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Volume 53, Number 1, Spring 2011

A History of Land Use and Natural Resources in the Middle San Pedro River Valley, Arizona

Nathan F. Sayre

This paper reconstructs and interprets the land use and natural history of a poorly studied reach of the San Pedro River in southeastern Arizona (figure 1). The paper is organized chronologically, beginning with a summary of prehistoric conditions and human activities. Greater emphasis is placed on the historic period, however, for which human uses and impacts are better documented, more directly relevant to current conditions and issues, and generally more significant than in centuries past. Social, political, and economic topics are covered only to the extent that they bear on the use, ownership, and management of land, water, vegetation, livestock, and wildlife. Similarly, events that occurred outside of the study area are treated only insofar as they affected local conditions and activities.

Elevations in the study area range from 800 m at the north end of the river corridor to more than 2,600 m at the top of the Rincon Mountains. The San Pedro River falls roughly 230 m on its way through the area. Average annual precipitation increases with elevation from roughly 25 cm to more than 60 cm. The terrain is extremely rugged, characterized by deep tributary canyons and washes cut into the foothill slopes on either side of the river. Vegetation communities include cottonwood-willow riparian forests and mesquite bosques along the San Pedro River, mixed broadleaf forests in tributary canyons and washes, Upper Sonoran desertscrub on lower elevation uplands, Sonoran and Chihuahuan semidesert grasslands at intermediate elevations, and madrean oak woodlands in the surrounding mountains. Conifer forests occur at the very highest elevations.

Development is very limited. The three roads that serve the area are unpaved and minimally maintained. Two towns—Redington and Cascabel—appear on the map, reflecting past locations of schools, stores,

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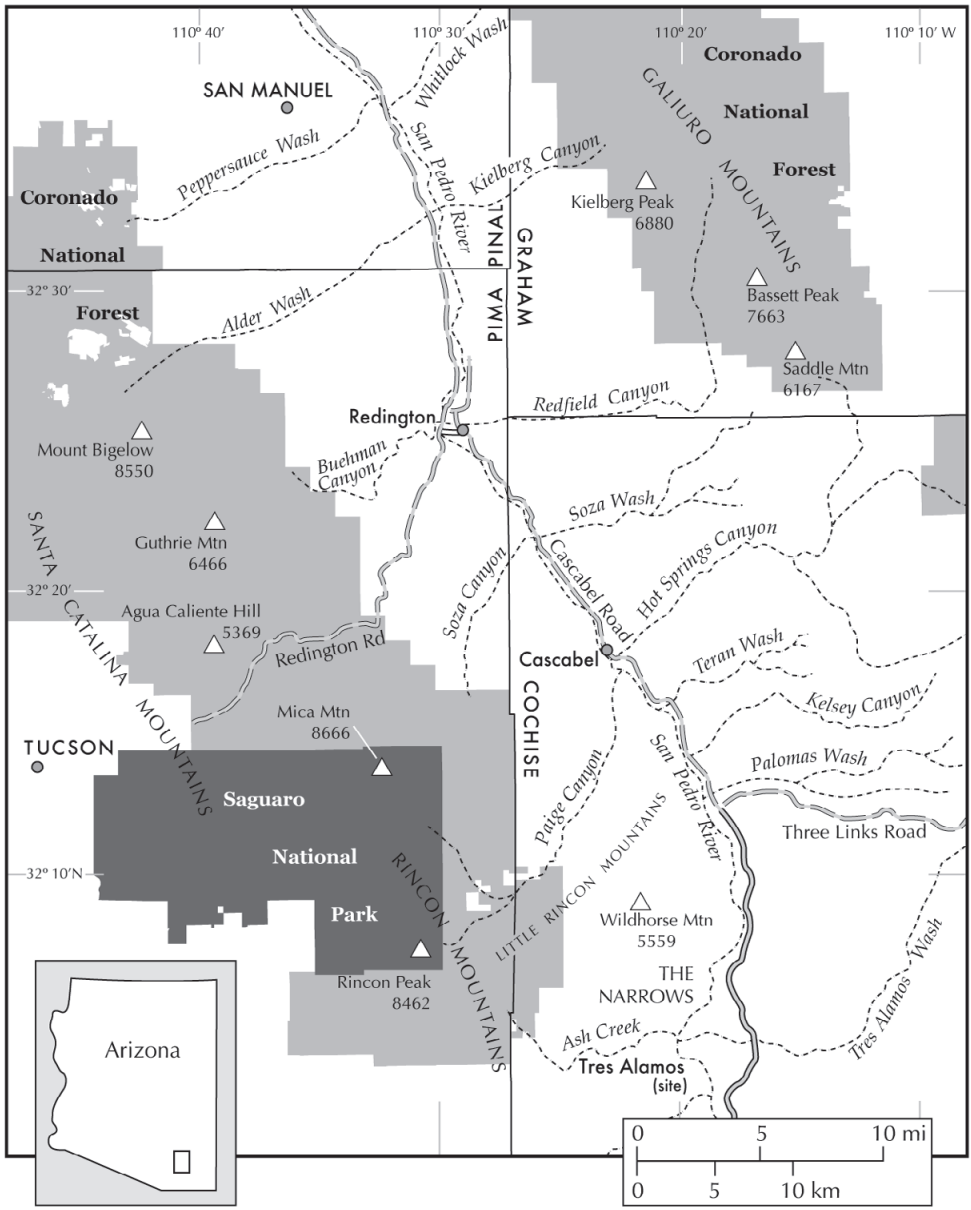

Figure 1. Map of the Middle San Pedro River Valley, Arizona. The river flows from south to north. The area covered by this study encompasses the lands tributary to the river from the Narrows (a geological feature that separates groundwater basins above and below it) downstream to Alder Wash and Kielberg Canyon. (Source: Arizona Geographic Information Council.)

and post offices, but neither has an identifiable commercial center at present. Electrification occurred in the late 1950s and telephone service arrived in 1993. The current population, estimated at 175 year-round residents, is less than was found in the area in the early twentieth century, and probably less than occurred during some prehistoric periods.

Crop agriculture and livestock production have been the dominant land uses since the arrival of Spanish missionaries in the region 300 years ago, although these activities were limited and sporadic due to the threat of Apache depredations until the late 1870s. State lands are leased to private ranchers for grazing, as are most national forest and Bureau of Land Management (BLM) lands. A modest amount of mining occurred in the mountains early in the twentieth century. Hunting is a long-standing land use throughout the area, now limited to fall and winter seasons; other recreational uses are generally concentrated on U.S. Forest Service (USFS) and National Park Service (NPS) lands at higher elevations. In the last 30 years, conservation and residential land uses have increased in significance, but in terms of overall area they remain secondary to agriculture.

Methods and Sources

Compared to the rest of the San Pedro River valley, the study area has experienced relatively little historic human activity and scholarly attention, and consequently it is poorly documented in published sources. Prehistoric settlements did exist but are smaller and less studied than sites elsewhere in the valley. The earliest sites of significant historic activity were upstream at Tres Alamos (Tuthill 1947) and downstream at Aravaipa (Hadley, Warshall, and Bufkin 1991). Later, major mines were established to the south (at Cananea, Bisbee, and Tombstone) and to the north (at San Manuel, Mammoth, and Winkelman), but not in the study area. A railroad was contemplated through the area in the late nineteenth century, and a paved highway was planned in the 1960s and again in the 2000s, but neither was ever built. Recently, rapid residential growth and attendant environmental issues have drawn renewed attention to the upper San Pedro River around Sierra Vista, but the Cascabel-Redington area has remained comparatively obscure.

As a result, reconstructing the history of the middle San Pedro watershed is often difficult. Census data, for example, tend to lump the

study area together with surrounding locales such as Tucson, Benson, or Willcox, making it difficult to determine population numbers with precision. Historical treatments of southeastern Arizona are numerous, but they rarely focus on the area in question here; there are only a few ecological studies specific to this reach of the San Pedro (Zimmermann 1969; Lombard 1998). Resource information is much more abundant for the upper San Pedro (BLM 1998), but its relevance to the study area cannot be assumed.

Archival research and interviews were the main methods employed for this study. Major archives included the Arizona Historical Society, the University of Arizona libraries, the Tucson office of the BLM, the Tucson and Willcox offices of the Natural Resources Conservation Service (NRCS), the Supervisor's Office of the Coronado National Forest in Tucson, the Soza-Carrillo-Frémont House Museum in Tucson, the Center for Desert Archaeology and The Nature Conservancy in Tucson, and the Amerind Foundation in Dragoon. Water rights information for the area was obtained from the Tucson office of the Arizona Department of Water Resources. The research was conducted as one part of the Lower San Pedro Watershed Assessment Project, funded by a grant from the Arizona Department of Water Resources, and some findings from the rest of the project were also consulted.

Several topics are especially poorly documented. A complete soil survey of the study area is only now being conducted, so information on soils was largely unavailable (see Zimmermann 1969 for a brief description of major soil types). The State Land Department has virtually no historical archives regarding its lands, despite being the largest single landowner in the area (figure 2). Aerial photographs from the 1930s and 1950s for the northern half of the study area have apparently disappeared from the archives of the NRCS in Tucson, and they could not be located at the Willcox NRCS office or the Arizona Historical Society.

Interviews were conducted with past and current residents of the area using a semi-structured interview protocol. Questions focused on land use and management practices for the times and places that the interviewee was present in the study area. An initial list of potential interviewees was produced by contacting current longtime residents; these interviewees in turn helped to identify others. Interviews were one to two hours in length and most were recorded digitally for future reference. Eighteen interviews were conducted; the amount of new information obtained from each interview declined as the research proceeded

