

Archive and Laboratory Embedded in the Landscape: Future of the Santa Rita Experimental Range

Abstract: The Santa Rita Experimental Range (SRER) is both an archive of past ecological research and a laboratory for continuing research embedded in the southern Arizona landscape. The scientific questions being asked there have changed over the last 100 years, but SRER with its monitoring stations and its legacy of repeat photography still offers a unique opportunity to study environmental change through time. Now that it belongs to the State of Arizona, however, the Arizona State Land Department (ASLD) could conceivably sell it for commercial development if the Arizona legislature were to revoke its special status for “ecological and rangeland research purposes” administered by the University of Arizona. As metro Tucson, Green Valley, and Sahuarita continue to experience explosive growth, State Trust Lands are being auctioned off to real estate developers. Pima County’s Sonoran Desert Conservation Plan is attempting to preserve biodiversity, open space, cultural resources, and working ranches throughout eastern Pima County. The Santa Rita Experimental Range provides one of the best opportunities to do so on State Trust Lands in the upper Santa Cruz Valley.

Assuming SRER survives for another century, several research topics suggest themselves: (1) the ecological dynamics of exotic Lehmann lovegrass and efforts to eradicate or control it; (2) the impact of urban and exurban development on native wildlife and vegetation; and (3) the development of grass-fed, hormone-free beef and the networks necessary to market it successfully. But all future research must build upon and respect the integrity of the SRER archive with its ongoing record of vegetation change, hydrological and nutrient cycles, and human efforts to manipulate them.

Introduction

The future of the Santa Rita Experimental Range (SRER) can only be comprehended within the context of the dynamic political ecology of twenty-first-century Arizona. This makes forecasting a risky proposition at best. When SRER was created in 1903, Arizona was a largely rural territory dominated by extractive industries, particularly copper mining, irrigated agriculture, and ranching. World War II transformed Arizona’s economy, triggering explosive urban growth. By the end of the twentieth century, Arizona was an overwhelmingly urban State fueled by the service and industrial sectors of its economy (Sheridan 1995). I doubt any seer in 1903 would have predicted a metropolitan Phoenix of three million people, an industrial border zone swelling like a tick on cheap labor and a multibillion dollar illegal drug trade, or a countryside transformed into a playground for urban dwellers.

Research on SRER has reflected the explosive growth of Arizona and the West. SRER was created “to protect the native rangeland from grazing and to conduct research on problems associated with livestock production” (Medina 1996: 1). When D. W. Griffiths initiated research there, Arizona was a lunar landscape in places, its grasslands denuded by more than two decades of unregulated grazing, and its woodlands decimated by indiscriminate timber and fuelwood cutting and grass harvesting (Bahre 1991; Humphrey 1987; Sayre 2002). It was a true tragedy of the commons on the open range because there were no legal mechanisms to regulate grazing or woodcutting on Arizona’s vast public domain (Sheridan 1995).

A century of rangeland reform provided the necessary regulation. The Forest Reserves, which developed into the National Forest system, first introduced exclusive grazing allotments in the early 1900s. The establishment of State Trust Lands after

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Statehood in 1912 extended a similar system to more than 10 million acres selected by ranchers, largely in Arizona's grassland valleys (Sayre 2002). Finally, in 1934, the Taylor Grazing Act regulated grazing on the rest of Arizona's Federal public domain.

Most of the research on SRER during the twentieth century focused on how to make grazing lands more productive. Range scientists developed the Santa Rita System of grazing rotation and struggled to halt the invasion of woody shrubs, particularly mesquite, onto Arizona grasslands. The needs of ranchers dominated SRER's research agenda.

But as Arizona's cities sprawled outward or leapfrogged into desert valleys and mountain meadows, urban needs began to push aside rural concerns. City dwellers wanted open space where they could hunt, fish, hike, camp, ride, and shoot. The growth of the environmental movement brought issues of biological diversity to the forefront, particularly after the passage of the Endangered Species Act in 1973. Because ever-declining proportions of the population made their living off the land, or from industries that processed timber, beef, milk, wool, cotton, or copper, the struggle to make a living in the rural West no longer dictated political debate, even though ranching and mining interests remained disproportionately strong in the Arizona legislature. New and powerful constituencies that privileged recreation or biodiversity over resource extraction increasingly challenged ranchers, loggers, and miners over the management of public lands.

By the beginning of the twenty-first century, researchers were increasingly turning to SRER to ask questions that had nothing to do with range management or beef production. Eleven of the 26 current projects (42 percent) on SRER focus on ecological or geological questions unrelated to range issues, including termite biology and control, the behavior of the swallow-tail butterfly, and seismic imaging of the Santa Rita Fault (Peter Else, personal communication). Even several of the studies that factored in the impact of grazing did so in order to study rates of carbon and nitrogen sequestration in the soil. Such research was driven by climatological, not range management, concerns. SRER had developed into a landscape laboratory with an ever-broadening ecological mission.

State Trust Lands

Meanwhile, residential development crept closer and closer to the boundaries of SRER. The status of SRER itself was not really threatened for the first 73 years of its existence because it belonged to the Federal Government. But in 1988, a convoluted land swap to create Buenos Aires National Wildlife Refuge in the Altar Valley transferred SRER to the Arizona State Land Department (ASLD). Arizona Senate Bill 1249 stipulated that SRER would be utilized by the University of Arizona for "ecological and rangeland research purposes...until such time as the legislature determines the research can be terminated on all or parts of the lands." Given the budget cuts imposed on Arizona universities over the past 15 years, those words are hardly comforting. The fate of the SRER will depend on how the Arizona Legislature values the promotion of research and conservation of open space.

