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Chapter 4:

The Dynamic Environmental History of Southwest Willow Flycatcher Habitat: A Survey of Changing Riparian Conditions Through Time

The extent of riparian habitat in the southwestern United States during the past 100 years appears to have been reduced by modern land development, urban expansion, and a general increase in human populations (Finch 1996; Shaw and Finch 1996). Thousands of acres of river flood plain along the Rio Grande and Colorado rivers have been cleared for agriculture, construction of housing, and industrial development. River channels have been diverted and contained by dams, levies, and other water control structures in order to provide irrigation and drinking water, and to protect this investment in development from the destructive forces of periodic flooding (Tellman and others 1997; Wozniak 1995). Additionally, livestock grazing and the suppression of fire in upland ecosystems have detrimentally affected the overall conditions of riparian habitat (Thibault and others 1999).

The U.S. Fish and Wildlife Service added the Southwestern Willow Flycatcher (*Empidonax traillii*) to the endangered species list due to the brood parasitism of Brown-Headed Cowbirds and the destruction and modification of riparian habitats (U.S. Fish and Wildlife Service 1995). Cottonwood-willow riparian ecosystems are essential habitat for this species. While we can assume that industrial-era human expansion and land use have been responsible for Willow Flycatcher habitat loss, the environmental history of Southwestern cottonwood-willow ecosystems likely did not follow a linear trend of development or degradation.

Southwestern riparian ecosystems follow a dynamic regime of change and are not ecologically static. Prior to the installation of flood-control structures, periodic and catastrophic flooding replenished soil nutrients and served to “replant” riparian vegetation, while simultaneously removing large stretches of cottonwood-willow habitat from river flood plains (Whitney 1999). Human environmental manipulation, such as the burning of vegetation and clearing of land for agriculture, has been another factor of change to these already dynamic ecosystems. Although occurring at first on a limited scale, this interaction between people and the environment of the Southwest has occurred for at least 12,000 years (Cordell 1984). Archaeological research shows that not only were riparian plant and animal species used as sources of food, medicinal plants, and wood fiber for shelter and firewood, certain drainages in southwestern New Mexico were virtually stripped bare of trees during the eleventh and twelfth centuries A.D. (LeBlanc 1985).

According to ethnographic accounts, many American Indian cultures used and affected riparian habitats in a variety of ways. While some groups burned the vegetation along rivers and streams to provide clear hunting areas, others pruned and even planted riparian plants, willows for example, for future use (Blackburn and Anderson 1990; Fowler 1986 and 1996; Opler 1983a and b).

The overall effects of human land use changed in both method and intensity with Spanish conquest and settlement after 1540. This environmental change greatly intensified after 1846 when Anglo-American ranchers, farmers, and miners began to settle in the Southwest (Scurlock 1998; Wozniak 1996). Combined with the effects of modern development, this long-term, socioecological interaction has influenced and helped create the riparian conditions we see today.

We provide in this chapter a brief environmental history of Southwestern Willow Flycatcher habitat. Our geographical focus is the American Southwest (i.e., New Mexico, Arizona, and portions Southern California). We begin by describing the general changes and development of ecological conditions in the Southwest since the end of the Pleistocene. This description of the area's natural history provides a background for a discussion of human-environmental interactions with stream-side ecosystems, and importantly, illustrates the dynamic quality of Southwestern ecosystems. Within this context, we discuss Pre-Columbian and ethnohistorical evidence of riparian land use and manipulation. This is followed with a survey of historical observations of riparian habitat, first those of Spanish explorers, then more detailed accounts by Anglo-American trappers, military officers, and ornithologists. The section on exploration also provides accounts of direct sightings of Willow Flycatchers and the collection of vegetation and bird species. We then review the effects of European and Anglo-American expansion and settlement on the environment of the Southwest. Finally, we conclude with a discussion of how this historical ecological information may be useful in the management of Southwestern Willow Flycatcher habitat.

Ecological Conditions During the Holocene

By the end of the Pleistocene, c.12,000 to 10,000 years before present (B.P.), vegetation zones in the Southwest were 900 to 1,400 meters below present elevations. Sagebrush was more widespread during early- and full-glacial periods than it is today. Vegetation zones that had been at lower altitudes during the Pleistocene shifted to higher elevations during the transition from the glacial to post-glacial periods (Hall 1985:117). During the early-Holocene (10,000 to 7,000 B.P.) climatic conditions were generally more cool and moist than at present. This cool period was followed by a gradual warming and drying of the climate beginning approximately 7,000 B.P. and extending to 5,000 B.P. During this period of the middle-Holocene, average annual temperatures were between one and two degrees Celsius higher than today's annual temperatures (Mannion 1991:53-54). Pollen records from sites throughout the Southwest show that the middle-Holocene was extremely warm and dry relative to any other period. There was a reduction in woodland and riparian vegetation, and at alpine localities tree lines appear to have been as much as 70 meters above those of today. Alluvial valleys were eroded, resulting in the truncation of many alluvial pollen records (Hall 1985:118). After 5,000 B.P., there was a gradual increase in moisture levels and a correspondingly progressive increase in woodland and forest vegetation (Hall 1985:118). During the Little Ice Age, occurring during the late-Holocene from approximately A.D. 1450 until 1900, annual temperatures were one to two degrees Celsius cooler throughout the Northern Hemisphere than they are today (Kreutz and others 1997).

As demonstrated by the arid conditions of the middle-Holocene and cooler period of the Little Ice Age, the Holocene has been a period of climatic variability. Additionally, these broad-scale fluctuations were accompanied by more periodic climatic patterns. For example, historical records used to reconstruct more than four hundred and fifty years of El Niño-Southern Oscillation (ENSO) effects show that climate and moisture regimes varied extensively during the late-Holocene (Quinn and others 1987). By studying documented observations of abnormal weather, flooding, destruction of settlements, reductions in coastal fisheries, and other unusual natural events, Quinn and others identified moderate, strong, and very strong El Niño occurrences from 1525 to 1987. High-resolution alluvial sedimentary deposits in Ecuador show that the current periodicity of ENSO was established about 5,000 B.P. (Rodell and others 1999:518-519).

In the American Southwest, fire-histories show that years of increased or decreased regional burning have been closely related to the extreme ENSO phases (Swetnam and others 1999). Extensive drought and fire records, compiled for the Southwest from dendroclimatological data, show that extreme El Niño (high moisture) phases result in an accumulation of fuels. When followed by La Niña drought conditions, such fuels result in a greater number of fires on a regional scale (Swetnam and Betancourt 1998:3132-3136). Such patterns of climatic and moisture change would have affected levels of runoff and groundwater accumulation. This oscillating cycle of precipitation and fuel accumulation followed by drought and burning likely affected riparian vegetation as well as upland forests.

Native American Use of Riparian Ecosystems

For at least the past 12,000 years, humans have been living in and interacting with ecosystems throughout the Western Hemisphere (Cordell 1984; Frison 1991). The American Southwest has an abundance of archaeological and ethnographic resources that have the potential to enhance our understanding of riparian history. Archaeological research and excavation often includes the study of past environments through the examination of buried botanical remains collected from archaeological sites and other locations where pollen might be preserved, such as a peat bog or lake bottom (Birks and others 1988; Chambers 1993). Studying the remains of plants used by prehistoric and historic cultures can provide insights into human land use and environmental effects (cf. Pearsall 1989).

Prehistoric archaeological sites are often associated with riparian areas because of the presence of water and high resource availability. Riparian vegetation was used for firewood, construction material, shade, and food (Cordell 1984). Frequently, the macrofloral remains are well preserved in Southwestern archaeological sites, and pollen analysis of site sediments often reveals willow (*Salix* spp.), cattail (*Typha* spp.), and other riparian plants (Reinhard and others 1991:119; see also Cummings 1995a, b, 1997).