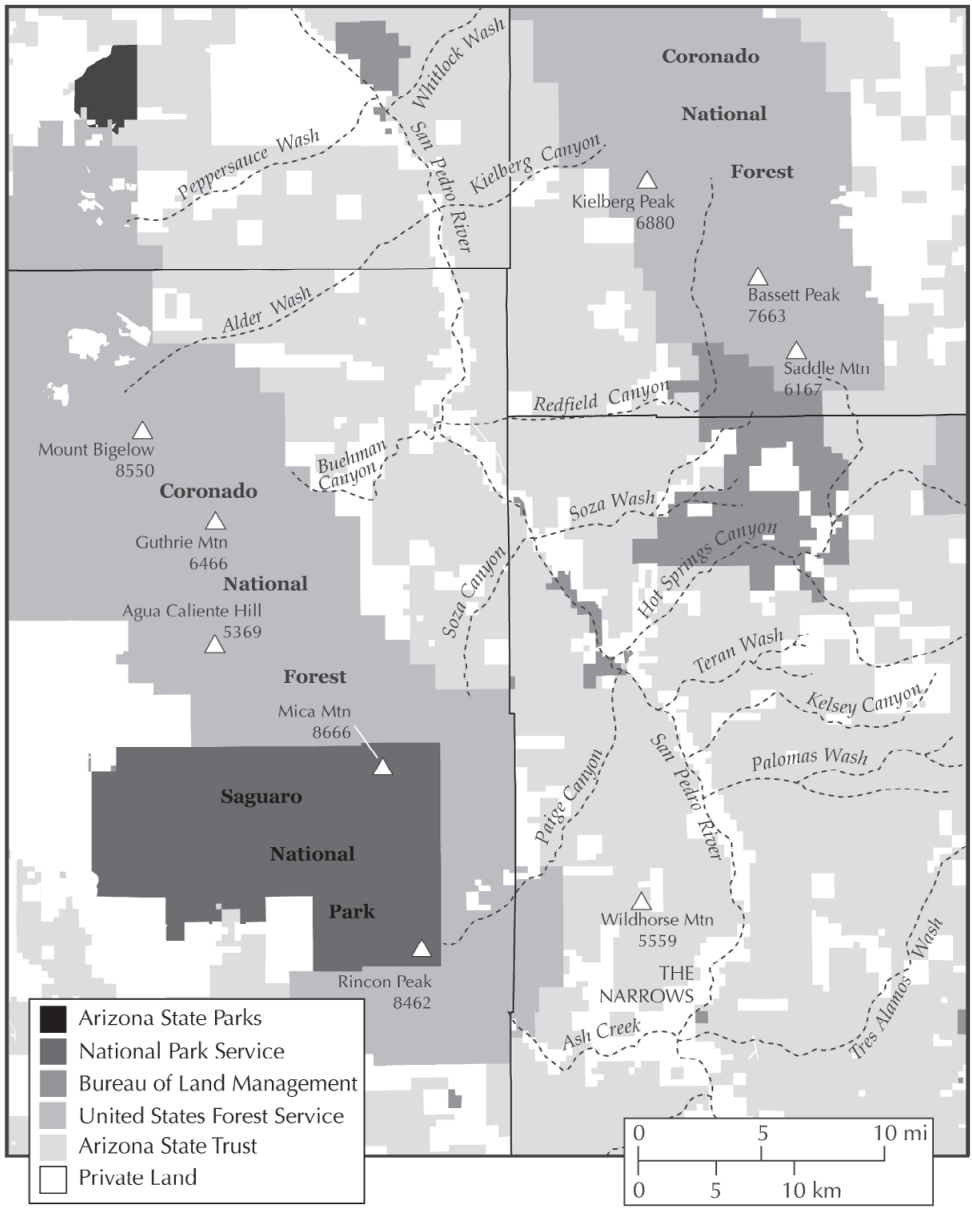

Figure 2. Landownership status in the study area. (Source: Arizona Geographic Information Council.)

until further interviews seemed unwarranted. With a few exceptions, interviews with current landowners proved less valuable than expected, because most properties in the area have changed hands at least once in the past twenty-five years. Conversely, almost all of the most valuable interviewees—those resident in the area between 1925 and 1985—no longer live in the study area, having moved to Tucson or Benson for reasons of work, family, or health.

Prehistoric Period

> No other river valley reveals the story of the first humans in the Greater Southwest as completely as the San Pedro River Valley.
>
> —Bruce B. Huckell (2003)

Archaeological research has conclusively documented human presence in the San Pedro River valley going back at least 11,000 years. Based on sites excavated near Fairbank, Charleston, and Naco, paleontologists have hypothesized that early humans may have caused the extinction of Pleistocene megafauna such as the mammoth. Although sites of such age have not been found in the study area, humans almost certainly used the area for hunting and gathering. Human impacts from this period cannot be assessed in detail due to limited data and the fact that the climate at that time was considerably wetter and cooler than at present.

The San Pedro also contains sites from the Archaic and Early Agricultural periods (figure 3). One Archaic site has been identified in the study area, at Lone Hill west of Redington; it indicates hunter-gatherer lifeways from 5,500 to 3,500 years ago. Another very large Archaic site is located just south of the study area near Benson. Farther upstream, the Fairbank site has yielded evidence of maize agriculture 3,000 to 3,500 years ago, and by AD 50 crops there included corn, beans, squash, cotton, and tobacco. These innovations were accompanied by construction of the earliest permanent, year-round settlements and irrigation canals (Lyons 2004).

During the Preclassic period, from AD 50 to 1200, agriculture became increasingly important and settlements more permanent. Sites in the study area from this period reveal cultural practices and artifacts related to those of the Hohokam peoples of the Phoenix, Tucson, and Tonto basins. A regional shift from seasonally mobile to more settled villages occurred

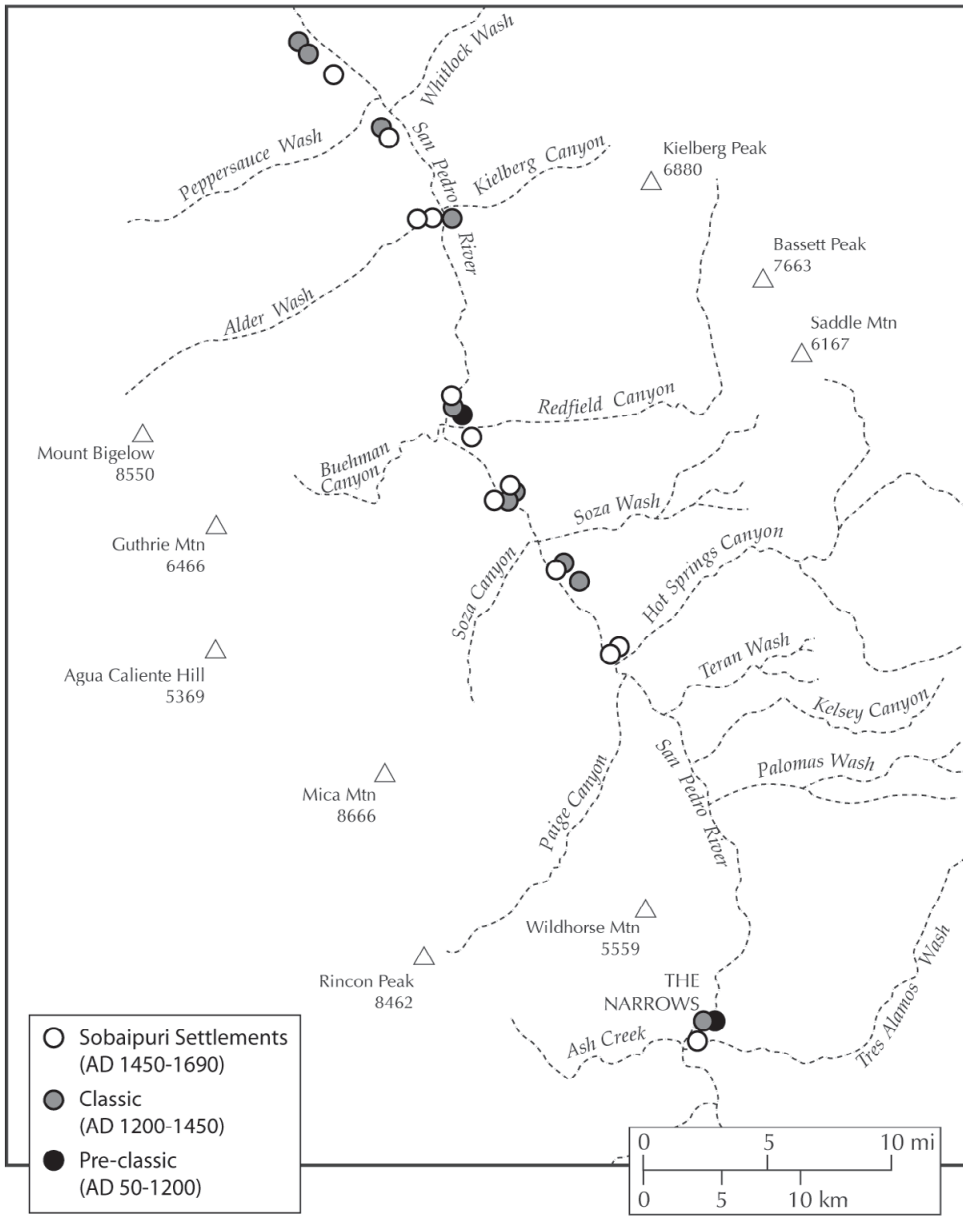

Figure 3. Archaeological sites in the Middle San Pedro River Valley. (Source: Center for Desert Archaeology.)

around AD 500–600. Increasing inter-village organization developed over the following two centuries, culminating in a period of widespread ballcourt construction between AD 800 and 1050. This appears to have been a time of relative peace and favorable rainfall, enabling development of agricultural villages dispersed along waterways throughout the region, including in the study area. Cultivation appears to have extended up onto the terraces adjacent to the floodplain as well, as evidenced by extensive rock piles, which archaeologists believe were constructed for growing agave plants.

Sites in the study area display influences from several cultural groups, suggesting complex transitions and interactions among peoples over time and space. Five ballcourt sites have been found in the study area, including a major site at Redington, indicating Hohokam presence or influence. Differences in pottery and architecture between sites north and south of Mammoth, however, suggest that the study area was at the edges of Hohokam influence and also experienced contact with peoples farther east (e.g., from the Mimbres Valley of southwestern New Mexico).

Major changes in settlement patterns occurred during the Classic period, from AD 1200 to 1450. First, migrants from the Mogollon Highlands and northeastern Arizona moved into the study area, especially after about 1300, bringing new architectural and artistic customs. Second, dispersed pithouse settlements contracted to form concentrated villages of masonry and adobe built near major irrigation systems. Eleven platform mound sites have been found along the San Pedro from Redington north, each associated with an irrigation system of up to 5 miles in length. South of Redington, platform mounds are not found, and evidence from the Reeve Ruin and Davis Ranch sites suggests the arrival of peoples from northeastern Arizona, nearly 300 miles away. Although culturally distinct, these settlers traded goods with their neighbors and shared some of their land-use practices, such as irrigated agriculture. Based on an exhaustive analysis of sherds, bones, stone fragments and pieces of shell at 29 sites throughout the lower San Pedro, the Center for Desert Archaeology (Clark and Lyons 2003) summarized Classic period human land uses this way:

> The San Pedro floodplain was covered with maize fields fed by canal systems up to 8 km long. Each canal system was built and maintained by an irrigation community containing between 100

and 300 people. Beans and squash were also cultivated. Mesquite beans and various cacti fruits were favorite gathered resources. An occasional trip was made to obtain juniper berries from the mountain slopes far above the floodplain. Although cotton was grown in other river valleys of central and northern Arizona, we encountered no evidence of this raw material for textiles. Even more conspicuous is the near-absence of agave, considering the thousands of rock piles, presumably used in cultivating this plant, that line many of the terraces overlooking the floodplain.

By 1450 the San Pedro Valley was depopulated. This was undoubtedly related to the collapse of Hohokam civilization throughout the region at this time, probably due to the prolonged and severe drought of the late thirteenth century. No archaeological sites have been found in the study area from the ensuing 200 years.

Spanish and Mexican Period

The expedition of Francisco Vásquez de Coronado in 1540 is thought to have traversed the San Pedro Valley, although exactly where remains a subject of scholarly debate. It appears Coronado's party did not pass through the study area, but they did bring herds of horses, cattle, goats, sheep, and pigs into present-day Arizona for the first time. By the end of the seventeenth century, livestock were present in the southern part of the San Pedro Valley, although their presence near the study area is not documented until later (Hadley, Warshall, and Bufkin 1991).

The first documented presence of Europeans in the study area occurred in 1692, when Spanish captain Francisco Ramírez pursued a band of suspected horse thieves to Baicatcan, a Sobaipuri village on the lower San Pedro River (Bolton [1936] 1984). The location of Baicatcan has long been disputed, but recent archaeological research by the Center for Desert Archaeology suggests it was at Cascabel, on a mesa overlooking the mouth of Hot Springs Canyon.

The Sobaipuris lived all along the lower San Pedro (DiPeso 1953), and they soon became allies of the Spaniards against their common enemy to the east, the Apaches. Late in 1697, the Jesuit missionary Padre Eusebio Francisco Kino traveled down the San Pedro and recorded the earliest documentary description of the study area. He found Baicatcan

abandoned, but farther downstream he encountered a string of occupied villages. Captain Juan Mateo Manje, who accompanied Kino, wrote that "the whole valley is wide, long, and very fertile. Their fields are irrigated with acequias," which watered crops of calabashes, beans, corn and cotton (Bolton [1936] 1984). From Kino and Manje's writings, and from archaeological research, scholars estimate that the Sobaipuri villages in the study area supported between 280 and 575 persons in the late 1690s (William Doelle, Center for Desert Archaeology, written communication).

