nutrient cycles.

In contrast, the agroindustrial monocultures rely on sterile hybrids for their seed stocks (which makes them dependent on seed merchants and suppliers). Hybrids typically require high inputs to attain higher yields: These inputs include agricultural chemicals (pesticides, herbicides, and fertilizers) and considerable quantities of water for irrigation.[20] The use of hybrids also tends to be associated with the erosion of crop genetic diversity. And there are usually additional impacts involving higher rates of soil erosion, salinization, and compaction.

Some of the landraces that are characteristic of Chicano agroecosystems include *maize de invierno* (a white roasting corn used in making *chicos* or *posole*), *bolitas* (a beige-colored bean related to the pinto), a wide variety of *chiles* (hot green peppers), and *calabasita* (Mexican green squash). Various "naturalized" exotic varieties have been adapted to the high-altitude conditions of the Culebra watershed; *habas* (horse beans) are one such example. Historically, Chicano agroecosystems tend not to have extensive plots of land dedicated to alfalfa or other field crops for feeding livestock. Pastures with perennial polycultures of native grass are preferred. The Chicano farmer favors a combination of landraces for row crops, native grasses for pasture, and a variety of imported hybrids and exotic landraces for subsistence gardens. In

Table 7.2. Domesticated crops, animals, and grasses in Hispano agroecosystems.

Crops		
beans (*bolita*)*	chives	parsley
beans (pinto)*	cilantro	peas (English)
beans (string)	corn (blue)	peas (sweet)
broccoli (3)	corn (yellow sweet)	potatoes (5)
cabbage (2)	decorative flowers (gladiolus, etc.)	turnips
*calabasita**		vine tomatoes (5)
carrots (3)	*habas* (horse beans)*	wheat (3)
cauliflower	lettuce (3)	yellow crookneck squash
chicos (7)*	onions	zucchini
Orchard Crops		
apple (2)	chokecherry*	plum (3)/(1*)
cherry (2)	pear	
Animals		
cats	ducks (5)	hogs (6)
cattle (6)	geese (3)	horses
chickens (8)	goats (5)	rabbits
dogs	guinea fowl	sheep (4)
Grasses		
black grama*	brohme*	wheat (luna crested)
blue fescue*	redtop*	wheat (western crested)
blue grama*	timothy*	

Notes: Numbers in parentheses indicate horticultural varieties and breeds. Asterisks indicate native landraces.

addition, Chicano agroecosystems typically include orchards with exotic fruit trees (apple, pear, plum, and cherry), imported berry brambles (raspberry, currant), native berry shrubs (chokecherry), and a wild (semidomesticated) miniature plum known locally as *cirhuelita del indio* (see table 7.2 for a partial list of crops grown on Chicano acequia-fed farms).

Natural Pest and Weed Controls

Given the biodiversity of crops grown in Chicano agroecosystems, it is not surprising that natural (biological) pest and weed controls are the order of the day. The primary form of weed and pest control involves careful intercropping of landrace crops. Intercropping, combined with rotational plantings, creates a

condition known as allelopathy (what the home gardener knows as "companion planting" and ecologists recognize as a chemical interrelationship between plants). For example, the traditional trinity of Indian crops—corn, beans, and squash—serves more than to provide for a balanced diet. Together, these companion plants work to fertilize the soil (beans as legumes are nitrogen-fixers), control weeds and soil erosion (squash as a ground cover reduces weed invasions and soil loss), and eliminate many insect pests (the biodiversity and adaptation of the three crops to local microclimate and soil conditions help them resist diseases and infestations). (For further discussion, see Altieri et al. 1987; see also Barreriro 1992).

Chicano agroecosystems can thus be characterized as landrace polycultures that feature both species and structural diversity. They exploit the full range of microenvironments, maintain and enhance nutrient cycles and soil tilth, rely on biological interdependencies that provide pest control, rely on local resources with little mechanical technology, and rely on local varieties of crops and incorporate wild plants and animals (see also Altieri et al. 1987, Harlan 1976).