State Trust Lands will be the defining battleground between the forces of development and conservation during the early twenty-first century. Arizona currently has 9,471,000 acres of State Trust Lands, more than any other State in the Union (table 1). Nearly 90 percent of this acreage (8,457,000 acres) is grazed under a system of leases, generally for 10-year periods, unless classified for commercial sale. Until recently, those leases were preferential, but court cases instigated by environmental and public education advocacy groups have initiated an open bidding process. One possible unintended consequence of those decisions is a greater vulnerability to development on State Trust Lands.

Arizona's State Trust Land system began when the Territory of Arizona was established on February 24, 1863. The Act of Congress granted the new territory sections 16 and 36 of each township for the benefit of the "Common Schools." The State Enabling Act (Section 24) of June 20, 1910, allotted two more sections of each township (2 and 32). Four sections of every township in the new State were to be held in trust for public schools. The Enabling Act (Sec. 25) also gave Arizona an additional two million acres to benefit other public institutions including penitentiaries, insane asylums, miners' hospitals, and normal schools (ASLD Historical Overview 2003).

To administer those lands, Arizona's first State Legislature established a three-member State Land Commission.

Table 1—Ten States with Trust Lands greater than one million acres^a.

State	Year of Statehood	Acres granted	Sections granted	Acres in 1995 ^a	Percent original
Arizona	1912	8,093,000	6, 16, 32, 36	9,471,000	117
New Mexico	1912	8,711,000	6, 16, 32, 36	9,217,000	106
Montana	1889	5,198,000	16, 36	5,132,000	99
Utah	1896	5,844,000	6, 16, 32, 36	3,739,000	64
Wyoming	1890	3,473,000	16, 36	3,602,000	104
Colorado	1876	3,686,000	16, 36	2,858,000	78
Washington	1889	2,376,000	16, 36	2,812,000	118
Idaho	1890	2,964,000	16, 36	2,404,000	81
Nebraska	1867	2,731,000	16, 36	1,514,000	55
Oregon	1859	3,399,000	16, 36	1,438,000	42

^aAdapted from Souder and Fairfax 1996.

The Commission wisely decided not to sell State Trust Lands but to manage them for their “highest and best use.” The Commission also recommended that a State Land Department be created to oversee such management in order to maximize revenues for the beneficiaries. The Arizona legislature accepted those recommendations and created a State Land Code in 1915 (ASLD Historical Overview 2003).

Because homesteaders, miners, Indian reservations, National Forests, and other Federal entities had already withdrawn the designated school sections in many townships, the Enabling Act (Sec. 24) granted Arizona the right to select an equal amount of in lieu lands from the Federal public domain. The Arizona State Selection Board, which consists of the Governor, Attorney General, and State Land Commissioner, carries out this process. The board selected most State Trust Lands between 1915 and 1960, through both in-lieu selection and land exchanges with the Federal Government. Those exchanges were originally engineered to create blocks of State Trust Lands rather than isolated sections.

Homesteaders had already preempted most arable land. Federal law prevented the State from acquiring mineral lands. Consequently, the State Selection Board concentrated on acquiring the best grazing lands in Arizona (ASLD Historic Overview 2003). In fact, ranchers often hired brokers in the Arizona State Capitol of Phoenix to make sure the lands they wanted to lease made it through the selection process. As a result, State Trust Lands constitute much of the nonprivate land in Arizona’s grassland valleys, particularly in the central and southeastern parts of the State (Sayre 2002).

As Arizona’s urban centers have expanded, these lands have also become the most attractive for residential development, particularly when they are within an hour’s drive of metropolitan Phoenix, Tucson, Flagstaff, or Prescott. The relentless expansion of metropolitan Phoenix has chewed up much of the private ranch lands originating as homesteads in the Salt River Valley. Moreover, metro Phoenix’s demand for second homes at higher elevations has fueled the conversion of private ranch lands into subdivisions from Kingman

to the White Mountains. Metropolitan Tucson, about 25 percent as large as metro Phoenix, has generated the same relentless demand across much of southeastern Arizona.

As developers run out of private land to subdivide, they are going to exert ever-greater pressure on ASLD to sell off State Trust Lands. ASLD can do so under Arizona’s Enabling Act and Constitution, which mandate that State Trust Lands be managed for their beneficiaries, which now number 14 (table 2). As trust law evolved from its British common law origins, both public and private trusts interpreted “highest and best use” to be the maximization of revenues, not the conservation of natural resources or the preservation of open space or biological diversity (Souder and Fairfax 1996).

