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From the Rio to the Sierra: An Environmental History of the Middle Rio Grande Basin

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Dan Scurlock

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From the Rio to the Sierra: An Environmental History of the Middle Rio Grande Basin

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A fire history study in the northern Manzano Mountains indicates a period from 1550 to 1636 when relatively frequent, spreading fires occurred. This was followed by a period (1637–1723) of infrequent, spreading fires, and then, from 1724 to 1773, by a period of episodic, widespread fires. From 1773 to about 1810, there were no fires in the area. This absence of fires may have been due to intensive livestock grazing, especially sheep, and fuelwood cutting by Hispanic residents in the greater Albuquerque area (Baisan 1993: 4).

Fires did occur in the northern Manzanos from 1811 to 1842, then frequency declined until 1904, after which time no more fires occurred. Lack of intensive grazing and firewood cutting may have created the fuel to sustain fires until 1842. Sharp increases in grazing and cutting after that year may have caused the decrease, and organized fire suppression probably accounts for the cessation of fires after 1904 (Baisan 1993: 4–5).

PLANT COMMUNITIES

The following brief reconstructions of historic plant communities in the study region are based primarily on the work of Brown (1982), Brown and Lowe (1980), Crawford et al. (1993), Dick-Peddie (1993), Gross and Dick-Peddie (1979), Leopold (1951), and Watson (1912) and secondarily on various historical sources cited in the following pages. Changes in floodplain communities, and their dominant species, are presented in Table 48. Following these community descriptions are selected historical observations on the region's flora, included as supplemental material. The next section will deal with impacts on these communities over the last 150 years.

Riparian

As long as 2 million years ago a riparian cottonwood woodland, or bosque, existed along the Rio Grande. The cooler, wetter conditions that prevailed at that time in New Mexico also supported several associated plants, including birch (*Betula* sp.), western chokecherry (*Prunus virginiana*), willow (*Salix* spp.), and cattail (*Typha* sp.). When the Spanish arrived in the 16th century the banks, sand bars, and adjacent floodplain areas were vegetated with scattered bosques of varying-age valley cottonwood (*Populus deltoides* ssp. *wislizeni*) (Fig. 51), with a willow (*Salix* sp.) and salt grass (*Distichlis spicata*)-dominated understory (Table 48). Open, grassy areas, or vegas, were also present. Cattails and other wetland species grew in and around ponds, marshes, and swampy sites. Other major plants associated with the bosques included New Mexico olive (*Forestiera pubescens* var. *pubescens*), baccharis (*Baccharis wrightii*), false indigo bush (*Amorpha fruticosa*), wolfberry (*Lycium andersonii*), and, in southern reaches, mesquite (*Prosopis glandulosa*). All of these plant communities were considerably modified by human activity during the historic period (Crawford et al. 1993: 27–28; Dick-Peddie 1993: 151–152; Table 48).

Besides cattails, other common plants such as sedges (*Carex* spp., *Eleocharis* sp.) rush (*Juncus* sp.), scouring rush (*Equisetum hyemale*), buttercup (*Ranunculus cymbalaria*), pepperwort (*Marsilea vestita* ssp. *vestita*), mosquito fern (*Azolla mexicana*), reed grass, or carrizo (*Pragmites australis*), and yerba mansa (*Anemopsis californica*) grew around wetlands or on areas with high water tables. The deeper water of swamps and ponds held floating plant communities of algae (*Spirogyra, Vaucheria, Oedogonium*) and duckweed (*Lemna minor*). The submerged species of water plants were milfoil (*Myriophyllum spicatum*) and hornwort (*Ceratophyllum demersum*) (Crawford et al. 1993: 28; Table 48).

These plants and the communities they made up were adapted to a dynamic, moist, floodplain environment with an unstable substratum. Relatively high moisture availability originated from periodic floods, standing surface water, and shallow ground water. These floods scoured new and old channels, washed away stands of trees and understory vegetation, created new wetlands, and formed new channels and sand bars. Flood actions resulted in the creation of gradients across the floodplain, which resulted "in a dynamic successional sequence in a riparian habitat continuum" (Reichenbacher 1984: 15, 20). Flooding is basically an erosional-depositional process promoting "forest and age diversity on the floodplain" and in its meandering "creates the distribution of the different communities and age classes" (Crawford et al. 1993: 28). Fire, natural and human caused, probably played a lesser role in the creation, composition, distribution, and age structure of these communities. These dynamic processes were present until their alteration and modification in the early 1900s (Crawford et al. 1993: 29; Table 48).

Grasslands

Grasslands covered much of the study region between stream floodplains and up to 6,000 to 7,000 feet elevation in the early historic period. This botanical zone has been called desert grassland, desert-grassland transition, desert savanna, desert shrub grassland, and grassland transition. These various names suggest the obvious transitional nature of this plant community (Brown 1982: 122–131; Dick-Peddie 1993: 106–107). With intensive grazing of these communities for 200 to 400 hundred years, forbs and shrubs have replaced various bunch grasses favored by livestock. Various grama species and other bunch grasses were the dominant types in these "seas of grass," as they were sometimes called in the historic period. Prior to the arrival of the Spanish, various Native American groups intentionally burned these grasslands periodically. Lightning-caused fires may have occurred even more frequently. These burns may have killed encroaching woody forbs and shrubs and stimulated vigorous growth. The complete role of fire in the maintenance of these grass-

Table 48—Historic floral community dominant plant species, Middle Rio Grande Valley.

Period	Communities/dominant species
Spanish Colonial (1540–1680)	Bosque (riparian woodlands)
	Cottonwood groves—*Populus deltoides* ssp. *wislizeni* (discontinuous)
	Willows—*Salix exigua, S. gooddingii, S. amygdaloides* (understory areas and river edge)
	New Mexico olive—*Forestiera pubescens var. pubescens* (isolated understory areas)
	Seepwillow—*Baccharis salicifolia* (isolated understory areas)
	False indigo bush—*Amorpha fruticosa* (isolated understory areas)
	Wolfberry—*Lycium andersonii* (isolated understory areas)
	Mesquite—*Prosopis* sp. (southern reach; isolated understory areas)
	Salt grass—*Distichlis spicata* (understory areas)
	Common reed grass—*Phragmites australis*
	Cienegas, esteros, charcos (wetlands)
	Algae—*Spirogyra, Vaucheria, Oedogonium* (deeper water)
	Duckweed—*Lemna minor* (deeper water)
	Chara spp. (shallow water)
	Water-milfoil—*Myriophyllum spicatum* (shallow water)
	Hornwort—*Ceratophyllum* sp. (shallow water)
	Cattail—*Typha latifolia* (shallow water margins)
	Sedge—*Carex* sp., *Eleocharis* sp. (shallow water margins)
	Rush—*Juncus* sp. (shallow water margins)
	Scouring rush—*Equisetum hyemale* (shallow water margins)
	Buttercup—*Ranunculus cymbalaria* (shallow water margins)
	Pepperwort—*Marsilea vestita* ssp. *vestita* (shallow water margins)
	Mosquito fern—*Azolla mexicana* (shallow water margins)
	Coyote willow—*Salix exigua* (wet banks)
	Cottonwood (wet banks)
	Vegas (meadows)
	Sedges (wet meadows, water edges)
	Rush (wet meadows)
	Common Reed Grass (wet meadows)
	Salt grass (wet meadows)
	Yerba Mansa—*Anemopsis californica* (wet meadows)
	Appearance of naturalized exotic plants such as alferillo (*Erodium cicutarium*), horehound (*Marrubium vulgare*), dandelion (*Taraxacum officinale*), mallow (*Malva neglecta*), etc.
Middle-late Spanish Colonial-Mexican Republic (1681–1846)	Similar to plant communities distribution above but fewer or no stands of cottonwoods around settlements, more ditches with *Chara*, sedge, rush, bullrush, and willow species.
Territorial (1846–1912)	Bosque (riparian woodlands)
	Similar to above but fewer stands of cottonwood, with generally smaller trees; more ditchside habitat.
	Cienegas, esteros, charcos (riparian wetlands)
	Increase due to rising water table and increasing soil alkalinity, dense ditchside thickets and stands of willow, senna (*Senna bauhinioides*), sunflower (*Helianthus annuus*), and goldenrod (*Solidago* spp.).
	Vegas (meadows)
	Appearance and spread of exotic species such as curly dock (*Rumex crispus*), Russian thistle (*Salsola kali*), and Johnson grass (*Sorghum halepense*) (southern reach).

continued on next page

Table 48—Historic floral community dominant plant species, Middle Rio Grande Valley (continued).

Period	Communities/dominant species
Statehood (1912–present)	Bosque (riparian woodlands)
	More extensive stands of young and maturing cottonwoods and understory willow species dominant until 1940s. Major reduction in wetland and aquatic species.
	Bosque eradicated in local areas inundated by major reservoirs or by floodplain clearing for development.
	Cienegas, esteros, charcos (wetlands)
	Extensive until 1930s drainage and reclamation or inundation by reservoirs.
	Appearance of tamarisk, or salt cedar (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*), Siberian elm (*Ulmus pumila*), and tree of heaven (*Ailanthus altissima*) and spreading rapid.
	Increase in four-wing saltbush (*Atriplex canescens*), Russian thistle.

Sources: Crawford et al. 1993: 28; Hedke 1925: 23; Watson 1912, Hink and Ohmart 1984, Scurlock 1988a, 1993a, and Soil Conservation Service 1994

Figure 51— Three men in a "ferry" boat on the Rio Grande, 1880s. Note honey mesquite (left center), valley cottonwood seedlings on sandbar (upper center), and scattered, older cottonwoods (back). This locale is now inundated by Elephant Butte Reservoir. Photo courtesy New Mexico Bureau of Mines Photo Archives, Socorro.

lands, however, is uncertain (Bahre 1991: 138–141; Dick-Peddie 1993: 106–107). Intensive grazing has so denuded many stands that today their scant, patchy condition will not carry extensive fires. Other factors, such as climatic change and fire suppression, probably have a role in compositional change in this community (Bahre 1991: 42–53).

Various travelers across the region in the early to mid historic period commonly referred to the vast stretches of densely growing grama and other bunch grasses. By the middle 1800s, recorded historic observations, and particularly field notes from public land surveyors later in the century, indicate that changes in plant composition had already occurred or were in progress. The species of grass more palatable to livestock had been decimated, followed by encroachment of shrubs and woody or herbaceous species, including introduced ones. For determining more recent changes, the technique of repeat photography (i.e., rephotographing a view of vegetation at the same historical location) has been used to document these changes (Dick-Peddie 1993: 9–20).

Using surveyors' notes on public lands in New Mexico from the 1870s and 1880s, Gross and Dick-Peddie (1979) reconstructed "primeval vegetation types," including grasslands, for about 1880 (Fig. 52). Based on this map, desert grassland and sand scrub were generally found east of the Middle Rio Grande Valley, reflecting a subsequent change by an invasion of saltbush, creosotebush, juniper, sand sagebrush, or yucca. West of the river, juniper and pinyon at higher elevations constituted the major invader species into grasslands (Dick-Peddie 1993: 11). In some locations, the present composition has led to classification of this community as savanna.