Holistic Land and Livestock Management

One of the most significant, and most often overlooked, characteristics of Chicano agroecosystems is their integration of farming and ranching. As noted earlier, Chicano agroecosystems are not just farms and not just ranches: They typically incorporate aspects of both production systems—hence the term "agropastoral." The typical Chicano agropastoral operation produces at least four types of plant crops: row crops (such as corn, beans, squash, chili), forage crops (such as alfalfa, hay), pastures (native grasses such as timothy, blue fescue, redtop, brome), and subsistence garden crops (such as corn, beans, squash, chili, tomatoes, peas, broccoli). But these operations also produce livestock, typically, cattle, sheep, goats, pigs, and horses. This integration of crops, forage, pasture, and livestock increases biodiversity and maintains trophic complexity. The presence of farm animals also means that a steady supply of organic fertilizer is available in the form of manure. Sheep and goats can be used to control invasive noxious weeds.

Land and range management practices in Chicano agroecosystems are centered on controlling three types of problems: overgrazing, loss of soil fertility, and soil erosion. The use of Holistic Resource Management (HRM) practices to control grazing and soil erosion is increasingly evident (on HRM, see Savory 1988). The HRM model involves several primary practices: rotational

grazing to reduce pressures on forage and pasture crops; electrical paddocks to control livestock movements and concentrations; and intense supervision of grazing animals.[21]

Polycultures and Rotational Intercropping

Chicano agroecosystems combine elements of both perennial and annual polycultures. The perennial polycultures include native grass meadows that are never tilled or cultivated. These meadows are used as rotational pastures for grazing livestock. The annual polycultures include row crops that can be intercropped (with the corn-bean-squash-chili complex being the most common). The row crop plantings usually involve minimum tillage and plowing.[22] Some Chicano agropastoralists have in more recent times adopted monoculture plantings of alfalfa and other forage and livestock crops. However, Chicanos usually avoid alfalfa monocultures and, in most cases, plantings follow eight- to twelve-year rotational sequences: for example, alfalfa-oats-barley-corn. Rotations often include a fallow period.

Soil and Water Conservation

Chicano agroecosystems have historically experienced fewer problems with soil erosion than have agroindustrial monocultures. There are several features that contribute to soil conservation. First, most Chicano agropastoralists practice zero or minimum tillage, particularly in the native grass meadows that predominate in the riparian bottomlands. Second, where tillage and cultivation are practiced, the combination of crop diversity and cover crops reduces soil erosion. Third, since most agropastoralists avoid large-scale mechanization, there are fewer erosive impacts from the use of heavy machinery. Fourth, most agropastoralists practice "organic" farming, with very little use of agroindustrial chemicals; organic farming practices tend to increase soil tilth and reduce soil erosion.

There are some other factors that contribute to soil conservation on Chicano farms and ranches. Historically, since Chicanos were the first to settle in their respective microbasins, they tend to have the best land; few Chicanos have been pushed off onto marginal lands that are more erosive. The tendency of Chicanos has been to farm only in riparian bottomlands: These areas have deeper soil horizons (usually dating to Pleistocene deposition) and tend to be protected from wind erosion by the proximity of higher lands (such as surrounding mesas and foothills). Another contributing factor to soil conservation is the existence of numerous windbreaks. The acequia networks, as we have

seen, create numerous cottonwood and willow stands that double as windbreaks. Tree lines, woodlots, orchards, and naturally occurring wetland willow and cottonwood stands provide further protection against wind erosion.

Under certain circumstances, acequia irrigation practices can contribute to soil erosion. Such circumstances nearly always involve human error: For example, flooding fields with excessive water or irrigating at too rapid a pace can contribute to soil erosion from runoff. In some cases, farmers may inappropriately try to irrigate fields with too steep a gradient. If fields are furrowed at angles parallel to the gradient, erosion may result. However, the main cause of soil erosion in Chicano agroecosystems has been overgrazing.[23] Overgrazing became a problem only after the conquest of the bioregion by the United States: The commercialization of livestock production, the expanded demand for beef occasioned by the arrival of the railroad, and the opening of new markets were major factors in the overgrazing of these lands (see Peña 1992, 1994). More recently, Chicanos have adopted a variety of strategies to control grazing (for example, HRM as noted above).