For much of the twentieth century, ASLD determined “highest and best use” to be grazing leases. In part, this reflected the low demand for State Trust Lands outside the Phoenix and Tucson basins. Ranchers were also the most powerful constituency of ASLD. The sale or lease of State Trust Lands had to be advertised and opened to competitive bidding at public auctions, where they had to be leased or sold to the “highest and best bidder” (Arizona Enabling Act, Sec. 28). But Section 28 of the Enabling Act also stipulated, “Nothing herein contained shall prevent: (1) the leasing of any of the lands referred to in this section, *in such manner as the Legislature of the State of Arizona may prescribe* (italics mine), for grazing, agricultural, commercial, and domestic purposes, *for a term of five years*” (Arizona Enabling Act 2003). In 1936, the 74th Congress amended the Enabling Act to extend that period to 10 years. The Arizona Constitution (Article 10, Sec. 3) states, “Nothing herein, or elsewhere in article X contained, shall prevent: 1) The leasing of any of the lands referred to in this article in such manner as the legislature may prescribe, for grazing, agricultural, commercial and homesite purposes, for a term of ten years or less, without advertisement” (Arizona Constitution 2003) Ten-year grazing leases became preferential, with current holders able to renew their leases without competition (Sayre 2002).

Table 2—Beneficiaries of Arizona State Trust Lands^a.

Beneficiary	Acres in FY 2001	Percentage of total
Common Schools (K-12)	8,107,420	87.4
Normal Schools	174,808	1.9
University Land Code	138,125	1.5
Agricultural and Mechanical Colleges	125,234	1.4
School of Mines	123,558	1.3
School for the Deaf and Blind	82,662	0.9
Military Institutes	80,168	0.9
State Charitable, Penal, and Reformatory Institutions	77,753	0.8
Penitentiary	76,333	0.8
State Hospital	71,249	0.8
Legislative, Executive, and Judicial Buildings	64,406	0.7
University of Arizona	54,591	0.6
Miners’ Hospital (1929)	47,843	0.5
Miners’ Hospital	47,771	0.5
Total	9,271,921	

^aAdapted from Arizona State Land Department Historic Overview 2003.

As Phoenix and Tucson grew, however, other constituencies challenged the ranchers. Until 1966, many States permitted their trust lands to be dedicated to transportation rights-of-way and other uses that did not generate revenue. But in *Lassen v Arizona Highway Department*, the U.S. Supreme Court ruled, "The Enabling Act unequivocally demands both that the trust receive the full value of any lands transferred from it and that any funds received be employed only for the purposes for which the lands were given" (quoted in Souder and Fairfax 1996). The Arizona legislature reinforced the intent of that decision when it passed the Urban Lands Act in 1981. The act allowed ASLD to include higher land values generated by surrounding planning and zoning regulations in its assessment of full value. In the words of ASLD, "Today the Land Department's urban lands lease and sale program is the largest revenue producer for the Trust" (SLD Historical Overview 2003: 3).

The Arizona State Land Department goes on to say, "Nearly all the most valuable urban Trust land around the northern border of the Phoenix metropolitan area and north and west of Tucson are Common Schools Trust lands. The large block of Trust lands on the south and southeast sides of the Tucson metropolitan area is divided amongst the various institutional Trusts" (SLD Historical Overview 2003:3). The ASLD also notes that 1,628,079 acres of State Trust lands have been sold or exchanged during the 88 years since Statehood (1912–2000).

That figure will undoubtedly increase during the twenty-first century. One report of Pima County's Sonoran Desert Conservation Plan (SDCP) notes that 53,000 acres of State Trust Lands have been reclassified for commercial sale or lease within a 25-mile radius of I-10 and I-19 in Tucson (SDCP Our Common Ground 2000: 11). A recent article in the *Arizona Daily Star* notes that the ASLD is planning to auction off 1,500 acres on the northeast corner of Houghton and Valencia in southeastern Tucson. The city of Tucson's Comprehensive Planning Task Force allows up to eight residential units per acre in the area, so more than 10,000 homes could be constructed on those 1,500 acres alone. Vistoso Partners, LLC, bid \$29.1 million for 1,071 acres of State Trust Lands on the northwest corner of Houghton and Valencia in 2002, almost twice the appraised value of the land (Grubbs 2003).

Such reclassifications affect State Trust Lands that directly border on SRER. As land values escalated south of metropolitan Tucson and along the I-19 corridor, ASLD imposed 5-year limits on 16 grazing permits in eastern Pima County. Eight of these Special Land Use Permits (SLUPs) occur in the Upper Santa Cruz Valley watershed. They comprise 49,000 acres, encompassing 11 percent of the entire area. The largest SLUP runs from Los Reales Road on the north to SRER on the south. Its western boundary is the Santa Cruz River and its eastern border is Corona de Tucson. Ranchers grazing SLUPs can be evicted in 30 days even if their permits are current. Moreover, they will not be reimbursed for any improvements on the State Trust Lands in question. In other words, SLUPs are State Trust Lands reclassified for commercial sale or lease that permit grazing on an interim basis only (SDCP Our Common Ground 2000: 45). Most of the State Trust Lands surrounding SRER will most likely be auctioned off and developed during the next 50 years.

Recently, advocacy groups like the Arizona Gamebird Alliance and Forest Guardians have won several court challenges to ASLD's preferential grazing leases. As it stands now, environmental groups—and developers—can bid against ranchers who have long incorporated grazing leases on State Trust Lands into their ranching operations. Competitive bidding is in its infancy, but it has the potential to drive ranchers who depend on State Trust Lands out of business. Say, for example, a developer wanted to build a subdivision or a resort on a mixture of private and State Trust Land in eastern Pima County. If that developer has deep pockets, he/she could cherry pick State Trust Land grazing leases by outbidding ranchers who have run their cattle on those leases for a generation or more. The removal of such leases would destroy the economic viability of the ranches in question. And because few ranchers can afford to wait 10 years until the leases come up for bid again, the ranchers would be forced to sell their private lands to the developer or subdivide it themselves.