During the Paleo-Indian period (ca. 12,000 B.C. to 5,500 B.C.) and the Archaic period (5,500 B.C. to A.D. 400), people in the Southwest primarily foraged and hunted for subsistence (Cordell 1984). With the introduction of maize into the area, between 2,000 B.C. and 1,500 B.C. (Minnis 1992) until approximately A.D. 400, people continued to follow a hunting and gathering economy but with an increased dependence upon agriculture. Interestingly, during the Archaic period land use in some areas concentrated on upland landscapes that had high elevational diversity and therefore a greater range of resources to be exploited throughout the year (Tainter and Tainter 1996).

Between A.D. 400 and A.D. 600, until the beginning of Spanish colonization in A.D. 1540, agricultural groups began to build permanent settlements throughout what is now Arizona and New Mexico. Unlike those of earlier, Archaic period groups, these settlements were in some areas associated with large river-bottom environments (Tainter and Tainter 1996). Prehistoric farmers planted crops in riparian areas after clearing flood plains of vegetation (Cordell 1984; LeBlanc 1985). Agricultural societies in the Southwest had significant effects on riparian ecosystems. These societies included: the Patayan cultures located along the Colorado river in western Arizona; the Hohokam on the Gila, Verde, Salt, and San Pedro rivers in south-central Arizona; and the Anasazi of the Four Corners region in the San Juan, Little Colorado, and Rio Grande river basins. The Mogollon culture, which covered much of southern New Mexico, southeastern Arizona, and northern Sonora and Chihuahua, Mexico, was associated with the Rio Grande, Gila, Salt, the Rio Conchos, Rio Yaqui, and Rio de Sonora rivers (Cordell 1984).

In the southwestern corner of New Mexico archaeological and paleoenvironmental research in the Mimbres Valley reveals that prehistoric cultures had a profound effect on riparian ecosystems. A team of scientists headed by archaeologist Steven LeBlanc speculates that the Mimbres Valley underwent human-caused degradation during the period from A.D. 1000 to A.D. 1130 (LeBlanc 1985). Centuries of occupation and land use greatly reduced tree-cover in the river valley's riparian areas. Before A.D. 1000, cottonwood had been a common source of firewood and roof timbers but this source became depleted. Examination of wood charcoal shows that people were forced to use upland trees as substitutes when cottonwood was depleted. Clearing of the valley bottom for agriculture also likely affected the riparian plant community. After the valley was abandoned, most of the original vegetation returned. However, pollen analysis indicates that at least one species, sycamore (*Platanus wrightii*), was eliminated entirely from the ecosystem (1985:21).

Riparian-related vegetation was utilized as a resource by a variety of American Indian tribes throughout the Southwest and Great Basin. These cultures systematically tended riparian landscapes through the use of fire, pruning vegetation, and planting stands of willows and other plants in new locations (Anderson 1999; Blackburn and Anderson 1993b). The Timbisha Shoshone of Death Valley, California, used fire to clear riparian areas of dense willows and various grasses in order to promote the growth of certain types of seeds, particularly the white-stemmed blazing star (*Mentzelia albicaulis*) (Fowler 1996:40). The Timbisha routinely removed willows from springs and other water sources so that water could accumulate both for wildlife and for their own use (1996:98). As with pruning and selective harvest of riparian species, fire-use was localized and used for specific purposes (Anderson 1999). In order to produce straight willow stems for use in basketry, willow was pruned and coppiced by the Timbisha and other Shoshonean tribes in the Great Basin (Fowler 1986, 1996).

The Chiracahua Apaches of southwestern New Mexico and southeastern Arizona used the roots of tule (*Scirpus* spp.) and cattail (*Typha* spp.) for food and baskets. Sedge (*Carex* spp.) tubers and rootstocks of cattail were significant in the diet of the Mescalero Apaches of southeastern New Mexico and western Texas (Opler 1983a; Opler 1983b).

For native peoples, riparian ecosystems were highly productive and therefore attracted a high level of land use. This manipulation of vegetation likely occurred over thousands of years in both upland and lowland stream environments. Many of the streamside areas encountered by European and Anglo-American explorers may have in fact been semi-managed ecosystems (Blackburn and Anderson 1993b).

Western Exploration and Settlement

In 1540, the viceroy of New Spain ordered Fray Marcos de Niza, who traveled ahead of the Coronado expedition, to take note of "the nature, fertility and climate of the land; the trees, plants, and domestic and wild animals…the rivers, whether they are large or small" (Hammond and Ray 1940). De Niza neglected to write about the natural world through which he passed, contrary to the viceroy's orders. Alvar Nuñez Cabeza de Vaca, in the chronicles of his journey from a shipwreck in Florida to New Spain (Mexico), described crossing the Rio Grande somewhere north of what is now El Paso; he suggests the presence of settlements and farms on the flood plain (Cabeza de Vaca 1542). Hernando de Alvarado and Fray Juan de Padilla, on their way to rendezvous with Coronado along the Rio Grande, noted the existence of cottonwoods near present day Albuquerque (Hammond and Ray 1940:183).

In general, the journals and documentation of Spanish explorers do not mention riparian or other vegetation in detail. Although Spain sent scientific expeditions to New Spain between 1785 and 1800, primarily for the purpose of recording plant and animal life in addition to mineral and other resources, none traveled through the American Southwest (Engstrand 1981).

Journals of explorers, trappers, and members of military expeditions contain information relevant to identifying historical environmental conditions during following the Spanish Colonial period (1540 to 1821) as well as during and following the Mexican period (1821 to 1848). American fur trappers entered the Southwest as early as 1831 (see Gregg 1905). The records of American military expeditions associated with the war with Mexico, 1846 to 1848, and the exploration of possible routes for transcontinental railways contain the most thorough observations of environmental conditions prior to the twentieth century (Abert 1962; Bell 1870; Pattie 1905; Pike 1966; Sitgreaves 1853; Wislizenus 1848).

During his explorations of New Mexico in 1805, Zebulon Pike observed that, "the cotton tree is the only tree of this province except some scrubby pines and cedars [juniper] at the foot of the mountains. They form borders on the banks of the Rio del Norte and its tributary streams. All the rest of the country presents to the eye a barren wild [wilderness] of poor land, scarcely to be improved by culture, and appears to be only capable of producing sufficient subsistence for those animals which live on succulent plants and herbage" (Pike 1966:47).

In 1826, fur trapper and trader James Pattie remarked that near Socorro, New Mexico, the river bottoms were thinly timbered and that the only growth was cottonwood and willow (Pattie 1905:86). However, during their first night on the Gila River, Pattie's group trapped over thirty beavers. The next day they journeyed along the river, and became "fatigued by the difficulty of getting through the high grass, which covered the heavily timbered bottom" (1905:87).

In the 1830s, explorer Josiah Gregg noted that the aspen along the upper portion of Santa Fe Creek were as "thick as cottonwoods in the Missouri bottoms" (Gregg 1905:282). However, the effects of human land use also were observed by Gregg. Commenting on the Rio Grande Bosque, he wrote that, "on the water-course there is little timber to be found except cotton-wood, scantily scattered along their banks. Those of the Rio del Norte are now nearly bare throughout the whole range of settlements, and the inhabitants are forced to resort to the distant mountains for most of their fuel" (1905:159). Similar observations of riparian vegetation along the Rio Grande were made by Adophus Wislizenus in 1846. The banks of the Rio Grande and south of Albuquerque, he observed, were bare of trees, with only occasional cottonwoods (Wislizenus 1848:34).