The establishment of the Soil Conservation Service (SCS, now the Natural Resources and Conservation Service NRCS), has, on the whole, proven beneficial to Chicano practices. However, the SCS has a mixed record in attending to the needs of Chicano agropastoralists. Like the Extension Service, the SCS has not always placed a high priority on the needs of Chicano agricultural regions, and there are some cases where the SCS encouraged Chicanos to destroy woodlands in order to expand the acreage under cultivation with alfalfa monocrops. In more recent years, the SCS has increased the number of Chicano staff and emphasized projects in "limited resource" farming communities. Some of the more interesting projects include the introduction of regenerative and restorationist projects to assist locals in repairing damaged lands.

Water conservation is another aspect of Chicano agroecosystems that merits discussion. The acequia irrigation tradition has been criticized as wasteful and inefficient. We have seen how this criticism is most often made by state hydrologists and some environmentalists. The debate has raged for decades, with critics emphasizing the "loss" of water, since most acequias are earthen works. This has led to pressure to line the ditches with concrete to prevent the leakage of water. But the "loss" of water is a matter of perspective: The water is lost to what legal experts call "beneficial human use." From an ecological perspective, the leaking water is not lost. We have already noted that acequias create habitat niches and biological corridors and thus contribute to the maintenance of biodiversity. The water "lost" by leaking acequias

is very much a part of the local hydrological cycle. The water returns to the cycle via evapotranspiration (the evaporation of water through plant life) and aquifer recharge. These processes can contribute to cooler and wetter local microclimates: Evapotranspiration, for example, contributes to local rain cycles through convection currents that result in summer afternoon thunderstorms.

Low Mechanization/Human and Animal Power

Chicano agroecosystems are characterized by low levels of mechanization. The cultural landscape of the riparian long-lot does not lend itself easily to extensive mechanization: Most long-lots are too narrow for the use of large machinery like combines or center-pivot sprinkler systems. The huge capital expenditures required for large machinery further discourage mechanization on most Chicano farms and ranches. Historically, Chicano farmers and ranchers have relied on human and animal power for their plowing, planting, cultivating, and harvesting. As long as family labor is available for farmwork, the incentive to mechanize remains low. However, increasing mechanization is apparent on some farms and ranches. The use of tractors, moldboard plows, windrowers (swathers), and bailers is not altogether uncommon, particularly among Chicanos who produce alfalfa and hay for livestock feed. But, to the extent that farmers adopt perennial polycultures, machinery is less likely to be used as extensively.

Restoration Ecology

Given historical problems with overgrazing and soil erosion, some Chicano farmers and ranchers have adopted regenerative and restorative agricultural practices to repair damaged lands. One type of practice involves the restoration (really rehabilitation) of the native dry land grass prairie ecology that was predominant in much of the bioregion before the advent of the railroad and the commercial raising of livestock. The native blue grama prairies were overgrazed in much of the bioregion between the 1890s and 1930s (see Peña 1995a; Peña forthcoming; Peña and Martínez 1998). Restoration work in the Culebra microbasin is becoming more common as Chicano farmers, working with the SCS and other agencies, re-establish prairies using a combination of native and exotic dry land grasses.

Autarkic Prosumption

Perhaps one of the reasons for the endurance of Chicano farms and ranches is that they have always produced both for subsistence and the market. Production for subsistence, or prosumption, has stabilized the farming operations during bust cycles in the economy, insulating the smallholders against the loss of land and keeping them in agricultural production. During periods of rising market demand, Chicanos have responded by producing and delivering farm produce to the market (in this region, particularly the organic produce markets in northern New Mexico). This autarkic quality has allowed Chicano agropastoralists to survive the boom/bust cycles of the economy. Moreover, when market conditions have been poor, the local producers have turned to traditional bartering networks.

