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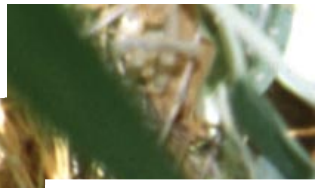

Abstract

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Numbers of brown-headed cowbirds (*Molothrus ater*) are increasing in some regions of North America, while certain populations of long-distance, neotropical migratory songbirds (NTMs) are declining. In the Southwestern United States, several species of NTMs nest only in riparian habitats. The significant decline of two species of NTMs dependent upon riparian habitat, the southwestern willow flycatcher (*Empidonax traillii extimus*) and the least Bell's vireo *(Vireo bellii pusillus*), is of great concern. Brood parasitism by the brown-headed cowbird and loss of riparian habitat may be the primary causes of the decline of these populations. Extant data on the distribution, abundance, density, and rates of parasitism of the brown-headed cowbird in New Mexico have not been synthesized and interpreted. Our goal was to collect and review existing data on the brown-headed cowbird in New Mexico, compare them to data from adjacent western states, and interpret the findings. We hypothesized that increased human use of riparian habitats in New Mexico had resulted in increased abundance of brown-headed cowbirds and their parasitism on riparian-dependent NTMs. Our results suggest that quantitative studies should be conducted to determine the distribution, abundance, density, and rates of parasitism of brown-headed cowbirds in New Mexico's riparian habitats because existing data are inadequate. Results of such studies will allow conclusions to be made about the multiplicative effects of riparian habitat use and modification by human activities on cowbird and rare NTM populations.

Keywords: brood parasitism, brown-headed cowbird, *Empidonax traillii extimus*, *Molothrus ater*, neotropical migratory songbirds, Rio Grande, riparian, southwestern willow flycatcher

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Cover photos (left-right): Brown-headed cowbirds, Middle Rio Grande (slide collection of Deborah Finch); blue grosbeak nest with 3 cowbird eggs (speckled) and 4 grosbeak eggs found at Rio Grande Nature Center, Albuquerque, NM (photo by Wang Yong); male blue grosbeak captured at mist-net station, Rio Grande Nature Center, NM (photo by Wang Yong).

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Sara H. Schweitzer, Deborah M. Finch, and David M. Leslie, Jr.

Contents

Introduction

Numbers of brown-headed cowbirds (*Molothrus ater*) are increasing in some regions, while certain populations of long-distance, neotropical migratory songbirds (NTMs) and other nonmigratory birds are declining. In the Southwestern United States, several species of NTMs nest only in riparian habitats (Saab et al. 1995). Factors that contribute to the decline in populations of these songbirds include fragmentation, degradation, and destruction of nesting habitat. These changes to the nesting habitat of NTMs can benefit the brown-headed cowbird, a brood parasite. The cowbird's habit of laying its eggs in nests of other species can decrease the productivity of host species significantly. Increases in the brown-headed cowbird population in certain regions of the Southwest have been attributed to human activities that caused riparian habitat loss and degradation.

The significant decline of two NTM species dependent upon riparian habitat, the southwestern willow flycatcher (*Empidonax traillii extimus*) and the least Bell's vireo (*Vireo bellii pusillus*), is of great concern. Both species are federally and state listed as endangered (State Game Commission 1990, USFWS 1995). Brood parasitism by the brown-headed cowbird and loss of riparian habitat have been cited as the primary causes of the decline of these populations (USFWS 1995). This review synthesizes the available information on brown-headed cowbird populations and uses of riparian habitat in New Mexico. Data from studies conducted throughout the West and Southwest were incorporated as examples and references where there were little or no data from New Mexico.

The objective of this review was to summarize existing data and narratives from studies in New Mexico on:

- riparian communities and activities that have affected them;
- distribution and abundance of populations of brown-headed cowbirds and NTMs using riparian habitat for nesting;
- rates of parasitism by cowbirds on NTMs; and
- nest success of NTMs with parasitized and unparasitized nests.

Methods

Our review focused on riparian habitats associated with the following major river basins within New Mexico: the Rio Grande, San Juan, Pecos, Gila, and Canadian. An extensive literature search and data synthesis were conducted on these areas in New Mexico and other Southwestern states (Arizona, southeastern California, and southwestern Texas). Topics reviewed included: riparian community ecology, passerine bird species associated with riparian habitat, human use of riparian habitats (past and present), and effects of these uses on bird species. The goal of this synthesis was to provide a single-source reference of historical review and present conditions of these communities in New Mexico. Special emphasis was placed on the response of the brown-headed cowbird to changes in riparian communities in New Mexico. Review of scientific journals, communication with subject experts, and computer searches of abstracted and indexed literature provided the majority of the material.

Riparian Habitats

Community Description

Riparian communities in New Mexico, as elsewhere, occur in or adjacent to a drainage and/or its floodplain and are characterized by species and/or life forms different from those of the immediately surrounding communities (Lowe 1964, Brown et al. 1977). These riparian communities are characterized by broad-leaved, winter-deciduous phreatophytic trees (Gaines 1980). Brown et al. (1977), in their delineation of riparian communities, described them as "composed either of constituents peculiar to the riparian situation, or an extension of a higher, climax association fingering downward into the drainage way." A riparian area may be <1 m wide adjacent to a steeply banked river or >1 km wide along lowland streams and rivers (Deusen and Adams 1989). Because riparian habitats are associated with linear waterways, they are ecotonal with high ratios of edge to surface area (Kauffman and Krueger 1984).

The most extensive riparian vegetation in New Mexico is associated with intermittent streams and rivers that drain the precipitation from mountains (Dick-Peddie 1993). These vegetative communities evolved to recolonize rapidly because occasional flooding could scour all vegetation including mature trees (Dick-Peddie 1993). Adaptive mechanisms of riparian plants vary from prolific seed production, to efficient dispersal, to efficient and rapid vegetative reproduction.

Dick-Peddie (1993) classified riparian habitats of New Mexico into four groups:

1. Mature montane riparian vegetation, which often takes the form of a closed-canopy or gallery forest.

The closed canopy greatly reduces soil temperature during the growing season and increases available soil moisture. Mature trees resist all but the most extreme scouring by floodwaters and thereby reduce erosion, contain channel banks, and retard nutrient loss (Dick-Peddie 1993).

2. Floodplain-plain riparian vegetation, which is typically found on older, meandering river systems where there are extensive floodplains (e.g., the Rio Grande).
3. Arroyo riparian vegetation, which occupies drainages that dissect bajadas and mesas of New Mexico (Dick-Peddie 1993).
4. Closed basin-playa-alkali sink riparian habitats, which are internally drained depressions in varied watershed sizes. These communities are usually broad, flat, or gently sloping areas where water tends to spread. Water moves slowly after light rains and tends to evaporate, producing an increase in salinity. Dense stands of native fourwing saltbush (*Atriplex canescens*) are common in closed basins.

The studies herein were conducted primarily on floodplain-plain riparian vegetation.

Importance of Riparian Habitat to Birds

Riparian habitats constitute only about 1% of the landscape in the Southwest (Knopf et al. 1988, Ohmart 1994), but they support greater wildlife diversity and abundance than most other community types (Deusen and Adams 1989, Dick-Peddie 1993, Ohmart 1994, Thompson et al. 1994). More than 60% of vertebrates found in riparian habitats of the Southwest are obligates (Ohmart and Anderson 1982). The San Juan and Gila River Valleys of New Mexico are extremely rich in avian species. Hubbard (1977) believed that 16-17% of the breeding bird species of temperate North America nest in these valleys. About 40% of the 94 bird species known to breed in riparian areas of the Southwestern United States nest in riparian habitats of the Rio Grande (Schmidly and Ditton 1979).

Studies in Arizona and California found that riparian habitats of cottonwood-willow (*Populus-Salix* spp.) supported more nesting bird species than any other vegetation type (Ingles 1950, Brown et al. 1977). Cottonwood-willow forests provide a stratified foliage profile and, when mature, a habitat niche for a shade-tolerant understory of younger or smaller trees, shrubs, vines, and forbs (Gaines 1980). Habitat diversity and species richness are greater in riparian areas than in surrounding habitats because the composition of vegetation tends to be independent of the upland vegetation.