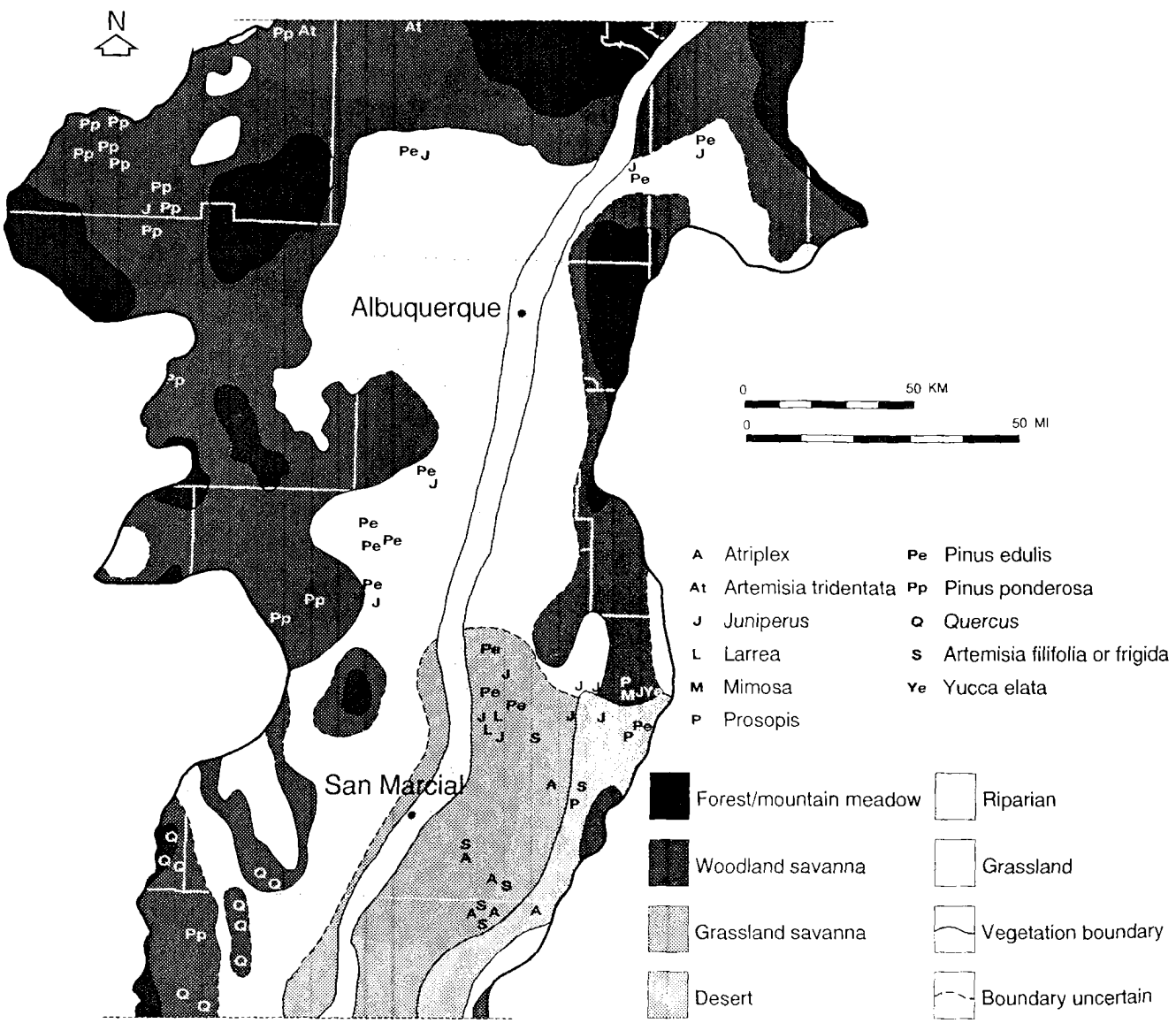

Figure 52—Reconstructed primeval vegetation types, 1870–1900 (after Gross and Dick-Peddie 1979).

Desert Grassland

The desert grassland community flanks the Middle Rio Grande Valley from the Cochiti Pueblo area to about Socorro (Fig. 53). Much of the desert grassland occupies sites that were previously plains-mesa grasslands. Intensive grazing, fire suppression, and perhaps other factors have resulted in the invasion of forbs and shrubs; their composition is highly variable. The dominant grass of this community is black grama (*Bouteloua eriopoda*). Other grama species are present, as are the dominants tobosa (*Hilaria mutica*), fluff grass (*Erioneuron pulchellum*), and bush muhly (*Muhlenbergia porteri*). Some common, associated shrubs and forbs include saltbush (*Atriplex* spp.), prickly pear (*Opuntia* spp.), *Yucca* spp., feather peabush (*Dalea formosa*), and snakeweed (*Gutierrezia sarothrae*) (Brown 1982: 112, 115–131; Dick-Peddie 1993: 106–108, 117–118; Fig. 51).

Plains-Mesa Grasslands

Generally occurring on intermountain mesas and bajadas at elevations between 5,500 and 6,500 feet are the plains-mesa grasslands, which were historically more extensive, but human disturbance over the last 200 years has reduced their range. These communities were made up of 90 percent grass species such as blue grama (*Bouteloua gracilis*) across the region, western wheatgrass (*Pascopyrum smithii*) and galleta (*Hilaria jamesii*) on northern mesas, and Indian ricegrass (*Oryzopsis hymenoides*) on bajadas. Various dropseed (*Sporobolus* spp.) species, along with Indian ricegrass, occur on some sandy northern and central mesas. At the extreme south end of the study region black grama and various dropseed species occur. Alkali sacaton (*Sporobolus airoides*) dominated swales across the region, sometimes in association with tobosa. A number of other shrubs, forbs, and herbaceous plants, such as *Yucca* spp., saltbush, sagebrush (*Artemisia* spp.), and rabbitbrush (*Chrysothamnus* spp.), make up the other ten percent of the vegetative cover. Due to climate and land forms, the plains-mesa grassland vegetation of New Mexico demarks the southwestern boundary of the continental grassland (Dick-Peddie 1993: 105–106; Soil Conservation Service 1994)..

Figure 53—Desert grassland near Isleta Pueblo. Bunch grasses, broomweed, and scattered four-wing saltbush (behind fence) are dominant species. Photo by author.

Scrublands

Four scrubland plant communities have been recognized in the region: Great Basin desert scrub, Chihuahua desert scrub, plains-mesa sand scrub, and montane scrub (Dick-Peddie 1993). Intensive grazing, fire, fire suppression, and climatic variations have shaped these associations in the historic period. These communities are dominated by shrub species adapted to lower moisture availability and other poor or severe climatic, geomorphologic, and edaphic conditions. The Great Basin desert occurs to the west and northwest of Albuquerque. Dominant species in the Great Basin community are shadscale (*Atriplex confertifolia*), fourwing saltbush (*A. canescens*), sagebrush, winterfat (*Krascheninnikovia lanata*), and rabbitbrush (Dick-Peddie 1993: 129–130; Soil Conservation Service 1994).

The Chihuahua desert scrub community occurs in the southern part of the study region, extending from Socorro south to the boundary below San Marcial. Originally smaller in extent, intensive grazing coupled with climatic fluctuations and fire suppression have resulted in extensive enlargement of its historical range in the last century or more. This increase has included the replacement of the two previously discussed grassland communities. The two major plant species are creosotebush (*Larrea tridentata*) and tarbush (*Flourensia cernua*), with soaptree yucca (*Y. elata*), white thorn (*Acacia* spp.), and various cacti species in association (Dick-Peddie 1993: 131–132; Soil Conservation Service 1994).

The third community, the plains-mesa sand scrub, flanks the Middle Valley from Cochiti to Socorro and is also found to the east of the Bosque del Apache National Wildlife Refuge. This vegetative type is determined by deep-sand areas, as well as by climatic conditions. Common plants include sand sagebrush (*Artemisia filifolia*), broom snakeweed, and *estafiata* (*Artemisia frigida*). Dominant grasses include hairy, blue, and sideoats grama (*Bouteloua hirsuta, gracilis, curtipendula*), alkali sacaton, and mesa dropseed (*Sporobolus flexuosus*) (Dick-Peddie 1993: 128–129).

The last scrub community, the montane scrub, generally occurs in patches or strips within more extensive types of upland vegetation. This community occurs on exposed rocky slopes or ridges subject to variable and severe climatic conditions. A number of species of common shrubs are present: mountain ninebark (*Physocarpus monogynus*),

buckbrush (*Ceanothus fendleri*), Mormon tea (*Ephedra torreyana*), mountain mahogany (*Cerocarpus montanus*), Apache plume (*Fallugia paradoxa*), scrub oaks (*Quercus* spp.), banana yucca (*Y. baccata*), and gooseberry (*Ribes* spp.) (Dick-Peddie 1993: 123–127).

Juniper Savanna

The juniper savanna community is an ecotone between grasslands and woodlands in the region; widely scattered juniper or oak species (less than 130/acre) occur in a grass matrix (Fig. 47). All of the regional juniper savanna is composed primarily of one-seed juniper (*J. monosperma*) and several major grasses, including three grama species, plains lovegrass (*Eragrostis intermedia*), galleta, sixweeks threeawn (*Aristida adscensionis*), and Indian ricegrass. Gambel oak (*Quercus gambelii*) or gray oak (*Q. grisea*) in place of juniper are less common in grassland stands. This community, which may have formed in the historic period, has expanded extensively due to intensive livestock grazing, climatic variation, and fire suppression (Dick-Peddie 1993: 87, 91–93).

Pinyon-Juniper Woodlands

The pinyon-juniper woodlands occur on lower mountain slopes and higher mesas, generally between 6,000 and 7,500 feet. The community is dominated by pinyon (*Pinus edulis*) and one-seed juniper or alligator juniper (*J. deppeana*) (Fig. 54). Blue grama grass is generally present, and in some instances understory shrubs such as mountain mahogany, skunkbush (*Rhus trilobata*), and Gambel or wavy leaf (*Quercus undulata*) oaks. The Gambel oak may be codominant with the conifers. This community has also extended its range into grasslands over the past 100 years or so, owing primarily to overgrazing and fire suppression (Dick-Peddie 1993: 87–90). This zone has been heavily used since the late prehistoric period for collecting of fuelwood, construction materials, and medicinal and edible plants. Understory grasses were intensively grazed throughout the historic period.

Ponderosa Pine

Ponderosa pine (*Pinus ponderosa*), the most important commercial species in the region, is dominant in this community, which occurs from about 7,200 to 8,500 feet. Other tree species, such as Gambel oak, pinyon pine, and Rocky Mountain juniper (*Juniperus scopulorum*), sometimes occur in association. Common understory shrubs include Fendler buckbrush (*Ceanothus fendleri*) and gooseberry (*Ribes* spp.). A number of grasses are found here, including Arizona fescue (*Festuca arizonica*), bluestems (*Schizachyrium* spp.) and gramas, mutton grass (*Poa fendleriana*), mountain muhly (*Muhlenbergia montana*), and pine dropseed (*Blepharoneuron tricholepis*). Severe disturbances, such as intensive logging or fires, have often led to prolonged midsuccessional dominance by oaks, junipers, or pinyon. Intensive grazing and fire suppression have also led to an interruption in successional stages in this community (Dick-Peddie 1993: 66–68, 76–78; Soil Conservation Service 1994).

Subalpine and Mixed Coniferous Forest

These forests generally occur in the region between 8,500 and 12,000 feet, where there is relatively heavy snow accumulation and a short growing season. These communities are important to the watershed because of their storage of water and discharge from deep snowpack. The two diagnostic tree species in the subalpine are corkbark fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*). Engelmann spruce, Douglas fir (*Pseudotsuga menziesii*), and white fir (*Abies concolor*) form communi-

Figure 54—Pinyon-juniper at El Malpais National Monument, Cibola County. Photo by author.

Figure 55—Mixed conifer forest above riparian zone (leafless boxelder trees on right), Sandia Mountains. Photo by author.

ties in the lower part of this zone (Fig. 55). Limber pine (*Pinus flexilis*), Douglas fir, boxelder (*Acer negundo*), Rocky Mountain maple (*Acer glabrum*), and aspen are present in some ecological situations. Meadows with a diversity of grasses, sedges, and wildflowers occur in this community. Numerous grasses (32 species) are found scattered through the forest as well. The subalpine forest has been utilized historically for logging, hunting, plant gathering (medicinal and edible), and recreation, primarily hiking and skiing. These uses, and fire suppression since the turn of the century, have modified the composition of this community (Dick-Peddie 1993: 51–66, 76–77).

Alpine Tundra

The alpine tundra, which is the highest of all plant communities, is found in only one area in the Middle Basin, on the higher peaks of the Sangre de Cristo Mountains north of Santa Fe. This virtually treeless zone is found above 12,000 feet and is made up of several sub-communities, or associations, determined by microclimates, topography, and soil types or surface rocks (Dick-Peddie 1993: 47–48).

Perhaps the most common plant association is the "cushion," composed of several low-growing species, including *Carex rupestris*, a rhizomatous sedge that helps form sod. Some of the other dominant plants include alpine sage (*Artemisia scopulorum*), cushion yellow aster (*Tonestus pygmaeus*), and bistort (*Polygonum bistortoides*) (Dick-Peddie 1993: 49).

Another association is fellfield, or rock field, which supports cushion-like, perennial plants that "hug" the ground. Some of these plants include alpine forget-me-not (*Eritrichium nanum*), alpine clovers (*Trifolium* spp.), and moss-pink (*Silene acaulis*) (Dick-Peddie 1993: 48).

A third association is known as kobresia turf, named for the principal species found there, *Kobresia myosuroides* Another common plant of this sub-community is alpine avens (*Geum rossii*) (Dick-Peddie 1993: 48–49; Soil Conservation Service 1994).

Still another association is the rock outcrop, or rubbleland, made up of talus, stone-stripe, or rock-detritus. Characteristic plants include a groundsel (*Senecio atratus*) and two yellow, flowered saxifrages (*Saxifraga chrysantha* and *S. flagellaris*). A variety of lichens are widespread in this association (Dick-Peddie 1993: 49).

Native Americans camped and hunted in the tundra of the Sangre de Cristos as early as 3,000 years ago, perhaps to hunt bighorn sheep and snowshore hare in summer. In the historic period, Pueblo, perhaps Apache, and Hispano people hunted and herded their livestock here. The Pueblos also maintained shrines (and still do) on some of the higher peaks. In more recent years recreational use has caused some adverse impacts, especially affecting vegetation along trails and around camps (deBuys 1985: 21–27, 31–38).