Common Property Resources

Chicano agroecosystems have traditionally relied on access to the common lands of community land grants. Access to common property resources is a critical component in the sustainability of the agropastoral tradition. The availability of common lands for limited rotational grazing, wood gathering for fuel, hunting, fishing, and wildcrafting (the harvesting of edible wild plants and medicinals) has helped to stabilize Chicano agroecosystems and reduce land degradation on the private riparian long-lots. However, enclosure of these common lands has proven profoundly detrimental to the agropastoralists. In the Upper Río Grande, enclosure has been practically universal and it has destroyed the ability of many families to remain in agriculture. The restoration of common lands is thus one of the most important unresolved issues facing the ethnoecology of Chicano farming communities. Restoration, in this context, is twofold: It involves both the ecological restoration of degraded common lands and the restoration of traditional usufructuary rights (for further discussion, see Peña 1995a; Peña and Valdéz Mondragon 1997).

Links to Market and Governmental Institutions

Chicano agropastoralists have always produced for the market and not just for subsistence; this is why there was a long tradition in the bioregion involving the construction of *carretas* (carts), which were used to transport farm produce to the market. There was a long period, from 1848 through the 1970s, when Chicano agropastoralists experienced discrimination in credit markets. Many Chicanos were denied credit by banks and other agricultural production creditors. However, this may have proven to be a blessing in disguise. Since Chicanos could not gain access to credit, they avoided debt and thus the loss of land that is often associated with indebtedness. Since the late 1970s, Chicano agropastoralists have enjoyed relatively unfettered access to credit markets and

have demonstrated their ability to use it to their advantage. It is now not uncommon for Chicanos to make use of producer credit associations and federal and private banks to expand their operations or acquire new land (see Peña forthcoming).

Like non-Chicano producers, Chicanos are establishing relationships with a variety of governmental agencies to improve and strengthen their agricultural operations. In addition to relationships with private and public sector creditors, Chicanos are working with a full range of governmental agencies such as the Extension Service, NRCS, Agricultural Stabilization and Conservation Service (ASCS), and U.S. Forest Service (USFS). Chicanos have played a key role in the establishment of soil conservation districts and are active in federal projects like the Conservation Reserve Program (CRP), designed to protect wetlands and other landscapes that provide wildlife habitat.

Conclusion

The ethnoecology of Chicano farming systems in the Culebra microbasin is characterized by the riparian long-lot/acequia cultural landscape. This ethnoecological complex promotes and protects biodiversity and represents a sustainable adaptation to local environmental and cultural conditions in high-altitude arid-zone watersheds. As an autochthonous form of local democratic self-governance, the watershed commonwealth serves two primary roles in the agropastoral community: "technical" (as in the maintenance and operation of the ditch networks) and "ethical" (as in the transgenerational reproduction of land and water conservation values). Finally, agroecological practices derived from local knowledge utilize renewable energy systems, mimic natural patterns in their species and structural diversity, preserve the diversity of heirloom germplasms, contribute to a local sense of place and land ethics, and contribute to sustainable patterns for agriculture within the regional, political, and economic context.

Cultural landscapes in Chicano agroecosystems—that is, the riparian long-lot\acequia complex—clearly present a unique set of opportunities for the protection of biological diversity. For example, from the perspective of island biogeography we might argue that these agroecosystems serve as habitat islands and biological corridors connecting larger regional islands. Under these circumstances, farming and ranching are directly productive of biodiversity because the land use pattern encourages the protection of an optimum

mix of plant and animal communities. The practices that sustain the land and water also provide stability for the agropastoral community.

There are many serious threats to the integrity of these biological island habitats. For example, the Pecos and Wheeler Peak Wilderness areas have been severely damaged by overgrazing and excessive recreational use. The Taos ski area presents a threat to the Wheeler Peak microbasin, while a molybdenum mine in Questa threatens the Red River and Latir Peaks areas. Battle Mountain Gold presents mining threats in the Rito Seco area of the Culebra microbasin, and the Forbes Trinchera, with its three subdivisions, presents a threat to the watershed from real estate development and the four hundred miles of roadway associated with widespread construction and timber operations. The Culebra Mountain Tract is currently threatened by massive logging activities involving cuts of eighty to one hundred million board feet on thirty-four thousand acres (see Peña and Valdéz Mondragon 1997). Nevertheless, the Culebra remains the primary undisturbed area between the northern and southern Sangre de Cristo. It is the only remaining, relatively intact, habitat island in the mountain corridor without protection against development and environmental degradation.