Beginning in 1846, American military expeditions resulted in some of the most detailed environmental descriptions of the Southwest during the nineteenth century. As part of Col. Stephen Kearny's expedition during the Mexican American War, engineer Lt. William H. Emory produced a detailed journal that contains numerous descriptions of riparian vegetation in the Southwest. On the Purgatory River, shortly after entering New Mexico, Emory remarks that, "the blighted trunks of cotton-wood and locust trees were seen for many miles along its course, but the cause of decay was not apparent" (Emory 1848:17). He also recorded sighting "black locust, the everlasting cotton-wood, willow, wild currents, hops, plums and grapes, artemesia [sic], *Clementis verginiana*, *salix*, in many varieties; and a species of angelica" (1848:17). On the Canadian River, Emory described the presence of a few cottonwoods (1848:19).

Emory carefully documented the birds he encountered on the expedition. While on the Canadian River he wrote that, "birds are rare, with the exception of the cow-bunting [cowbird?], which has been seen in great numbers on the whole route [from Bent's Fort] in a state so tame as to often alight on our horses" (1848:21). Additionally, he described healthy stands of willows and cottonwoods on the Cimarron and its tributary streams (1848:22).

Emory recounted that the area around Santa Fe was entirely cultivated through use of irrigation and that the expedition's horses had to be sent to graze 12 to 30 miles from the city (Emory 1844:35). He remarked that the area near Albuquerque was destitute of wood and that grass was sparse for the expedition's horses; however, he observed significant cottonwood and willow growth, along with evidence of beavers, south of Albuquerque (1848:47-48). At Polvadera, the river was fringed with large cottonwoods, and Emory observed flocks of geese "blue-winged ducks, plovers, doves and a few meadow larks" (1848:48). There were "immence [sic] flights of sand-cranes and geese well within gunshot of houses and the largest towns" (1848:48). He mentioned that as he traveled south, the cottonwood growth become more plentiful (1848:50).

South of Socorro, Emory's party encountered an area which he judged to be "the best in New Mexico; the valley is broader, the soil firmer, and the growth of timber, along the river, larger and more dense" (Emory 1848:53). Emory noted evidence of irrigation and two deserted towns in the area that had once been a successful Spanish settlement. After passing the Fra Cristobal Mountains, Emory remarked on shooting three quail and one small lark that resembled a "sparrow-hawk" (1848:54). Interestingly, at this point in the journal he made the statement that "game in New Mexico is almost extinct" (1848:54). In contrast, when the expedition reached the area located one mile north of San Felipe, he observed that their camp was, "well grassed and wooded, and apparently untrodden by the foot of man" (Emory 1848:55). For the first time in New Mexico, Emory's expedition saw abundant evidence of game (1848:55).

The expedition left the valley of the Rio Grande and traveled west toward the Gila River. After crossing over table lands and entering more hilly terrain, Emory observed a stream with "green trees and luxuriant foliage…. The stream was clear, limed, and cool, the first but one I had seen since crossing the Alleghenies, where water could be drunk without imbibing a due proportion of mud and sand" (1848:57). As the group progressed further, he noted that, "in the valley grows cotton-wood, a new variety of evergreen oak…and a new kind of walnut" (1848:57). Emory wrote that the sides and banks of the Rio Mimbres were "covered with a growth of stunted live oak," and the valley was "densely covered with cotton-wood, walnut, [and] ash" (1848:57). He stated that the river was filled with an abundance of fish "without scales [Roundtail Chub]" (1848:61-62). The Gila River valley, according to Emory, was covered with a luxuriant growth of trees, "chiefly cotton-wood, a new sycamore, mezquite [sic]…a few cedars, and one or two larch [Arizona Cyprus?]" (1848:62).

Lt. J. W. Abert, also under Col. Kearny's command during this period, traveled in a separate expedition and kept a journal much like the one recorded by Emory. Abert recorded specific bird sightings and like Emory made observations of the vegetation encountered. For example, on the Purgatory River, he observed, "we here saw several flickers, with red lined wings and tails…the common flicker, and large flocks of the yellow headed black bird" (Albert 1962:30). Further down the Purgatory River, he recorded sightings of "red shafted flickers" (1962:30-31). Like Emory, Abert also observed the "common cow bird" (1962:32). Abert described the riparian vegetation he encountered in much the same manner as Emory had; he described the campsites on the Canadian River as "shaded by large cottonwood trees and willow thickets" (1962:35).

In 1850, an expedition led by Captain L. Sitgreaves surveyed a segment of the Rio Grande, the Zuni River, and the Colorado River (Sitgreaves 1853). Like Emory and Abert, Sitgreaves reported on the vegetation he encountered. More detailed and technical observations, however, were made by S. W. Woodhouse, M.D., the surgeon and naturalist of the expedition. Woodhouse noted that, "From El Paso, passing up the Rio del Norte, the vegetation alters but little, the timber being principally cotton-wood, and mezquit [sic] extending as far as the Jornada del Muerto." From the Pueblo of Santo Domingo to Albuquerque, Woodhouse noted that there was little change in vegetation "with the exception of a few scattered cottonwood trees…or occasionally a few cedars [junipers]" (1853:35). Significantly, Woodhouse made thorough and detailed observations of birds, and recorded sightings of "Trail's Fly-catcher" and the "Dwarf Fly-catcher" (1853:74-75). What he calls "Trail's Flycatcher" is likely the Southwestern Willow Flycatcher (*Empidonax traillii extimus*).

Interestingly, when describing the Zuni River, Woodhouse remarked that they encountered "in but one place a few poplars (*Populus augustifolia*), and near these trees was a beaver dam, in which was growing cattails (*Typha latifolia*)" (Woodhouse 1853:36). He also noticed beaver lodges on the banks of the Little Colorado, although there was little timber.

However, he did mention "a species of swamp-willow (*Salix*)" (1853:36). As the expedition approached the San Francisco Mountains, he noted that the cottonwood became more abundant (1853:39). Woodhouse wrote that the banks of the Little Colorado were "fringed with cotton-wood trees" and that at its confluence with the Colorado, he had trouble measuring the velocity of the of the river due to a "dense growth of willows and weeds" (1853:40).

Woodhouse noted several streams with willows, and upon finally reaching the "Colorado of the West," he remarked, "On the banks of this stream are growing willows (*Salix* spp.) of several kinds, one of which, the *Salix augustifolia*, affords good fodder for the mules; they oftentimes, whilst on this stream, had nothing else, and in fact we thought that we were doing well when we found this species of willow" (1853:39). Additionally, he observed that from the place where they first encountered the Colorado to the mouth of the Gila (Figures 4-1 through 4-3), "south to the entrance of the Great Desert," the vegetation varied little, being cottonwood, mesquite, and willow (Woodhouse 1853:39).

The extensive Wheeler railroad surveys, conducted from 1871 through 1874, produced seven volumes of information about the West (Wheeler 1878). Volume VI documents the vegetation encountered in detail (Figures 4-4 through 4-6). As reported in Volume V, ornithologist Henry W. Henshaw collected extensively in western New Mexico, Arizona, Utah, and Nevada. In all, his expedition procured more than 3,000 birds (Henshaw 1875). In 1874, his party, which included two other scientists, traveled from Santa Fe to Fort Wingate, New Mexico, through Arizona to Fort Crittenden near the Mexican border. From Fort Crittenden, they returned to New Mexico through eastern Arizona, then north along the Rio Grande to Santa Fe.

In his report, Henshaw recorded the species, sex, location, and the number of birds collected during the expedition. He stated that, "no birds have been introduced that have not actually been taken or observed by the expedition. In all cases where we have utilized the notes of observers other than members of the survey, attention is called to the fact" (Henshaw 1875:139).