FAUNA

Mammals

From the late prehistoric period to the arrival of the Spanish, Native Americans hunted virtually every species of mammals in the region for food, hides, or body parts. Bones and other physical remains of various mammal species, as well as various birds, reptiles, and amphibians, have been identified and recovered from a large number of late prehistoric archeological sites (Hewett and Dutton 1945; Hibben 1975; Marchiando 1977; Schaafsma 1980; Young 1980). Petroglyphs, pictographs, and especially kiva wall murals also document some of the local fauna (Table 49). From this evidence, and from early historic observations, the species, their ranges, and their relative numbers can be reconstructed to varying degrees.

The pre-Spanish Middle and Upper basins supported a diverse number of vertebrate species with relatively abundant populations. More than 140 mammals, more than 400 birds, a fair number of reptiles and amphibians, and 31 fishes were found in the study region. Important as game animals to Native Americans were bison, pronghorn, elk, deer, bighorn sheep, and various rabbit species. These mammals, as well as others such as grizzly bear, and black bear, wolf, beaver, and river otter, were hunted and trapped for their hides and furs by Indian groups, as well as by the later Spanish and early Anglo Americans.

At one Anasazi archeological site of the same period, Pottery Mound, near Los Lunas, 33 animal species have been identified, including bear, jaguar, mountain lion, wolf, coyote, fox (?), bald eagle, parrot, macaw, and whooping crane (Table 50). Macaws and parrots represent border or interior "Mexican" species, probably brought up the Rio Grande as caged or skinned specimens.

The early Spanish explorers and missionaries, in the period 1540–1766, primarily described the common large mammals, species that were of interest for their meat, hides, or coarse furs. These species included bison, mule deer, and white-tailed deer, elk, pronghorn, bighorn sheep, gray wolf, and Mexican wolf, black bear, grizzly bear, mountain lion, bobcat, cottontail, and jackrabbit. Two of these—buffalo and the elk—were curiosities, and live specimens of each were even shipped to the King of Spain (Simmons 1978: 19, 22). Other species, such as pine marten, ermine, beaver, river otter, porcupine, fox, and jaguar, are mentioned less frequently in the documents (Ayer 1965: 37; Bolton 1946: 353; Espinosa 1942; Hodge 1946: 350; Kinnaird 1958: 95; Weber 1971: 12–13).

Terms such as "large numbers, abundant, infinite, and inexhaustible" were used by various Spaniards in describing mammal populations. These descriptors were used into the early 19th century, especially for bear, bison, deer, elk, bighorn sheep, and rabbits. Wild horses were also present on grasslands in relatively large numbers (Ayer

Table 49—Fauna identified from faunal remains and kiva murals—Kuaua Pueblo.[a]

Mammals	Birds	Reptiles and amphibians	Insects
Pronghorn antelope	Goose sp.	Rattlesnake sp.	Butterfly sp.
Badger	Cooper's hawk	Water snake sp.	Caterpillar sp.
Bat	Red-tailed hawk	Tortoise	Cricket sp.
Bear	Sparrow hawk	Frog sp.	Bedbug sp.
Bison	Hawk sp.	Tadpole sp.	Worm sp.
Bobcat	Bald eagle	Newt sp.	
Coyote	Golden eagle		
Deer	Quail sp.		
Elk	Turkey		
Fox	Sandhill crane		
Gopher	Macaw (introduced through trade)		
Cottontail sp.	Roadrunner		
Jackrabbit	Owl sp.		
Mole	Hummingbird sp.		
Mountain lion	Swallow sp.		
Bighorn sheep	Jay sp.		
Crow			
Magpie			
Mountain bluebird			
Loggerhead shrike			

[a] *Occupied ca. 1325–1600.*
Sources: Dutton 1963

1965: 37; Carroll and Haggard 1942: 99–100; Coues 1987: 597; Hodge 1946: 350; Kinnaird 1967: 95; Simmons 1991b: 168; Thomas 1941: 112–113).

Hunting of mammals by Spaniards was generally at a subsistence level, and sport hunting, practiced by only the well-to-do explorer, landholder, or government official, was even rarer in the 16th and 17th centuries. Obviously, there was some impact on animal populations; for example, the Jicarilla Apache believed that bighorn sheep were driven from the valleys into the mountains of northern New Mexico by Spanish hunting pressure. Much more impact on these mammal populations was generated by governors, encomenderos, and traders, who obtained meat, furs, and hides for consumption, export, or personal use from various Native American groups. The most important meat and hide animals were bison, mule deer, elk, and pronghorn, but the total number of animals taken is unknown, although it was undoubtedly less than the Santa Fe Trail trade in hides that occurred from 1821 to the 1850s. For example, in 1639 the governor shipped 122 painted buffalo hides and 198 chamois skins (pronghorn? bighorn sheep?) south to present northern and central Mexico. In 1660 another governor exported 1,350 deerskins and a quantity of buffalo hides to Parral. At the end of his term he had 1,200 pronghorn hides and four bundles of elk skins. Under the encomienda at Pecos Pueblo in 1662, 18 buffalo hides, 37 buckskins, and 66 antelope hides were collected in 1 month from resident Indians (Weber 1971: 12–21).

Table 50—Fauna identified from Pottery Mound kiva murals.

Mammals	Birds	Reptiles	Insects
Jaguar	Mallard	Rattlesnake	Dragonfly
Mountain lion	Whooping crane	Gila monster?	Mosquito
Wolf	Red-tailed hawk		Grasshopper
Coyote	Bald eagle		
Skunk	Quetzal		
Bear	Military macaw		
Fox	Thick-billed parrot		
Pronghorn	Roadrunner		
Deer	Magpie		
	Great horned owl		
	Pileated woodpecker		
	Swallow		
	Raven or crow		
	Yellow-headed blackbird		
	Yellow warbler		
	Yellow-breasted chat		
	Horned owl		
	Phainopepla		
	Bluebird		

Source: Hibben 1975: 65–67, 110–111, 115

Hispanic settlers used hides and robes primarily for clothing and bedding. Other uses included the manufacture of teguas (moccasins, from skin), furniture (skin), picture "canvas" (skin), musical instruments (bone), and bedding (hide) (Boyd 1974: 118, 251, 256; Reeve and Cleaveland 1979: 155–156).

Pueblo and Spanish hunters, sheepherders, and farmers were sometimes attacked and mauled by grizzly bears. This species, as well as mountain lions and wolves, preyed on sheep, goat, and horse herds, but very limited attempts were made to control this predation. Dogs, which could fend off all but grizzly bears, were a deterrent to livestock losses of this kind (Ebright 1994: 229; Simmons 1978: 35).

Following Spanish resettlement in 1693–1700, trade in animal hides with regional Native American groups increased relatively sharply. Nomadic Indians brought skins to the settlements for trade, as well as to an annual summer or fall trade fair, where a brisk exchange in hides and meat occurred. Bison, elk, deer, and pronghorn remained the key barter items. The exchange of skins and coarse furs, encouraged by government officials and stimulated by market demand, increased over the century, and by the early 1800s they were probably the main export items of New Mexico (Adams and Chavez 1956: 252–253; Scurlock 1991b; Weber 1971: 22, 28, 30–31).

Bison ranged seasonally as far west as the San Agustin Plains and the grasslands of northeastern Arizona in the late prehistoric period (Callenbach 1996: 17–18) and the Salinas and Galisteo provinces in the early colonial period (Bailey 1971: 152–156). A herd was also reported in the Chama River valley as late as the 1690s. There was a mountain race of bison in the southern Rockies in Colorado, but whether they occurred in northern New Mexico is speculative (Christman 1971: 46). All of these bison were either exterminated or driven eastward due to pressure by Navajo, Apache, Pueblo, and Hispanic hunters. By the late 1700s, intensified hunting pushed them farther eastward, across the Pecos River (Bailey 1971: 12–13; Hammond and Rey 1966: 87; Weber 1988: 126). The Estancia valley and upper Galisteo basin were two areas so impacted. By the early 1800s, Hispanic buffalo hunters from the Rio Grande drainage, called ciboleros, were taking 12,000 animals annually from the Pecos River onto the Southern Plains. By the mid 1800s the hide trade, spurred by Anglo traders, began to decimate the Southern Plains herd. During this period remnant, small herds or individual bison sought refuge in secluded valleys and high mountains across the region. For example, two buffalo were killed near Santo Domingo Pueblo in the early 1800s (Christman 1971: 44–47; Griffin 1947: 22, 51; Henderson and Harrington 1914: 13–14).

Two species of mammals, the Norway rat and house mouse, that were introduced in the colonial period have been naturalized. The horse and burro, also brought by the Spanish, became feral by the 1700s (Findley 1987: 107–108, 149–150).

At the time of the opening of the Santa Fe Trail in 1821, with its subsequent flood of traders and trappers entering New Mexico (Hafen and Hafen 1993: 93), populations of hunted and trapped mammals, except for the buffalo, were probably near their early historic (1500s) levels. Trappers found beaver, black bear, and grizzly bear, deer, and elk to be common along unsettled riparian corridors and in the mountains. By 1826, however, beaver populations in the Upper and Middle Rio Grande and adjacent mountain ranges, especially the Sangre de Cristo and Jemez, were decimated overall and extirpated in reaches of many streams (de Buys 1985: 93; Flores 1992: 8; Weber 1971: 65,215, 224). Trapping of beaver, however, remained relatively intense in some areas of the region over the next 20 years, owing to the continued market demand back east. Traders also continued to obtain pelts through a brisk trade with Native Americans. Some 5,000 beaver skins were transported over the Santa Fe Trail from New Mexico in 1834 (Table 51).

A couple of trappers during this period saw "great numbers of bears," up to 220 in a single day, and a third trapper claimed to have seen 50 or 60 grizzly bears in a day in the region (Cleland 1963: 44; Pattie 1966: 52). The former number is probably an exaggeration, but the latter may be accurate. For the 1830s and 1840s bears, as well as wolves, were described as common. Deer and elk were noted by one observer as only fairly common regionwide, while another referred to them, as well as bear, as "well stocked" in the Sangre de Cristo Mountains (Bodine 1979: 255; Gregg 1966, I: 192–195; II: 207–210). Bighorn sheep were also still relatively common in some canyon and mountain locales, and pronghorn were still commonly found on the bajadas and other grasslands of the study region in the mid 1800s (Henderson and Harrington 1914:

Table 51—Beaver (pelts) trapped or shipped over the Santa Fe Trail, 1824–1841.[a]

Year	Pounds/pelts[b]	Value[c]
1824	4,820/	$14,460
1825–26	33,333/	$100,000
1826	2,044/	
1827	1,843/1110	
1827–28	398/240	$1,194
1828	1,200/	$5,000
1829	951/240	$4,298
1831	993/	$2,980
1831–32	13,182/	
1832	4,700/	ca. $14,100
1833	3,088/1,860	$9,264
1834	8,300/ca. 5,000	$15,000
1836[d]	1,660/1,000	ca. $3,000
1837[d]	103/62	ca. $309
1839[d]	383/	ca. $1,149
1841[d]	365/	

[a] *Almost all from central and northern New Mexico and southern Colorado.*

[b] *An average beaver pelt weighed about 1.66 pounds, a pack of beaver fur averaged about 31 pelts or 52 pounds.*

[c] *The 1823–33 mountain price averaged $3.00 per pound.*

[d] *From only one trader.*

Source: Weber 1971

15). All of these mammals were reported to be common in the northern parts of the Sandia Mountains. These population numbers probably held until the 1860 or even into the 1870s.

By 1832 the illegal exchange of alcohol for furs had become a problem for Native Americans on the plains. Father Martinez of Taos complained to government officials that this trade was resulting in "these Indian nations [becoming] extremely demoralized and were prompted to greater destruction of buffaloes in order to satisfy their appetites for strong drink . . ." (Lavender 1954: 229–230). Increasing demands back east for robes dictated a rise in price, which exacerbated the alcohol trade and decimation of buffalo herds (Lavender 1954: 13; Carroll and Haggard 1942: 102). Most of the robes collected were shipped east over the Santa Fe Trail or south down the Chihuahua Trail, formerly called the Camino Real (Weber 1971: 217). Based on his observations in the early 1830s, Josiah Gregg (1966, II: 149, 212) warned that the buffalo might become extinct.

In late 1846–47, at the time of the arrival of the U.S. military and the first Anglo settlers, wildlife populations, excluding the buffalo, were still relatively high away from the region's settlements. Travelers commonly reported seeing black bears and grizzly bears, deer, elk, pronghorn, wolves, coyotes, prairie dogs, rabbits, and wild horses. Raccoons, mountain lions, bobcats, weasels, bighorn sheep, and beaver, which were still being trapped, were also recorded in army reports and diaries of civilians (Abert 1962: 18, 22–23, 29, 31, 33–35, 116–118, 138–139, 144–145; Bailey 1971: 310, 357, 364; Brown 1983: 15; Cooke 1952: 54; Hannum 1930: 221–222; Ligon 1961: 8; Marcy 1988: 244, 252; Ruxton 1973: 178; Weber 1971: 224; Wislizenus 1969: 33).