The Sobaipuri-Spanish alliance persisted, but so did the Apache threat, which intensified in the decades following Kino's death in 1711. In 1762 Spanish authorities ordered the Sobaipuris—numbering some 400—to withdraw from the San Pedro Valley and settle at the missions and presidios of the Santa Cruz Valley, which were struggling to maintain an adequate supply of Indian labor (Wilson 1995). This did not help security along the Apache frontier, and it effectively eliminated the Sobaipuris as a distinct social and cultural group. Through assimilation with the Pima (O'odham) Indians or by some other mechanism, the Sobaipuris soon disappeared. The lower San Pedro reverted to unoccupied frontier again, effectively controlled by the Apaches.

In the 1790–1820 period relative peace prevailed while the Spanish colonial administration provided rations to the Apaches. Spanish ranchers began to spread beyond the Santa Cruz Valley, establishing ranchos and developing large herds of livestock. The prominent Elías Gonzáles and Pérez families dominated the upper San Pedro, and in the late 1820s and early 1830s they successfully petitioned the Mexican government for three large land grants above present-day St. David; another petition, for an area around Tres Alamos, was unsuccessful (Mattison 1946). That Spanish ranching did not extend farther downstream probably reflects the lower rainfall and forage productivity of the study area compared to the upper watershed.

The rations system broke down following Mexican independence in 1821, and by 1840 the San Pedro settlements had been abandoned. Livestock became feral and reproduced prolifically, becoming both a menace and a source of meat to soldiers, emigrants, and Apaches in the 1840s and 1850s (Wilson 1995). These animals probably entered the study area, but their numbers and impacts on natural resources are undocumented.

U.S.-Apache Frontier Warfare

For 22 years after the Gadsden Purchase in 1854 transferred southern Arizona to U.S. sovereignty, the study area was effectively a no-man's land in the ongoing guerrilla war between the U.S. military and the Apaches. The bulk of the fighting occurred elsewhere, but the insecurity was regional, and it prevented permanent settlement in the study area until 1876, when most of the Apaches were removed to the newly created San Carlos Reservation.

The road through the study area was first constructed in 1857–58 as part of the El Paso and Fort Yuma Wagon Road, built under contract for the Department of the Interior. The Leach Road—named for superintendent of construction James B. Leach—entered the San Pedro Valley by Nugents Pass, at the current location of the Cascabel-Willcox ("Three Links") Road. It proceeded downstream along the east bank of the river as far as Aravaipa before fording the river and continuing west (Wilson 1995). The road did not spur settlement in the study area, however, both because of the Apaches and because the route was poorly chosen for local purposes. In seeking to facilitate cross-territory traffic (en route to California, for example), Leach had completely bypassed Tucson. When overland mail and stagecoach service expanded in the late 1850s, carriers chose alternate routes, such as the one from Tres Alamos west to Tucson and thence north to the Gila.

Several natural resource conditions can be inferred from the U.S.-Apache war period. First, soldiers stationed along the San Pedro—at Aravaipa Creek and Babocomari Creek, for example—experienced chronic malaria, apparently due to nearby cienegas where mosquitoes were abundant. The cienegas were associated with—and may in some cases have been created by—beavers, which were abundant in the river (Hutton 1859) and which may have been trapped as early as the 1820s (Wilson 1995). Second, the accounts of military and emigrant groups describe large fish—18 to 20 inches in length—in the river, indicating the presence of significant reaches of perennial flow and large pools.[1] Third, these accounts do not indicate entrenchment of the river, except perhaps between Tres Alamos and the Narrows. Finally, the Apaches routinely set grasslands in the region on fire, whether by accident, for hunting, or for tactical-military purposes (Dobyns 1981). These factors may have been interrelated, judging from events that followed.

Reoccupation, 1876–1890

Settlement along the River

According to some sources, six Anglo-American families from Tucson settled at the current site of Redington in 1865 (McKelvey 1958b). Documentary support for this claim is weak, however (Soza 1994), and even if settlement did occur, it did not last long. Permanent reoccupation of the study area did not take place until the late 1870s and the 1880s, when Mexican American and Anglo-American homesteaders began to establish small farms and ranches.

Reconstructing the precise dates, names, and locations of these early settlements is difficult because documentary sources are limited, uneven, and sometimes inconsistent. Most of the area was not surveyed until 1879, by which time many homesteads had already been established. As a result, even official homestead records may not reflect actual dates of settlement. The activities of a handful of settlers are recorded in newspaper clippings, memoirs, and stories, but the majority of homesteaders left very little mark on the historical record.

By far the most thorough early descriptions of the study area are found in the notebooks and maps of surveyors employed under the U.S. Surveyor General. The area around the Narrows (Township 15 S Range 20 E) was first surveyed in 1873 by T. F. White. He recorded only one house, in section 15 and apparently abandoned, which he labeled "Nigger Brown's old house." He noted that there were no settlers north of the Narrows (see below). White also noted two acequias, in sections 21 and 31, as well as two "wood roads" leading west into the Rincon Mountains in section 31. All of these structures were just south of the study area, near Tres Alamos.

Most of the river corridor through the study area was first surveyed in 1879 by John L. Harris, who recorded 30 homesteaders by name. Of these, 18 had Hispanic surnames; the rest were Anglo-American.[2] At almost all the homesteads, Harris also noted the presence of cultivated fields and irrigation canals.

For reasons not revealed in the surveyors' notes, one river-corridor township at the southern edge of the study area (T14S, R20E) was not surveyed until 1902. The original deeds for homesteads in this township were obtained from a subsequent owner of the properties. These

records document the earliest successful claimants—those who perfected title—but may not reflect the earliest settlers.

An exhaustive archival study of General Land Office homestead records was completed by Edward Soza (1994) in order to document early Mexican settlement in the San Pedro Valley. Soza identified 38 homestead filings made in the study area between 1880 and 1891 by persons with Hispanic surnames. Of these, the earliest date of actual settlement (rather than filing of claims) is 1877, by Angel Gonzáles.

Presumably, official homestead records were less prone to certain kinds of errors (e.g., misspellings, misattribution) than were the surveyors' notes, which were gathered during site visits (when settlers may have been absent). On the other hand, homestead records were also subject to error (or intentional misrepresentation as to date of settlement), because they were not gathered in the field. In any case, the names and locations of settlers in the Soza study sometimes differ from those recorded in surveyors' field notes, and Soza did not attempt to gather information on settlers with non-Hispanic surnames.

The early homesteads were small, being limited by the acreage restrictions of the Homestead Act and its successor acts (160–640 acres). Homesteaders undoubtedly grazed livestock on surrounding public domain, but securing title to land required improvements related to crop agriculture. In almost all cases, settlers chose sites where alluvial deposits from tributary canyons created broad, fertile areas adjacent to the San Pedro, and where water could be easily diverted from the river for irrigation. Most tributaries contained perennial water only at higher elevations where arable land was scarce, and they were generally not settled until slightly later (see below). The pattern of deeded land in the study area today—concentrated along the river and its major tributaries—is the direct result of homestead activities (figure 2).

What the early homesteaders produced must be discerned from other sources, as surveyors' notes and homestead filings are silent on this issue. The Arizona *Mining Index* of October 4, 1884, reported that Josiah Pool was manufacturing sugar and syrup from sorghum and sugarcane grown at his farm near the mouth of Hot Springs Canyon. In 1889, according to the *Arizona Citizen*, Pool had 100 fruit trees and 100 blackberry bushes, but he had lost "a beautiful bed of strawberry vines" to recent flooding.[3] Farther downstream the Redfield brothers, Henry and Lem, who may have settled as early as 1875 and for whom Redfield Canyon

is now named, produced butter for sale in Tombstone (Taylor n.d.). On his ranch at the mouth of Soza Wash and Soza Canyon, Antonio Campa Soza raised corn, wheat, barley, watermelons, squash, beans, apples, milk, and cheese as well as cattle and hogs. Some of this produce was taken over Cebadilla (now Redington) Pass for market in Tucson (Carlos and Héctor Soza interview, 15 June 2004).

On the whole, agriculture in this period was oriented toward subsistence rather than commercial profit. The recollections of old-timers and their descendants describe large gardens, diverse farms, and neighbors who routinely bartered with each other for fruits, vegetables, meat, dairy, and poultry products. Antonio Soza's flour mill was used by residents up and down the river to process their wheat and corn (Soza 1939). In addition, many homesteaders relied on non-agricultural jobs or enterprises to obtain cash income. The Soza family had numerous business ventures and real estate holdings in Tucson. Blas Sánchez, who homesteaded near the mouth of Kelsey Canyon in 1880, secured a contract to deliver the mail from Benson to Redington for $1,200 a year (Alfredo Araiza biographical information). Particularly among Mexican American families, homesteads were sources of food as much as or more than sources of income (Martin 2004).

Settlement Away from the River

The dates of settlements away from the San Pedro River are difficult to determine. Much of the area is extremely rugged and was not surveyed until 1919–1935, by which time settlers were already established. These settlements were based on ranching or, in a few cases, mining (Wilson 1995).

One upland site, at Hookers Hot Springs in upper Hot Springs Canyon, was definitely settled much earlier. Dr. Glendy King arrived there in 1875, building two adobe houses and establishing a cattle operation. He homesteaded 480 acres and dreamed of creating a health spa to capitalize on the hot springs. The Apache threat intermittently drove him to Tres Alamos or Tucson for safety. In 1884, King was killed in a dispute with a neighbor, Edward Drew, who was attempting to homestead farther down the canyon. The following year, King's property was acquired by Henry Hooker (see below), from whom the hot springs now take their name. Hooker quickly realized King's health spa dream, refurbishing the adobe

houses and constructing bathhouses, a modest dining room, and croquet and lawn tennis courts. He also stocked the ranch with about 1,000 cattle by 1887 (Mills 1981). For a brief period in the early 1890s, Hookers Hot Springs was a popular destination, attracting 400 to 500 guests each summer, and the area attracted sufficient settlers to warrant a post office, under the name Gatewood. Severe drought followed by national financial crisis and a devastating flood in 1893 spelled the community's demise, although Hooker and his sons retained the ranch until 1906.

Natural Resource Conditions at the Time of Reoccupation

From the memoirs and recollections of old-timers, and especially from surveyors' field notes, it is possible to reconstruct natural resource conditions in the study area circa 1880 in greater detail than for any earlier point in time.

Frank Pool lived in the study area from 1883 to 1894, when he was a boy. In 1940, he recalled

> The San Pedro valley at the time we located there was one of the most beautiful valleys I ever saw. The river was a living stream, a few farms were already under cultivation. Grass everywhere, fine cattle range from Mexican line to the mouth of the river where it joined the Gila River. Wild game in abundance. Deer. Antelope. Wild hogs. Beaver. Raccoons. Foxes. Wild cats. Mountain lions. Bear. Rabbits. Quail. Doves. Ducks and geese. River was teeming with fish. Suckers and Gila Salmon. We caught Gila Salmon 10 to 15 pounds each. (Pool 1940)

Elena Vásquez Cruz was born on the Soza ranch in 1912. Her recollections of her grandparents' arrival in Redington, in 1884, were told to Patricia Martin (2004):

> The land was fertile; there was plenty of water for farming. My grandmother and her family settled on a little corner of land close to the river. They grew corn, squash, and beans. They collected honey from beehives. They were very happy because they had all the food they wanted. The boys grazed their milk goats across the river on a hill.