Many researchers have noted that populations of several NTMs have declined over the last 25 years (Robbins et al. 1989, Terborgh 1989, Askins et al. 1990, Finch 1991, Petit et al. 1995). In the Southwest, NTMs frequently select riparian habitat for nesting sites (Carothers et al. 1974, Ohmart 1994). Hubbard (1977) estimated that 25% of breeding avifauna in the Gila and San Juan River Valleys of New Mexico was restricted to riparian habitat. Ten of 32 avian species listed as endangered by the New Mexico Department of Game and Fish (State Game Commission 1990) depend on riparian habitat for breeding and/or feeding sites, and four of these are NTMs. Throughout the Southwest, lowland desert riparian habitats support a disproportionate number of rare and endangered bird species (Johnson et al. 1987).

Human Alterations to Riparian Habitats

In 1979, Schmidly and Ditton stated, "exploitation by man has greatly altered the riparian habitats of the Southwest, and, in the last 100 years, the rate of alteration has increased significantly." More than 15 years have passed since this statement was made and concern for New Mexico's riparian communities has increased (Crawford et al. 1993).

Johnson and Jehl (1994) estimated that "95% of riparian woodland, the richest ecologic formation for nesting birds in western North America, has either been degraded or destroyed in the past century by water management, agriculture, and domestic livestock grazing." They stated that domestic livestock grazing was the most pervasive threat to riparian habitats and their avifauna and implicated nest parasitism by brown-headed cowbirds as causing population declines in several riparian-nesting bird species. Degradation or destruction of riparian habitats and an increase in abundance of cowbirds are synergistic. Cowbirds are "edge" species (O'Conner and Faaborg 1992) that benefit from increased access to passerine nests in fragmented riparian woodland, insects and waste grain from agricultural fields, and grazing livestock in and adjacent to riparian habitat (Rothstein 1994).

Riparian habitats benefit human populations by providing water, rich soils for agriculture, lush forage for domestic livestock, recreational opportunities, and home sites (Ohmart and Anderson 1986). Because of these benefits, human activities have altered riparian habitats for centuries (Deusen and Adams 1989, Rothstein 1994). Since the late 1800s, however, alterations to riparian habitats in the Southwest have been on larger spatial and shorter temporal scales than those implemented earlier by American Indian and Spanish inhabitants (Rosenberg et al. 1991). Many native plant and animal species have not been able to withstand these recent, extreme changes to their environment (Dick-Peddie 1993).

The riparian forest habitats of New Mexico are experiencing increased impacts from the demands of a growing

human population. Loss of riparian habitat could result in loss of about 46% of bird species breeding in the San Juan Valley (Schmitt 1976) and about 49% of bird species breeding in the Gila River Valley (Hubbard 1971). The Middle Rio Grande (MRG) Biological Interagency Team completed the Bosque Biological Management Plan in 1993 (Crawford et al. 1993) to mitigate stresses experienced by the MRG riparian ecosystem. This plan recognized the need to avoid fragmentation of riparian forests and to enhance cottonwood communities.

Effects of Human Settlement

Plants and animals in riparian habitats were used by the local populations of American Indians and Spaniards. There was little change in the vegetation along the lower Rio Grande between 1582 and 1846, but by the late 1800s to early 1900s most of the gallery forests of cottonwoods had been removed for agriculture, building material, livestock forage, and fuel (Engel-Wilson and Ohmart 1979). Old settlements have now become urban centers (e.g., Albuquerque), and demands on riverine resources have increased significantly. In response, reservoirs have been created to provide drinking and irrigation water, and remaining riparian woodlands have been cleared for agricultural and urban development. More than 2,800 ha of wetlands of the Middle Rio Grande ecosystem have been drained for agriculture and development (Funk 1993).

The consequences of human population growth on riparian resources are similar throughout the Southwest. Concern about damage to river hydrology and the native riparian ecosystem from dam construction (e.g., Davis Dam, Glen Canyon Dam) on the Colorado River (Carothers et al. 1974) was the impetus for several avian research projects within riparian habitats of the lower Colorado River. Results from these studies indicated that species composition and structural complexity of riparian vegetation (vertical and horizontal) strongly influenced abundance and richness of avian species. Anderson and Ohmart (1977) assessed the importance of vegetative structure to bird populations relative to spatial and temporal dimensions in the riparian environment of the lower Colorado River. Carothers et al. (1974) found greater numbers of bird species and total populations of nesting birds in homogeneous cottonwood stands along the Verde River, Arizona, than in mixed deciduous areas along its tributaries. Their findings demonstrated the importance of spatial diversity among habitats and foliar height diversity within habitats to bird species diversity and riparian community structure.

Woody riparian vegetation has increased down river of the Glen Canyon Dam on the Colorado River in Arizona because natural, annual scouring flows no longer occur (Carothers and Sharber 1976, Brown and Johnson 1985). This new habitat provides nesting sites for riparian breeding birds where none existed previously. Carothers and Sharber (1976) found that summer resident bird species were restricted almost exclusively to the narrow belt of riparian vegetation along the Colorado River.

The Amistad Dam on the lower Rio Grande caused the loss of the original shoreline and its riparian vegetation (Schmidly and Ditton 1979). This habitat alteration affected bird populations that used the riparian vegetation for nesting, foraging, roosting, and cover during migration.

The floodplain-plains riparian community of New Mexico has suffered greatly from human activities (Dick-Peddie 1993, deBuys 1993). Cottonwood and willow regeneration is minimal. Exotic species, notably saltcedar (*Tamarix* spp.) and Russian olive (*Elaeagnus angustifolia*), are increasing, and dumping, arson, and vandalism from adjacent urban dwellers are frequent (Dick-Peddie 1993, deBuys 1993).

The introduction and spread of exotic plant species, such as saltcedar, throughout the Southwest have affected plant species composition, richness, and diversity in riparian communities. Saltcedar has replaced native cottonwood and willow trees at many places along the lower Rio Grande (Schmidly and Ditton 1979). Virtually no cottonwood gallery forests remain between El Paso and Presidio, Texas, on the lower Rio Grande. Only a few isolated cottonwoods remain along ditches or canals apart from tall, dense saltcedar forests (Schmidly and Ditton 1979).

Between 1967 and 1971, about 21,600 ha of riparian vegetation were removed along the Pecos River (Ohmart and Anderson 1986). This vegetation had roots in perennial ground water or in the capillary fringe above a water table (phreatophytic). Because most of these species transpired large quantities of water, managers believed that water would be saved if the species were removed. However, results from studies along the Pecos River suggest that an insignificant amount of water is saved if phreatophytes are removed (Ohmart and Anderson 1986).

Along the lower Rio and Pecos River, passerine species used saltcedar more than they did in the lower Colorado River system (Hunter et al. 1988). This suggests that native avifauna can adapt to and benefit from introduced plant species in some areas.

Alluvial riparian floodplains have been converted to agricultural fields primarily along larger rivers (Ohmart 1994), and water has been provided to the entire floodplain via irrigation canals and ditches. Impacts of such agricultural practices on bird populations are diverse. Densities of some bird species increase in the presence of agricultural land because they use crops as a food source (Carothers et al. 1974, Anderson et al. 1984). In Arizona, where cultivated fields were adjacent to riparian habitat, Anderson et al. (1984) found that when resources in other areas were scarce, the interface accommodated large densities of

birds such as the mourning dove (*Zenaida macroura*), Gambel's quail (*Callipepla gambelii*), white-crowned sparrow (*Zonotrichia leucophrys*), and loggerhead shrike (*Lanius ludovicianus*). Thus, Anderson et al. (1984) concluded that interface habitat was important in maintaining avian populations that normally inhabit riparian areas or migrate into the lower Colorado Valley. Rosenberg et al. (1991) suggested that significant increases in populations of species associated with agricultural fields created from alluvial riparian floodplains (e.g., cowbirds, European starlings [*Sturnus vulgaris*], and house sparrows [*Passer domesticus*]) may have adverse effects on populations of sensitive avian species. Also, most croplands do not provide suitable nesting habitat for NTM birds (Petit et al. 1995).