By the 1850s the Anglo instigated robe trade and hunting had severely reduced buffalo populations. No buffalo were reported in New Mexico, and hunters from the Rio Grande were having to travel at least 250 miles to find them. This situation existed until the late 1870s-early 1880s, when a few stragglers from the almost extinct Southern Plains herd wandered into the eastern part of the territory. Because of this scarcity, many Hispanic families increased the size of their sheep and goat herds (Bailey 1971: 14; Batchen 1972: 64–65; Weber 1982: 98). The Territorial Legislature had passed an act in 1880 to protect the buffalo, but it was too late and the last buffalo was seen in New Mexico in 1889 (Bailey 1971: 13–14; Gard 1960: 216).

Populations of other mammals were also subjected to increased hunting, as well as to loss of forage due to growing livestock herds and loss of habitat as a result of the growth of old settlements and the establishment of new ones in the 1860s and 1870s. Nevertheless, elk, bighorn sheep, pronghorn, and grizzly bear remained relatively common in isolated areas. In other locales there were reports of reduced populations, especially of deer and elk (Bailey 1971: 15–17; Barker 1953: 88; Batchen 1972: 49–50, 64, 66, 68; Henderson and Harrington 1914: 2, 16; Lange 1959: 130; Lange and Riley 1966: 167, 170–172).

At the time of the coming of the first railroads to the territory, 1879–81, several local extinctions of mammals occurred. For example, native elk were extirpated in the Jemez Mountains, primarily due to commercial hunting for railroad construction workers (Scurlock 1981: 31). Also, bighorn sheep disappeared from the Jemez Mountains and Merriam's elk from the southern Sangre de Cristo Mountains, primarily due to hunting pressure (Barker 1953: 88; Hewett and Dutton 1945: 105; Lange and Riley 1966: 94). By 1890 market hunters had killed the last Merriam's elk in northern New Mexico. Hunting pressure also severely reduced the pronghorn in a number of grassland locations (Barker 1976: 107; Tyler 1975: 32, 42, 55–56).

Overgrazing began to adversely impact wildlife as well, and livestock raisers also hunted and trapped such predators as the gray wolf, and Mexican wolf, and grizzly bear. These animals were increasingly preying on livestock as a result of the reduction of their prey species (Brown 1983: 31). Grizzlies were more heavily impacted than wolves by stock overgrazing, as they depended partly on grasses, forbs, and shrubs for food (Brown 1985: 100).

Federal involvement in predator control was initiated in 1885, when the Department of Agriculture began to study the use of poison on these animals (Dunlap 1984: 143). Also, a new steel leghold trap for grizzly bears was first used in the region at this time (Brown 1985: 114). By the 1890s bounties were offered on wolves and other predators, and professional trappers, known as "wolfers," began working in the region (Brown 1983: 43; Burbank 1990: 98). Wolves numbered several thousand over the entire territory at this time (Bennett 1994: 200).

The Territorial Legislature also passed the first game laws to regulate hunting of meat and hide animals during the 1890s (Findley et al. 1975: 329), but populations continued to decline. Bighorn sheep were exterminated in the Sandia Mountains by the end of the century, and beaver had been exterminated in virtually all of the region's mountain ranges by fur trappers and meat hunters by this time (Bailey 1971: 215; Findley 1987: 86; Pickens 1980: 83). Pronghorn and deer populations continued to decline in the study region and were reduced further due to ever-increasing hunting pressure.

In 1905 the U.S. Forest Service began to hire trappers to take wolves on federal forest lands, and 3 years later a bounty of $20 for black bears and up to $50 for grizzly hides was paid. The Territorial Legislature enacted a $15 bounty for wolves in 1909 (Barker 1953: 153; Burbank 1990: 98; Dunlap 1984: 143). These species, as well as mountain lions, bobcats, and coyotes, were hunted and trapped in increasing numbers, especially on forest lands (Brown 1985: 123–124). Perhaps the last grizzly was exterminated in the Sandia Mountains in 1906, and the species was re-

duced to small numbers in other more isolated ranges (Bailey 1971: 365; Barker 1953: 33; Cooper 1989). A total of 510 coyotes were killed on national forest lands in 1907, and some 271 bobcats were trapped or shot on these same public lands (Bailey 1971: 293, 212; Table 52).

In 1900, Congress passed the Lacey Act, which prohibited market hunting and illegal importation of exotic wildlife (Borland 1975: 122). The New Mexico Game and Fish Department was created by the Territorial Legislature in 1904 (Barker 1970: 185). Black bears and wolves remained relatively common, but bighorn sheep were extirpated in several mountain ranges (Bailey 1971: 17, 309, 349–368; Barker 1953: 88; deBuys 1985: 280).

Northern Rocky Mountain elk were introduced to Vermejo Park by its owner in 1908, and within a few years to the Pecos District of the Santa Fe National Forest (Barker 1953: 93–95; Ligon 1927: 71). Pronghorn, reduced to a couple of thousand animals statewide, were removed from the legally hunted game list (Barker 1970: 1982; Matthieson 1959: 283). However, the pronghorn population in the state dropped to a low of 1,200 to 1,700 in 1915–16. This contrasts with an estimated population of 100,000 animals around 1850 (Barker 1970: 192; Findley et al. 1975: 334). Competition with cattle, sheep, and goats, as well as intensive hunting, caused this decrease (Table 52).

Mountain lion and black bear populations were holding their own in the Jemez and Carson National forests, but gray wolves and grizzly bears were becoming rare in the period 1910–20 (Bailey 1971: 286; Henderson and Harrington 1914: 29; Rothman 1992: 140). Increased trapping and poisoning was spurred by congressional action in 1914 mandating the U.S. Biological Survey to take wolves and other livestock predators on public lands. Aldo Leopold of the Forest Service and J. Stokely Ligon with the New Mexico Game and Fish Department were in charge of the program to eradicate wolves in the state. Some 300 trappers and hunters were employed by this program in 1914–15 (Brown 1983: 52, 126–127). Fifty-seven gray wolves and Mexican wolves were killed on national forest lands in 1915, and over 100 were killed in 1916. Mountain lions, coyotes, grizzly bears, and black bears, and bobcats also were taken in relatively large numbers during these 2 years. Loss of some 24,350 cattle, 165,000 sheep, and 850 horses, valued at almost 3 million dollars, was attributed to wolves, mountain lions, grizzly bears, coyotes, bobcats, and "wild dogs" in 1916 (Brown 1983: 57). These livestock figures, which were probably inflated, were used to justify increased hunting, trapping, and poisoning of predators (Brown 1983: 54–57, 1985: 127–133).

The grizzly bear population declined to only 48 animals by 1917. Predator control intensified this year and the next to help produce more beef for U.S. soldiers fighting in Europe in World War I. An estimated 33 black bears, 84 mountain lions, and 103 wolves were killed in 1917, and 123 wolves were trapped in 1918. Poisoning of grizzly bears was initiated by the U.S. Biological Survey in 1918; 28 animals were killed (Bailey 1971: 272, 287, 307, 311, 313, 353; Brown 1983: 57–58; Table 52).

Government trapping-poisoning and private trapping-poisoning, motivated in part by bounties, continued at an intensive pace into the 1920s (Bailey 1971: 307; Brown 1983: 58, 64, 67, 137, 272; Burbank 1990: 106). The grizzly bear, Mexican wolf, and gray wolf were near extinction in the region. Trapping and hunting had also severely reduced the deer, pronghorn, beaver, pine marten, mountain lion, bobcat, coyote, and prairie dog populations (Bailey 1971: 29, 215, 296; Findley 1987: 86; Ligon 1927: 15). By the early part of the 1930s the grizzly bear was probably extinct in the study region, and the gray wolf was extirpated in central and northern New Mexico. The last grizzly in the state may have been killed in 1931 (Barker 1953: 189–190; Brown 1983: 25, 1985: 155–156; 1985: 150, 160–161; deBuys 1985: 280; Ligon 1927: 15; Scurlock 1981a: 148).

Small numbers of pronghorn were reported near Santa Clara Pueblo and about 10 miles south of Santa Fe in the early 1940s (Hewett and Dutton 1945: 108; Hill 1982: 52). A few mink were observed in the Middle Rio Grande Valley in 1947, the same year that the bullfrog, which was probably introduced in the 1930s, was commonly reported in the area (Pillow and DeVaney 1947: 16–17; Sargeant and Davis 1986: 41).

The New Mexico Game and Fish Commission had been given full regulatory powers to manage the wildlife of the state, including establishing hunting seasons and bag limits (Barker 1970: 188; Findley et al. 1975: 29; Flader 1978: 105). Black bears were given protection by the state in 1927,

Table 52—Mammal populations, 1900–1935.

Species	1900	1905	1910	1915	1920	1925	1930	1935
Merriam elk	VR	E	R[a]	R	R	U	U	U
Grizzly bear	U	U	R	VR	VR	VR	E	E
Black bear	C	C	C	C	U	U	U	U
Gray/Mex. wolf	U	U	R	VR	VR	VR	VR	E
Coyote	C	C	C	C	C	U	U	U
Mountain lion	C	C	U	R	R	R	R	R
Pronghorn	U	R	R	R	R	R	U	U
Bighorn sheep	R	R	VR	VR	VR	VR	VR	R
Beaver	R	R	R	R	R	R	R	R
Bobcat	C	C	U	U	U	U	U	U
Pine marten	U	U	R	R	R	R	R	R

A = abundant, C = common, U = uncommon, R = rare, VR = very rare, E = extinct.
[a] Reintroduced.
Sources: Bailey 1971; Barker 1970; Brown 1983, 1985; Findley et al. 1975; Ligon 1927

and in 1933 bighorn sheep from Banff National Park were released into the Sangre de Cristo Mountains. Six years later the Federal Aid to Wildlife Act was passed by Congress, and the state acquired some 30,000 acres of wildlife habitat with available funds (Barker 1970: 100–101). Thirty-seven elk from Yellowstone National Park were released in the Sangre de Cristos, and other elk from Oklahoma were released on Mount Taylor in 1940–42 (Barker 1970: 109–110; deBuys 1985:356). La Joya State Waterfowl Refuge was also established during this period (Barker 1976: 104).

Federal and state programs to control or eradicate predators in parts of the region continued into recent decades. With the wolf and grizzly bear eliminated, the focus was primarily on the coyote, which preyed on game species and livestock. The bobcat and mountain lion were also targeted in the 1950s and 1960s. In 1949 the federal Predatory Animal Control introduced the compound 1080, a highly lethal rodenticide, for control of predators and rodents. In 1954 the Federal Government outlawed the indiscriminate use of poison to kill livestock predators. Some sheep raisers began using the "coyote getta," a tube that was stuck in the ground and baited on the end, such that when a coyote, fox, or bobcat bit the bait, a cyanide pellet was propelled by a charge into the animal's mouth. A number of other nontarget mammals, such as badgers, skunks, domestic dogs, and cats, were killed by this apparatus (Brown 1983: 103; Schaefer 1975: xxiii-xxiv).

Trapping, poisoning, and hunting by personnel from various public agencies continued as well. For example, in 1963 over 6,300 coyotes were killed, but notably, there was no decrease in the statewide population. Larger "problem" animals such as black bears or mountain lions were trapped or tracked down and shot by government hunters (Findley et al. 1975: 281–282; McDonald 1985: 12; Moyer 1979: 71).

Birds

Uses of birds by Native Americans were discussed in Chapter 3. Twenty-nine species have been identified in late prehistoric kiva murals; they are listed in Tables 49 and 50. The close relationship between the Pueblo and birds was discussed by Henderson and Harrington (1914) and Tyler (1979).

As with mammals, early Spanish explorers only commented generally on species that occurred in large numbers, such as sandhill cranes, geese, turkeys (domesticated and wild), crows, and starlings (blackbird sp. ?). Spanish hunting of birds was limited; turkeys were usually acquired through trade with the Pueblos. Hunting of "quail, partridges . . . grouse" is mentioned in documents, but apparently this activity was limited (Carroll and Haggard 1942: 99). Numbers of species such as wild turkey, prairie chicken, and "partridges" (probably grouse) appear to have been greater than in more recent history, and their ranges were more extensive (Bolton 1946: 353; Hodge 1956: 353–354; Kinnaird 1967: 95).