Several years later her father started a homestead at Redington, where the family raised alfalfa, corn, wheat, barley, lentils, peanuts, peas, yams, garbanzos, tobacco, chiles, onions, carrots, potatoes, hogs, and cattle.

The General Land Office surveys provide a more systematic account of conditions in the study area, albeit one with a narrower focus. In his 1873 survey of T15S, R20E, which encompasses the Narrows and straddles the southern boundary of the study area, Thomas White wrote:

> The San Pedro River runs through the center of this Township. Bordering on it is much good farming land, more particularly on the S. or S.W. portion: a number of settlers are there engaged in farming. In section 15, the valley closes in to a narrow canon, but afterward widens somewhat. There are no settlers along the river N. of the canon. The remainder of the township falls on hilly land, sometimes very broken. The most of this is good pasture land.

North of the Narrows, White wrote that "mesquite timber is found along the river." This site—at the boundary of townships 14 and 15 south, range 20 east—is the only mesquite bosque site recorded in the original surveys. Six miles south, by contrast, White wrote, "Where this line crosses the valley, the soil is very rich, and considerable of the land under cultivation. The valley is bare of timber. The balance of the line is on the hills, and is mostly over poor land, some of it fit for pasturage." This contrast may have reflected natural conditions, or it may have been a product of past woodcutting around Tres Alamos.

As noted above, most of the river corridor through the study area was first surveyed in 1879 by John Harris. His general descriptions of four townships, reproduced in full in box 1, emphasize rich soil in the San Pedro floodplain, sufficient water in the river for irrigation, and vegetation dominated by grass. Mesquite, cottonwood, and palo verde were present along the river but not dominant. Portions of each township were not surveyed at that time due to the rugged topography of the surrounding mountains.

The surveyors' section line measurements and notes reveal further details about the area. "Grass" or "fine grass" was noted at almost all quarter-section corners, and trees large enough to serve as witness trees (which appears to have meant more than 3 inches in diameter and less than 200 feet distant) were unevenly distributed: very limited in the central portion of the study area, but more numerous at both the southern and northern reaches. Witness trees included mesquites of up to 18

Box 1: General Descriptions of Four Townships along the San Pedro River in the Study Area 1879

T11S, R18E

The foregoing field notes describe all the lines of subdivision in Tp. 11 S. Range 18 E. that are practicable and cover all the ground in the Township that is surveyable. The surveyed portion of the Township embraces a portion of the rich San Pedro valley, the river flowing northerly through the Township and containing sufficient water for the irrigation of the agricultural land. The soil of the valley is deep and rich and very productive. There is a heavy growth of *sacaton* grass in portions of the Township. The lands bordering the valley are considerably broken but affording excellent grazing. There is Cottonwood and Mesquite timber in various portions of the Township. The W. half of the township is wholly impracticable, high broken ranges of hills cut by deep, precipitous canons and wholly waterless.

T12S, R18E

The unsurveyed portion of Township 12 S. Range 18 E is wholly impracticable. W. of the range line running N. between secs. 33 & 34, a low range of broken mountains brs. N. & S. shutting in close to said range line, bowing out a little only at the W. side of sec. 21. I could not extend the lines to the W. of said range line except around sec. 21, as in a short distance they became impracticable from mountains and canons. The Surveyed portion of the Township embraces a portion of the San Pedro valley. The river runs through or across the N.E. portion of the Township and contains sufficient water for the irrigation of the agricultural land. The soil is rich and deep. The land bordering the valley are fine grazing lands and in many places have good soil. There is some mesquite, palo verde and cottonwood timber in the Township.

Box 1: General Descriptions of Four Townships along the San Pedro River in the Study Area 1879 (cont.)

T12S, R19E

The extreme East and northeastern portions of Township 12 S Range 19 E are *unsurveyable*. The ground is impracticable broken by low mountains and canons and the country inaccessible and worthless. The surveyed part of the township covers a portion of the San Pedro valley and the bordering grazing land. The San Pedro river flows through the Southwestern part of the Township and contains sufficient water for the irrigation of the agricultural land. The valley soil is rich, deep, and very productive. The valley is bordered by hills and rolling land with mesquite and palo verde in places. There is fine grass in some sections of the Township.

T13S, R19E

The *unsurveyed* portion of Township 13 S. Range 19 E. is wholly impracticable, being the broken and very precipitous approaches to the Rincon mountains. The surveyed portion of the Township covers part of the San Pedro valley with abundance of water for irrigation. The soil of the valley is very rich while that of the bordering uplands is largely good. There are cottonwood and mesquite trees in the valley and mesquite and palo verde in places elsewhere. There is fine grass in parts of the Township.

Note: Field notes of surveyor John Harris, archived in the Tucson offices of the Bureau of Land Management. T14S, R20E was not surveyed until 1902.

inches diameter; walnuts up to 18 inches diameter; a cottonwood of 28 inches diameter; a hackberry of 8 inches diameter; and an ash of 5 inches diameter. Dense thickets of trees were noted only twice, however: once

south of the Redfield homestead (T11S, R18E, Secs. 22, 23, 26, 27, 34) and once just downstream of the Narrows (see above).

Finally, marshy or swampy conditions were observed near the Redfield homestead (T11S, R18E, Sec. 23), between the Van Alstine and Mendoza homesteads (T13S, R19E, Sec. 10), and just south of the study area near the Narrows (T15S, R20E, Secs. 20, 21, 28, 29). The San Pedro River appears to have had water throughout its length at the time of Harris's survey (November and December 1879): he measured the river as 7 to 11 m wide at most locations, and as wide as 17 m at a few places.

A number of items are conspicuous by their absence from the early surveyors' field notes. There is no mention of beaver or livestock, for example. Also absent is any evidence of downcutting or incision of the main river channel downstream of the Narrows. In this case, the omission probably indicates that downcutting had not yet occurred in the study area. If it had, it would have made irrigation by acequias much more difficult, as diversions would have had to be located far upstream to deliver water to fields on the adjacent terraces—something that would not have escaped the surveyors' notice. Later surveyors' notes specifically describe steep cut banks on both sides of the river (see below).

The Cattle Boom, Droughts, and Environmental Change, 1880–1905

The 1880s and 1890s were a period of dramatic growth in livestock production in southern Arizona, part of the post–Civil War cattle boom across the western United States. With the removal of the Apaches, vast areas of grasslands were suddenly available for settlers' sheep, goats, and cattle, which moved into the area in enormous numbers from Texas, California, and elsewhere (Morrisey 1950; Sayre 1999). The ecological effects of the cattle boom were complex, particularly because they unfolded simultaneously with the effects of mining, timber cutting, agricultural clearing, and the construction of roads, irrigation systems, and railroads (Dobyns 1981). Nevertheless, it is well established that during recurrent severe droughts the number of livestock in southern Arizona was much higher than the grassland resource could support.

Outside of homesteads, the land was open to all users; fencing the public domain was both illegal and prohibitively expensive. Under these conditions, the key to controlling enough land for one's livestock was to

control the limited natural water sources. A special report of the 1880 census remarked that in Pima County—which until 1881 included present-day Cochise County—"every water-claim adapted to the business had in 1880 a herd of cattle or less frequently a flock of sheep relying upon it" (U.S. Census Bureau 1883).

The Census Bureau estimated that the entire San Pedro Valley contained not more than 8,000 cattle and 12,000 sheep in 1880. It described livestock production in the lower San Pedro[4] as dominated by small producers, mostly Mexican and Mormon, with cattle herds of 50 to 250 head each, small flocks of sheep, or both. Unfortunately, there are no comparably detailed accounts in subsequent censuses. Figures are available only for Cochise County as a whole. They indicate that the number of cattle in the county nearly tripled between 1884 and 1891, from 33,000 to 95,000.

Numbers plummeted due to the drought of 1891–93, to a low of 43,000 in 1894, then rose steadily again until 1900. Another drought then brought numbers down once again, from 70,000 in 1900 to 30,000 in 1904. These numbers derive from tax assessors' records—the actual number of cattle was probably 1.5 to 2 times higher (Wagoner 1952). Significant numbers of goats and sheep may also have been present in some areas, such as Aravaipa (Hadley, Warshall, and Bufkin 1991) and Happy Valley (see below).

Few details of the cattle boom in the study area have emerged from the research conducted for this study or from previous reports. Interviewees made no mention of grazing during the period, probably because it predated their familiarity with the area. The public agencies that currently manage state and federal lands in the study area did not exist until after 1900, and their records contain no earlier information.

The best descriptions available are those provided by two major ranchers whose herds extended into the study area: Henry Hooker and Charles Bayless. Hooker's Sierra Bonita Ranch was located at the headwaters of Aravaipa Creek, on the northeast side of the Galiuro Mountains. Hooker had between 10,000 and 20,000 head of cattle, and he estimated that the Sulphur Springs Valley had 50,000 head in the 1880s (Griffiths 1901). Some of these animals undoubtedly ranged into the lower San Pedro Valley. Bayless's father began ranching in the Redington area in 1885, and his lands eventually extended around the north end of the Santa Catalina Mountains to Oracle and Catalina (Santiago 1994). Both Hooker and Bayless responded to a questionnaire sent by David Griffiths

of the U.S. Department of Agriculture in 1901, inquiring about past range conditions. Their answers are reproduced in boxes 2 and 3.

Hooker's description is rather general and may reflect conditions upstream or downstream of the study area; Bayless, however, was intimately familiar with the study area, especially around Redington. At the time, both men were involved in political efforts to create a lease system for grazing on the public domain, and this may have led them to dramatize the damage of the open range somewhat and to focus too narrowly on cattle. It is now understood that channel cutting occurred prehistorically as well, and that as a geomorphic-hydrological phenomenon it cannot be attributed to overgrazing alone; mining, timber cutting, irrigation diversions, roads and railroads, and beaver extirpation also contributed to trigger downcutting in interaction with drought and flooding (Dobyns 1981; Hereford 1993).

There is also no way to corroborate Hooker's and Bayless's figures for cattle numbers in the area or to infer stocking rates, since the range was not fenced. These are only minor qualifications, however, and the central details of their accounts are consistent with the available evidence for the study area and with patterns observed elsewhere in the region. During drought periods the demands of livestock far exceeded forage production, resulting in overgrazing at virtually all sites within 5 miles of a water source. When heavy rains returned, severe erosion ensued. Entrenchment in turn triggered a series of environmental changes: desiccation of former cienegas and floodplains, loss of sacaton meadows and streamside forests, and encroachment of mesquite and other shrubs into the terraces adjacent to the new channel. These changes wiped out or rendered useless existing diversions and acequias, forcing settlers to make expensive investments to repair, lengthen, and protect their irrigation systems (figure 4).

The precise date of entrenchment in the study area is a matter of debate. There were areas farther upstream that may have been entrenched in the 1850s (Cooke and Reeves 1976), although Hereford (1993) disputes this interpretation of early accounts. He argues that entrenchment occurred at a few sites in the upper San Pedro after about 1882 and more generally after 1890. The latter date is consistent with Bayless's description, which suggests entrenchment occurred shortly after 1889. An unnamed farmer residing "in the river valley eighteen miles north of Tres Alamos"—perhaps Antonio Soza—told a newspaper that a flood in August 1890 had "dug down the channel of the San Pedro river an

Box 2. Henry Hooker's Description of Past and Present Rangeland Conditions, 1901

The San Pedro Valley in 1870 had an abundance of willow, cottonwood, sycamore, and mesquite timber, also large beds of *saccaton* [sic] and *grama* grasses, sagebrush, and underbrush of many kinds. The river bed was shallow and grassy and its banks were beautiful with a luxuriant growth of vegetation. Now the river is deep and its banks are washed out, the trees and underbrush are gone, the *saccaton* has been cut out by the plow and grub hoe, the mesa has been grazed by thousands of horses and cattle, and the valley has been farmed. Cattle and horses going to and from feed and water have made many trails or paths to the mountains. Browse on the hillsides has been eaten off. Fire has destroyed much of the shrubbery as well as the grass, giving the winds and rains full sweep to carry away the earth loosened by the feet of the animals. In this way many waterways have been cut from the hills to the river bed. There is now little or nothing to stop the great currents of water reaching the river bed with such force as to cut large channels and destroy much of the land under cultivation, leaving the river from 10 to 40 feet below its former banks. Thus it has caused much expense in bringing the water to the cultivated lands, and necessitated much labor to dam up the channel and keep the irrigating ditches in repair.