Such cherry picking would accelerate the transition from ranching to real estate development and fragment a once-open landscape. Wildlife corridors would be disrupted. Fire as a natural process or a landscape management tool would be removed from the toolkit. Both legal and illegal recreational impact on the surrounding lands would increase. Biological diversity as well as the ranching economy would suffer (Sheridan 2001).

There is a growing movement to modify the mandate of ASLD and allow some State Trust Lands to be managed for conservation, not maximum economic returns. A broad coalition of environmental groups including The Nature Conservancy, Sonoran Institute, Grand Canyon Trust, and Arizona League of Conservation Voters drafted a proposal to put an initiative concerning State Trust Land Reform on the 2002 ballot. Before doing so, however, a working group of stakeholders encompassing educators, ranchers, developers, conservationists, and business representatives held a series of meetings to see if they could develop an initiative all could support. The working group failed to reach consensus in time for the 2002 elections. The group therefore agreed to continue meeting to hammer out an initiative for 2004. They also signed a forbearance agreement not to undermine the dialogue until they had arrived at a consensus or decided to disband (Arizona League of Conservation Voters 2003).

Despite this delay, the Arizona legislature had already taken a first step to conserve selected State Trust Lands. In 1996, legislators passed the Arizona Preserve Initiative (API). Amended several times since then, API strives to preserve portions of State Trust Lands in and around urban areas as open space. API defines conservation as "protection of the natural assets of State Trust Land for the long-term benefit of the land, the beneficiaries, lessees, the public and unique resources such as open space, scenic beauty, protected plants, wildlife, archaeology, and multiple use values" (ASLD Arizona Preserve Initiative Program 2003: 1).

The Arizona Preserve Initiative also created a process to reclassify State Trust Lands for conservation purposes. Citizens groups, State and local governments, and State land lessees can petition the State Land Commissioner to nominate State Trust Lands for reclassification. After public hearings and studies of the impact of reclassification on

current lessees have been carried out, the Commissioner may reclassify the land in question, enabling it to be leased for up to 50 years or even purchased for conservation purposes. In 1998, Arizona voters provided a funding mechanism for API when they approved Proposition 303, the so-called Growing Smarter Initiative. Proposition 303 allocated \$20 million per year for 11 years to lease, buy, or purchase development rights on State Trust Lands “to conserve open spaces in or near urban areas and other areas experiencing high growth pressure” (Arizona State Parks 2003: 2). As metropolitan Tucson moves south, SRER is likely to qualify for acquisition under those guidelines.

Unfortunately, API has also been challenged. In Tucson, Pima County planned to purchase Tumamoc Hill in Tucson, where the century-old Desert Laboratory is located, and convey it to the University of Arizona. Negotiations have been suspended until the challenge is resolved. If the challenge is ultimately defeated, however, API may offer a mechanism, albeit a potentially expensive one, to preserve SRER in the rapidly developing Santa Cruz Valley. Without additional protection through API—or through the much more difficult process of amending the Enabling Act and Arizona’s constitution to make conservation one of ASLD’s mandates—the Arizona legislature will be increasingly tempted to revoke SRER’s protected status and auction it off to the highest bidder.

Metropolitan Tucson and Urban Sprawl in the Santa Cruz Valley

Development is already lapping at the borders of SRER. Private (156,455 acres; 35 percent) and State Trust Lands (212,745 acres; 47 percent) compose a whopping 82 percent of the Upper Santa Cruz River Valley (449,684 acres) where SRER is located (SDCP Our Common Ground 2000: 40). Private and State Trust Lands abut most of the northern and western boundaries of SRER. The expansion of Green Valley has already spun off several high-end subdivisions including Rancho Sahuarita and Quail Creek along the northwestern side of SRER. Because voters in Green Valley have turned down several attempts to incorporate the community, however, it is difficult to disaggregate Green Valley growth trends from eastern Pima County as a whole.

The formerly agrarian community of Sahuarita, on the other hand, incorporated in 1994, when it had a population of 2,159 residents. Ironically, it did so to preserve its rural character from Green Valley encroachment. Since then, Sahuarita’s population has jumped to 3,242 according to the 2000 census, and its estimated population in July 2002 was 5,455. According to the Pima Association of Governments (2000: 5), “Dramatic growth is anticipated in Sahuarita, both in land size through annexation activity, and in population growth resulting from the development of a 2810 acre master planned residential community. Sahuarita’s growth rate was 99.02% between 1990 and 2000.” In the last decade, Sahuarita has embraced, not restricted, growth.

In 1996, the Pima Association of Governments projected a population of 23,374 in Sahuarita in 2050. That projection is probably low. Sahuarita and other communities in the Santa Cruz Valley will develop even faster in the next

20 years as the City of Tucson expands south and south-east, where private and State Trust Lands have fewer endangered species issues to impede development as they have done in the northwest part of Tucson. Municipal planners anticipate that both Houghton and Sahuarita roads will become major corridors of residential development as well as transportation as metro Tucson’s population continues to increase. This will intensify development north and east of SRER in addition to accelerated development along the I-19 corridor in the Green Valley-Sahuarita areas.