As he traveled through the Gila valley Henshaw remarked that the avifauna was very much like that of the Colorado Valley (1875:140). In all, Henshaw collected and documented what were then classified as fifteen different species of "flycatcher," including the Willow Flycatcher (*Empidonax traillii*), which he referred to as the "Little Flycatcher" (1875:356-358). Henshaw's team collected Willow Flycatchers throughout Arizona, in the White Mountains, at Fort Apache, Fort Bowie, and Fort Crittenden. A list of these birds, and observations made by Henshaw, is provided in Appendix A. Reviewing the results of his other expeditions, Henshaw remarked that these birds (Southwestern Willow Flycatchers) were

> …exceedingly numerous near Provo, River [Utah] in willow thickets; sparingly so in eastern Nevada. Colorado, New Mexico, and Arizona are all included in the range of this flycatcher; its abundance being dependent upon the presence or absence of its favorite grounds…. Wherever willows are found growing in small clumps or fringing the streams, this flycatcher is almost certain to be found common (Henshaw 1875:357).

During the 1860s and 1870s, U.S. Army surgeon and ornithologist Elliott Coues collected and recorded birds and mammals as a member of numerous military expeditions in the West (Coues 1866, 1874, and 1878). Coues describes *Empidonax traillii* as being an abundant "Flycatcher of the West" and he observed that at "Fort Whipple, in Arizona, it is the commonest and characteristic species of its group," ranging from the central plains to the Pacific (Coues 1874:252-253).

Dr. Edgar Alexander Mearns recorded his observations of mammals and trees encountered during the Mexican Boundary Survey of 1892 to 1894. The survey party covered territory from Fort Worth, Texas, to San Diego, California, along the present border of the United States and Mexico. Mearns states that the streams along the route were lined with trees, including Fremont cottonwood, black willow, box elder, walnut, sycamore, oak, mulberry, and ash (Mearns 1907). He described cottonwood and willow as associated with every permanent stream, bordered with a broad zone of mesquite (1907 261:32-35d). Mearns estimated that about 160,000 to 180,000 hectares of riparian vegetation covered the Lower Colorado River flood plain between Fort Mojave and Fort Yuma (Rosenberg and others 1991:21).

In 1910, over a period of three months, ornithologist Joseph Grinnell surveyed the Colorado River from Needles, California, to Yuma, Arizona. During the expedition, Grinnell systematically collected and studied the plants and animals of the Lower Colorado Basin. The party collected 1,374 bird specimens, along with large numbers of other vertebrates (Grinnell 1914:52). Grinnell described cottonwood and willow as the dominant vegetation in the flood plain adjacent to the river, while the higher terrace was predominantly covered with mesquite and "salt-bush" (1914:60-61). He observed that the river landscape continually changed as floodwaters cut new channels and cleared areas of vegetation. New sediment was continually deposited on the inside curve of the river. Trees tended to grow in a successive pattern. The youngest cottonwoods and willows growing nearest to the water's edge, progressively older and taller trees growing away from the river.

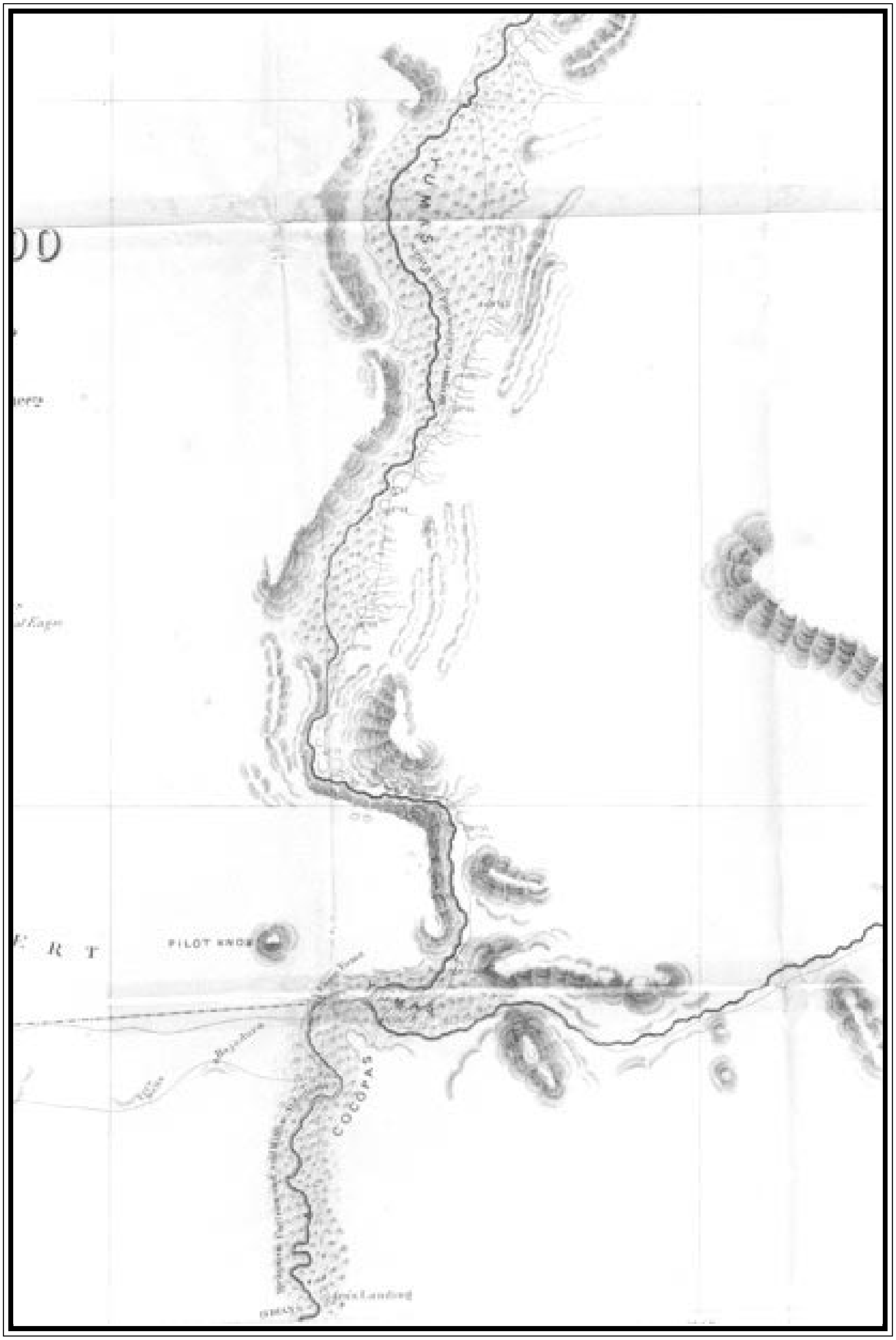

Figure 4-1. Lower portion of the Colorado River with large areas of mesquite, cottonwood, and willow represented. Map made from information collected during 1851 Sitgreaves expedition (Sitgreaves 1853).