The struggle to protect the Culebra as a biological corridor between the southern and northern Sangre de Cristo mountains is developing in the context of a campaign for the preservation of rare and endangered cultural landscapes. The most vulnerable aspect of this ethnoecological complex is the need for a healthy, undisturbed watershed. Therefore the most critical public policy and organizing challenges for the farming communities of the Culebra microbasin center on land reform (that is, the restoration of a common property regime) and environmental degradation (a result of the enclosure of the commons).[24] At stake in this struggle is the preservation of a national environmental treasure and the survival of a human community that has evolved into a rare example of a human "keystone species."

Notes

1. This cultural "headwaters" bioregion includes the counties of Río Arriba, Taos, Mora, San Miguel, and Guadalupe in New Mexico, and Costilla and Conejos in Colorado. This roughly covers the distance from San Luis, Colorado, to Española, New Mexico, (approximately 130 river miles).

2. More than 99 percent of the water supply in the Upper Río Grande comes

from this headwaters bioregion in southern Colorado and northern New Mexico. Most of the water is runoff from melting snow in the high mountains. Technically, most of Mora and San Miguel Counties are in the Arkansas and Pecos River watersheds, but these are also predominantly Chicano areas and share cultural and familial ties with the rest of the "Rio Arriba." See Hay (1963:491).

3. The oldest Spanish-Mexican settlement in the Upper Río Grande was San Gabriel (settled in 1598). The oldest existing settlement is Santa Fe (settled in 1610). Most of the settlers who came to work on the land were *mestizos* (the offspring of Indian and Spanish mixtures). The Spanish-speaking peoples of the Upper Río Grande are thus primarily the descendants of indigenous mestizos and not full-blooded Spaniards. We prefer to use the term Chicano (instead of Spanish-American or Hispanic) in order to acknowledge the diverse character of the mestizo culture, which has roots in Mexican, native American, Iberian, and Moorish (north African) cultural traditions.

4. The agropastoral upland village is based on the integration of farming and livestock-raising. For more on the cultural ecology of Chicano agropastoralism see Peña (1992); Peña (forthcoming); Van Ness (1987).

5. See García (1989, 1998); Peña (1992, 1998); see also the intriguing commentary by Noss (1994).

6. Technically, the Culebra microbasin is not considered tributary to the Río Grande. Since the turn of the century (1910), when Euroamerican farmers constructed reservoirs in the watershed, the Río Culebra has not normally reached the Río Grande, twenty miles west, as a surface flow. However, the watershed is still connected to the Río Grande via groundwater aquifers.

7. The villages of the Culebra include Viejo San Acacio (settled temporarily in 1850 and permanently in 1853), San Luis (1851), San Pablo (1852), San Pedro (1852), San Francisco (1854), Chama (1855), and Los Fuertes (1860?). On the settlement of the Sangre de Cristo land grant, see Stoller (1992) and Valdéz Valdéz (1991).

8. In addition to the twenty-three acequias with original nineteenth-century water rights, there are another forty-five acequias in the Culebra microbasin with more junior surface water rights.

9. In addition, the BMG strip mine and cyanide leach vat processing mill is located on land abutting the Mountain Tract in the Rito Seco watershed; see Peña and Gallegos (1993). Since 1995, logging on the Taylor Ranch threatens the watershed with cuts of 90 to 210 million board feet.

10. Flooding is especially a problem during the "rain-on-snow" events characteristic of the area during the wet months of spring through early summer. Rain accelerates the rate at which snow pack melts, especially in exposed cut block areas.

11. For a scientific study of the impact of logging operations on the Culebra watershed see Curry (1995); see also Peña and Valdéz Mondragon (1997).

12. For more on the land rights struggle in San Luis, see La Sierra Foundation of San Luis (1995); Peña (1995a, 1998); Peña and Gallegos (1993, 1997); Peña and Valdéz Mondragon (1997); Stoller (1985).