Even though medium- and high-density developments are being built in southeastern Tucson and Green Valley, other residential and commercial development will undoubtedly mimic long-established patterns in metropolitan Tucson itself. Ever since the 1960s, Tucson’s growth has been increasingly land extensive. In 1930, when Tucson’s population was 32,506, there were 4,526.7 persons per square mile in the city. That density rose slowly through the 1960 census, and then began to fall: 3,306.0 in 1970; 3,344.1 in 1980; 2,573.3 in 1990; and 2,490.7 in 2000. In 1990, a staggering 35 percent of land within the incorporated limits of the City of Tucson was undeveloped. Because land is generally cheaper on the edges of an urban center, demand and the housing market have provided bigger lots in new subdivisions, not greater urban densities and infilling within existing municipal boundaries. The result is urban sprawl and exurban leapfrogging as 13 acres of desert a day—nearly 5,000 acres a year—are bulldozed.

A consensus seems to be emerging among City of Tucson and Pima Association of Governments prognosticators that eastern Pima County will have a population of about 1.7 million people by 2050, twice as many people as live here now (table 3). Like estimates in the past, those projections may be too high (Pima County 2002). Regardless of the numbers, however, growth will be relentless. If Pima County’s ambitious Sonoran Desert Conservation Plan goes into effect, much of that growth will be channeled south and southeast of metro Tucson. That puts SRER on a collision course with urban sprawl and exurban leapfrogging.

Even if SRER itself escapes development and is preserved as open space devoted to scientific research, the impacts of development will nonetheless intensify. SRER has been open to hunting since it came under the jurisdiction of ASLD. Traffic from drug runners and undocumented

Table 3—Population projections for Pima County^a.

Year	Arizona	Pima County
1999	4,595,375	836,153
2000	4,961,950	854,329
2010	6,145,125	1,031,623
2020	7,363,625	1,206,244
2030	8,621,050	1,372,319
2040	9,863,625	1,522,615
2050	11,170,975	1,671,182
Change 1999 to 2050	6,575,600	835,029
Percent change 1999 to 2050	143.1	99.8

^aAdapted from Pima Association of Governments and Arizona Department of Economic Security (based on July 1, 1996).

workers seeking employment also has intensified in the last decade and shows no signs of abating. As any rancher in southern Arizona will tell you, more hunters, target shooters, drug runners, and undocumented crossers mean more open gates, cut fences, punctured water lines, and trash. Such traffic also jeopardizes the safety of researchers and the security of research equipment.

Increasing numbers of people living along SRER's borders will also increase other legal and illegal activities as well—poaching, wildcat dumping, pothunting of archaeological resources, vandalism of research equipment, soil disturbance resulting from ORVs, and depredation of wildlife by pets or abandoned cats and dogs. To ensure the integrity of the landscape, not to mention safety and security of personnel and equipment, SRER will have to intensify its onsite vigilance or risk seeing its research resources seriously erode.

Sonoran Desert Conservation Plan

One glimmer of hope is a rising demand for open space among residents of eastern Pima County, including people in Green Valley and other communities of the Upper Santa Cruz Valley. In 1999, a coalition of environmentalists, astronomers, and neighborhood associations in Green Valley and Elephant Buttes persuaded the Pima County Board of Supervisors to reject a request for rezoning the southern half of the historic San Ignacio de la Canoa Land Grant comprising some 6,000 acres by Fairfield Homes. It was the first time the Board of Supervisors—by a vote of 4 to 1—had denied a major rezoning in 25 years (Hadley 2000; Sheridan 2000). A series of occasionally bitter negotiations eventually resulted in an approved rezoning that allowed Fairfield Homes to build homes and a golf course west of I-19 and to develop commercial properties along a strip east of the freeway around the Canoa Road interchange. Approximately 4,800 acres, or 80 percent of Canoa Ranch, on the other hand, was not rezoned. Pima County later purchased that portion of the Canoa land grant as a county preserve.

Similar battles over rezoning and development are being waged across eastern Pima County. The most comprehensive attempt to control urban growth and to protect biodiversity, cultural resources, working ranches, and open space is Pima County's Sonoran Desert Conservation Plan (SDCP). The listing of the cactus ferruginous pygmy owl as endangered in 1997 triggered the SDCP. In 1998, the Pima County Administrator and his staff decided to seek a Section 10 permit under the Endangered Species Act (ESA) to avoid site-by-site battles over development and to protect the County from lawsuits brought by environmental groups such as the Center for Biological Diversity. A Section 10 permit requires a permittee to develop a Habitat Conservation Plan (HCP). In return for adopting specified conservation measures and practices designed to minimize and mitigate impacts on covered species, an HCP protects the permittee from being sued or prosecuted for incidental take. HCPs are designed to protect critical habitat while at the same time offering security to property owners and municipalities on lands that are not so designated.

Rather than simply applying for a permit covering the pygmy owl, however, the County decided to develop a multispecies HCP to avoid expensive and time-consuming species-by-species mitigation. At the time, eastern Pima County was home to seven species that already had been listed as threatened or endangered, and 18 more that had been proposed or petitioned. The County therefore initiated a process to identify other "species of concern." Pima County wanted an HCP that would channel urban growth and development into areas of lower biological diversity while protecting core areas of critical habitat for listed species and other species that might be listed in the future. In addition, Pima County sought to update its Comprehensive Land Use Plan and included conservation of cultural resources, working ranches, riparian areas, and mountain preserves.