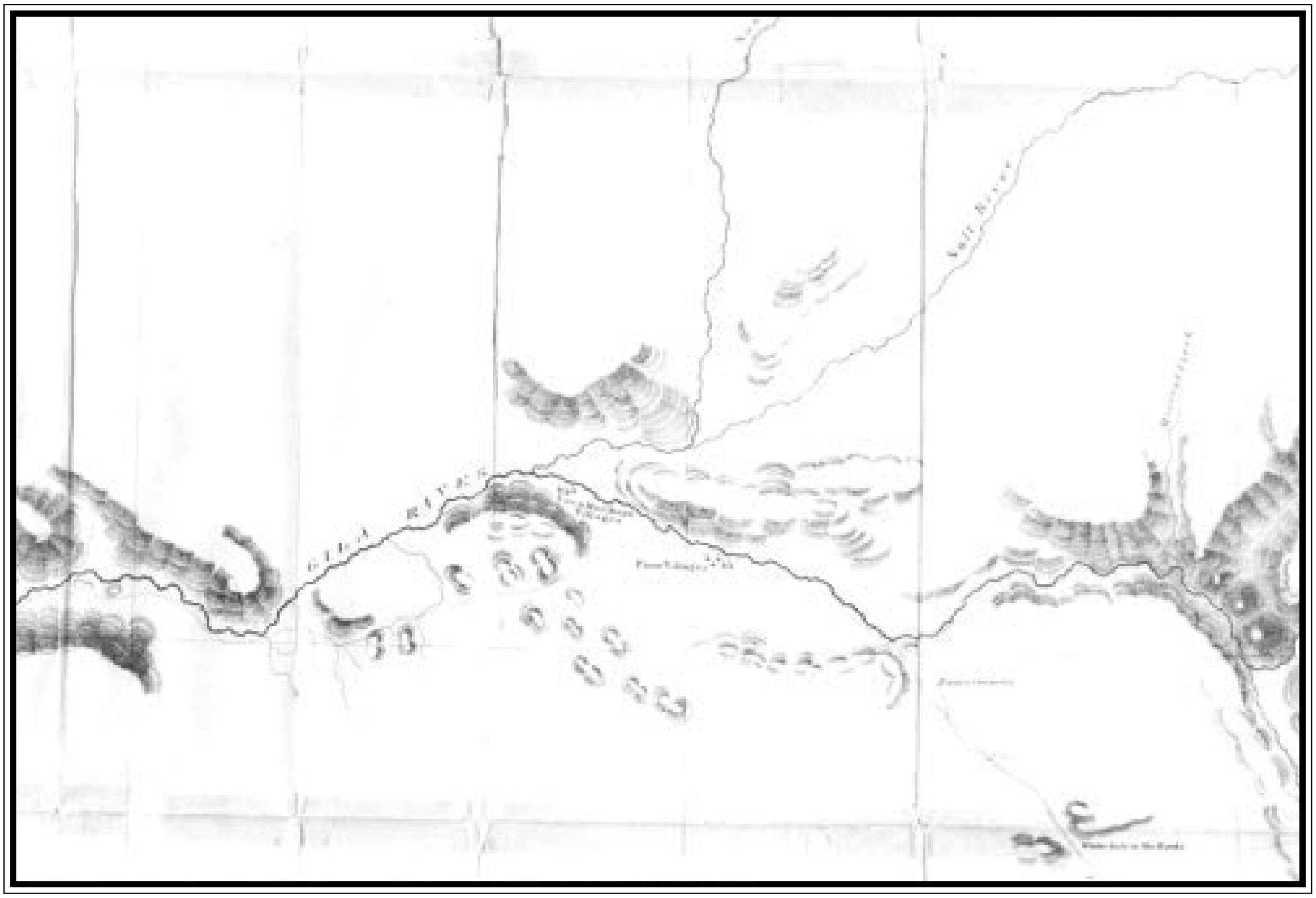

Figure 4-2. Middle portion of Gila River. Map made from information collected during 1851 Sitgreaves expedition (Sitgreaves 1853).

Grinnell also described the effects of Laguna Dam, which was completed in 1909, as already altering large areas of the Lower Colorado River landscape by 1910. The vegetation growing along a ten-mile stretch of the river had been decimated by rising water levels, while a prodigious amount of sediment was deposited over the flood plain. As water subsided, the original riparian vegetation was replaced by "vast mudflats growing arrowweed. All of this change, of course, involved the birds and mammals of the area affected, in addition to the plant life" (Grinnell 1914:61-62).

Grinnell observed and collected Willow Flycatchers (*Empidonax traillii*) during the 1910 survey, referring to the species as the "Traill Flycatcher" (Grinnell 1914). He first spotted several of the birds on the California side of the Colorado River and again sighted Willow Flycatchers five miles northeast of Yuma. Grinnell states that, "On both sides of the river in the vicinity of Pilot Knob the species [*Empidonax traillii*] was frequently observed" and that, "The birds were never detected away from dense willow growths close to water" (1914:151).

In California, Grinnell described "Western Traill Flycatchers" (*Empidonax traillii*) as being present in riparian ecosystems throughout the length the state, east and west of the Sierras." He stated that the birds "avoid in major part forested areas including north-west coast belt, the open deserts, and the higher mountains...this flycatcher exists in summer time practically wherever its special habitat exists" (Grinnell and Miller 1944:256). At that time, *traillii* could be found within the "Lower and Upper Sonoran zones, Transition [zones], and even Canadian [zones]. Altitudes of known nestings extend from within a hundred feet of sea level, for example at Alviso and Palo Alto, Santa Clara County, up to at least 8,000 feet, in the neighborhood of Mammoth, Mono County" (1944:256). The Flycatchers were primarily restricted to willow thickets, "along streams in broad valleys, in canyon bottoms, around mountain-side seepages, or at the margins of ponds or lakes" (1944:257).

In a 1908 study that focused on the San Jacinto Mountains of southern California, Grinnell and Swarth described *Empidonax traillii* as only occurring