Source: Griffiths 1901.

average of ten feet" (Dobyns 1981). This may well have been the same flood that washed away Soza's adobe house, his flour mill, and all but one of his hogs (Soza 1939).

Most likely, entrenchment began at discrete sites along the river and expanded rapidly during subsequent flood events. Severe floods recurred in the study area in 1891, 1905, and 1916 (Dobyns 1981), and by far the largest peak flow ever measured was in 1926, when the railroad bridge at Benson was destroyed (Hereford 1993).

When government surveyors returned to the study area in later years, they recorded the depth and location of steep cut banks adjacent to

Box 3. Charles Bayless's Description of Past and Present Rangeland Conditions, 1901

About twelve years ago the San Pedro Valley consisted of a narrow strip of subirrigated and very fertile lands. Beaver dams checked the flow of water and prevented the cutting of a channel. Trappers exterminated the beavers, and less grass on the hillsides permitted greater erosion, so that within four or five years a channel varying in depth from 3 to 20 feet was cut almost the whole length of the river. Every year freshets are carrying away new portions of the bottom lands. At present this valley is a sandy wash from bluff to bluff, while the few fields remaining are protected from the river at large and continuous expense. Thus, in addition to curtailing the area of good land, the deep channel has drained the bottoms, leaving the native grass no chance to recover from the effects of close pasturing. It also makes it more difficult to get irrigating water onto the surface of the land.

Of the rich *grama* grasses that originally covered the country so little now remains that no account can be taken of them. In some parts of the foothills *alfilaria* furnishes limited but excellent pasture during the spring and early summer. Where stock water is far removed some remnants of perennial grasses can be found. Grasses that grow only from seed sprouted by summer rains are of small and transitory value. The foliage of the mesquite and catsclaw bushes is eaten by most animals, and even the various cacti are attempted by starving cattle. However, the thorns and spines of the cacti more than offset the value of the pulp. No better pasture was ever found in any country than that furnished by our native *grama* grasses, now almost extinct. . . .

Twelve years ago 40,000 cattle grew fat along a certain portion of the San Pedro Valley where now 3,000 can not find sufficient forage for proper growth and development. If instead of 40,000 head 10,000 head had been kept on this range, it would in all probability be furnishing good pasture for the same number to-day. Very few of these cattle were sold or removed from the range. They were simply left there until the pasture was destroyed and the stock then perished by starvation.

Source: Griffiths 1901.

Figure 4. Acequia on the Gámez-Araiza homestead, 1927. (Photo courtesy of Maria Troutner.)

the river. Francis Jacobs's survey notes for T14S, R20E, surveyed in 1901–02, describe banks 14 and 15 feet high. The boundary of T13S between R19E and R20E was resurveyed in 1923; the notes describe the San Pedro as "a shallow stream of muddy water, 100 lks. [66 feet] wide, flowing . . . between banks 20 ft. high." Farther north, the south boundary of T12S, R19E was resurveyed in 1933. There, the surveyor encountered "dense mesquite" immediately east of the river and banks 7 and 8 feet high on the sides of the main channel—both new developments since 1879 (see box 4).

No comprehensive analysis of entrenchment has been done for the study area, but Hereford (1993) analyzed entrenchment of the upper San Pedro. He found that the channel grew rapidly from 1890 to 1955, and that after that date the rate of growth declined abruptly. He concluded that in the post-1955 period, "the river system has adjusted to the entrenchment disturbance and has probably attained, or is close to attaining, a new equilibrium with a quasi-stable channel configuration" (Hereford 1993:

Box 4. General Descriptions of Three Sites in the Study Area from Later Surveys

Downstream of the Narrows (T14S, R20E), 1902

The River Valley is covered with dense mesquite so thick that one cannot walk through it. The South East part slopes, from a high divide on the East, to the river, and is covered with various thornbushes and cacti. . . . The San Pedro River flows through the Tp from S. to N. at the time of the survey there was about 1500 inches of water running in the River and the farms along the valley are irrigated therefrom.

Buehman Canyon Area (T12S, R18E), 1921

There is very little timber of any kind. On the higher portions is some scattering mesquite and palo verde. A few sycamore, willow and alder are found along Buehman Canyon. The undergrowth is principally greasewood, ocotillo, Spanish dagger and catclaw. There is a fair growth of grass. Buehman Canyon contains an intermittent stream of water, which is the only water in the township. . . . C.C. Parker has a homestead in sec. 7.

Paige Canyon Area (T14S, R19E), 1923

. . . scattering growth of mesquite and oak on the mountain spurs, while along Turkey Creek in Paige Canyon are found sycamore and cottonwood trees, which are very large. . . . The west half of the township is covered with a fair growth of nutritious grasses, which furnishes good pasture for horses and cattle, the southern and eastern portions having a heavier growth of brush undergrowth, which furnishes excellent pasture for goats and sheep. There is one settler in each of the following secs. 7, 18, 20, 28 and 31, all of whom are engaged in stock raising to which the township is best adapted.

Source: GLO surveyors' notes, archived in the Tucson office of the Bureau of Land Management.

40–41). Hereford viewed entrenchment as at least partially due to shifts in climate rather than human activities, and he speculated that 450 years might be needed for the channel to aggrade on its own.

Entrenchment did have one benefit, which was widely acknowledged at the time: it eliminated the cienegas where malarial mosquitoes had bred (Dobyns 1981). Aside from this, however, entrenchment was a significant and enduring environmental change for the worse, one that has prompted remedial efforts ever since.

Consolidation and Commercialization

Homesteads were too small to be viable ranching operations by themselves, and entrenchment of the San Pedro made irrigated agriculture more difficult: longer ditches were needed to convey water to fields that now stood 3 to 6 m above the main channel. Entrenchment also altered the flood regime and habitat characteristics of the river corridor: sacaton grasslands converted to mesquite bosques due to the dropping alluvial water table and the absence of periodic flooding. Combined with droughts and financial crises, these changes helped drive many homesteaders out of business. Between 1885 and 1940, landownership was consolidated into fewer and larger properties, and land tenure on state and federal lands was rationalized under systems of leasehold. Consolidation both responded and contributed to a decline in subsistence-oriented production and the rise of solidly commercial farms and ranches specializing in a smaller number of products.

Private Landownership

The largest and best-documented instance of consolidation was the Reddington [*sic*] Live Stock Company, a subsidiary of the Bayless and Berkalew Company. William Bayless purchased his first land in the study area in 1884, near Redington. With financial backing from Jehiel W. Berkalew of New York, William and his son, Charles, acquired dozens of homesteads over the following four decades. In 1886 they bought the Redfield Ranch and three other properties. Drought and flooding forced seven families to sell to Damoetas Markham in 1890, and the following year Markham sold his holdings to Bayless and Berkalew. Some properties were acquired by

payment of back taxes; others were bought from Louis Zeckendorf and Albert Steinfeld, Tucson merchants who had foreclosed on homesteads put up as collateral for loans. Still others were purchased outright, as were the homesteads of Jacob Youtcy (1900), Antonio Comaduran (1901) and Juan Ochoa (1901). By 1910 the Carlink Ranch extended nearly 20 miles down the San Pedro from above Redington to near San Manuel (figure 5). In addition, the Bayless and Berkalew Company bought large landholdings near Oracle, Catalina, and Tucson. They raised premium cattle, sheep, hogs, sorghum, alfalfa, vegetables, and wheat (Santiago 1994). Near the end of his life, in the mid-1930s, Charles Bayless divided the ranch into three parts, giving his niece and nephew-in-law the Carlink Ranch and selling the other pieces to the Rhodes and Bingham families.

Elsewhere in the study area, Antonio Campa Soza played a similar role on a somewhat smaller scale, buying out the mostly Mexican American homesteaders surrounding his family's homesteads. Soza had a chapel and a school built to serve the small community, and his children married into many of the homesteaders' families—Vigil,

Figure 5. Wheat fields on the Carlink Ranch, circa 1900. (Photo courtesy of the Smallhouse family.)

Apodaca, Sáenz, and Gonzáles, for example (Soza 2004). The present-day Three Links Farm, between Palomas Wash and the Narrows, was consolidated by Harry Saxon in the 1920s (Barbara Clark interview, 4 June 2004).

Consolidation did not necessarily mean depopulation, however. The population of the Pool voting precinct—roughly the southern half of the study area—increased from 108 people in 1910 to 160 in 1920 and 175 in 1930 (census rolls).[5] Enlarged farms required larger labor forces for planting, cultivating, irrigating, and harvesting crops. The declining level of the San Pedro increased labor demands further: longer and more robust irrigation works were required to transport the water, and the gradual conversion of floodplain grasslands to mesquite made clearing and maintaining cultivated fields more difficult. Large numbers of cowboys were needed to gather and work herds of cattle on upland ranges that remained mostly unfenced until the 1930s (see below). Subsequently, grazing allotments required fencing and the development of water sources (windmills, wells, improved springs, and earthen tanks) in addition to traditional cowboy work. Often, smallholders did not physically move when they sold out but instead became employees of the new owners, perhaps even remaining in their own old homes (Santiago 1994).

There were also smaller farm properties, especially in the southern half of the study area, that experienced only limited consolidation until the Depression. The 1920 census rolls for the Pool voting precinct indicate that the Apodaca, Arándulez, Sánchez, Fautimes, Soza, Vásquez, Gámez, Salas, Rivera, and Mungía families continued to own their own properties, and that all were held free (i.e., not mortgaged). It appears this community of Mexican American small farmers persisted in the blend of subsistence production, barter, and outside wage labor that had characterized the earlier reoccupation of the area (Martin 2004). They grazed their livestock on the surrounding state or public-domain rangelands—none of their names appears in the records of the Forest Service. Several of these properties consolidated in the late 1930s and 1940s to form the C Spear Ranch—apparently triggered by drought, the Depression, and the fencing that followed the Taylor Grazing Act. Farther upstream, the Bidegain family consolidated holdings between Pool Wash and Palomas Wash during the Depression (Pete Bidegain interviews, 28 April and 3 June 2004).

Fences and Grazing Leases on State and Federal Land

The Santa Catalina and Galiuro forest reserves were created in 1902, followed in 1907 by the Rincon Forest Reserve. The Catalina and Rincon reserves were folded into the Coronado National Forest in 1908, at which time the Galiuro Reserve became part of the Crook National Forest. In 1953, the Crook was incorporated into the Coronado (Hadley 2001).

Beginning in 1905, the Forest Service was legally empowered to allocate the forage resources of these lands among local ranchers. In theory, ranchers received grazing "preferences" based on historical use: where their animals had grazed and in what numbers. Ranchers were also expected to have private or leased land in the area sufficient to support their herds. The idea was to give individual ranchers long-term, exclusive legal tenure so that they would have an incentive to conserve the range. Similar legal mandates were given for Arizona state lands after statehood in 1912, and for the remaining public domain under the Taylor Grazing Act of 1934.