To determine which species needed to be protected, the County created a Science Technical Advisory Team (TAT) composed of wildlife biologists and agency personnel who manage wildlife. It also hired a biological consulting firm—RECON of San Diego—to prepare an HCP that would serve as the *biologically* preferred alternative. "The goal of the Science TAT and RECON was to identify vulnerable species of concern and their potential critical habitats. The County attempted to erect a so-called "firewall" to shield the Science TAT and RECON from political pressure" (Davis 2001). The two independent peer reviewers of the Sonoran Desert Conservation Plan—Reed Noss, Ph.D., and Laura Hood Watchman, M.S.—praised Pima County's "demonstrated commitment to keeping science insulated from politics....The autonomy of the scientists (including the STAT, the consultants, and the expert reviewers) in the Plan allows them to exercise their best scientific judgment about what it takes to fulfill the primary goal of the conservation plan—preserving the biodiversity of the region" (Noss and Watchman 2001).

The County also established a Cultural Resources TAT to identify where vulnerable archaeological and historical sites were located. Not surprisingly, the greatest densities of such sites were along riparian corridors, which were the areas of greatest biological diversity as well.

Thirdly, the County set up a Ranch Conservation TAT. The County pointed out that working ranches had defined metropolitan Tucson's urban boundaries for more than a century. Despite the objections of some environmentalists, it also argued that keeping working ranches in business was the cheapest and most effective way to preserve open space in eastern Pima County. Despite some later problems, this recognition encouraged ranchers to participate in the process.

The County assigned staff to the three TATs and charged them with gathering information to help develop the HCP. During the first 4 years of the SDCP, however, the Science TAT and RECON received the lion's share of the resources because Federal funding for SDCP was restricted to the biological elements of the plan. After several years of intense consultation and review, the Science TAT identified 55 species of concern. RECON then crafted the biologically preferred alternative, proposing a system of biological core reserves, which were renamed Biological Core Management Areas. The criteria for selection were areas where there were "high potential habitat for five or more vulnerable species, special elements (e.g. caves, perennial streams, cottonwood-willow forests), and other unique biological features." The

County went on to say, “Land use and management within these areas will focus on conservation, restoration, and enhancement of natural communities, with provision for other land uses that are consistent with improvement of conditions for ‘vulnerable species,’ soils, and native vegetation” (CLS Map 2/2002). Biological Core Management Areas encompass more than 800,000 acres—one-third of eastern Pima County (2,443,141 acres). SDCP therefore became the largest HCP being proposed in the United States.

The Santa Rita Experimental Range is considered part of a Biological Core Management Area except for the northwestern corner, which is called a “Scientific Research Management Area.” The County therefore wants SRER—some 53,159 acres—to remain undeveloped and free of any land uses that would diminish or destroy critical habitat. One of the major limitations of SDCP, however, has been the refusal of the State Land Department to participate. Despite its location within a Biological Core Management Area, the County could not prevent the State Land Department from leasing or selling SRER as commercial property if the Arizona legislature were to revoke its special status as a research range. Both Tumamoc Hill’s Desert Laboratory and SRER were established in 1903 to monitor desert and grassland environments. It is ironic that during their centennial year, both may be threatened by sale and development.

Archive and Laboratory Embedded in the Landscape

As the Upper Santa Cruz Valley develops, open space will become even more precious for ecological as well as aesthetic reasons. SRER provides the largest bridge in the wildlife corridor linking the northern Santa Rita Mountains to the Sierrita and Cerro Colorado Mountains to the west. This corridor has been fragmented by development in and around Green Valley and Sahuarita. The I-19 freeway also truncates the corridor by imposing a perilous obstacle to mammals and reptiles attempting to move east and west. In the future, however, animal-friendly underpasses may be constructed. The conservation of Canoa Ranch was a critical first step in maintaining this corridor. Keeping SRER development free would be an essential second step. A third major step—the preservation of Sopori Ranch, which straddles Pima and Santa Cruz counties—will require much more mobilization and money to achieve.

The Santa Rita Experimental Range, however, is far more than open space or wildlife habitat. As the oldest active research range in the United States, SRER is both a landscape laboratory and a unique ecological archive with a century of research embedded in its soil, watersheds, and vegetation. If scientists are ever going to understand the complexities of arid and semiarid ecosystems, they have to be able to conduct long-term studies that preserve, and build upon, the studies of the past. Synchronic snapshots of a landscape, like those of a culture ethnographers engender, are nothing more than stages in the process of investigating dynamic, ever-changing systems. Taken alone, they may offer simplistic, distorted, even misleading glimpses of the system in question. Short-term economic considerations must not be allowed to obliterate the soils and vegetation

that encode these 100 years of past research in their ever-changing physical, chemical, and community structures.

It is impossible to foresee all future research directions that may arise during the next 100 years. SRER will probably never be dominated by research designed to improve the livestock industry as it was for much of its first century. Grazing is a relatively small part of Southwestern economies now, and scientists are responding to other constituencies and other concerns. More to the point, the notion that SRER—or any other experimental range or biological reserve, for that matter—can serve as an ecological analogue for an entire region has been undermined, as the limitations of Clementsian equilibrium models of plant succession and climax vegetation communities in semiarid regions have been exposed. Landscapes are ever-changing products of historical forces, both natural and anthropogenic, not Platonic templates waiting to be restored to their true essences. Range science—and the accumulating experience of conscientious ranchers—increasingly recognize that range management must be tailored to individual landscapes as they change from season to season and year to year (Sayre 2001).