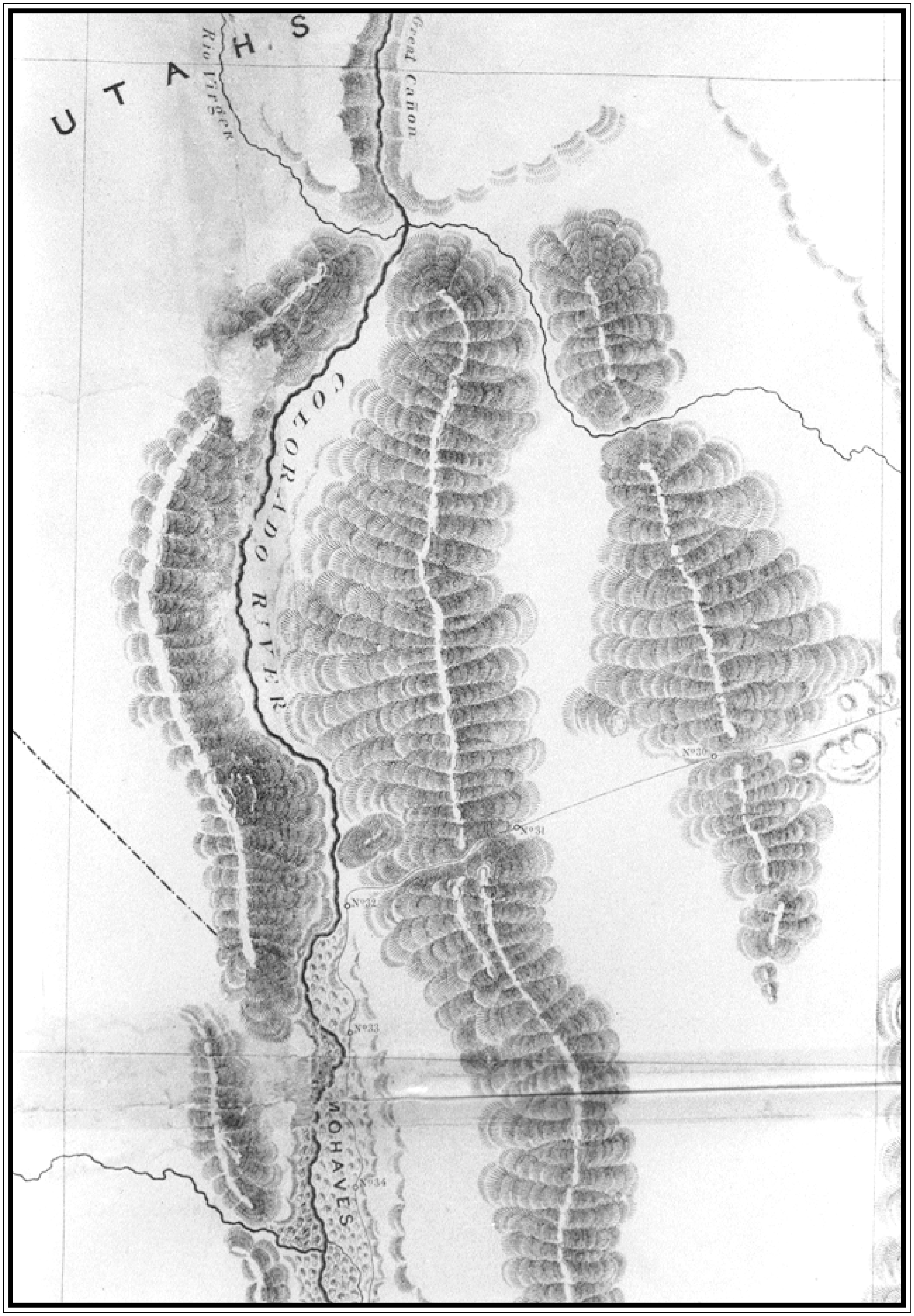

Figure 4-3. Colorado River along Arizona, California, and Nevada boundaries. Confluence of the Virgin River and the Colorado is show in upper portion of map (Sitgreaves 1853).

Figure 4-4. Riparian habitat at the head of the Conejos River in south central Colorado. Photo taken during Wheeler railroad surveys of the 1870s (Wheeler 1878).

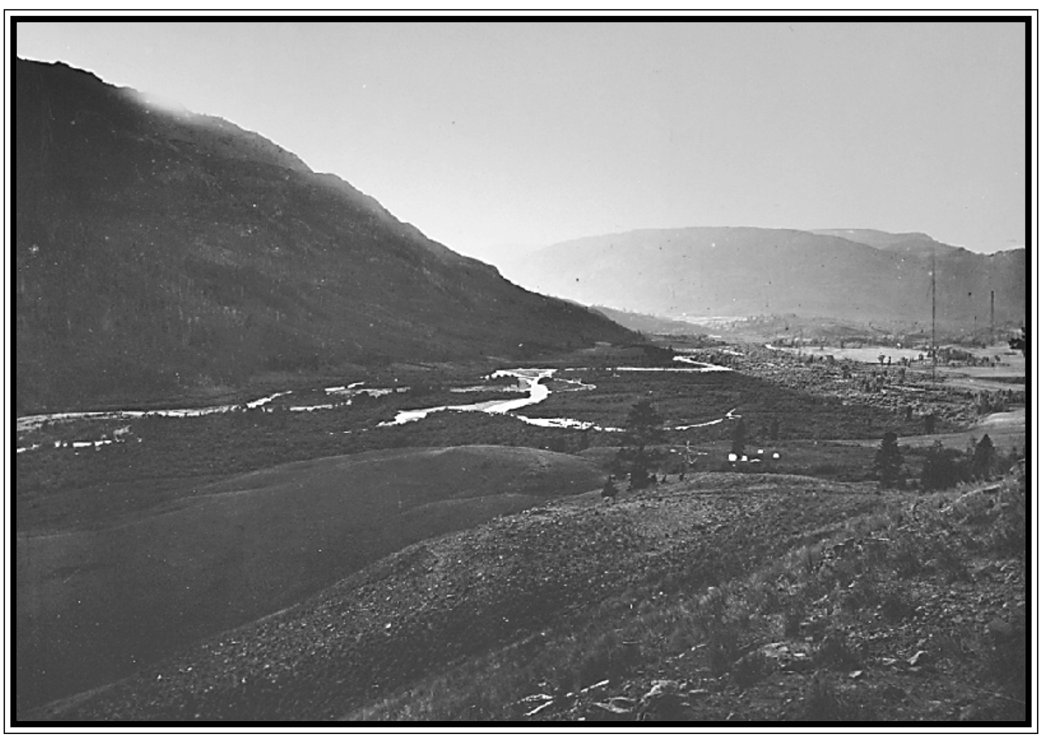

Figure 4-5. Braided stream and riparian habitat along the Conejos River in south central Colorado. Photo taken during Wheeler railroad surveys of the 1870s (Wheeler 1878).

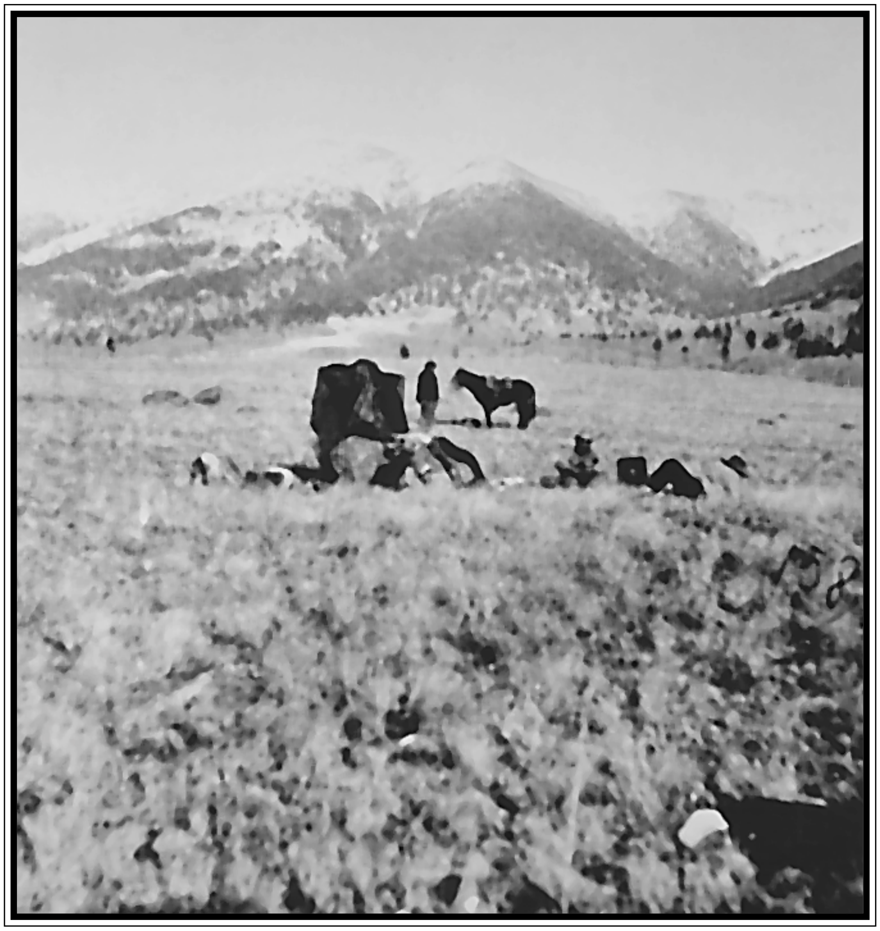

Figure 4-6. Base of the San Francisco Mountains in Arizona with Wheeler survey party and photographic equipment in the foreground (Wheeler 1878).

on the desert side of the mountain range during spring and in late summer moving to other locations in the San Jacinto area (Grinnell and Swarth 1913). Their group collected *traillii*, which appear to have been abundant, at Cabezon and Dos Palmos. The birds were found in thickets of desert willow at Carrizo Creek and Palm Canon and in other areas up to 3,000 feet above sea level. Grinnell and Swarth collected 19 *traillii* specimens during the survey (1913:256). Additionally, Grinnell and Kellogg each mention *Empidonax traillii* as occurring in the Trinity region of northern California (Grinnell 1916:404; Kellogg 1916:382).