Assigning grazing preferences proceeded fairly quickly on the Forest Service lands; in 1908, for example, Ollie Barney Sr. received a preference for his goat herd in the Happy Valley area. Most state land sections had to be selected from the public domain by the State Land Selection Board, a legal process that ranchers often instigated in order to obtain secure tenure (Sayre 2002). The state land in the study area was selected no later than 1940, and probably by about 1920.

To be fully effective, however, the lease systems required fencing to demarcate and enforce allotment boundaries, and in the study area this was an extremely expensive proposition because of the rugged terrain. State lands, although generally less steep than Forest Service allotments, had to be fenced at the lessees' expense. Forest Service files suggest that fencing was not widespread in the study area until the 1930s at the earliest, and that most allotment boundaries were not fully fenced until the 1960s (see below). Many fences may have been constructed by Civilian Conservation Corps crews such as the one that was based in the Rincon Valley.

The recollections of interviewees are broadly consistent with this timeline, although the precise date of fence construction on non-forest lands is somewhat unclear. Pete Bidegain, whose father owned the Pool Ranch from the early 1930s to around 1960, recalls that fencing began in the 1930s, and that before that time his father used to capture wild

horses in the area (interview, 28 April 2004). His sister-in-law, Scottie Bidegain, who lived at the ranch from 1941 to 1952, recalls that the range was fenced, but that rotational management was impossible for lack of interior ranch fences (interviews, 5 May and 26 May 2004). But Jean Russell, who owned another ranch in the area in the 1940s, recalls that the range was open (interview, 7 May 2004)—this may have been the case longer on some ranches than others. Unfortunately, the State Land Department has not maintained archives of records pertaining to its grazing leases. The BLM, which has administered Taylor Act lands since 1946, also has very little historical documentation.

The construction of fences fundamentally changed the conditions for grazing management in the study area. Previously, livestock movements were dictated by topography, water, and forage availability, and (to a greater or lesser extent) by the activities of cowboys or herders (by both herding and the placement of salt blocks). Animals from neighboring ranches intermingled, concentrating in areas of better feed, water, or microclimates (e.g., shade during the summer). Annual and seasonal roundups were necessarily joint undertakings by all the ranchers in the area.

With fences in place, the levels and locations of grazing pressure could be more easily controlled. Topography, forage, and water availability; microclimates; and human activities remained important factors within a fenced ranch or allotment, but mingling among herds and inter-ranch labor cooperation became the exception rather than the rule. Fences enabled ranchers and agencies to regulate the number of animals utilizing a given area, which in theory would prevent overgrazing. On the other hand, fences could also confine livestock in an area where forage was lacking due to grazing and drought, resulting in overgrazing that might not have occurred in the absence of fences.

Modern Farming and Ranching

Much as fences modernized grazing management in the study area, groundwater pumping modernized farming, especially after electrification of the study area in the late 1950s. Pumping was particularly important because entrenchment of the river channel had made maintaining gravity-powered systems increasingly difficult and expensive. Combined with a

growing array of modern agricultural technologies—from tractors and sprinkler systems to fertilizers, pesticides, and modern seed varieties—groundwater irrigation made farming an increasingly capital-intensive and large-scale enterprise.

Modern farming and ranching required progressively less human labor (per unit of land or output) over time, as capital investments substituted for the work of cowboys, irrigators, and fieldworkers. The population of the study area began to decline as people sought employment elsewhere or gave up agriculture altogether. World War II accelerated this trend, both by exposing local people to broader horizons and by compelling producers to get by with fewer employees. The development of the San Manuel copper mine just north of the study area further impinged on the labor pool and the agricultural ethos of Redington and Cascabel.

The overall trends within agricultural production during the middle and late twentieth century were twofold: (1) expansion of irrigated cropland by clearing mesquite and installing groundwater-based irrigation systems; (2) integration of farming and ranching by planting fields to pasture or hay species instead of market crops, or growing hay for sale to other livestock producers. The major exception was the Bingham family, which continued to grow a variety of vegetables for sale in towns such as San Manuel.

Natural resource conditions remained dynamic, although the changes were less dramatic in this period than in earlier ones. Trees, cacti, and brush encroached on grasses in upland ranges due to reduced fire frequencies—fires were both directly suppressed and indirectly prevented by livestock grazing. Lehmann lovegrass, a perennial bunchgrass introduced from South Africa, increased as well above about 900 m elevation. A nonnative tree, salt cedar (tamarisk), colonized the river channel quickly in the 1950s; according to Zimmermann (1969), salt cedar was the dominant vegetation on 187 ha of bottomland between Tres Alamos and Redington in 1964, although it was absent from an 11 km reach near Redington and virtually absent from tributary drainages. Based on field mapping and aerial photos, Zimmermann also reported that broadleaf forests—composed of walnut, hackberry, ash, sycamore, willow, and cottonwood—were limited to tributary drainages, occurring at only one site on the San Pedro River proper, near the mouth of Edgar Canyon 3 km downstream from Redington. More recent studies indicate that cottonwood and willow gradually reasserted themselves after 1965, apparently favored by higher

than normal winter rainfall from 1975 to 1995 (Fichtel 1998). Loss of floodplain lands to entrenchment continued but at a much slower rate. Perhaps most notable was the loss of perennial flow from long reaches of the San Pedro River after approximately 1940 (Jean Russell interview, 7 May 2004). This was presumably due to increased water use by trees in the river corridor and withdrawals for irrigation.

Surface and Ground Water Rights

The vast majority of surface water rights in the study area date to the 1880s (table 1). After a flush in the 1910s, surface water development dropped off until the 1950s, then grew through the 1970s before diminishing again. These patterns probably reflect the overall intensity of agricultural expansion in the area, and secondarily, the need to develop new points of diversion as entrenchment proceeded.

Obtaining water from wells for domestic purposes began no later than 1909, if the dates attached to formal groundwater rights are accurate. The earliest groundwater right specifically for irrigation purposes is dated 1923. The 1950s witnessed a sharp spike in the establishment of groundwater rights in the study area, including rights filed specifically for irrigation purposes. Initially, large pumps were powered by diesel or gas; electricity became available in the late 1950s. The pattern prevailed until the 1990s, when establishment of irrigation groundwater rights declined but overall groundwater rights increased, evidently due to residential development. As of 1990, an estimated 8,583 acre-feet per year of water were used for irrigation between the Narrows and Redington (Fichtel 1998; Lombard 1998).

Development of Irrigated Cropland

Aerial photographs of the study area have been taken at roughly 20-year intervals going back to 1935. Although some sets are incomplete, these photos provide an objective measure of cultivated lands along the San Pedro over the past 70 years. Acreages were derived by comparing 1996 aerial photos with earlier sets and visually estimating the size of each past field as a percentage of its 1996 size. Unfortunately, only two historical photo sets—1935 and 1987—are sufficiently complete to allow comparisons for the entire study area. They show a 247% increase in irrigated

Table 1. Surface and groundwater rights established in core of the study area, by decade.

		Groundwater rights (number)			
Decade	**Surface water rights**	**All kinds**	**Domestic**	**Irrigation**	**Total capacity of wells for irrigation (gals./min.)**
1870s	33				
1880s	1,977				
1890s	11				
1900s	112	6	2		
1910s	277	2	0		
1920s	50	6	1	1	750
1930s	120	10	3	1	1,000
1940s	136	26	5	8	7,000
1950s	275	45	7	14	11,215
1960s	242	34	5	14	10,797
1970s	379	36	10	18	9,552
1980s	40	47	24	18	8,067
1990s	14	54	33	6	1,355
no date	429	151	38	11	775

Note: Area covered is T11S, R18–19E; T12S, R18–19E; T13S, R19–20E; T14S, R19–20E. Note the large number of undated rights and preponderance of surface water rights dated to the 1880s.

Source: Arizona Department of Water Resources.

acres over the 52-year period, from 1,292 to 3,186. In the subsequent nine years the total increased only 5% more.[6]

Looking more closely at those areas covered by the intervening photo sets, from 1955 and 1967, one can conclude that the majority of the increase occurred between 1955 and 1967, a period when agricultural prices were good and electricity made groundwater pumping more convenient. In the southern half of the study area (for which the aerial coverage is complete) farmland totaled 278 and 279 ha in 1935 and 1955, respectively. In 1967, the same reach of the river had 654 ha under irrigation—a 234% increase. By 1987 it had increased another

9% to 714 ha, and in 1996 the total was 766 ha. If one includes the 10 parcels covered in all sets except 1967, the rates of change are similar: a small increase from 1935 to 1955 (316 to 347 ha), followed by a 240% increase over the 1955–1987 period (834 ha). In 1947, the Soil Conservation Service (SCS 1947) calculated that the Redington District had approximately 656 ha of farmland; 1996 aerials indicate 1,329 ha cleared and 1,169 ha in use. If the 1947 figure is accurate, it suggests that the expansion commenced well before 1955, probably due to growth during and after World War II.

Prior to entrenchment, croplands had been developed out of sacaton grasslands. As the river channel lowered, the alluvial water table dropped below the root zone of sacaton, and the absence of periodic floods allowed mesquite trees to establish. By 1930, sacaton meadows had converted to mesquite bosques through most of the study area. With their taproots easily accessing water 6–12 m below ground level, mesquites could grow large quite rapidly on the terraces along the river. A 1937 University of Arizona Agricultural Experiment Station Technical Bulletin (Nichol 1937) characterized the mesquite bosques between Cascabel and Redington as "remnant areas of the original stands" known to have lined major rivers prior to Anglo settlement. This was clearly a misperception, as no significant bosques had been observed in that reach by surveyor John Harris in 1879.

At mid-century, then, cropland development generally required significant investments in mesquite removal, and most of the expansion of fields came at the expense of mesquite bosques. Some studies suggested that large mesquites consumed about as much water per unit area as alfalfa (Don Decker interview, 8 September 2004), and some farmers aggressively set about removing the bosques. "By late 1965, about 3,900 acres or about half of the mesquite forests growing on the presumed pre-1880 flood plain between Tres Alamos and Redington had been cleared" (Zimmermann 1969). At the Carlink Ranch around Redington, the costs of mesquite removal were offset (at least in part) by proceeds from the sale of lumber and charcoal (McKelvey 1958a).

Comparing Two Droughts: The 1930s and the 1950s

Interviewees remembered the drought of the 1930s as much worse than that of the 1950s, even though many climatologists consider the latter drought much more severe. There appear to be two reasons for this.

First, the farms and ranches in the area in the 1950s were insulated from the worst drought effects by their irrigated land. As long as there was water for irrigation, crops could be raised to sell or pasture could be grown to sustain livestock. The practice of irrigating pasture for livestock to use either in drought or during a portion of the year was common as early as the 1930s (Scottie Bidegain interviews, 5 May and 26 May 2004). The development of groundwater increased significantly in the 1950s (table 1), perhaps in response to severe drought conditions.

Second, the 1930s drought occurred at a time of economic depression, when prices for agricultural commodities were extremely low. Cattle prices, for example, were so low that the federal government's drought relief program bought animals for $10 apiece and then killed them on site to prevent further range degradation. (Pete Bidegain's father found the program so abhorrent that he bid against the government for his neighbors' animals and took them to permanent pasture near Willcox (interviews, 28 April and 3 June 2004).) The 1950s, in contrast, was a period of relative prosperity and significant growth for agricultural producers. (This could backfire on producers, however. Scottie Bidegain [interviews, 5 May and 26 May 2004] recounted that her family went into debt to expand their operation in the early 1950s, only to be caught during a price drop in 1952.)