That same appreciation for the historical dynamism of semiarid ecosystems applies to nonrange ecological research as well. But as the validity of atemporal space is challenged, a growing appreciation for time has surged. Using repeat photography, Rodney Hastings and Raymond Turner (1965) drew attention to the importance of historic climate change 40 years ago in their classic *The Changing Mile*. Turner and his colleagues have recently updated that work, carefully evaluating the “tangle of hypotheses”—both “climatic and cultural”—advanced to explain vegetation change in the Sonoran Desert region (Turner and others 2003: 276). Researchers like David Griffiths (1904, 1910), Wooten (1916), and Parker and Martin (1952) pioneered the technique on SRER. As McClaran (this proceedings) notes, “Currently, the repeat photography collection is one of the largest and most accessible in the world.”

The Santa Rita Experimental Range also has provided a laboratory for the systematic remeasurement of precipitation patterns, vegetation, and experimental manipulations of the landscape. Again, to quote McClaran (this proceedings), “The most incontestable conclusion from this century of vegetation change is that future changes can not be perceived and understood if there are no records of previous conditions.” Such systematic remeasurement has enabled scientists to understand the cyclic nature of burroweed and cholla cactus eruptions, to refine estimates of grass response to grazing intensity, to untangle the hypotheses for the spread of mesquite across Southwestern grasslands, and to recognize the temporal limitations of mesquite-eradication programs. Systematic remeasurement is SRER’s greatest scientific legacy—the most important reason why the integrity of SRER must be preserved. The preservation of that integrity must be carried out at the landscape level by protecting SRER from development or any other impacts that would compromise it as a research laboratory. At the same time, however, preservation must extend to the site level as well. Future experiments must build on the records of the past, and must not interfere with the records of the past. SRER is both a laboratory *and* an archive. Future experimental manipulations of the landscape, whether of

vegetation, soils, or watersheds, should be carefully conducted so they do not diminish or destroy past experiments already embedded in the landscape.

Future Research Directions _____

As I noted at the beginning of this paper, it is impossible to predict all future directions of research on SRER. Nonetheless, I do have a number of suggestions. Currently, tremendous emphasis is placed upon the invasion of non-native exotic species into Southwestern ecosystems and the need to eradicate them and “restore” those ecosystems to some sort of preinvasion state (Tellman 2002). The most widespread exotic invader on SRER in particular and on southeastern Arizona grasslands in general is Lehmann lovegrass (*Eragrosis lehmanniana*). Biological reserves such as the Buenos Aires Wildlife Refuge have devoted considerable resources of money and manpower to combating this perceived threat, without much success.

The Santa Rita Experimental Range should serve as a laboratory to better understand the dynamics of Lehmann lovegrass and to evaluate the effectiveness of manipulations to control or eradicate it. Is its current dominance on some Southwestern grasslands a long-term change or a short-term fluctuation? What sort of systemic changes does its dominance trigger in grassland ecosystems? Is the genie out of the bottle or can the genie be shoved back into the bottle and the bottle corked? And if so, how much time and money is it going to take to do so?

Another research topic garnering enormous attention is the role of fire in grassland and forest ecosystems. Both ranchers and agency land managers alike are re-examining the fire suppression policies of the past and exploring the benefits of letting naturally ignited fires burn. Prescribed fires are also being set to reduce fuel loads, curtail the spread of woody shrubs like mesquite, and improve the productivity and abundance of perennial grasses. Greater experimentation with fire on SRER is problematic for several reasons, however. One has nothing to do with ecology and everything to do with rising property values. Despite increasing recognition of the ecological benefits of fire, agencies continue to suppress any fires within a 5-mile radius of existing commercial or residential structures. As the transition from ranching to real estate development accelerates in the Upper Santa Cruz Valley, the political latitude to let fires burn or to carry out prescribed burns will continue to shrink.

An additional concern is the need to preserve the integrity of previous research on SRER. Any decision about whether to let a natural fire burn or to set a prescribed fire has to be carefully weighed against the “noise” such a fire might introduce into research involving ongoing systematic remeasurements of hydrologic and nutrient cycles, species composition, and other variables. Moreover, the greater adaptability of Lehmann lovegrass over native perennial grasses to fire has to be taken into consideration. Future research directions on SRER must always recognize and mitigate their impacts on long-term studies of environmental change.

Rapid urbanization will, on the other hand, provide wildlife biologists with greater opportunities to investigate the impacts of development on desert grassland fauna. Wildlife

biologists should be encouraged to set up long-term monitoring systems to measure those impacts in a systematic fashion rather than conducting short-term studies of individual species. Aside from climatic change, no other factor is going to influence wildlife dynamics to a greater extent than urban, suburban, and exurban development in the rural West.

Those same forces will affect SRER in other ways that should be studied as well. The spread of exotic plant species from neighboring subdivisions, shopping centers, and roads, the ecological effects of legal and illegal recreational activities, the impact of increased lighting and microclimatological changes brought about by urban heat islands and air pollution—these are just some of the anthropogenic factors that undoubtedly will modify the environment on as well as around SRER. SRER was created to serve rural interests at a time when Arizona was a largely rural society. The balance tipped more than a half-century ago, and now SRER is poised to explore the urban-rural interface that is transforming the State.