13. For an overview of the principles of agroecology see Altieri et al. (1987).

14. Much of previous research has been done at the level of regions, communities, or land grants and not specific farms and ranches. Moreover, previous research is based on cultural-ecological and not ethnoecological principles.

15. This research is funded by a four-year grant from the National Endowment for the Humanities (NEH) with matching support from the Colorado College. The NEH study, "Upper Río Grande Hispano Farms: A Cultural and Natural History of Land Ethics in Transition, 1598–1998," is coordinated by the Río Grande Bioregions Project, a research unit of the Hulbert Center for Southwestern Studies at Colorado College. The first publication associated with this project is Peña (1998).

16. The Metis of Canada fought a war (in 1868–1870 and 1885) with the British over the imposition of the square-grid land survey system. The Metis, of French/Native Canadian mixture, were one of the few other major ethnic communities, besides the Chicanos, to make use of the riparian long-lot in North America. The Metis ultimately lost this struggle, while the Chicano cultural landscapes endured. See Howard (1952); Powell (1962:34,n.7).

17. The first to make this argument was John W. Powell (1890:111–16); see also Peña (1992); Rívera and Peña (1997); Van Ness (1987).

18. In the San Luis Valley, the long-lot is called a *vara* strip or *extensión;* in the Embudo-Velarde-Alcalde region it is called a *suerte.* The author thanks Estevan Arellano for this clarification on the regional nuances of the local vernacular terms used to describe this cultural landscape.

19. The vara is a unit of measurement used in the ancient metes and bounds system; one vara is approximately 33.3 inches wide. The vara measures width and not length. In the Iberoamerican system, length is measured by leagues (*leguas*). See Van Ness and Van Ness (1980:9).

20. We studied records in the State Engineers Office in Denver and found that center-pivot sprinkler systems use three to five times as much water as traditional acequia systems in the San Luis Valley.

21. It is interesting to note that this aspect of ranching activity has benefited from the simple technological addition of the truck. With a truck, one person can easily supervise a herd of two hundred to five hundred animals.

22. For example, during a soil survey conducted in July 1994, Robert Curry (staff watershed scientist) found that the soil horizon at the Corpus A. Gallegos Ranches in San Luis yielded an "A" horizon at least five feet deep. The only evidence of a "plow pan" was a half-inch-thick clay lens at about two feet in one of the corn *milpas.* See also Peña (1995b).

23. See Peña (1994) for more on the problem of overgrazing in Chicano farming communities.

24. The problem of land degradation is complicated by the complete enclosure of the common lands, an issue we explore elsewhere. See Peña (1995a); Peña and Martínez (1998).

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8

Conserving Folk Crop Varieties

Different Agricultures, Different Goals

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Over the last twenty-five years, a substantial investment in the conservation of crop genetic resources worldwide has been made by public and private sectors in many countries. One impetus for this conservation effort came from researchers who were alarmed at the rapid disappearance of folk crop varieties (also known as landraces) as well as the habitat of wild crop relatives (see, for example, Frankel 1970). Another motivation for crop genetic resource conservation came from observing the effect of a narrowed genetic base in the agricultural systems of industrialized countries. An example of this was the southern corn leaf blight damage in the United States in 1971, a loss of an estimated $500 million to $1 billion, or about 15 percent of the U.S. crop that year, attributed to the broad use of the same cytoplasmic male sterility gene (Walsh 1981). The result was increased concern for genetic resources and diversity that continues today under the broader title of biodiversity.

A new issue is emerging in the discussion of crop genetic resource conservation, or perhaps more correctly, it is just now beginning to be articulated (Soleri and Smith 1995), concerning the goals of conservation and some of their implications. This paper discusses the conservation of crop genetic resources, specifically folk varieties, in terms of the genetic goals of the people for whom those resources are being conserved, how different goals require different conservation strategies, and some ideas on how we can start to conduct research that specifically addresses those goals. We look particularly at farmer-breeder selection and the characteristics of folk crop varieties for insights into the genetic goals for traditional crop varieties and the people who cultivate them.