Early Anglo American accounts, such as that by Gregg (1966, I: 195) in the 1830s, refer to large numbers of sandhill cranes, Canada and snow geese, and various ducks. Gregg may have been the first Anglo to record roadrunners in the region. In October 1841 Texan George Kendall (1935) wrote the following about birds in the Middle Valley: "Among the stubble, on either side of the road, we noticed immense flocks of blue and white herons and wild geese, so exceedingly tame that we could approach within a few yards of them. The Mexicans seldom kill them, and hence their tameness." Five years later another traveler down the river noted "an abundance of geese, ducks, and pelicans . . ." (Wislizenus 1965: 34).

In 1846 Lt. William Emory (Calvin 1968: 79, 83) recorded "myriads of sand crane, geese, and brant" between Albuquerque and Padillas, and "immense flights of sand cranes and geese" up and down the valley from Padillas to La Joya.

Of the early American observers, Lt. James Abert was the most keen and comprehensive in respect to collecting and describing animal species, recording a number of mammals and 26 species of birds along the Middle Rio Grande (Abert 1962: 65–142; Table 53).

Sandhill cranes remained common throughout the valley over the remainder of the century, and Merriam's turkeys were found in virtually every isolated riparian reach in the study region (Henderson and Harrington 1914: 33, 35). In addition to the above species, army personnel in the 1850s also recorded a single whooping crane, swans, pelicans, blue herons, bitterns, quail, doves, blackbirds, meadowlarks, cardinals (*Pyrrhuloxia* ?), robins, bluebirds, and "snow-birds" (?) (U.S. Surgeon-General's Office 1857: 250–251).

Perhaps the earliest trained naturalist to collect and report on mammals and birds of the region was Samuel Washington Woodhouse, Assistant Surgeon, U.S. Army. He accompanied an army expedition in 1850–51 that

Table 53—Birds recorded by Abert (Alameda to south of Socorro), fall 1846.

Loon sp.	Red-winged flicker (common)
Swan (*C. americanus*)	Sapsucker (yellow-bellied?)
Brant	Gold-winged woodpecker (?)
Goose-snow	Steller's Jay
Teal sp.	Raven
Mallard	Creeper (brown)
Duck	Robin
Merganser	Mexican blue bird (western? mountain?)
Bald eagle	Butcher bird (loggerhead shrike?)
Sparrow-hawk (kestrel)	Blackbird
Wild turkey	Meadowlark (western)
Quail (scaled or Gambel)	
Blue crane (great blue heron?)	

Source: Abert 1962: 71–99, 117–125

marched up the Rio Grande from El Paso to Santa Fe (Ligon 1961: 7). Another army doctor, T. Charlton Henry (1856), recorded 170 species of birds while stationed at forts Thorn, Fillmore, and Webster in 1853–54. His lists include comments on range and seasonal occurrences.

In 1853 U.S. Army surgeon Caleb Burwell Kennerly followed the same route as Woodhouse but only upriver to Albuquerque. Leaving the Ives expedition at this point, he joined the Whipple railroad survey party that marched west to El Morro and Zuni Pueblo via Laguna and Ojo del Gallo. He, too, observed and collected birds in the region (Ligon 1961: 8).

The best known ornithologist of the historic period who worked in New Mexico was Florence Merriam Bailey. She reported trumpeter swans as a rare migrant to New Mexico; whistling swans, once a rare migrant, apparently were extinct by the time she published her *Birds of New Mexico*. She recorded goshawk as an uncommon nester, golden eagles as common residents in the mountains, and ferruginous hawks as a common summer resident on the St. Augustine Plains. Bald eagles were common in western Socorro County. Sage grouse were recorded as common about 1900–08 but soon were extirpated. Band-tailed pigeons, according to Bailey, were fairly common in the higher ranges of the regions, and loggerhead shrike were common nesters in lower elevations (Bailey 1928: 103, 104, 156, 172, 177, 180–181, 211, 297, 597).

By the late 1800s hunting, poisoning, and development had reduced many bird populations and contributed to the extirpation of others, such as the whooping crane, sage grouse, trumpeter swan, and whistling swan. Some locales still supported relatively large numbers of ducks, geese, blue grouse, and turkeys until the early part of this century (Henderson and Harrington 1914: 34–35, 37, 45; McDonald 1985: 22; Nims 1980: 126). A relatively comprehensive list of birds of the region was compiled by Fannie Ford at this time (1911); she reported 314 species and subspecies.

J. Stokely Ligon (1927), who with Aldo Leopold directed the predator control program, headed up a wild game survey of the state in 1926–27. Birds covered included golden eagles, which Ligon viewed as "a serious enemy of certain species of game," as well as the young of cattle, goats, and sheep. He noted the "slaughter" of hawks, which he considered both beneficial and harmful, had severely reduced their populations. He called for legislation that would protect all birds of prey because of their controlling rodents through predation. Magpies were considered "enemies" of quail, pheasants, and turkeys, and Ligon recommended that federal and state wildlife personnel initiate control programs for magpies (Ligon 1927: 31, 49–52, 55, 58–59, 114–119, 134).

Ligon (1961) later published his *New Mexico Birds and Where to Find Them*, which included historical data on 399 bird species in the study region. Included with species descriptions are notes on former ranges and status of rare, endangered, or threatened species. Ligon (1961: 3, 6–13) also discussed earlier ornithologists and their works (Chapter 6).

Fish

The indigenous fish fauna of the Upper and Middle Rio Grande in the late prehistoric and early historic periods was much more diverse than that of today. The native fish fauna of the two basins at the beginning of the historic period numbered about 27 species (Sublette et al. 1990: 2). Six large species, now extinct, are evidenced by bone or scale remains in prehistoric Anasazi sites or identified from early Spanish records. At least five other species were extirpated later in the historic period (see Chapter 5, Table 62) by morphological and hydrological changes in the basin's drainages, high siltation, overfishing, introduction of aggressive exotic fishes, construction of dams and reservoirs, climatic changes, and probably introduced pollutants (Gehlbach and Miller 1961; Miller 1961: 365, 394–398; Sublette et al. 1990: 2, 9–11).

The late prehistoric-historic Pueblo harvested fish from the Upper and Middle Rio Grande drainages, probably in limited numbers (Hewett and Dutton 1945: 132, 136). Early Spanish reports are replete with superlative adjectives for the size of native fish populations, such as "abound," "large quantities," "teemed," and "great abundance" (Ayer 1965: 37; Espinosa 1936: 34; Kinnaird 1967: 94). Some members of these early expeditions, as well as later colonial travelers and settlers, caught and ate fish, including eels, from the Rio Grande and tributary streams (Adams and Chavez 1956: 40, 58–59; Espinosa 1936: 34; Galvin 1972: 55, 57). Thirteen species have been identified from early Spanish records (Table 54).

Trout, unidentified as to species, were "abundant" in the Santa Fe River according to Dominguez (Adams and Chavez 1956: 40) in 1776 and Gregg (1966, I: 142) in the 1830s. In 1782 Fray Morfi described the Rio del Norte (Grande) as "crystalline" above the mouth of the Chama River. On fish in the river, he wrote

> It is stocked with fish that are quite good, some of them more than three quarters of a vara [= 33.3 inches] long, having a small mouth placed where other fish have the gill, very few bones and being very appetizing. Matalote, species of barbel larger by a third [of a vara] is a delicious fish, very bony; bagre, a rock fish like sea-brim and of its large size, without more bones than those serving as ribs. It is most pleasing. Cat-fish does not have scales nor bones but in place of these a long nerve from the head to the mouth, ending in a pyramidal point like three fingers. The largest will be about a third of a vara in length (Thomas 1932: 112).

During this period trout were reported to be abundant in various locales in the region, a condition that continued into the 19th century.

Six large species of fish were extirpated in the early territorial period (1846–1912). The shovelnose sturgeon was last taken from the Rio Grande near San Ildefonso in 1874 by members of the Wheeler Geographical and Geological Exploration Survey. They also noted the occurrence of American eel near Santa Fe. Some 14 years later an unidentified species of catfish, weighing from 75 to 100 pounds, probably now extinct, was being caught in the Rio Grande near Rincon (Clark 1987: 32; Schissel et al. 1989: 159).

After the early influx of Anglo settlers (1846–79) into central and northern New Mexico, which placed new pressures on water and fish populations, the Territorial Legislature passed a law in 1880 making it a misdemeanor to use drugs, explosives, or artificial obstructions in taking fish. Trout could be taken only by hook and line. Additionally, operators of mills or factories could not legally discharge harmful waste into trout waters. Another act, passed 9 years later, authorized fish wardens for every county to assist sheriffs and commissioners in enforcing fish laws, including a closed season for fishing, except for members of needy families. This legislation also directed that a sluice for the passage of fish had to be maintained at all dams (Clark 1987: 32).

In spite of the new laws passed in the late 19th and early 20th centuries, native trout and other game fish populations began to decrease in various locations. The exotic and competitive rainbow trout and brook trout were introduced into many rivers and creeks in the region in 1907–08 and 1928. Other species were introduced by the Game and Fish Department in later years (Barker 1953: 54–56; Kuykendahl 1994: 3; Sublette et al. 1990: 67, 77, 166, 331). Still other exotic species, used as bait, were introduced accidentally by fishermen in this century.

Between the early 1900s and the 1940s native trout populations were decimated, or even extirpated, in many locales in the study region due to overfishing, diminishment of stream flows, increasing sedimentation, pollution, and introduction of aggressive exotic species (Hewett et al. 1913: 35; Pillow and DeVaney 1947; Sublette et al. 1990: 49–74; Fig. 56).

Only limited scientific collections were conducted in the early part of this period, until the work of William J. Koster

Table 54—Fish identified from Spanish records.[a]

bagre—channel catfish (*Ictalurus furcatus*), yellow cat (*Ameiurus natalis*)
corbina—"sea trout" (?)
matalota—"suckers," bony-tail chub (humpback?) (*Gila robusta, G. elegans*)
casona, cazon—gar-pike (*Lepisosteus platystomus*)
sardina—"shiner," "silvery" chub (*Notropis dilectus*)
mojarra—"sardine" (?)
trucha—trout (*Salmo spilurus*)
anguila—eel (*Anguilla chrysypa*)
boquinete—sucker (*Moxostoma congestum*)
aguja—long gar pike or shovelnose sturgeon (*Scaphirhynchus platyrhynchus*)
pescadito—Rio Grande chub (*Leuciseus nigrescens*)
corcobado—"hunchback" buffalo fish
gaspregou—sheepshead (*Aplodinotus granniensa*)

[a] *Scientific name identifications were made by Dr. David Star Jordan pre 1916.*

Sources: Ayer 1965: 37, 261–262; Espinosa 1936: 34, 38; Hodge and Lummis 1916

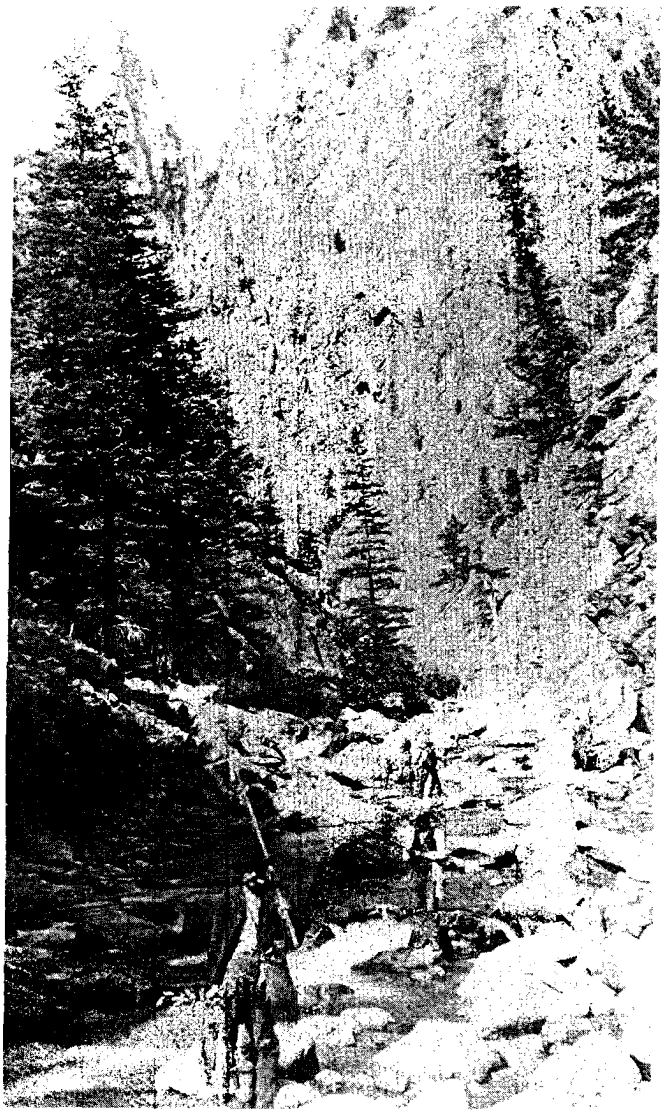

Figure 56—Fishermen on Brazos River, Rio Arriba County. Photo courtesy Museum of New Mexico Archives, Santa Fe (negative no. 72377).

at the University of New Mexico began in 1939. Koster published an overview of his work in 1957 (Crawford et al. 1993: 37). In recent years the U.S. Fish and Wildlife Service and the New Mexico Game and Fish Department have worked to control exotic species and have reintroduced some native fishes, especially trout, to several streams in the region.