Future of Public Lands Ranching _____

But what of SRER’s original mission—range research? In the early 1900s, both scientists and ranchers alike recognized the degradation of Southwestern ranges because of the lethal intersection of overstocking and prolonged drought. At that time, however, livestock grazing was still considered the highest and best—indeed often the only—use of much of Arizona’s arid and semiarid terrain. SRER was designed to demonstrate how ranges could be restored, and how ranching could become a sustainable industry.

Today, many environmentalists call for an end to livestock grazing on Western public lands. Even when ranching is still considered a legitimate use of Forest Service, Bureau of Land Management, and State Trust lands, ranchers have to compete with an ever-growing number of other constituencies—hikers, campers, hunters, birders, and offroad vehicle users, among others—who demand a voice in how public lands are managed. At a time when the costs of inputs continue to rise while cattle prices stagnate, in the midst of another prolonged drought, ranchers face increasing government regulations and a volatile political climate. When you combine these “push” factors with skyrocketing prices for private lands, it is hardly surprising that many ranchers sell out to developers or subdivide their private lands themselves (Knight and others 2002; Sayre 2002; Sheridan 2001).

Is there a future for public-lands ranching in the West? That question is beyond the scope of this paper to answer, even though many of us believe that sustainable ranching should be encouraged for a variety of economic, ecological, and social reasons. One possible strategy to diversify cattle ranching is the development of niche markets for beef. Growing numbers of consumers are becoming increasingly health conscious and environmentally sensitive. The nonvegetarians provide a growing market for beef that is not injected with hormones and finished in feedlots. Moreover, they may prefer to buy locally produced beef because it is so much more energy efficient. And for those consumers who

oppose the killing of predators such as mountain lions and coyotes, and who support the reintroduction of Mexican gray wolves, beef certified as predator friendly may be attractive. But as Will and Jan Holder of Ervin's Beef in eastern Arizona have discovered, such beef is difficult for individual producers or even small groups of producers to achieve.

The Santa Rita Experimental Range has a unique opportunity to explore and nurture such alternative strategies. Experiments in the production of grass-fed, hormone-free, and predator-friendly beef could be conducted on SRER. And because SRER is managed by the University of Arizona, University marketing specialists, agricultural economists, and anthropologists could identify potential markets and investigate ways in which to get those products to consumers. The development of linkages between Arizona producers and Arizona consumers would reduce energy costs, stimulate local economies, and serve as a modest counterpoint to the relentless globalization of the beef industry. This, it seems to me, would be an eminently reasonable twenty-first-century application of the University of Arizona's original land-grant mission.

Conclusions

To ensure that SRER remains intact as a landscape laboratory and archive, the University scientists and staff who manage it need to aggressively build a political constituency—within the University, the State Land Department, the Arizona legislature, and among the public—that will resist any attempt to reverse its special legislative status. More quietly, but just as decisively, SRER advocates should reach out to political allies who will convince the State Land Department and the Arizona legislature to give it special conservation status, either under the Arizona Preserve Initiative or as part of more general State Trust Land reform. Now that SRER will have a manager for the first time since it was transferred to the State Land Department, the manager and the scientists who work with him should establish contacts with the groups who joined together to fight the development of Canoa Ranch. These include environmentalist organizations such as the Coalition for Sonoran Desert Protection, the Smithsonian's Whipple Observatory, and neighborhood associations and citizen's groups in Green Valley and Elephant Butte. Pima County, the University of Arizona, and perhaps even Coronado National Forest also have an interest in keeping SRER as a research range free of development.

Ironically and paradoxically, the very people who move into subdivisions creeping closer and closer to the borders of SRER may become SRER's most enthusiastic advocates. The conservation of 56,000 acres of open space and desert grassland just beyond their back doors should be an attractive proposition for SRER's new neighbors. SRER cannot do much to stem the tide of development around it, so it should embrace the newcomers and let them know what a unique scientific and ecological resource they live next to. A "Friends of SRER" should be formed. Retired professionals should be invited to become stewards of both archaeological and research sites to increase on-the-ground vigilance to prevent vandalism and other illegal activities. Lecture series and field trips focusing on grasslands research and sustainable

ranching should be offered. As anyone who does much public speaking in southern Arizona knows, Green Valley audiences are large and appreciative. Rather than waiting until its status may be threatened, SRER should take positive steps to increase its public visibility and build constituencies that support it.

Research on SRER should also embrace the inevitable. The threats posed by encroaching development can also be turned into opportunities. As more and more desert and grassland valleys are fragmented by subdivisions across Arizona and the West, the need for precise, long-term ecological studies of landscape fragmentation and population growth becomes ever more acute. SRER is a biological reserve in the path of growth, so it is uniquely well positioned to investigate growth's impact upon the flora and fauna of the Upper Santa Cruz Valley.

Finally, SRER should not abandon its first patrons—the ranchers of the Southwest. As Ruyle (this proceedings) points out, many of the principles of sustainable ranching in the semiarid West were tried and tested on SRER. Fundamental monitoring techniques were pioneered there as well. The Santa Rita Experimental Range helped ranchers reverse the degradation of Southwestern ranges and meet the economic and ecological challenges of the twentieth century. It should continue to assist them to meet the very different challenges the twenty-first century is going to pose.

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