Euro-American Impacts on Southwestern Riparian Ecosystems

Beginning with Coronado's *entrada* (1540 to 1542), native cultures began to change. Throughout the world, European contact with indigenous societies has disrupted native cultures in a number of ways (Ferguson 1992a and b). Coronado's expedition likely effected environmental change by pressuring Puebloan groups to produce food and fuel for his soldiers (thereby putting additional pressure on flood plain resources) and by introducing metal tools with which native people could more effectively clear trees (Wozniak 1995). European contact with Native Americans also introduced previously unknown diseases into a native population with no immunity to European illness. This caused a vast decline in population and a disruption of the cultural and economic activities focused on resource production (Ramenofsky 1987), such as burning undergrowth, harvesting native plants, producing crops, and managing water, all of which would have affected vegetational patterns.

By 1598, Spanish settlement affected environmental change on a large scale. Spanish colonists introduced domesticated livestock, intensive ditch and flood irrigation, a plethora of European plants, use of metal tools, and the plow. This resulted in tremendous changes in water systems, the clearing of larger tracts of land, grazing pressures, and the expansion of nonnative plants (Scurlock 1998:105-119).

Fur trappers were some of the first Americans to affect Southwestern riparian areas primarily by trapping beaver. Trappers often traveled in groups, or "brigades," that would trap *all* of the beaver from a drainage before moving on to the next river system (Vandiveer 1971; Ross 1956; Karamanski 1983; Chittenden 1935). The destruction of beaver dams likely resulted in a narrowing of riparian areas due to less water retention in certain drainages. This caused a change in riparian vegetation. The clearing and regeneration pattern would have been less dynamic.

By the time of the first major cattle drives from Texas to the California gold fields in 1850, there were already indications of overgrazing in the Southwest. Hispanic ranchers were raising tens of thousands of sheep and cattle, along with goats and horses (Raish 1995; Scurlock 1988; Scurlock 1998). Texan cattlemen established two major routes from west Texas to California: one trail crossed New Mexico near Albuquerque and then proceeded west across Arizona to Los Angeles; the other cattle trail passed along the region of what is now the Mexican-American border through southeastern New Mexico, to Tucson, then to San Diego. Despite the fact that this enterprise was only marginally successful, due to the extremely long distances and shortages of grass and water (Beck and Haase 1989:29-30), the cattle drives had significant effects on those areas through which they passed (Emory 1857).

During the 1870s and 1880s, numbers of cattle and sheep grew dramatically in the Southwest. Anglo-American ranchers accumulated vast herds numbering in the millions, and the ecological conditions of rangeland and riparian areas worsened. Native American herds grew and had a lasting effect on the lands as well (Scurlock 1998:96-97). Topsoil stripped of vegetation eroded with wind and runoff, which increased stream sediment and the down cutting of streams (see Abruzzi 1995; Scurlock 1988 and 1998; Tellman and others 1997; Widdison 1959; Wilson 1988; Wozniak 1995).

Timber cutting also significantly altered the river bottoms of the Southwest. Cottonwood was cut for steamboat fuel along the Colorado, while pine and other soft woods were removed from mountain ranges (Rosenberg and others 1991). Around the perimeters of settlements such as Albuquerque, firewood had become scarce by the time the American military arrived during the late 1840s (Emory 1848; Rosenberg and others 1991; Whipple 1856; Wislizenus 1848; Sitgreaves 1853). Removal of tree-cover resulted in increased runoff, and subsequently high sediment loads.

The arrival of the railroads during the late 1870s and early 1880s brought new settlers, resulting in the expansion of urban areas. This greatly increased the amount of river land under cultivation (Wozniak 1995). With the railroads, ranchers were able to ship their cattle and sheep to eastern markets. These new transportation systems facilitated the availability of an increased number of industrial and agricultural technologies, thus allowing the development of even more arable land, an increase in the number of sawmills, and other industrial enterprises (Hess 1992; Worster 1993).

Since the 1890s, numerous rivers and streams in the Southwest have been dammed, pushed between levies, and diverted to satisfy the ever-increasing demands of urban landscaping, industry, drinking water, and irrigation. Agricultural lands replaced cottonwood-willow habitat, and although the numbers of range stock have decreased, riparian areas continue to be impacted by cattle grazing. Additionally, nonnative plants such as salt cedar and Russian olive, after their introduction early in the twentieth century, began out-competing native riparian vegetation, in part due to altered hydrological regimes (Scurlock 1998; Tellman 1997).

Discussion

This chapter provides a sketch of a vast and complex historical and ecological topic. The dynamic climatic, vegetational, and human history of the Southwest demonstrates the remarkable changeability of its environment. Riparian habitats in the Southwest are not now, nor have they ever been, in a state of equilibrium (Swetnam and others 1999:1201). These dynamics of change include long-term climatic variation and human-environmental interaction. While climatic variation, drought, and periodic flooding continually have changed drainage and vegetation patterns, humans also have manipulated Southwestern ecosystems since the end of the Ice Age.

Archaeological research shows that not only were riparian species used for food and medicinal purposes, but also that certain southwestern drainages were virtually stripped bare of trees by prehistoric horticulturists. Large areas were cleared for agriculture and riparian vegetation was used for construction and firewood (LeBlanc 1985). The archaeological record contains riparian-related macroremains and pollen, however many archaeological investigations have not focused on overall anthropogenic environmental effects. Although the presence of willow and cattail pollen in archaeological sites does not provide an indication of past riparian conditions, such evidence does demonstrate that humans utilized the resources available in these streamside ecosystems. Long-term burning, pruning, and planting of riparian vegetation by native peoples likely helped to create current conditions, and knowledge of their techniques may in fact present a model for future restoration efforts (Anderson 1999). Further review of the ethnographic record can provide a wealth of information about past Native American land use.

Historical observations made by explorers and biologists shows that the Willow Flycatcher was locally common in the cottonwood-willow habitats of the southwest in the 1800s. The first-hand observations discussed here were made by a few individuals traveling along primary routes, and therefore provide only a sample image of past riparian conditions. The ability to draw conclusions about the extent of riparian vegetation and the distribution of Willow Flycatchers could be enhanced by further review of archival material at the state, county, and community level.

It is necessary to discuss the broad spectrum of historical conditions of riparian systems in the Southwest. Conducting environmental history requires an interdisciplinary approach incorporating the expertise of multiple scientific and humanistic fields (Worster 1993:156). Ecosystem conditions of the recent and distant past need to be evaluated using a variety of information sources (e.g., paleobotany, geomorphology, as well as local historical documents). Additionally, local historical societies, family journals, legal documents, and photographs could be significant sources in developing a local-level environmental history of riparian ecosystem conditions for specific project areas.

Managing Willow Flycatcher habitat is ecologically and socially complex and challenging. An ecosystem must be studied and evaluated prior to the establishment of appropriate target conditions and objectives concerning the restoration of various components (Dahm et al. 1995:225). Managing riparian ecosystems (i.e., re-establishing Willow Flycatcher habitat), requires clear understanding of the ecological complexity and linkages between biotic communities and the abiotic environment, recognition of the dynamic character of ecosystems, and knowledge of humans as ecosystem components (Christensen and others 1996:669-670). These ecological factors need to be understood at the local and regional scale and temporally over the short- and long-term (Swetnam and others 1999:1190). The so-called "range of historical variability" for the Southwest has been quite broad. Considering the dynamic nature of Southwestern landscapes, it would be misguided to designate a specific point in time from which to establish a desired future condition for riparian restoration (Swetnam and others 1999:1201; Sprugel 1991).