Insects

Except for mosquitoes, insects are mentioned infrequently in the Spanish colonial, Mexican, and territorial periods (1540 to 1912) in New Mexico. Chinch bugs and grasshoppers (or locusts) were the most common insects alluded to by observers. In 1846 George Ruxton recorded 75 varieties of grasshoppers and locusts (Hafen 1950: 150). "Worms," moths, honey bees, "lantern bugs," beetles, lice, tarantulas, mosquitoes, and flies were less commonly mentioned. Mosquitoes were a nuisance, and moths, on at least one occasion, destroyed a large amount of wool in a warehouse in Albuquerque (Simmons 1982: 115). Apparently, the common house fly was introduced to New Mexico between 1840 and 1915 (Gregg 1966, I: 195).

SUMMARY

The Middle Rio Grande Basin, as well as the inseparable Upper Basin, had sustained millennia of human use by the time of first European contact in 1540. Environmental forces such as droughts, floods, and erosion were the primary determinants of the physical and biological conditions over time.

Pueblo, Navajo, Apache, and Southern Ute Indians had modified the landscape, as they, or their predecessors, had for centuries hunted, gathered, farmed, burned, and done other activities. Changes were minimal, temporally and spatially, compared with later modifications generated by the coming Spanish and Anglo Americans due to world view, small populations, and limited technology of these Native Americans. These indigenous peoples were, in fact, as they viewed themselves, entities interrelated with other environmental components of the region. This was reflected in their rituals, songs, languages, and other ecocultural traits. Also, changing environmental conditions significantly shaped the behavior and activities of these indigenous human populations.

Following the later arrival and settlement of two dominant Euro-American groups, historical conditions began to change more dramatically. The Spanish and Anglo views of the environment, their introduced infectious diseases, metal weapons and tools, new cultigens, and exotic plants, and their rapidly expanding populations (after 1750) brought new and extensive impacts to the study region. These impacts resulted in even more complex changes, sometimes extreme, not only for the physical landscape and associated biological components but also for the indigenous peoples as well. Attempts to regulate and manage the forces at work began in the late 1800s, but effective efforts of new laws, agencies, and programs were not able to reverse some processes such as species extinction. More recently, management and preservation of environmental conditions have been more successful, owing to changing environmental views of the private sector, as well as those of government agencies. Clearly, the historical conditions of 1540, or 1750, or even 1920 will never be replicated.

CHRONOLOGY

1400s–1600s	Based on archeological evidence, 54 species of birds were used at Las Humanas and Pueblo del Encierro for meat, feathers, and personal adornment (Snow 1981: 364).
1540	Alvarado, one of Coronado's chroniclers, wrote this description of the Tiguex Province (Isleta to near San Felipe): "This river of Nuestra Senora flows through a broad valley planted with fields of maize and dotted with cottonwood groves. There are twelve pueblos, whose houses are built of mud and are two stories high. They have a food supply of maize, beans, melons and turkeys in great abundance" (Bolton 1969: 184). He also described the Rio Grande as "a large, mighty river" (Hodge 1946: 352).
1540	From first European contact and throughout the historic period, the main items traded by the Pueblos to other Native American groups were corn flour, pollen, and husks; pinyon nuts; turquoise; salt; feathers of eagles, hawks, turkeys, and a number of small birds; and woven baskets and pottery (Sando 1989: 29–30, 38).
1540	The Rio Grande floodplain was 35 to 40 feet lower than the 1962 levels (Titus 1963: 11).
1540	The Pueblos gathered large quantities of herbs . . ." for food (Hammond and Rey 1940: 256).
1540	The Tiguex Pueblo kept poisonous snakes (probably rattlesnakes) in their villages. Poison was extracted from the snakes and placed on arrow-points to facilitate killing of prey animals (Bandelier and Hewett 1937: 169).
1540–41	The Pueblos collected pine nuts, and some were stored for later consumption (Hodge 1946: 350).
1540–94	Spanish explorers noted the abundance, utility, and trade value of furs and skins (Weber 1971: 14).
1541	(fall) Castaneda reported a large number of cranes (probably sandhill), wild geese, crows, and "starlings" (probably a species of black-

Prior to Euro American settlement these forests were much more open and parklike, with scattered stands varying in age, and crown cover usually not exceeding 25 percent. Crown fires were rare (Covington and Moore 1994: 39–41).

In the upper Pecos River drainage *Pinus ponderosa*, *P. edulis*, and *Juniperus monosperma* were harvested intensively for use as lumber, posts, and fuelwood in the 19th century. There were 500 sheep grazing in the area of Rowe at this time. In the early 1900s all of the trees north and east of Rowe were clear-cut to create pasture for cattle. Some relatively recent chaining of pinyon-juniper was carried out between the present Interstate 25 and the town (Meszaros 1989: 13–14, 52–55).

CHANGES IN PLANT SPECIES

Extirpated Plants

Several plant species identified from archeological excavations or historical records appear to have been depleted or extirpated locally, primarily through abusive land use such as overgrazing in the late 19th and early 20th centuries (Bohrer 1978). All were prehistoric-historic food sources, which indicates they may have been relatively widespread and abundant prior to more recent impacts causing decimation or extermination. These species are listed below in Table 58, with known distribution within the study region.

Almost 400 species of grasses have been collected and identified in New Mexico. Several of these, listed in Table 59, have not been found since their collection date 50 or more years ago. Most, if not all, are probably extinct (Allred 1993).

Introduced and Naturalized Plants

Some 101 non-native plants have been introduced in the study region, primarily from Europe and Asia, during the historic period, 1598 to the present (Table 60). For the most part, these species have been considered ecological and economic pests. Some of these introductions were intentional, but others were accidental. The Spanish brought several plants to New Mexico early in the colonial period, for example, clovers (*Melilotus* and *Trifolium* spp.) for livestock feed and alferillo (*Erodium cicutarium*) and hoarhound (*Marrubium vulgare*) as medicinals (Table 60). Others, such as goathead (*Tribulus terrestris*), were unknowingly carried by livestock, in agricultural seed bags, or in clothing. Mullein (*Verbascum thapsus*), an important medicinal plant to the Spanish, has thrived in disturbed areas, especially in new burn sites. Less aggressive is shepherd purse (*Capsella bursa-pastoris*), which is found in meadows (Gay and Dwyer 1970: 62; Wooton 1915: 556).

Table 58—Plant species extensively decimated or extirpated.

Common name	Scientific name	Range
Stickleaf	*Mentzelia albicaulis*	NW and W New Mexico
Purslane	*Portulaca* spp.	NW and NC New Mexico
Winged pigweed	*Cycloloma atriplicifolium*	NW and NC New Mexico
Contrayerba	*Kallstroemia* sp.	NW New Mexico
Wild onion	*Allium macropetalum*	NW New Mexico
Nodding onion	*A. cernuum var. obtusam*	C and W New Mexico
Spiderwort	*Tradescantia occidentalis*	NW and C New Mexico

Source: *Bohrer 1978 and Soil Conservation Service 1994*

Table 59—Extirpated grass species.

Common name	Scientific name	Location	Year last collected
Bristlegrass	*Setaria verticillata*	Mesilla Valley	1907
Sacaton or dropseed	*Sporobolus vaginiflorus*	Las Cruces and Bernalillo Co.	1895
Wright's Bluestem	*Bothriochloa wrightii*	Grant Co. (two locations)	1885, 1904
Cordgrass	*Spartina gracilis*	Santa Rosa	1945
Gamagrass	*Tripsacum lanceolatum*	Guadalupe Canyon	1915 pre
Muhly	*Muhlenbergia arsenei*	Soda Dam, Sandoval Co.	1938
Muhly	*Muhlenbergia andina*	Upper Pecos River	1908
Rattlesnake Chess	*Bromus brizaeformis*	Pecos National Forest	1913 pre
Lovegrass	*Eragrostis hypnoides*	Elephant Butte Dam	1941

Source: *Allred 1993 and Soil Conservation Service 1994*

Anglos brought even more exotic species than the Spanish to the study region (Table 60), some of which have become serious problems due to their aggressive invasion of native plant communities, use of substantial water, and successful competition with the native flora (deBuys 1985: 224–226; Hitchcock 1935: 49, 76, 112–114, 230–231). The two most costly flora introductions, ecologically and economically, have been Russian olive (*Elaeagnus angustifolia*) and salt cedar or tamarisk (*Tamarix ramosissima*). Both are native to regions of Euro Asia, with climates and soils similar to those of central New Mexico, so these two species have spread rapidly. Salt cedar was introduced as an ornamental in Albuquerque as early as 1908, and by 1926–27 had been used widely to control erosion and silt on tributary streams. By 1936 it had invaded the valley extensively, helped by the flood of 1929 (Crawford et al. 1993: 30; Robinson 1965: 147; Scurlock 1988a: 138). Between 1935 and 1947 salt cedar had spread over an estimated 24,500 to 51,120 acres of irrigable farmland in the Upper and Middle valleys (Hay 1972: 288; Lowry 1957: 4).

Similarly, the Russian olive was planted for bank stabilization and ornamental purposes in the early part of this century. By 1934 it had spread into the Rio Grande bosque, and 26 years later was a dominant component of the ecosystem (Crawford et al. 1993: 30; Freehling 1982: 10).

Between 1946 and 1956 the Bureau of Reclamation sprayed the herbicides 2,4-D and 2,4,5-T on stands of tamarisks in the main valley and tributaries in an attempt to control its spread, which was largely ineffective, The tree expanded its range over about 60,000 acres. Annual water use by the tamarisk stands was estimated to be 240,000 acre-feet, or about twice the amount used by cultivated crops (Dortignac 1956: 47). About 20,000 acres along the main stem of the river are now dominated by salt cedar and Russian olive (Crawford et al. 1993: 35).

Other exotic tree species that are becoming major components of riparian ecosystems are Siberian elm (*Ulmus pumila*), tree of heaven (*Ailanthus altissima*), and white mulberry (*Morus alba*) (Crawford et al. 1993: 30; Scurlock 1988a: 139). Russian thistle (*Salsola kali*) was introduced accidentally, via the cow-catchers of the Santa Fe trains, into the Galisteo basin pre 1890. This species has now spread to the upland grasslands flanking the valley and onto the floodplain (Wooton 1895).

During the 1930s, crested wheat grass (*Agropyron cristatum*) was introduced into New Mexico by the U.S. Department of Agriculture for its forage value and is now established across the region (Hitchcock 1935: 231). Kentucky bluegrass (*Poa pratensis*) was introduced to regional mountain ranges in this century as well (deBuys 1985: 289).

CHANGES IN ANIMAL SPECIES

By the end of World War I, intensive hunting and trapping, grazing, and habitat modification had severely reduced populations of predatory mammals, as well a game species. As natural prey species of the wolf, coyot grizzly bear, bobcat, and mountain lion were reduced b various human activities, the predators began to tak much more livestock. J. Stokely Ligon, head of the Ne Mexico Game and Fish Department at the time, consic ered wolves, coyotes, bobcats, and mountain lions "th most serious enemy of game conservation in New Mexico (Ligon 1927: 49–50). He, along with Aldo Leopold of th Forest Service, led the government effort to eradicate thes predators, especially the wolf and the grizzly bear.

By the early 1900s, bears, especially grizzlies, an wolves were restricted to the higher, more remote moun tain ranges due to these hunting and trapping pressures They were relatively common in the San Mateo range nea Grants in 1905 (Bailey 1971: 365). An estimated 48 grizzl bears remained in the state in 1917, scattered from th Sangre de Cristo to the Black Range. By 1928 an estimatec 16 grizzly bears remained in the state. Several grizzly bear were reported on the Jemez District of the Santa Fe National Forest in 1940, the last recording of this species ir the state (Brown 1985: 133, 137, 140, 153, 160–161). Black bears, however, had received protection from the State Legislature in 1927, and populations remained relatively stable (Findley et al. 1975: 29).

Gray wolves were still found in the Manzano Mountains in 1903, preying on livestock, some were reported there in 1916. There were 19 wolves killed in the Santa Fe National Forest in 1915 and 37 in 1916 (Bailey 1971: 309–311). Some 34 wolves, gray and Mexican subspecies, were trapped, poisoned, or shot in the state in 1925 (Brown 1983: 150). Only a small number of gray wolves were extant in the Middle and Upper basins. In 1934 the last gray wolf in Colfax County was killed (Brown 1984: 85). The last gray wolf in the study region was killed in 1932 in the Valle Grande of the Jemez Mountains by a rancher (Scurlock 1981a: 148).