In the far West, the settlement of the Central Valley of California in the late 1800s significantly changed the nesting avifauna in forested riparian habitats (Gaines 1980). Riparian vegetation removal was one of the first significant alterations to the Central Valley (Katibah 1984). Today, the banks of the Sacramento River and its tributaries are bordered by many remnants of the once extensive riparian woodland (Thompson 1980). Breeding populations of at least 11 bird species, including the willow flycatcher (*Empidonax traillii*) and Bell's vireo (*Vireo bellii*), declined significantly, while breeding populations of the brown-headed cowbird and the European starling increased significantly in response to riparian woodland cutting and agriculture development (Gaines 1980). The population of brown-headed cowbirds increased through natural range expansion. The European starling, introduced to America's east coast in the 1800s, adapted well to human-disturbed habitats and native bird species' nest cavities.

Along the Colorado, Gila, Salt, and Santa Cruz Rivers of Arizona, Hunter et al. (1987) found that loss of mature broadleaf trees (e.g., cottonwoods) and snags coincided with the decline of large raptors and cavity nesters. Loss of mixtures of broadleaf trees and shrubs at low elevation river systems resulted in the decline or absence of nine NTMs (Hunter et al. 1987) that had lost their preferred nest and perch sites. In addition, changes in plant composition and structure at these sites may have coincided with microhabitat changes (e.g., temperature and humidity) that were unacceptable to many nesting avian species (Hunter et al. 1987).

Unmanaged grazing by domestic livestock in riparian habitat is frequently detrimental to avian communities (Saab et al. 1995). Riparian areas attract livestock because they provide shade and nutritious, palatable forage (Ames 1977, Kauffman and Krueger 1984). Because grazing varies so much in its local intensity, its impact on breeding birds is not uniform nor easily defined (Kauffman and Krueger 1984). Mosconi and Hutto (1982) examined the effects of heavy grazing (2.5 cow-calf units/ha) and light grazing (0.3 cow-calf units/ha) in riparian areas on bird populations. Although there were no significant differences in total bird densities between sites, bird species composition and foraging guilds were significantly different. Flycatchers were most affected by grazing. The foraging guilds affected most were ground-foragers and foliage-gleaners. Passerines associated with riparian habitats are generally vulnerable to overgrazing. Cowbirds benefit from foraging with grazing animals by catching insects that are flushed (Ryder 1980). Livestock grazing in and adjacent to riparian habitat likely would enhance the quality of such sites for cowbirds, and provide them with greater access to nests of flycatchers and other NTMs, as well as improved foraging opportunities.

Riparian vegetation is used by numerous resident and short- and long-distance NTMs during migration, breeding, and wintering because of its species composition and structure. These communities also support human activities associated with an increase in abundance of some bird species and a decrease in others. The challenge faced by the land manager is to balance human uses of riparian areas with the needs of dependent communities of native flora and fauna, and with the recovery of rare and endangered species (e.g., the southwestern willow flycatcher and least Bell's vireo). The brown-headed cowbird presents a special challenge because this species profits from human activity while most long-distance migratory birds decline, and the cowbird frequently selects long-distance migrants as hosts for its offspring (Friedmann and Kiff 1985), further decreasing recruitment success of long-distance migrants.

Cowbird Natural History

Description

Cowbirds are in the family Emberizidae (warblers, tanagers, grosbeaks, sparrows, and blackbirds) and the subfamily Icterinae. Adult cowbird males weigh from 40 to 50 g and adult females are 10% smaller than males (Lowther 1993). The length of both adult males and females averages 19 cm from tip of bill to tip of tail (National Geogr. Soc. 1987). Cowbirds are terrestrial or semiterrestrial birds, and all but one genus are parasitic (Friedmann 1929). The nonparasitic *Agelaioides* and the parasitic *Tangavius* genera are distributed in South America. The *Molothrus* genus contains four parasitic species that are distributed in North and South America and the West Indies (Friedmann 1929). Species of *Molothrus* are characterized by plumage dimorphism with dark males and lighter-colored females. Male brown-headed cowbirds (*M. ater*) are blackish with a greenish metallic sheen and brown head and neck (Friedmann 1929, Lowther 1993).

Females are brown, do not have a metallic sheen, and sometimes are indistinctly streaked below (Friedmann 1929, Lowther 1993). Although three species of *Molothrus* breed in the United States (brown-headed cowbird, shiny cowbird [*M. bonariensis*], and bronzed cowbird [*M. aeneus*]), the brown-headed cowbird is the most abundant and widely distributed (Lowther 1993).

Because *Molothrus* spp. are obligate brood parasites, they depend on avian host species to incubate their eggs and rear their young. Brown-headed cowbirds parasitize at least 220 avian species (Friedmann and Kiff 1985), but results from several studies suggest that they select certain hosts, perhaps returning to the species that raised them (Post and Wiley 1977, Walkinshaw 1983, Friedmann and Kiff 1985). Mayfield (1965) hypothesized, however, that the apparent selectivity of cowbirds for certain hosts may result from failure of observers to find parasitized nests abandoned by a host early in the incubation period.

Three subspecies of the brown-headed cowbird are recognized: the dwarf cowbird (*M. a. obscurus*), Nevada or sagebrush cowbird (*M. a. artemisiae*), and brown-headed cowbird (*M. a. ater*) (Freidmann 1929, Laymon 1987, Rothstein 1994). Distributions of the dwarf and sagebrush subspecies are farthest west, primarily California, Arizona, and Nevada (Bailey 1928, Friedmann 1929, Friedmann 1971). The sagebrush cowbird also is found in the Great Basin and Western Great Plains regions of the U.S. (Lowther 1993). The sagebrush and dwarf cowbirds may be closely related. Grinnell (1909) believed that the sagebrush cowbird was derived from the dwarf cowbird and not from the brown-headed cowbird that is found east of the Mississippi River. Bailey (1928) stated that the dwarf cowbird was relatively common in the southwestern corner of New Mexico. Hereafter, unless otherwise noted, reference to the brown-headed cowbird refers to the *M. a. ater* subspecies.

Distribution

The brown-headed cowbird is endemic to the short- and mixed-grass prairies of North America (Great Plains and Great Basin regions; Mayfield 1965, Rothstein 1994), where they developed a commensal relationship with native herds of bison (*Bison bison*) and other large ungulates. Originally, cowbirds were known as buffalo birds (Friedmann 1929). As these large animals grazed, they flushed insects and reduced the amount of vegetative ground cover, increasing the availability of insects and seeds. Bailey (1928:660) described the brown-headed cowbird as a "fairly common breeder over much of the lower parts of New Mexico except the southwestern corner." Her data and references indicated that New Mexico was the western edge of the brown-headed cowbird's range.

Before settlement, the brown-headed cowbird was rare in the tallgrass prairies and unbroken tracts of forest in the Eastern United States (Mayfield 1965). These habitats did not provide adequate foraging opportunities for cowbirds. By the late 1700s, the Eastern forests had been opened substantially by loggers and farmers. In addition, herdsmen opened pathways to the West and began to increase the number of cattle, sheep, and swine grazing and trampling the tallgrass prairie (Mayfield 1965). The cowbird expanded its range and increased in abundance in response to these activities (Mayfield 1965, Brittingham and Temple 1983, Friedmann and Kiff 1985).

In the West, Spanish explorers and missionaries traveled north from Mexico and established small settlements in the Lower Colorado River Valley and along the Middle Rio Grande in the late 1500s to 1600s (Bailey 1928, Rothstein 1994). The Spaniards brought livestock with them, which may have enabled the dwarf cowbird to become common by the early 1900s along the Colorado River, in the Tucson, Arizona area, and farther east into southern Texas (Rothstein 1994). Hanna (1928) first reported observations of dwarf cowbirds in the San Bernardino Valley, California in 1918, and by the late 1920s, he stated that the "continual increase of the dwarf cowbird ... caused me considerable alarm." In the San Gabriel River Valley, California, Rowley (1930) noted an apparent increase in dwarf cowbird numbers from 1920 to 1929. The sight of a cowbird had been uncommon and only seven parasitized nests were found from 1920-1924, but from 1925-1929, Rowley (1930) found 21 parasitized nests in the San Gabriel River Valley. During a banding study near Phoenix, Arizona in 1942, Neff (1943) commented that dwarf "...cowbirds were so numerous as to be a nuisance about the traps...."