Having knowledge of all the dynamic forces that helped to shape riparian habitat will give decision-makers a greater range of opportunities and options when considering the management and reestablishment of cottonwood-willow vegetation. Understanding these changes in riparian ecosystem conditions, and dynamics behind them, can provide an invaluable perspective that applies to the re-establishment and management of Southwestern Willow Flycatcher habitat within the limits of modern human social and resource demands.

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Appendix A

WHEELER SURVEY BIRD DATA (Henshaw 1875)

The following lists only those species that are referred to as "Flycatcher" by Henshaw.

Ash-throated Flycatcher (*Myiarchus cinerascens*)

Where Collected	Survey Year	Number of Birds
Fort Wingate, AZ	1873	3
Inscription Rock, NM	1873	1
Camp Apache, AZ	1874	2
Camp Bowie, AZ	1874	1
Camp Crittenden, AZ	1874	1

Notes

"Having a distribution nearly coincident with that of the preceding species, though extending somewhat farther to the north into Utah, Nevada, and Colorado. It is less abundant than the preceding [Cassin's], and inhabits much the same style of country, affecting rough, rocky country sparsely wooded, or the brushy creek bottoms, even extending its range out to a considerable distance on the dry plains" (Henshaw 1875:345-346).

Recorded as the **Yellow-bellied Flycatcher** (*Myiodynastes luteiventris*), now known as the **Sulphur-bellied Flycatcher**

Where Collected	Survey Year	Number of Birds
Chiricahua Mountains, AZ	1874	5

Notes

"This peculiar flycatcher appears to be a summer resident of the Chiricahua Mountains, Southern Arizona, were I obtained a pair of old birds, together with three young . . ." (Henshaw 1875:346-347).

Olive-sided Flycatcher (*Contopus borealis*)

Where Collected	Survey Year	Number of Birds
Nevada	1871	1
Near Ft. Garland, CO	1873	5
Rio Grande, CO	1873	2
Camp Apache, AZ	1873	2
Willow Springs, AZ	1874	1
Indian Valley, CO	1874	1
Bowie Agency, AZ	1874	2
Trinchara Creek, CO	1874	1
Conejos River, CO	1874	1
Mount Graham, AZ	1874	2
Black River, AZ	1874	1

Notes

"The Olive-sided Flycatcher appears to be much more abundant through the West generally than at the East, and in parts of Utah and Colorado has been found by our parties in considerable numbers. It is a highly characteristic bird of the pine region, ranging from about 7,000 feet up to timber line."

"We found it almost as numerous in Eastern Arizona, quite far to the south, as in Colorado; but I supposed that it was only thus present during the migrations. The past season [1873], however, specimens were taken near Camp Apache in July, which doubtless were breeding, and later, about the middle of August, young and old were secured near Camp Bowie, within one hundred miles of Mexico. Its replacement, therefore, in this region by *Contopus pertinax* would appear to be only partial, and the two breed in the same districts." (Henshaw 1875:350-351).

Little Flycatcher (*Empidonax trailli*, var. *Extimus*)

Where Collected	Survey Year	Number of Birds
Humboldt River, NV	1871	1
Provo, UT	1872	23
Wahsatch Mountains, UT	1872	1
Fort Garland, CO	1873	5
White Mountains, AZ	1873	1
Camp Apache, AZ	1873	1
Near Camp Apache, AZ	1873	2
Pueblo, CO	1874	1
Camp Bowie, AZ	1874	4

Fort Garland, AZ	1874	1
Camp Crittenden, AZ	1874	1
Pagosa, CO	1874	1

Notes

“Exceedingly numerous near Provo River in willow thickets; sparingly so in Eastern Nevada. Very quick and nervous in its movements, constantly crossing and recrossing the river and catching insects…. Colorado, New Mexico, and Arizona are all included in the range of this flycatcher; its abundance being dependent upon the presence or absence of its favorite grounds…. Wherever willows are found growing in small clumps or fringing the stream, this flycatcher is almost certain to be found common, and it is rarely seen in the summer in other situations. Its habits and notes appear to be identical with those of its eastern analogue, from which it differs mainly in its paler coloration. The nest is placed in the upright fork of a bush or sapling a few feet from the ground, and is composed of grasses and fibrous material, rather loosely woven together, and lined with fine grasses. Its general appearance is much like that of the nest of the Yellow Warbler, *D. aestiva*, but it is not nearly so compact nor artistic.” (Henshaw 1875:356-358).

Least Flycatcher (*Empidonax minimus*)

Where Collected	Survey Year	Number of Birds
Denver, CO	1873	1

Henshaw’s notes state that the habitat and behavior of this bird are much like that of *Empidonax trailli* (Henshaw 1875:358-359).

Recorded as the **Western Yellow-bellied Flycatcher** (*Empidonax flaviventris*, var. *Difficilis*), now known as the **Cordilleran Flycatcher** (*Empidonax occidentalis*)

Where Collected	Survey Year	Number of Birds
Rio Grande, CO	1873	1
Fort Wingate, NM	1873	1
Inscription Rock, NM	1873	1
Willow Springs, AZ	1874	2
Mount Graham, AZ	1874	1
Camp Bowie, AZ	1874	1

Henshaw’s notes state that the habitat and behavior of this bird are much like that of *Empidonax trailli*(Henshaw 1875:359-360).

Wright’s Flycatcher (*Empidonax obscurus*)

Where Collected	Survey Year	Number of Birds
Bull Run, NV	1871	2
Provo, UT	1872	1
Snake Creek, NV	1872	1
Denver, CO	1873	2
Fort Wingate, NM	1873	1
Inscription Rock, NM	1873	1
Camp Apache, AZ	1873	3
South of Camp Apache, AZ	1873	2
Santa Fe, NM	1874	2
Camp Bowie, AZ	1874	2
Fort Garland, CO	1874	3

Henshaw’s notes state that the habitat and behavior of this bird are much like that of *Empidonax traillii* (Henshaw 1875:360-361).

Hammond’s Flycatcher (*Empidonax Hammondi*)

Where Collected	Survey Year	Number of Birds
Beaver, UT	1872	1
Cedar, UT	1872	1
Rio Grande, NM	1873	1
Camp Apache, AZ	1873	5
Gila River, AZ	1873	4
Fort Bayard, NM	1873	1
Navajo Creek, NM	1874	1
Mount Graham, AZ	1874	6
Gila River, AZ	1874	1

Henshaw's notes state that the habitat and behavior of this bird are much like that of *Empidonax trailli* (Henshaw 1875:362-363).

Buff-breasted Least Flycatcher (*Mitrephorus fluvifrons*, var. *Pallescens*)

Where Collected	Survey Year	Number of Birds
Inscription Rock, NM	1873	5
Camp Apache, AZ	1873	1
Bowie Agency, AZ	1874	1

Notes

Little noted for this bird (Henshaw 1875:364).

Red Flycatcher (*Pyrocephalus rubineus*, var. *Mexicanus*)

Where Collected	Survey Year	Number of Birds
Pueblo Viejo, AZ	1873	1
Sonoita Valley, AZ	1874	3
Camp Lowell, AZ	1874	4
Gila River, AZ	1874	1

Notes

Little noted for this bird (Henshaw 1875:365).