Among the larger game mammals with low numbers in this period were pronghorn, mule deer, elk, bighorn sheep, and black bears. Only remnant populations of pronghorn were scattered over the grasslands, and mule deer were rare to extinct anywhere near settlements (Ligon 1927: 29). State and federal laws were passed in the 1920s and 1930s to manage and protect various game species. Some species, such as the pronghorn and mule deer, increased in number in some locales under professional management. Near population centers and in competition with livestock, pronghorns did not do so well. A few pronghorn were observed grazing about 10 miles south of Santa Fe in 1942 (Hewett and Dutton 1945: 108). Small numbers of this species were observed east and west of Albuquerque until the late 1940s or early 1950s. This was also a period of reintroduction of species such as bighorn sheep and elk to mountain ranges in the study region (Barker 1976: 100–101, 188; Clark 1987: 267; Flader 1978: 105; Pickens 1980: 83).

Table 60—Introduced plants.

Common name	Scientific name	Date of introduction	Source
Alfalfa	*Medicago sativa*	pre–1866	Meline 1966: 152–153; Wooton 1915: 343
Alfalfa dodder	*Cuscuta approximata*	?	Reed 1970: 294–295
Alferillo	*Erodium cicutarium*	?	Curtin 1965: 27; Tierney 1983: 16
Amaranth	*Amaranthus retroflexus*	post–1598	Haughton 1978: 19
Asparagus	*Asparagus officinalis*	pre–1851	Bartlett 1965, I: 237
Barnyardgrass	*Echinochloa crus-galli*	?	Reed 1970: 60
Bedstraw	*Galium aparine*	?	Reed 1970: 352–353; Tierney 1983: 112
Beggartick	*Bidens frondosa*	?	Reed 1970: 378–379
Bermuda grass	*Cynodon dactylon*	post–1880s	Wooton 1915: 84; Hoover et al. 1948: 663
Bindweed	*Convolvulus arvensis*	?	Reed 1970: 290–291
Black medic	*Medicago lupulina*	?	Reed 1970: 230–231
Black mustard	*Brassica nigra*	?	Reed 1970: 194–195
Bull thistle	*Cirsium vulgare*	?	Reed 1970: 398–399
Burdock	*Arctium minus*	?	Reed 1970: 372–373
Butter and eggs	*Linaria vulgaris*	?	Reed 1970: 42–45
Carpetweed	*Mollugo verticillata*	?	Reed 1970: 150
Centipede grass	*Eremochloa ophiuroides*	post–1919	Hoover et al. 1948: 671
Chickweed	*Stellaria media*	?	Reed 1970: 168–169
Chicory	*Cichorium intybus*	?	Reed 1970: 396–397
Cocklebur	*Xanthium strumarium var. canadense*	?	Reed 1970: 444–445
Corncockle	*Agrostemma githago*	?	Reed 1970: 154–155
Corn gromwell	*Buglossoides arvensis*	?	Reed 1970: 304–305
Crested wheatgrass	*Agropyron cristatum*	post–1935	Hitchcock 1935: 231
Curly dock	*Rumex crispus*	?	Reed 1970: 130–131
Dallasgrass	*Paspalum dilatatum*	post–1875	Reed 1970: 74–75; Hoover et al. 1948: 680
Dandelion	*Taraxacum officinale*	pre–1600?	Reed 1970: 438–439; Tierney 1983: 16
Field pennycress	*Thiaspi arvense*	?	Reed 1970: 214–215
Field sandbur	*Cenchrus carolinianus*	pre–1846	Reed 1970: 50–51
Foxtail millet	*Setaria italica*	Post–1849	Hoover et al. 1948: 691
Goatgrass	*Aegilops cylindrica*	pre–1950	Hitchock 1935: 243–246
Goathead	*Tribulus terrestris*	?	Reed 1970: 242–243
Goosegrass	*Eleusine indica*	pre–1935	Reed 1970: 62–63
Green fox-tail	*Setaria viridis*	?	Reed 1970: 85–86
Hedge bindweed	*Convolvulus sepium*	?	Reed 1970: 293–294
Henbit	*Lamium amplexicaule*	?	Reed 1970: 314–315
Hoarhound	*Marrubium vulgare*	pre–1600?	Wooton 1915: 556; Tierney 1983: 16
Italian ryegrass	*Lolium perenne* ssp. *multiflorum*	post–1820	Hoover et al. 1948: 676
Ivy leaf	*Ipomoea hederacea*	?	Reed 1970: 300–301
Japanese brome	*Bromus japonicus*	?	Reed 1970: 42–43
Johnsongrass	*Sorghum halepense*	post–1880	Reed 1970: 86–87
Kentucky bluegrass	*Poa pratensis*	post–1579	Gay and Dwyer 1970: 44
Lambsquarter	*Chenopodium album*	19th century?	Reed 1970: 132–133
Large crabgrass	*Digitaria sanguinalis*	?	Reed 1970: 58–59
Mallow	*Malva neglecta*	pre–1600?	Ford 1987: 75; Tierney 1983b: 16
Marijuana	*Cannabis sativa*	pre–1894	Bourke 1894: 143
Marshpepper	*Polyganum hydropiper*	?	Reed 1970: 122–123
Mayweed	*Anthemis cotula*	?	Reed 1970: 370–371
Meadow fescue	*Festuca pratensis*	19th century	Hoover et al. 1948: 672
Meadow foxtail	*Alopecurus pratensis*	?	Hoover et al. 1948: 649
Moth mullein	*Verbascum blattaria*	?	Reed 1970: 332–333
Mousear chickweed	*Cerastium fontanum*	?	Reed 1970: 158–159
Mullein	*Verbascum thapsus*	post–1800?	Haughton 1978: 227–228
Multiflora rose	*Rosa multiflora*	?	Reed 1970: 222–223
Mustard	*Sinapis arvensis*	?	Reed 1970: 192–193

continued on next page

Table 60—Introduced plants (continued).

Common name	Scientific name	Date of introduction	Source
Narrowleaf vetch	*Vicia sativa* ssp. *nigra*	?	Reed 1970: 238–239
Orchard grass	*Dactylis glomerata*	post–1760	Hoover et al. 1948: 664
Oxeye daisy	*Leucanthemum vulgare*	?	Reed 1970: 388–389
Pigweed	*Amaranthus albus*	?	Reed 1970: 142–144
Plantain	*Plantago* spp.	?	Reed 1970: 346–347
Poison hemlock	*Conium maculatum*	?	Reed 1970: 280–281
Prickly lettuce	*Lactuca serriola*	?	Reed 1970: 426–427
Prostrate knotweed	*Polygonum aviculare*	?	Reed 1970: 116–117
Purslane	*Portulaca oleracea*	pre–1600?	Reed 1970: 152–153; Tierney 1983: 16
Ragweed	*Ambrosia artemisiifolia*	?	Reed 1970: 364–369
	A. psilostachya	?	
	A. trifida	?	
Redroot pigweed	*Amaranthus retroflexus*	?	Reed 1970: 146–147
Redtop	*Agrostis gigantea*	?	Gay and Dwyer 1970: 8
Red (sheep) sorrel	*Rumex acetosella*	pre–1600?	Reed 1970: 128–129; Tierney 1983: 16
Rough cinquefoil	*Potentilla norvegica*	?	Reed 1970: 218–219
Russian knapweed	*Acroptilan repens*	?	Reed 1970: 384–385
Russian olive	*Elaeagnus angustifolia*	pre–1935	Freehling 1982: 100
Russian thistle	*Salsola kali*	post–1890	Wooton 1895; Bradfield 1974: 8
Rye Brome	*Bromus secalinus*	pre–1915	Hitchcock 1935: 48
Salsify	*Tragapogon dubius*	pre–1800	Fernald 1970: 1549; Camp et al. 1957: 13
Selfheal	*Prunella vulgaris*	?	Reed 1970: 316–317
Sheep fescue	*Festuca ovina*	1598?	de Buys 1985:225
Shepherd purse	*Capsella bursa-pastoris*	?	Reed 1970: 198–199
Siberian elm	*Ulmus pumila*	post–1919	Scurlock 1988a: 139
Smallflower	*Galinsoga parviflora*	?	Reed 1970: 410–411
Smallseed falseflax	*Camelina microcarpa*	?	Reed 1970: 190–197
Smooth brome	*Bromus inermis*	post–1884	Hitchock 1935: 658–660
Smooth crabgrass	*Digitaria ischaemum*	?	Reed 1970: 56–57
Sowthistle	*Sonchus arvensis*		
	S. asper	?	Reed 1970: 434–437
Stinging nettle	*Urtica dioica*	?	Reed 1970: 110–111
Sudan grass	*Sorghum bicolor* ssp. *drummondii*	post–1909	Hoover et al. 1948: 693
Sweetclover	*Melilotus officinalis*	pre–1915	Wooton 1915: 344; McKee 1948: 718
Tall buttercup	*Ranunculus acris*	?	Reed 1970: 186–187
Tall larkspur	*Delphinium barbeyi*	?	Reed 1970: 178–179
Tamarisk, salt cedar	*Tamarix ramosissima*	early 1900s	Robinson 1965: A6
Timothy	*Phleum pratense*	ca. 1747	Hoover et al. 1948: 684
Tree of heaven	*Ailanthus altissima*	post–1850	Haughton 1978: 388–389; Scurlock 1988a: 139
Tumble mustard	*Sisymbrium altissimum*	?	Reed 1970: 212–213
Watercress	*Rorippa nasturtium-aquaticum*	?	Reed 1970: 210–211
Weeping lovegrass	*Eragrostis curvula*	post–1934	Hoover et al. 1948: 670
Wild buckwheat	*Polygonum convolvulus*	?	Reed 1970: 120–121
Wild carrot	*Daucus carota*	?	Reed 1970: 282–283
Wild oat	*Avena fatua*	?	Reed 1970: 38–39
Wintercress	*Barbarea verna*	?	Fernald 1970: 716–717
Yellow foxtail	*Setaria pumila*	?	Reed 1970: 84–85
Yerba buena	*Mentha spicata*	?	Haughton 1978: 227–228

Terminology conforms to Soil Conservation Service 1994

Predator and rodent control by federal and state agencies continued into the 1940s–60s. A rodenticide known as 1080 was commonly used to control these species, followed by the use of a "cyanide gun" for control of coyotes (Brown 1983: 103; McDonald 1985: 12; Moyer 1979: 71). This device apparently had little impact on the overall population. More than 6,300 coyotes were poisoned or trapped in 1963 (Findley et al. 1975: 281–282).

In the Middle Valley, wildlife was adversely impacted by work of the Middle Rio Grande Conservancy District in the early to mid 1930s, especially species dependent on wetlands (Crawford et al. 1993: 39). As drainage canals were dug, the water table was lowered, draining the cienegas, charcos, and esteros. Populations of beaver, muskrat, mink, waterfowl, wading birds, and some reptiles and amphibians declined as a result. Subsistence and commercial hunting and trapping contributed to this decline as well (Crawford 1993: 39; Perrigo 1982: 62–63).

Mink were last reported in the Los Lunas area just prior to 1920, but a few individuals were present elsewhere in the Middle Valley until 1947 (Bailey 1971; Hink and Ohmart 1984, pt. I: 34; 324; Pillow and DeVaney 1947: 16). Minks were apparently the victim of trapping and habitat change. River otters were last observed at the northern boundary of the Middle Valley sometime before 1930 (Bailey 1971: 324). Never common, river otters also may have disappeared because of trapping, but increased temperature and sedimentation of the river were more likely causes.

The Norway rat was among the earliest introduced mammals that became naturalized (Table 61). This species was in the study region at least as early as 1851, and it was abundant in Albuquerque by 1888. Its high reproduction rate and ability to consume a considerable amount of a variety of foods has resulted in significant losses of field and stored agricultural produce. The Norway rat also carries diseases transmittable to humans, the best known being bubonic plague. This disease is still prevalent in the Middle Valley, where a number of cases are reported each year (Findley 1987: 107–108; Roots 1976: 43–44, 47, 52–53).

Another introduced rodent that has adapted to New Mexico's settlements and agricultural environments is the omnivorous house mouse. This species feeds on insects, agricultural produce, and other vegetative materials. It, too, carries the plague and a number of viral and fungal diseases, including harvest fever and typhus. A prolific breeder, house mouse populations can reach as high as 82,000 per acre. This species' impact on agricultural grains can be significant (Findley 1987: 109–110; Roots 1976: 54–56).

Wild horses and burros, although probably not as common as they were in the late 1800s and early 1900s, were present in the study region from the 1920s to the early 1940s (Findley 1987: 150; Table 61). They occurred in the Sangre de Cristo Mountains and the bajada of the Manzano Mountains and they were also recorded in the Jemez Mountains. By 1971 they had become a serious ecological problem at Bandelier National Monument due to their intensive grazing, which significantly increased soil erosion and damaged springs. They were subsequently removed by National Park Service personnel (deBuys 1985: 244; Rothman, 1992: 280–281; Speakman 1965: 31).