By the 1900s, the Nevada cowbird, a derivative from the dwarf cowbird subspecies (Grinnell 1909), was widespread throughout the Great Basin and adjoining parts of Oregon and Washington east of the Cascades (Laymon 1987, Rothstein 1994). This expansion may have been influenced by Anglo-American settlement of the region (Rothstein 1994).

Currently, the continued fragmentation of habitat by intensified agriculture, livestock production, timber harvest, and urbanization has provided cowbirds with better access to foraging sites and nests of forest interior hosts. While brown-headed cowbirds were originally restricted primarily to the central grasslands, they are now ubiquitous throughout North America. Likewise, the distribution of the dwarf and Nevada cowbird populations has increased in the far West. Analyses of the U.S. Bird Banding Lab's Breeding Bird Survey data from New Mexico determined that brown-headed cowbird numbers have increased in New Mexico from 1968 to 1994 (Mehlman 1995). Mehlman concluded that the increasing cowbird population in New Mexico was probably a result of the increasing human population and urbanization, changes in agricultural practices, or possibly a change in cowbird

distribution from the midwestern prairies to the Southwest. Mehlman did not attribute the increasing population trend to the presence of domestic livestock because livestock operations have been present in New Mexico since the Spanish settlements were established in the 1600s.

Life History

Brown-headed cowbirds are short distance migrants within North America. In the winter, cowbirds travel and form large roosts with other icterids, but they are frequently found at the margins of such aggregations (Lowther 1993). Spring migration to breeding habitat begins in March, and first eggs are laid in hosts' nests in mid-April (Lowther 1993). Egg-laying continues until mid-July (Lowther 1993) when foraging flocks are formed and migration to winter habitat begins. Brown-headed cowbird eggs are oval; average length and width are 21.45 x 16.42 mm (n=127; Bent 1965). Eggs have a white to grayish-white background color overlain by brown/gray spots which are usually more dense at the larger end of the egg (Lowther 1993).

The incubation period for cowbird eggs ranges from 10 (Briskie and Sealy 1990) to 12 days (Nice 1953). The host species provides all care for the egg(s). Cowbird eggs are laid synchronously with the host's eggs but usually hatch first because of their relatively short incubation period. In addition, cowbirds frequently parasitize hosts whose eggs are smaller than their own; thus, the host inadvertently provides more warmth to the cowbird egg, resulting in its hatching first (Friedmann 1929:187).

Cowbirds are altricial (naked, blind, move little, dependent on adults for food) and nidicolous (remain in the nest). Nice (1939) observed the development of a cowbird chick and reported the following: short flight at 11 days, hopped at 11 to 14 days, walked at 15 days, pecked at insect at 14 days, drank at 16 days, and picked up food at 17 days. Chicks leave the nest at about 8 to 13 days and are independent at 25 to 39 days (Woodward and Woodward 1979).

Male and female cowbirds are sexually mature at one year, but males may not breed during their first year (Lowther 1993). Studies in Canada found that a single female may lay >40 eggs per breeding season (Scott and Ankney 1980). Scott and Ankney (1980) used the product of the probabilities of survival from egg to fledging, fledging to independence, and independence to breeding to estimate that the probability of survival of a cowbird egg to adult cowbird was about 0.03. A stable population is maintained with this survival rate and a lifetime fecundity of 80 eggs per female (Scott and Ankney 1980).

Habitat Use

Brown-headed cowbirds use different habitats for breeding, roosting, and feeding. Breeding ranges of female cowbirds overlap host breeding areas, and ranges of male cowbirds overlap those of females. The primary intent of male cowbirds is to gain access to breeding females, while female cowbirds must gain access to hosts' nests (Rothstein et al. 1986). Aggression or expression of territoriality by cowbirds stems from competitive access to breeding females or to hosts' nests.

Female cowbirds are active but generally silent in breeding ranges in the morning (Rothstein et al. 1984). They are highly mobile and perch or fly high above the ground (Rothstein et al. 1984), presumably searching for hosts' nests. Breeding ranges are rarely used for foraging (Rothstein et al. 1984), but Yokel (1986) found that cowbirds feed opportunistically on cicadas in breeding ranges in a California riparian habitat. Morning ranges of males frequently overlap female breeding ranges (Yokel 1986), and males often travel with females (Rothstein et al. 1984). Males are active and vocal in the morning and in feeding ranges.

Sizes of female breeding ranges are associated with density of hosts' nests. Rothstein et al. (1980) determined that cowbird density was greater in riparian habitat than in open coniferous forests of the Sierra Nevada. Rothstein et al. (1984) suggested that cowbirds preferred dense riparian vegetation.

Cowbirds feed in flocks up to 7 km from breeding ranges (Rothstein et al. 1984). They are ground-feeders that walk among and near large grazing animals to feed on insects that are flushed and seeds that are exposed in the grazed vegetation and bare ground. They also feed in agricultural fields, livestock paddocks or corrals, and urban yards and feeders. Rothstein et al. (1984) found that female cowbirds used feeding sites from afternoon (>1115 hr) to dusk (>1815 hr) and were relatively sedentary at these sites. After dusk, females tended to roost in breeding ranges. Males also commuted to feeding sites in the afternoon but tended to move among sites more frequently than females. Commuting between morning breeding ranges and afternoon feeding sites may not be necessary if forage is abundant near breeding ranges.

Cowbirds and Their Hosts in New Mexico

Historical Overview

The first systematic survey of New Mexico fauna began in 1903 under the direction of C. Hart Merriam and Vernon Bailey (Bailey 1928). Bailey's book summarizes this systematic survey and earlier field notes. Merriam and Bailey's

surveys found that the brown-headed cowbird was a fairly common breeder over much of the low elevation region of New Mexico, except the southwestern corner at altitudes from 1,100 to 2,000 m. The dwarf cowbird was found only in the southwestern corner of New Mexico.

A few cowbirds were seen with almost every herd of cattle in the 1900s (Bailey 1928). At Mesilla Park, hundreds of cowbirds formed flocks of adults and fledglings in late July. Cowbirds migrated through the southern half of New Mexico from September to October to their wintering sites in Mexico. All cowbirds left New Mexico in the winter and returned in late April (Bailey 1928). Bailey noted that cowbirds parasitized 90 species of birds smaller than themselves. Nests of the willow flycatcher (*Empidonax trailli brewsteri* [formerly the Traill's flycatcher]) and two vireo species were listed as recipients of cowbird eggs.

Ligon (1961) published the second comprehensive book on the birds of New Mexico. He stated that the brown-headed cowbird was common and widespread, and that it posed a "serious limiting factor in the populations of smaller birds." He explained that cowbirds congregated in large flocks in the fall and often did considerable damage to unharvested head grains. Ligon (1961) reported that cowbirds were found statewide and at altitudes up to 2,400 m in the summer. The bronzed cowbird was reported to breed in the extreme southwestern corner of New Mexico. One of four nests of the willow flycatcher that were found in riparian habitat along the lower Rio Grande was parasitized by a cowbird (Ligon 1961). The least Bell's vireo, described as a very rare species, was found only in the southwestern corner of New Mexico, but no mention was made of its nests being parasitized.

Hubbard (1971) surveyed the summer birds and habitat of the Gila River Valley, New Mexico and reported that the brown-headed cowbird was uncommon to common throughout the valley. The vermilion flycatcher (*Pyrocephalus rubinus*), Lucy's warbler (*Vermivora luciae*), and yellow-breasted chat (*Icteria virens*) were cowbird hosts. The Bell's vireo (*Vireo bellii arizonae*) was considered rare to uncommon in the riparian habitat and valley mesquite. The bronzed cowbird (*Molothrus aneus loyei*) was an occasional to irregular summer resident of the Gila River Valley and was classified as an addition to the avifauna since the late 1950s to early 1960s. Hubbard (1971) noted that the brown-headed cowbird was most abundant in riparian habitats, which are important population centers for most of the passerine species. Hubbard (1971) recorded 143 bird species in the Gila River Valley at the height of the nesting season; 112 probably nested in the valley.