Formation of the Redington Soil Conservation District

The Redington Soil Conservation District—now known as the Redington Natural Resources Conservation District—was formed in April 1947. Its first supervisors were Kingston Smallhouse, Mike Bidegain, and Carlotta Claflin. To explain the rationale for the district's creation, a short paper was prepared by the Tucson office of the Soil Conservation Service and read at the district's first official meeting. Entitled "The Redington Soil Conservation District: Its Problems, Their Solutions" (SCS 1947), the paper included a brief description of the area and a list of county, state, and federal institutions that would formally cooperate with the new district. Most of the paper described the problems of ongoing erosion and entrenchment in the study area:

> In its native state the San Pedro Valley was a large sacaton draw subject to seasonal flooding from rains upstream. It had a very minor channel which is believed to have been intermittent rather than

> continuous. . . . Man-induced influence on the valley floor and the watershed above has caused serious flooding and deterioration. The channel of the San Pedro is now in places several hundred yards in width and has eroded to depths in excess of 20 feet. Huge areas of fertile land, almost complete farms, have been completely removed. Its present floor is a sand bed and for most of the year bears only a small stream of water. Following rains on the watershed, however, this stream becomes a raging torrent and continues to destroy its flood plain by bank cutting. Its silt-laden water in times of flood destroys the small dams which divert irrigation supplies to the land. . . . The depth of the river channel has intensified the problem of diverting irrigation supplies and necessitated the maintenance of long irrigation ditches to bring the water on grade to the land.

Other problems were mentioned much more briefly, including noxious weeds, rodents, and insect pests. Some problems were contained within individual properties, but many were larger in scope. Because nearly all the farms bordered the river, flooding and erosion were common problems. "The maintenance and improvement of the farming in the district is dependent upon concerted action to solve these problems. The district proposes to make a unified and comprehensive attempt toward their solution."

How the district's boundaries were chosen is not recorded in meeting minutes from the time. It is noted, however, that "the members in attendance represented 85 percent of farm land in [the] proposed district," suggesting that the boundaries reflected voluntary interest in participating.

Modernizing Irrigation

From 1947 on, most farmers and ranchers have coordinated their improvements with the Redington District, drawing on cost-sharing programs and technical expertise provided by the Soil Conservation Service (now NRCS). A major element of farming has been updating and improving irrigation systems to repair or prevent flood damage, improve water-use efficiency, or capitalize on technological or market changes. Between 1967 and 1987, a farm at the mouth of Teran Wash converted an old field to a pecan orchard. Throughout the district, irrigation diversions and ditches gradually gave way to wells and pipelines,

and flood irrigation was replaced by sprinkler systems. This occurred, for example, in the late 1970s and early 1980s on the Cascabel Land and Cattle Company's farm at the mouth of Kelsey Wash. From aerial photos, it can be seen that center-pivot sprinkler systems began to replace side-roll technology in the southern portion of the study area between 1967 and 1987. Today, only the Carlink Ranch continues to divert water directly from the San Pedro, and most of its fields are irrigated by pumps and sprinklers rather than flood methods.

Irrigation improvements have made water use more efficient (and less labor intensive) per acre of farmland, but gross water use has nonetheless increased due to the growing area of farmland in the study area. This increase correlates roughly with the disappearance of perennial surface flow in long reaches of the San Pedro, which Jean Russell (interview, 7 May 2004) dates to around 1940. If Russell's date is correct, however, other factors must also be considered, such as the 1930s drought and increased evapo-transpiration by mesquite bosques (compared to sacaton meadows), since the jump in groundwater pumping occurred slightly later.

Regulated Grazing on Forest Service Allotments

As mentioned above, there is very little documentary information regarding state and BLM grazing lands in the study area. This gap makes historical analysis of the lower-elevation rangelands difficult. For USFS lands, however, significant information can be found in the files for six allotments in the Catalina and Rincon mountains and three allotments in the Galiuros. Although the files represent the perspective of USFS personnel almost exclusively, they nonetheless provide our best picture of the management issues faced by ranchers in the district since about 1930.[7] The most comprehensive reports date from between 1950 and 1980.

In general, the issues and problems were very similar across all nine allotments. In the earliest period, grazing could not be controlled for lack of fencing. The Barney allotment in the Rincon Mountains was until 1927 grazed both by the Barney family's goat herd, under permit, and by trespass cattle from the Empire Ranch, which presumably entered the study area via Happy Valley.

Initially, most of the allotments showed signs of overgrazing in the recent past. After inspecting the Bellota allotment in the Santa Catalina

Mountains in March 1938, Acting Forest Supervisor H. Garvin Smith wrote, "All forage, curly mesquite, gramma [*sic*] and bunch grass types was found very short even in the rough almost inaccessible portions of the range. It looks like fully 100% utilization of all palatable forage plants, except of course, some of the larger browse, and of course trees and these have been hedged where stock was able to reach them."

It was very difficult to determine, however, whether poor range conditions reflected current overgrazing, periodic drought, or both. When Forest Ranger E. L. McPhaul crafted the 1938 plan for the Bellota allotment, he conceded, "As to whether the primary cause of the condition of the range was caused by severe drought or excess stocking, could not be definitely determined. . . . This range was in excellent condition in 1935. Grama hay could have been cut along the Redington road after the 1935 growing season."

Ranch boundaries were fenced first, often enclosing a mix of private, state, and forest lands. There were no interior fences to separate forest allotments from adjacent non-forest land until the 1960s, and in one case the allotment boundary has never been fenced. The boundary of Saguaro National Monument was not fenced until 1976–77. Most of the allotments in the Winchester Mountains are not fenced to this day (Don Decker interview, 8 September 2004).

An allotment's preference was supposed to reflect the forest land's portion of the overall forage needed to support the ranch herd. But this didn't necessarily work out in practice. Especially for the smaller allotments in the Happy Valley–Redington Pass area, officials frequently remarked that forest land was being disproportionately impacted by ranchers' herds.

Livestock distribution was the underlying problem. Cattle would congregate near water and on flatter or more sheltered areas. Terrain alone could generate severe maldistribution. The Redfield allotment in the Galiuro Mountains was the extreme example of this: with few water sources other than a stream at the bottom of a steep-sided canyon, cattle rarely reached most of the allotment. A 1962 analysis concluded that only 1,538 ha was suitable for grazing, out of a total area of more than 8,900 ha. More than 30 years earlier, an inspection memo had remarked that the accessible areas of the allotment were "being used too heavy."

Distribution problems could be addressed in several ways. One was to manipulate critical resources such as water and salt. Artificial water sources could help distribute livestock more evenly across allotments;

such improvements were made on several allotments as early as 1929, probably in conjunction with boundary fencing. The USFS also urged permittees to place salt blocks away from water sources in order to draw cattle into underutilized areas.

This approach appears not to have worked very well. Water development could be counterproductive, as it apparently was in the case of Parke Gilbert, permittee of the Last Chance allotment from 1953 to 1963. His investments in additional water sources reportedly led to deterioration by enabling him to stock more animals and impact a larger portion of the allotment. As for salting, reports from the 1940s to the 1960s are replete with complaints about permittees "salting on water." "The problem areas are the same old 'easy areas' which have been punished for years because of lack of management," complained a 1966 inspection of the Bellota allotment. "Attempts to achieve better management system [sic] by pasture fencing or by fencing the waters have been unsuccessful due to the reluctance of the permittee to change."

Another strategy was to change the overall number of permitted livestock. When a permit changed hands, the USFS typically "adjusted" the preference downward by 10–20% to correct for excessively high past stocking rates.[8] The Barney allotment dropped from 77 to 65 cattle yearlong (CYL) in 1951, when the permit passed from Ollie Barney Sr. to Ollie Barney Jr. The Bellota preference was reduced from 747 CYL to 685 CYL between 1947 and 1957, as its various component pieces were consolidated into a single permit held by Josephine Reeve. The Last Chance allotment was transferred from Allen and Bidegain to Allen and Allen in 1940, at which time its preference was cut from 164 to 135 CYL; it was further reduced, to 100 CYL, when Wilbur Gavin acquired it in 1966. The Fresno allotment preference was cut from 40 to 35 CYL in 1951, when Paul Watkins sold out to C. Z. Clopton. When the Ash Creek and Happy Valley allotments were merged under permittees Roderick J. and Evangeline MacKenzie in 1943, the combined preference was cut from 400 to 360 CYL.

These gradual cuts, and voluntary reductions during the 1950s drought, did not prevent long-term changes in vegetation over time, and by the 1960s USFS officials were recommending further reductions in preference numbers for several allotments. Spanish dagger, or amole, was replacing grasses in the Barney, Fresno, and Bellota allotments. Manzanita, oak, and juniper were encroaching into middle-elevation

perennial grasslands. Mesquite and acacia were problems at middle and lower elevations. A 1951 report for the Bellota allotment is typical: "Due to amole, the usable area should be cut down 80% to approx. 50%—impossible to get good distribution on allotment in summer even with additional water developments. Heart of allotment gutted—long slow process of recovery." Conditions did improve on some allotments when rainfall was good, but the majority of allotment inspection reports and memos indicated poor or fair conditions and static or downward trends in forage species during the 1930–1965 period.

A third strategy was to manipulate the temporal distribution of grazing. Beginning as early as the 1940s, USFS officials stressed the need to develop interior fencing to enable rotational grazing systems; to defer grazing on portions of an allotment each year; or to switch from continuous yearlong grazing to winter-only use to allow forage plants to grow without grazing during the summer months.

Grazing was however continuous and year-round throughout the study area until the late 1960s and the 1970s. Two permittees, Walter Gavin on the Last Chance allotment and Joe Goff on the Finley Springs allotment, were the first to implement rotational or deferred grazing in the late 1960s, and the files testify that conditions improved as a result. The 1974 Bellota allotment management plan instituted alternate-year summer rest. A similar system was implemented on the Barney allotment in 1978, and by 1982 conditions were fair to good and trends were stable to upward. In 1977, the Happy Valley allotment was managed under a rotation between Turkey and Paige creeks. Allowing grasses time to recover from grazing, via rotation or deferment, appears to have been more successful than strategies aimed at uniform spatial distribution or reductions in permitted numbers.

The late 1960s and the 1970s also saw the use of chemical sprays and prescribed fires to combat brush encroachment on grazing allotments in the study area, particularly in the Bellota allotment on Redington Pass. In Government Tanks pasture in 1967, 120 ha of mesquite were slated for spraying; the files do not indicate if this plan was carried out. A prescribed fire in South Italian Trap pasture in June 1977 resulted in 80% mortality of amole; another fire was planned for White and West Spring pastures in 1981. Apparently the mesquite persisted, however, for in 1985 another 120 acres in Government Tank were bulldozed and seeded to sideoats grama and other native species. As of 1988, the dominant grass at the site was Lehmann lovegrass.

Rotational or deferred grazing systems are now the norm on larger ranches in the study area, and interior fences have recently been constructed on many state and federal grazing lands. On some of the larger ranches in the study area—the C-Spear, Carlink, A7 and Three Links—interior fences have been constructed only in the past decade (Johnny LaVin interview, 14 February 2004; Don Decker interview, 8 September 2004). The river corridor has also been fenced to exclude livestock, both on active ranches and on properties acquired for conservation or residential purposes. Generally, uplands are grazed in the cool season, when the principal forage grasses are dormant and cattle are more likely to range across rugged terrain. During the hot growing season, livestock are moved to irrigated pastures along the river. This conforms with longstanding USFS recommendations to allow perennial forage grasses to rest from grazing during the growing season. As lands along the river are retired from agriculture, however—whether for residential or conservation purposes (see below)—summer deferral of grazing in uplands has become impossible for some ranches and more difficult for others (Don Decker interview, 8 September 2004).