Four exotic and naturalized bird species occur in the study region (Table 61). Of these, the two most prominent are the rock dove or domestic pigeon (*Columbia livia*) and the European starling (*Sturnus vulgaris*). The starling has increased substantially since its mid 1930s arrival in the region. This aggressive bird consumes large quantities of grain and is considered a pest on farms. Well adapted to urban environments, where it displaces native species through competition for food and nest sites, the starling is equally disliked by city residents (Roots 1976: 132).

Another introduced and despised bird that has adapted to urban and farm environments is the house sparrow (*Passer domesticus*). It feeds on some agricultural fruit and vegetable crops and also carries a disease that kills poultry. Introduced on the east coast in the mid 1800s, this sparrow reached New Mexico by the late 1800s (Roots 1976: 122–128).

A common species of game bird in the Middle Rio Grande bosque and agricultural fields is the ring-necked pheasant (*Phasianus colchicus*), introduced in the late 1800s-early 1900s. Popular with hunters, the pheasant is generally not liked by farmers because of the crop damage it can inflict. This species also competes with native quail (Roots 1976: 163–166).

Other species, especially indigenous fish populations, have also been adversely affected by the increasing sedimentation, as well as lowered stream flows, construction of water control facilities, pollution, and competition with introduced species (Table 62). From 13 to 19 non-native fishes have been introduced in the middle reaches of the river. These species, such as the rainbow trout, common carp, yellow perch, and largemouth bass, have generally competed successfully with native fishes. Some have preyed on native fishes, and others have cross-bred with natives. This has contributed to the decline or extirpation of several indigenous species (Sublette et al. 1990: 2, 9–11, 331; Table 62).

"Louisiana" bullfrogs were probably introduced into the Middle Rio Grande in the early 1930s. Their population increased rapidly, and the bullfrog soon became the most common amphibian in the valley (Hink and Ohmart 1984: 83; Pillow and DeVaney 1947: 16). A closely related amphibian, the leopard frog, has declined sharply over the last 4 or 5 decades, probably due primarily to predation by bullfrogs (Hink and Ohmart 1984: 83).

At least four invertebrates have been introduced into the Middle Valley —a pillbug (*Armadillidium vulgare*), a woodlouse (*Procello laevis*), the European honeybee (*Apis meillifera*), and the common housefly (*Musca domestica*) (Table 61). Although these four species may have entered the region relatively early in the historic period, actual dates of introduction are not known.

Table 61—Introduced fauna.

Common name	Scientific name	Date of introduction
Mammals		
Norway rat	*Rattus norvegicus*	pre-1851
House mouse	*Mus musculus*	?
Burro	*Equus asinus*	1598
Horse	*Equus caballus*	1598
Oryx	*Oryx gazella*	1969
Domestic cat	*Felis domesticus*	pre-1910
Birds		
Ring-necked pheasant	*Phasianus colchicus*	late 1800s
Chukar	*Alectoris chukar*	1931
Rock dove	*Columbia livia*	pre-1850
Starling	*Sturnus vulgaris*	1935 or 36
House sparrow	*Passer domesticus*	pre-1900
Amphibians		
Bullfrog	*Rana catesbeiana*	early 1930s
Fish		
Brown trout	*Salmo trutta*	early 1900s
Rainbow trout	*Oncorhynchus mykiss*	1896
Eastern brook trout	*Salvelinus fontinalis*	pre-1900
Common carp	*Cyprinus carpio*	1883
Golden shiner	*Notemigonus crysoleucas*	pre-1957
Yellow bullhead	*Ictalurus natalis*	pre-1950
Smallmouth bass	*Micropterus dolomieu*	pre-1957
White crappie	*Pomoxis annulari*	pre-1957
Black crappie	*P. nigromaculatus*	pre-1957
Walleye	*Stizostedion vitreum*	pre-1957
Yellow perch	*Perca flavescens*	pre-1950
Crustacean Isopods		
Pillbug	*Armadillidium vulgare*	?
Woodlouse	*Porcello laevis*	?
Molluscs		
Asian fingernail clam	*Corbicula* sp.	?
Insects		
European honeybee	*Apis meillifera*	?
Common housefly	*Musca domestica*	pre-1950

Sources: Crawford et al. 1993; Findley 1987; Hubbard 1978; Koster 1957; Ligon 1961; Swain 1948; Sublette et al. 1990

Extirpated, Rare, Endangered, and Threatened Fauna

Historic and current populations of the species listed below have been extirpated by one or more human activities including habitat destruction (building, damming streams, overgrazing, logging, mining, farming, etc.); sport and commercial hunting, trapping, and specimen collecting; fire suppression; construction of roads and railways; pollution of surface and shallow ground waters; and introduction of exotic animals. Related environmental events such as soil erosion, siltation of streams and lakes, modification of stream and spring flows, water contamination, and perhaps acid rain have and are adversely impacting flora and fauna. Forty-five species of vertebrate animals are listed (Table 62) as extirpated, rare, endangered, or threatened in the Middle Rio Grande Basin by the U.S. Fish and Wildlife Service (1991) and the New Mexico Department of Game and Fish (1988, 1990).

SUMMARY

The ecosystems of the Middle and Upper Rio Grande basins have been impacted and changed by human activities for more than 10,000 years. These modifications were relatively minimal until the arrival of the Spaniards, who brought livestock, new tools, cultigens, ditch irrigation, and another world view. They also introduced sev-

Table 62—Extirpated, threatened, rare, and endangered fauna.

Common name	Scientific name	Extirpated	Endandered, Threatened, or Uncommon Species[b]
Mammals			
American elk	*Cervus elaphus*	X	
Grizzly bear	*Ursus arctos*	X	
Black bear	*Ursus americana*		X
Mountain lion	*Felis concolor*		X
Jaguar	*Felis onca*	X	
Gray wolf	*Canis lupis*	X	
Black-footed ferret	*Mustela nigripes*	X	
Mink	*Mustela vison*	X	
Bighorn sheep	*Ovis canadensis*		X
Otter	*Lutra canadensis*	X	
New Mexican jumping mouse	*Zapus hudsoniuslatens*		X
Birds			
Bald eagle	*Haliaeetus leucocephalus*		X
Golden eagle	*Aquila chrysaetos*		X
Peregrine falcon	*Falco peregrinus*		X
Common blackhawk	*Buteogallus anthracinus*		X
Northern goshawk	*Accipiter gentilis*		X
Mexican spotted owl	*Strix occidentalis lucida*	X	
Whooping crane	*Grus americana*[a]	X	
Rio Grande turkey	*Meleagris gallopavo*	X	
Western snowy plover	*Charadrius alexandrinus*	X	
Least tern	*Sterna antillarum*		X
Neotropic cormorant	*Phalacrocorax brasilianus*		X
Willow flycatcher	*Empidonas trailii*		X
Tundra swan	*Cygnus columbianus*		X
Bell's vireo	*Vireo bellii*		X
Grey vireo	*Vireo vicinior*		X
Baird's sparrow	*Ammodramus bairdii*		X
Fishes			
Rio Grande bluntnose shiner	*Notropis simus*	X	
Shovelnose sturgeon	*Scapirhynchus platorynchus*	X	
Longnose gar	*Lepisosteus ossurs*	X	
American eel	*Anguilla rostrata*		X
Golden shiner	*Notenigonus crysoleucas*	X	
Rio Grande silvery minnow	*Hybognathus amarus*		X
Speckled chub	*Extrarius aestivalis*	X	
Rio Grande shiner	*Notropis jemezanus*	X	
Spotted gar	*Lepisosteus latirostris*	X	
Phantom shiner	*Notropis orca*	X	
Rafinesque	*Aplodinotus grunniens*		X
Blue sucker	*Cycleptus elongatus*	X	
Freshwater drum	*Aplodinotus grunniens*	X	
Blue catfish	*Ictalurus furcatus*	X	
Gray redhorse	*Moxostoma congestum*	X	
Amphibians			
Jemez Mountains salamander	*Plethodon neomexicanus*		X
Leopard frog	*Rana pipiens*		X

[a] *Reintroduced in 1970s.*

Sources: Bailey 1971; Crawford et al. 1993: 140–144; Findley 1987; Hubbard 1978; Ligon 1961; Sublette et al. 1990: 216, 345–350; U.S. Fish and Wildlife Service 1995

[b] *Species determined to be threatened or endangered, species that have declined in the historic period, and species that have always been uncommon.*

eral infectious diseases that devastated Native American populations. Anglo American conquest and occupation began in 1846, and they, too, brought new tools, technologies, cultigens, and a view that resources, including the land and water, are commodities to be bought and sold for economic profit.

By the end of the 19th century, environmental problems had become so severe and widespread that the federal and territorial legislatures began to enact regulations related to the conservation of water, soils, grasslands, woodlands, and forests and their associated fauna. For various reasons, effective regulation did not really occur until the 1930s, followed by a vigorous environmental movement that generated far-reaching legislation and regulations in the 1960s and 1970s. This evolution from a time of unregulated land and water exploitation to recent control and management of these resources for future generations is the focus of Chapter 6.

CHRONOLOGY

1598–1630 With the construction of more irrigation systems and the introduction of livestock by the Spanish, the demand for surface water increased significantly (Meyer 1984: 50).

1598–1680 New Mexico's governors dominated the export trade in furs and skins, such as those of buffalo, antelope, elk, and deer (Weber 1971: 18–19).

1598 (post) A grass native to Eurasia, sheep fescue (*Festuca ovina*), may have been introduced to New Mexico via the fleece and droppings of domestic sheep brought by Onate (deBuys 1985: 225).

1600s (early?) Spanish cattle, carriers of brucellosis, probably infected bison, elk, and bighorn sheep, resulting in a decrease of these animal populations in the study region. Native Americans, as well as Spaniards, were affected by this in the form of undulant fever (Callenbach 1996: 134–135).

1600s (early) (to 1680) Pueblo residents were forced to collect firewood, salt, and pinyon nuts in large quantities, to prepare hides, and to manufacture cotton blankets, causing stress among the villagers (Snow 1981: 368).

1610 (post) According to Aldo Leopold, mountain meadows and foothills were overgrazed by Hispanic livestock (Brown and Carmony 1995: 230).

1660 Governor Lopez de Mendizabal shipped 1,350 deer skins and a number of buffalo hides to Parral to market. He sent two other large shipments of skins there during his term. Some 1,200 pronghorn skins and four bundles of elk skins were later found at his property in Santa Fe (Weber 1971: 20–21).

1661 Some 60 Pueblo laborers from Quarai were conscripted by the Spanish to harvest and transport loads of pinyon nuts. Nineteen Indians from Abo worked for 6 days carrying maize from Tabira and Las Humanas pueblos to the house of Captain Nicolas de Aguilar in the Salinas District. Also, some 40 Indians of Jemez Pueblo were forced by the Spanish to transport pinyon nuts to "depots" at Santa Fe, Cochiti, or San Felipe (Scholes 1937: 394–395).

1661 Pueblo Indians from Tabira collected salt at a nearby salt marsh and transported it to the Las Barrancas estancia of Sargento Mayor Francisco Gomez (Scholes 1937: 401).

1661 The mission livestock were moved from Las Humanas to Abo because the Pueblos exhausted themselves hauling water for the stock from deep wells to the west of the village (Scholes 1937: 401).

1692 (late August) The condition of the Camino Real was degraded following 12 years of little or no traffic. In many places, grasses, forbs, and shrubs had grown up in the road bed. Vargas sent the sheep, cattle, and horses ahead to trample the vegetation, providing a clearer and smoother road for the wagons and settlers in the caravan. In some places, the road was gullied due to water runoff, and Vargas had men ready to repair the road (Hendricks 1993: 81).

1700–1800 About 27,000 new acres were put into cultivation by the Spanish in the middle and upper Rio Grande valleys (Hedke 1925: 23).

1736 (early) Five Albuquerque farmers requested that the alcalde allow them to move their livestock back to the Isleta area, where better grazing conditions existed (Baxter 1987: 24).

1739 Some residents of Albuquerque, who were experiencing scarcity of wood, insufficient pasture for livestock, a scarcity of irrigation water, and encroachment of footpaths on their land, requested and received the Tome land grant (Ellis 1955: 91; Oppenheimer 1962: 16).

1700s (mid) Intensive livestock grazing and fuelwood cutting led to denudation and soil erosion along Abiquiu Creek. Water from the stream tasted and smelled like cattle manure (McDonald 1985: 120).

1750 By this year Albuquerque and nearby communities were experiencing some pressures of overpopulation. Suitable agricultural land was taken, and livestock overgrazed some pastures and outlying rangelands. By this year, the bajada between Albuquerque and the Sandia-Manzano mountains was virtually