Schmitt (1976) conducted a similar study in the San Juan Valley in northwestern New Mexico. The brown-headed cowbird was casual to regular throughout the valley and was fairly common to locally common in riparian woodland and adjacent habitats. The willow flycatcher was an occasional breeding bird in riparian woodland-shrubland habitat. He recorded 105 species of birds in the San Juan Valley; 100 nested there.

Wauer (1977) conducted a survey along the lower Rio Grande of western Texas. He concluded that the riparian habitat of this area provided a significant migration corridor within the surrounding arid habitat. The mourning dove, verdin (*Auriparus flaviceps*), northern oriole (*Icterus galbula*), brown-headed cowbird, and house finch (*Carpodacus mexicanus*) exhibited the greatest selection for riparian habitat. The Bell's vireo was abundant during the breeding season and was unaffected by the abundance of brown-headed cowbirds. The bronzed cowbird was a summer resident within the riparian zones of Big Bend National Park since 1969. The primary hosts for the bronzed cowbird were hooded (*Icterus cucullatus*) and orchard (*I. spurius*) orioles (Wauer 1977).

Elephant Butte Marsh, one of the largest remaining wetlands in the Middle Rio Valley, was the study site for Hundertmark's (1978) survey of avifauna during the 1970 to 1975 breeding seasons. In his annotated list of breeding birds, he stated that the brown-headed cowbird was regularly found in riparian habitats and was fairly common overall. He found cowbird eggs in nests of willow flycatcher, Lucy's warbler, and red-winged blackbird (*Agelaius phoeniceus*). He found that the willow flycatcher was fairly common in riparian woodland or shrubland and that nearly all nests were over water. Of the 64 species known or believed to breed in Elephant Butte Marsh, Hundertmark (1978) found that 42% were restricted to riparian habitat.

Surveys along the Gila River during a six-month period in 1975 by Baltosser (1986) indicated that 112 species used the habitat, and that it was an important spring migration corridor. The Gila River Valley supported a great number of bird species in a relatively small area.

Freehling (1982) provided some of the first quantitative data on the density of breeding birds in New Mexico. He recorded 35 species of breeding birds, including the brown-headed cowbird (tables 1, 2, 3), during the breeding seasons of 1979 and 1980 along the Middle Rio Grande. Hildebrandt and Ohmart (1982) conducted a study along the Pecos River from 1979-1981 (table 1, figure 1) to determine the quality of the habitat for breeding, migrating, and wintering birds. Riparian habitat was selected over other habitats by breeding birds, but birds were most abundant in the Pecos River Valley in autumn. Hildebrandt and Ohmart (1982) suggested that the abundance of brown-headed cowbirds (table 2) could be used as an indicator of the nesting potential of a habitat for small to medium-sized birds that build open-cup nests, which are typical cowbird hosts. The blue grosbeak (*Guiraca caerulea*) had the greatest rate of parasitism in this study (Hildebrandt and Ohmart 1982).

Surveys by Hink and Ohmart (1984) along the Middle Rio Grande (figure 2) during 1981 and 1982 found 277 bird species in bosque and adjacent agricultural habitats. More than 60% of the bird species known to occur in New Mexico were found within these habitats. Breeding birds tended to concentrate in cottonwood forests of the valley.

Invasion and proliferation of saltcedar within the Pecos River Valley provide woody structure where little to none existed previously (Hunter et al. 1988). Several bird species have increased their distribution from Texas to the Pecos River Valley of New Mexico. Bird species that used cottonwood-willow habitat for nesting habitat within the lower Rio Grande Valley have persisted, in lower numbers, by nesting in saltcedar habitat (Hunter et al. 1988).

Hoffman (1990) conducted breeding and spring migration season studies in Rio Grande Valley State Park, within the Middle Rio Grande Valley, from 1987 to 1990 (table 1). He determined that brown-headed cowbirds were relatively common during the summer breeding season (45/100 acres; tables 2, 3). The most common breeding birds were black-chinned hummingbirds (*Archilochus alexandri*), mourning doves, black-headed grosbeaks (*Pheucticus melanocephalus*), and American robins (*Turdus migratorius*); none of these are common hosts for brown-headed cowbirds. Hoffman (1990) recorded 130 species during his study; 69 probably nested in the study area.

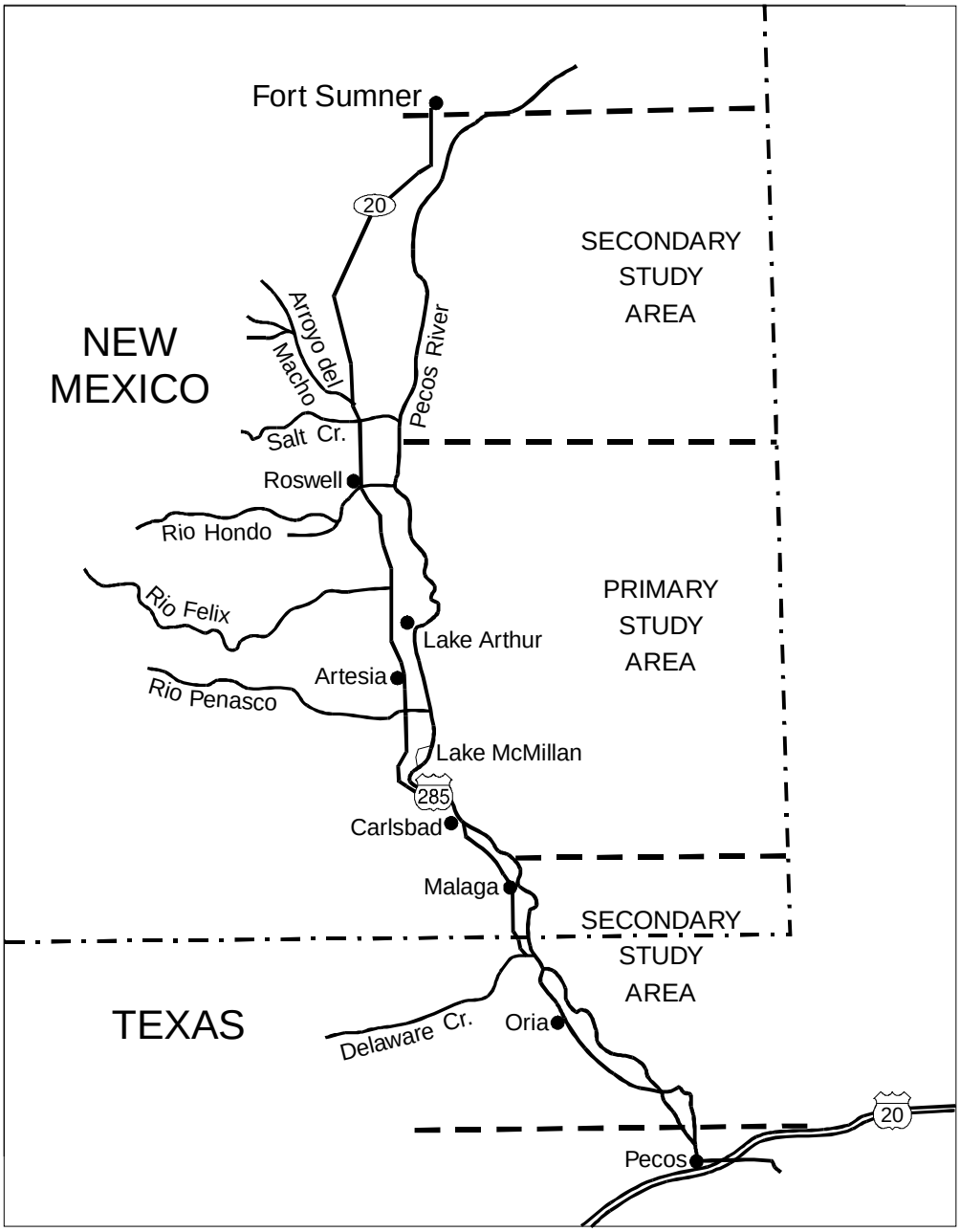

Figure 1. Area of New Mexico studied by Hildebrandt and Ohmart (1982).