1980–Present: Emergence of Subdivision and Conservation

The majority of state and private lands in the study area are still used for agricultural production. Most USFS allotments are also still active. Since 1980, however, two other land uses have increased significantly: subdivision of private lands into parcels intended primarily for use as residential homesites, and conversion of private and leased lands to conservation purposes not associated with agriculture. Although not necessarily incompatible with agriculture, both of these land uses represent potential competitors to agriculture as the area's defining economic activity and cultural identity.

Subdivision

Subdivision has occurred in four townships in the study area. Table 2 presents the number of landowners and the acreages involved, amalgamated to the township level. These data indicate that subdivision has affected a large

Table 2. Location, number, and size of subdivided private lands in the study area by township.

Township	Landowners	Acres private land	Avg. parcel size (acres)
T12E R19S	26	1,800	69
T13E R19S	93	5,360	58
T13E R20S	15	800	53
T14E R20S	31	3,320	107
Total	165	11,280	68

Source: Adapted from Lower San Pedro Watershed Assessment Project Task 4E, Appendix B.

area of land, principally along the San Pedro River corridor, but that it has not reached the high densities and small lot sizes typically associated with the term "subdivision." County zoning permits lots as small as 1.67 ha, but the average subdivided parcel in the study area is 27.5 ha. Individual parcel sizes vary widely, of course; some are as small as 1.8 ha, but 16 ha and larger parcels are much more common. Amalgamated at the section level, rates of fragmentation range from 10 to 259 ha per parcel.

Virtually all of the subdivision has occurred in the southern half of the study area, closer to Interstate 10 and the services available in Benson. Curiously, much of this subdivision can be traced to a pair of real estate transactions involving the City of Tucson. The first occurred in the spring of 1960, when the city purchased the former Bidegain Ranch—890 ha of private land and the state grazing lease to nearly 7,690 ha—from Mr. and Mrs. Lloyd W. Golder Jr. The acquisition was extremely controversial in Tucson because of apparent conflict of interest and profiteering by third parties, who were compelled by public pressure to withdraw from the deal (Sayre 2007). The city's intended use for the land—as a source of groundwater to be pumped over Redington Pass—was less controversial in Tucson but more problematic in the end. A lawsuit filed by farmers in the Avra Valley—where the city was also acquiring so-called "water lands"—eventually led to the 1969 *Jarvis* ruling by the Arizona Supreme Court prohibiting inter-basin water transfers. In the meantime, the city leased the ranch for grazing. The second transaction took place in 1985, when the city put its property up for sale by sealed bid auction. The winner was a development partnership,

which subdivided the private land and marketed lots under the name Cascabel Ranch Properties. Sales were not brisk, requiring more than 15 years to sell out.

Another major property, also known as Cascabel Ranch, was split into six pieces and sold between 1992 and 1995. The owner, Reese Woodling, had bought the Wagner (formerly Russell) Ranch in 1976 and added the Harry Smith farm to it in 1980. He marketed the property as a single unit for three years before concluding that he would have to subdivide it in order to find buyers. Most of the parcels were large enough to remain in agricultural use. Some have subsequently been subdivided again, however, resulting in parcels that are effectively residential rather than agricultural. The Cholla Group, LLC, acquired much of the private land and the state leases associated with the former Cascabel Ranch in 1997 and attempted (unsuccessfully) to develop 65 homesites in a combined ranch and residential venture.

Many subdivided parcels are undeveloped and belong to absentee landowners. There are 165 landowners in the southern half of the study area, but there are only 48 physical addresses. Of the 204 property owners identified from tax rolls for the entire study area, fewer than half (96, or 47%) have addresses within the study area.

If current landowners are representative, the study area appeals to retirees who wish to live in a rural area—that is, an area where agricultural production is a defining feature of the landscape and community. Residents who attended open houses as part of the Lower San Pedro Watershed Assessment Project were asked to complete a brief questionnaire about their backgrounds, properties, and reasons for living in the area. (The survey was non-random, so it cannot be taken as representative of all residents or landowners. Absentee landowners are, of course, grossly underrepresented.) Of 46 respondents, 25 (54%) were over 60 years of age, and 76% were over 50. Twenty-seven respondents (59%) had lived in the area less than 10 years, and the same number indicated that they had bought their properties for retirement. Twenty-eight respondents (61%) cited "rural lifestyle" as a reason for choosing to live in the area.

It appears that the market for subdivided parcels in the study area is relatively small at this time. Cascabel Ranch Properties had to significantly scale back plans for their Air Park development in the 1980s. The Cholla Group failed to attract buyers for its high-end lots. Properties often remain on the market for years, if one may judge from the presence of real estate signs (personal observation).

The lack of paved road access apparently makes the area less appealing than otherwise comparable areas for many retirees. The poor condition of the road is also a major issue for current residents. Cochise County has extended the pavement at the south end of the study area approximately 16 km since 1997. Paving the road all the way through to San Manuel would undoubtedly have a strong effect on subdivision and development patterns in the study area.

Because the road passes through three different counties, significant improvement is a complicated prospect politically and fiscally. It might be simplified by action at the state level, and beginning in the late 1960s a state highway was contemplated. Fifty-one parcels were acquired for a widened right-of-way, and three major bridges were built (one at Tres Alamos Wash, south of the study area, and two at Redington). Officially, the state abandoned the highway plan in the late 1970s due to cuts in federal highway funds (ADOT 1978); many local residents recall it as a pet project of a local politician, which died when he lost his seat on the Highway Commission. In the 2000s, a similar project was again floated but was defeated under intense pressure from local residents and regional environmental groups.

Conservation

In the 1970s The Nature Conservancy named the San Pedro River one of the world's "Last Great Places" for conservation of biological diversity. Its importance derives largely from the aquatic and riparian habitat the river supports and from its geographical location along one of North America's major migratory pathways for neotropical birds. The study area, in particular, lies at the ecotone of three major biomes: the Sonoran Desert, Chihuahuan Desert, and Apachean Highlands (Fichtel 1998). Since 1980, habitat conservation or restoration has motivated land acquisitions totaling more than 43,000 ha in the study area by public and private entities.

Conclusion

The history reconstructed here provides a context for understanding current conditions and evaluating land management goals and objectives. Several conclusions are worth noting.

First, human occupation and use of natural resources is extremely longstanding. Irrigated agriculture has occurred for 1,000 to 1,500 years, and the population of the study area was probably higher during some prehistoric periods than in the twentieth century. Impacts on natural resources are not directly correlated with population, however: water use has increased over the past 75 years, for example, even as population has declined.

Second, the landscape has been and remains extremely dynamic, changing in response to climatic and hydrological factors as well as land uses and management. The timing, frequency, and intensity of droughts, floods, and fires have all been critical drivers of environmental change, interacting with human impacts in complex ways. It is therefore difficult or impossible to assign causality to any single factor. Patterns observed in the past may or may not hold in the future.

Third, the most dramatic and enduring environmental change in the area has been entrenchment of the river channel after 1890. Whatever its causes, entrenchment ramified through the river corridor, affecting vegetation patterns, irrigation and farming systems, landownership patterns, flooding, and wildlife. It converted sacaton meadows into mesquite bosques, which were misrecognized as the "original" vegetation as early as the 1930s. Vegetation changes in the uplands have been less dramatic but no less enduring.

Fourth, these changes beg the question of any attempt to "restore" the lower San Pedro watershed: restore to which conditions, from which time period? Restoration of sacaton meadows is unlikely to succeed on any significant scale absent restoration of the pre-entrenchment disturbance regime, including periodic fires as well as sheet (rather than gully) flooding. Cottonwood-willow riparian forests have received a lot of conservation attention, but they are more common today than they were at the time of reoccupation in the 1870s and 1880s; this is definitely the case in the study area and may also be true regionally (Turner et al. 2003). Perennial bunchgrasses, even more than sacaton meadows, require periodic fires to outcompete shrubs. In short, any "restoration" plan must acknowledge the effectively irreversible nature of historical environmental changes and explain its conservation objectives in this light.

Fifth, although livestock grazing has unquestionably had a strong and extensive effect on the watershed, its impacts have changed significantly over time. The available evidence indicates that the impact of livestock

has diminished since about 1970. Although data specific to the study area are lacking, stocking rates have probably declined by more than half since the cattle boom period. Artificial water sources have reduced the dependence of livestock on natural surface waters, including the river itself. The advent of rotational and deferred grazing systems in the 1970s, coupled with pasturage on irrigated private lands along the river, has reduced the direct impacts of livestock on upland perennial grasses. Many changes in upland vegetation—such as increased trees, shrubs, and cacti—are unlikely to be reversed by livestock exclusion alone. Active management is required, particularly with regard to fire restoration and management.

Sixth, land-use change may promote or undermine natural resource conservation, depending not only on the proportions of land devoted to agriculture, residential development, and conservation but also on the interactions among them and how conservation is defined. At the present time, subdivision is not far advanced and landowners appear committed to an agricultural community. The conservation values of the area are widely recognized and increasingly protected. Resource conditions are greatly altered since 1870 but apparently improved since about 1960; irrigated agriculture probably benefits upland range conditions at the potential expense of groundwater in the river. Reduced access to irrigated bottomland for pasture and hay production has constrained livestock producers' management options, however, and drought continues to threaten their viability. Although irrigated agriculture is highly water consumptive, higher-density residential land use would impact other habitat values such as connectivity between mountain ranges for migratory species. Designated conservation areas and restoration of surface flow may make adjacent private lands more attractive to residential buyers, especially if the main road through the study area were to be paved.

Finally, there is considerable uncertainty built in to many of the area's most important natural resource issues. How will groundwater depletion and subdivision in the upper San Pedro watershed affect the river downstream, or the economy? Is the severe drought of recent years temporary, or might it continue as climate changes? Defining and achieving conservation in the area will require cooperation and constructive engagement among agricultural producers, resident and nonresident landowners, public agencies, and private conservation interests. ✣

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Notes

1. Bones of even larger fish—including one nearly five feet in length—have been found in the trash pits at Quiburi, a prehistoric site roughly 40 km upstream of the study area (DiPeso 1953; Miller 1961).

2. One settler near the confluence of Hot Springs Canyon and the San Pedro, at the site later known as Pool Ranch, had a surname that appears Chinese: Ming. Most likely this was Daniel Houston Ming (or a relative of his), who also ranched downstream at Aravaipa and was not ethnic Chinese (Hadley, Warshall, and Bufkin 1991).

3. Both articles are transcribed and located in the bio-files of the Arizona Historical Society in Tucson. The earlier article misspells Pool as "Poole," and the Historical Society has misfiled both articles under "Joseph" rather than Josiah Pool. (Joseph was one of Josiah's sons, but he was only 15 years old at the time of the earlier article.) Josiah Pool was a doctor as well as a farmer, and his farm became a significant center of community activity along the river: the site of a school, a post office, and a census precinct early in the twentieth century. Pool Wash takes its name from Josiah Pool.

4. Understood as the area downstream of Babocomari Creek. Curiously, the report described this as poor grazing land: "for many miles [these lands] are sandy and almost barren stretches, only relieved by the gietta-grass [*sic*] and greasewood, or in some localities by abundant mesquit brush and mescal, with varieties of the cactus, valueless to cattle."

5. Comparable figures for the Redington area are not available, because it was lumped with the rest of northeastern Pima County, including the northeastern Tucson basin.

6. The Nature Conservancy estimate of irrigated farmland is slightly higher: 3,770 acres as of 1990 (Fichtel 1998).

7. Before 1930 files either were not made or have been lost, although some documents contain references to conditions and permittees back to 1907.

8. Reductions without a change in ownership were difficult to institute because the price a rancher paid to obtain a permit was determined by the preference. "Dick Reeve has indicated to me that he thinks 500 head yl [yearlong] is about right but does not want the permit reduced because of the loss if he should sell out," noted a 1966 report on the Bellota allotment.

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