During winter 1992 and spring through summer 1993, Thompson et al. (1994) surveyed bird species at five different habitat types within the Middle Rio Grande Valley (table 1, figure 3). They recorded 162 species along their transects. Species richness was greatest in sites where Russian olive and saltcedar were codominants. They detected >98% of the neotropical migratory species that were present in this area historically. The brown-headed cowbird was not considered common in any of the five habitat types surveyed (tables 2, 3). The greatest numbers of resident and riparian-dependent bird species were within undeveloped riparian habitat, followed by drainage channel habitat. Data from this study indicated that populations of bird species that are well-adapted to human activities and landscapes were increasing (e.g., European starling, house sparrow, rock dove [*Columba livia*], cattle egret [*Bubulcus ibis*]). Species associated with young successional stages dominated by willows (e.g., Bell's vireo, painted bunting [*Passerina ciris*], southwestern willow flycatcher, hooded warbler [*Wilsonia citrina*], and yellow warbler [*Dendroica petechia*]) were declining.

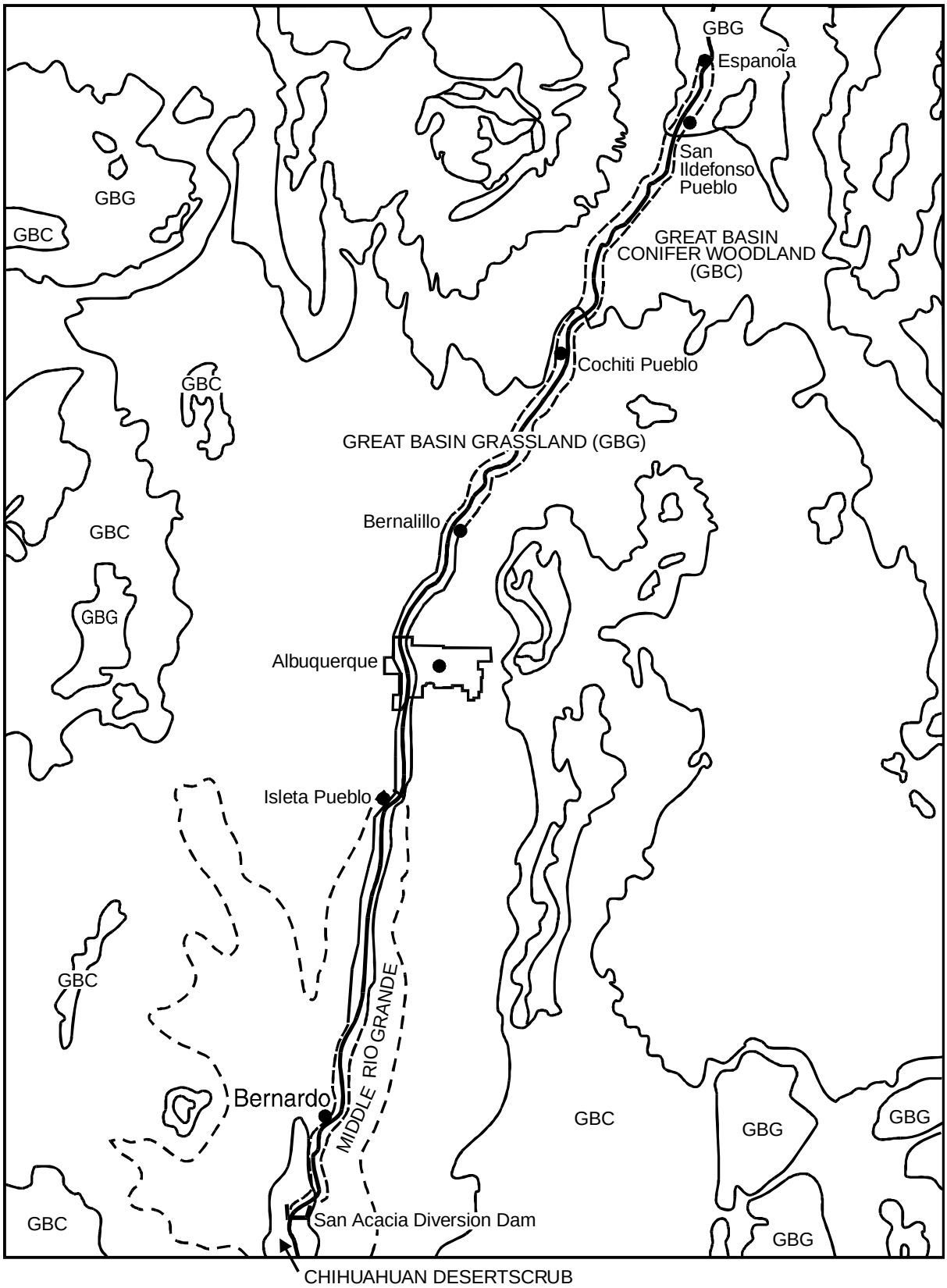

Figure 2. Area of New Mexico studied by Hink and Ohmart (1984).

During the 1993 breeding season, an effort was made to estimate the abundance and distribution of the southwestern willow flycatcher within the Rio Grande Basin of New Mexico. This effort was in response to the proposal to list the southwestern willow flycatcher as a federally endangered species (USFWS 1993; listed as endangered in March 1995, USFWS 1995). Schwarz (1993) conducted surveys within the Cibola National Forest (table 1) and found one willow flycatcher pair. Mehlhop and Tonne (1994) conducted surveys from the San Acacia Diversion Dam to the southern end of Bosque del Apache National Wildlife Refuge (NWR) within the Middle Rio Grande Valley (tables 1, 2). They found seven willow flycatcher pairs and three territorial males. They recorded two cases of parasitism by brown-headed cowbirds. Schwarz (1994) continued surveys in the Cibola National Forest during the 1994 breeding season (table 1) and recorded 24 brown-headed cowbirds on eight riparian transects and an average of 32 (±3 SE) species per sample site (tables 2, 3). Two southwestern willow flycatchers and no least Bell's vireos were recorded.

Studies on the species composition and abundance of migratory songbirds by Finch et al. (1995) at Bosque del Apache NWR within the Middle Rio Grande Valley (table 1) found that the brown-headed cowbird was one of the most abundant species during spring migration (tables 2, 3). They caught 244 individual cowbirds in mist nests; 9.2% of all birds captured (Finch et al. 1995).

Summary

Avian studies in New Mexico, beginning in the late 1970s, reported quantitative estimates of bird species composition, abundances, and densities (table 1), and several studies related these estimates to habitat characteristics. The results, however, are difficult to compare among studies because the estimates of abundance and density frequently are in different units, and methods used to survey and census birds are inconsistent or not standardized. Although none of these studies focused on the brown-headed cowbird, cowbirds were included, and their abundance and/or density and distribution can be examined within each survey location (table 2) and ecological region (table 3).

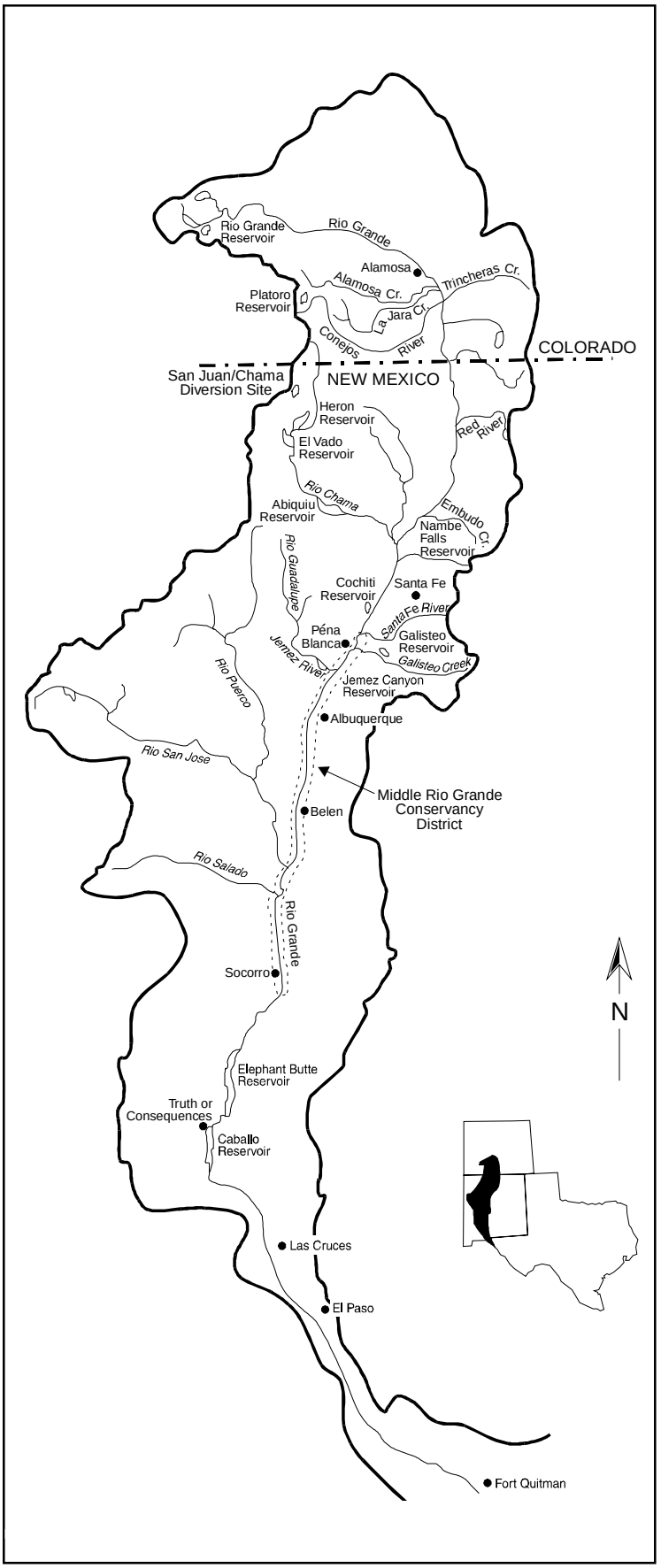

Figure 3. Thompson et al. (1994) surveyed the avian community of the Rio Grande Basin from just north of Santa Fe (Velvarde, Rio Arriba County) to just south of Las Cruces (Mesquite, Dona Ana County), New Mexico.

Table 1. Avian surveys conducted within major river drainages of New Mexico.

Author	Season	Year	County	General area of study	Description of area
Freehling 1982	Breeding	1979-80	Bernalillo	Middle Rio Grande Valley	Dominant woody species was Russian olive (*Elaeagnus angustifolia*)
U.S. Bureau of Land Management 1981	Fall migration	1980	Socorro	Middle Rio Grande Valley	Mesquite (*Prosopis* spp.) rolling upland, shrub piedmont, riparian woodland, and mixed shrub-grassland valley
Hoffman 1990	Breeding	1987-89	Bernalillo	Middle Rio Grande Valley	Rio Grande State Park, City of Albuquer que; woody species included cotton wood *Populus* spp.), Russian olive, saltcedar (*Tamarix* spp.), and coyote willow (*Salix gooddingii*)
Farley et al. 1994	Spring migration, breeding	1991-92	Socorro, Sierra	Middle Rio Grande Valley	30-yr-old cottonwood, 2-yr-old evegeta-ted cottonwood, 3-yr-old revegetated cottonwood, and 5-yr-old cottonwood riparian woodlands
Thompson et al. 1994	Spring migration, breeding, fall migration	1993-94	Rio Arriba, Los Alamos, Santa Fe, Sandoval, Bernalillo, Valencia, Socorro, Sierra, Doña Ana	Rio Grande floodplain	Cottonwood overstory and Russian olive understory; cottonwood overstory, and Russian olive and willow under story; cottonwood overstory, and saltcedar, Russian olive, willow understory; cotton wood and saltcedar overstory, and mesquite or no understory; Russian live, pecan, cottonwood/ willow, mesquite/saltcedar overstory
Finch et al. 1995	Spring migration	1994	Socorro	Middle Rio Grande Valley	Agricultural fields; cottonwood, mesquite, and saltcedar riparian woodlands
Mehlhop and Tonne 1994	Breeding	1994	Socorro	Middle Rio Grande Valley	Mature cottonwood stands and large expanses of saltcedar; few stands of willow
Maynard 1994	Breeding	1994	Rio Arriba, Los Alamos, Sante Fe, Sandoval, Bernalillo, Valencia, Socorro, Sierra, Doña Ana, Grant	Rio Grande, Coyote Creek, Rio Chama, Rio Puerco, Rio Nutria, Pescado River, Bluewater Creek, Pecos River, Gila River and its tributaries	Mature cottonwood, saltcedar, Russian olive, willow, alder (*Alnus* spp.) riparian woodlands; small areas of marsh
Baltosser 1986	Spring migration, breeding	1975	Grant	Lower Gila River Valley	Cottonwood, box-elder (*Acer negundo*), willow riparian woodland; sandy river bottom
Hildebrandt and Ohmart 1982	Spring migration, breeding, fall migration, winter	1979-81		Pecos River Valley; Primary study area: south to Loving, NM; secondary study areas: Ft. Sumner south to Roswell, NM, and Loving, NM south to Pecos, TX	Four-winged saltbush (*Atriplex canescens*), cottonwood, Roswell saltcedar, areas cleared of saltcedar, and honey mesquite (*Prosopis glandulosa*) woodlands
Schwarz 1993, 1994	Breeding	1993-94	Socorro	Riparian habitats within Cibola National Forest; tributaries to the Rio Grande	Willow, marsh areas, cottonwood, poplar riparian habitats

Table 2. Brown-headed cowbird densities estimated during avian surveys in riparian and adjacent habitats of New Mexico.

Study/location or habitat	Date of survey(s)	Density (N/40 ha)	Original units (if not N/40 ha)
Freehling 1982			
Isleta South	May - July 1979	33.5	
Isleta North	May - July 1979	27.5	
Montano	May - July 1979	50.5	
Sandia	May - July 1979	16.2	
	mean (SE)	31.9 (7.2)	
Isleta South	Aug. - Sept. 1979	0.5	
Isleta North	Aug. - Sept. 1979	2.1	
Montano	Aug. - Sept. 1979	2.1	
Sandia	Aug. - Sept. 1979	0.9	
	mean (SE)	1.4 (0.4)	
Isleta South	May - July 1980	38.2	
Isleta North	May - July 1980	48.5	
Montano	May - July 1980	36.6	
Sandia	May - July 1980	30.8	
	mean (SE)	38.5 (3.7)	
U.S. Bureau of Land Management 1981			
Mesquite rolling upland	29 May 1980	16	40/km^2
Shrub piedmont	10 June 1980	72.4	181/km^2
Riparian habitat	17 June 1980	8	20/km^2
Mixed shrub, grass valley	8-10 July 1980	6	15/km^2
Hoffman 1990			
Cottonwood, Russian olive, saltcedar, coyote willow	June-Aug. 1987, 1989	44.4	45/100 acre
Farley et al. 1994			
30-yr-old cottonwood riparian forest	April - May 1992		3.0 individuals detected
2-yr-old revegetated cottonwood site	late May - Jun 1992		1.0 individual detected
3-yr-old revegetated cottonwood site	late May - Jun 1992		2.7 individuals detected
5-yr-old revegetated cottonwood site	late May - Jun 1992		1.8 individuals detected
30-yr-old cottonwood riparian forest	late May - Jun 1992		2.6 individuals detected
Thompson et al. 1994			
Stratum 1	Apr. - May 1993		6 individuals detected
Stratum 2	Apr. - May 1993		19 individuals detected
Stratum 3	Apr. - May 1993		12 individuals detected
Stratum 4	Apr. - May 1993		11 individuals detected
Stratum 5	Apr. - May 1993		13 individuals detected
Stratum 1	Jun. - Aug. 1992, 1993		10 individuals detected
Stratum 2	Jun. - Aug. 1992, 1993		46 individuals detected
Stratum 3	Jun. - Aug. 1992, 1993		64 individuals detected
Stratum 4	Jun. - Aug. 1992, 1993		57 individuals detected
Stratum 5	Jun. - Aug. 1992, 1993		69 individuals detected
Stratum 1	Aug. - Oct. 1992, 1993		0 individuals detected
Stratum 2	Aug. - Oct. 1992, 1993		1 individual detected
Stratum 3	Aug. - Oct. 1992, 1993		0 individuals detected
Stratum 4	Aug. - Oct. 1992, 1993		1 individual (on the 1 marsh habitat transect)
Stratum 5	Aug. - Oct. 1992, 1993		0 individuals detected
Finch et al. 1995			
Agricultural fields	April - May 1994		0.72 birds/survey/ha
Cottonwood	April - May 1994		0.71 birds/survey/ha
Mesquite	April - May 1994		0.84 birds/survey/ha
Saltcedar	April - May 1994		0.77 birds/survey/ha

Table 2. Cont'd.

Study/location or habitat	Date of survey(s)	Density (N/40 ha)	Original units (if not N/40 ha)
Mehlhop and Tonne 1994			
San Acacia #1	June 1994	10.6	6/22.6 ha
McNierney #2	June 1994	29.8	5/6.7 ha
Lemitar #3	June 1994	23.9	20/33.5 ha
Lemitar Willow #4	June 1994	140.8	25/7.1 ha
Middle Socorro #5	June 1994	18.1	23/50.9 ha
Socorro Thicket #6	June 1994	45.7	8/7 ha
South Socorro Saltcedar	June 1994	40.0	20/20 ha
Long Stretch San Antonio Section #8	June 1994	20.0	50/100 ha
Bosque del Apache North #8A	June 1994	5.5	20/146 ha[1]
Bosque del Apache South #8B	June 1994	5.0	18/145 ha
San Antonio Willow #9	June 1994	42.9	3/2.8 ha
Northern Parula Willow #10	June 1994	38.1	4/4.2 ha
Mosquito Coast #11	June 1994	21.3	16/30 ha
Val Verde #12	June 1994	17.3	13/30 ha
Lower Val Verde Site #13	June 1994	12.6	22/70 ha
WIFL Condo Site #13A	June 1994	24.2	23/38 ha
Supra-train trestle tamarisk traillii tract	June 1994	3.2	65/806 ha
cattail site #15	June 1994	55.8	7/5.02 ha
Baja Mesa Peak #16	June 1994	28.4	3/4.22 ha
San Marcial/Ft. Craig	June 1994	12.1	32/106 a
dike ditch #18	June 1994	28.9	13/18 ha
west bank willow stand #19	June 1994[2]	52.9	9/6.8 ha
upper Elephant Butte state park #20	June 1994[2]	5.2	10/77 ha
Ft. Craig #21	June 1994[2]	5.9	5/34 ha
Lower Ft. Craig #22	June 1994[2]	6.4	4/25 ha
Ft. Craig cemetery #23	June 1994[2]	19.0	4/8.4 ha
Milligan Gulch #24	June 1994[2]	11.1	36/130 ha
Sheep Canyon #25	June 1994[2]	30.4	7/9.2 ha
San Acacia #1	July 1994	5.3	3/22.6 ha
McNierney #2	July 1994	11.9	2/6.7 ha
Lemitar #3	July 1994	7.2	6/33.5 ha
Lemitar Willow #4	July 1994	28.2	5/7.1 ha
Middle Socorro #5	July 1994	6.3	8/50.9 ha
Socorro Thicket #6	July 1994	22.9	4/7 ha
South Socorro Saltcedar	July 1994	12.0	6/20 ha
Long Stretch San Antonio Section #8	July 1994	19.2	48/100 ha
Bosque del Apache North #8A	July 1994	12.9	47/146 ha
Bosque del Apache South #8B	July 1994	13.1	47.5/145 ha[3]
San Antonio Willow #9	July 1994	85.7	6/2.8 ha
Northern Parula Willow #10	July 1994	76.2	8/4.2 ha
Mosquito Coast #11	July 1994	34.7	26/30 ha
Val Verde #12	July 1994	40.0	30/30 ha
Bell's WIFL Beach #12A	July 1994	24.5	3/4.9 ha
Lower Val Verde Site #13	July 1994	21.1	37/70 ha
WIFL Condo Site #13	July 1994	19.0	18/38 ha
Supra-train trestle tamarisk traillii tract	July 1994	3.4	68/806 ha
cattail site #15	July 1994	87.6	11/5.02 ha
Baja Mesa Peak #16	July 1994	56.9	6/4.22 ha
San Marcial/Ft. Craig	July 1994	19.2	51/106 ha
dike ditch #18	July 1994	28.9	13/18 ha
west bank willow stand #19	July 1994	47.1	8/6.8 ha
upper Elephant Butte state park #20	July 1994	22.9	44/77 ha
Ft. Craig #21	July 1994	226.7	34/6 ha
Lower Ft. Craig #22	July 1994	11.2	7/25 ha
Ft. Craig cemetery #23	July 1994	23.8	5/8.4 ha

Table 2. Cont'd.

Study/location or habitat	Date of survey(s)	Density (N/40 ha)	Original units (if not N/40 ha)
Milligan Gulch #24	July 1994	18.8	61/130 ha
Sheep Canyon #25	July 1994	130.4	30/9.2 ha
Maynard 1994			
Los Ojos Fish Hatchery	2 & 21 July 1994		14 individuals counted
Velarde	15 June & 9 July 1994		2 individuals counted
Chamita	14 June & 9 July 1994		5 individuals counted
San Juan Pueblo Bridge	15 & 17 June 1994		1 individual counted
Orilla Verde	20 June & 6 July 1994		3 individuals counted
Tierra Azul	17 July 1994		8 individuals counted
Santa Clara Oxbow	18 June 1994		4 individuals counted
Coyote Creek State Park	19 July 1994		7 individuals counted
Black Rock, Zuni Pueblo	20, 22 Jun, 4 July 1994		8 individuals counted
Gila Lower Box, USDOI, BLM	16, 17 Jun, 2 July 1994		4 individuals counted
Ft. West Ditch	June & July 1994		45 individuals counted
1830 Low Flow Channel	30 June & 19 July 1994		2 individuals counted
Pump Canyon Exclosure (BLM)	18 June 1994	15	12/80 acre
La Plata #9 (BLM)	16 June 1994	2	1/40 acre
Gallegos Tract (BLM)	25 June 1994	5	6/120 acre
Valdez (San Juan River); (BLM)	25 June 1994	12	10/80 acre
La Plata (BLM)	17 June 1994	3	7/200 acre
Bloomfield Tract (San Juan River) (BLM)	25 June 1994	10	2/20 acre
La Plata (BLM)	17 June 1994	2	2/80 acre
La Plata (BLM)	16 June 1994	3	4/120 acre
Quintana Ditch, Rio Chama	22 June 1994		1/3000 sq-ft area
Rio Chama Canyon (Rd. 151)	24 June 1994	5	3/23 ha
Black Canyon; Hyde State Park	8 July 1994		6/4-mi transect
Benedictine Monastery and Monastery Lake (along Pecos River)	7 July 1994		2/1-mi transect
Pecos Nat. Monument; Glorieta River	30 June 1994		2/2-mi transect
Pecos Nat. Monument; Pecos River	7 July 1994		3/1.8-mi transect
Pescado River (Zuni Pueblo)	22 June 1994		2/0.75-mi transect
Rio Puerco; La Ventana	10 July 1994		12/0.75-mi transect
North Corrales Bosque #1	11 & 27 Jun 1994		7/1.6-mi transect
Corrales flooded willows #2	11 & 27 Jun 1994	198	4/2 acre
Middle Corrales Bosque #3	11, 21, 27, 29 Jun 1994		30/4.5-mi transect
Rio Grande, Alameda Islands, North	11 July 1994		9/2-mi transect
Alameda #4	14 June 1994		30/2.2-mi transect
Corrales Unit #5	3 July 1994		11/1-mi transect
San Francisco Hot Springs to Gorilla Springs; Gila National Forest	25 June 1994		5/3.5-mi transect
Laney Allotment; San Francisco River; Gila National Forest	10 & 12 June 1994		5/4.2-mi transect
Trout Creek; US For. Serv. Allotment; Gila National Forest	14 & 19 June 1994		3/6.5-mi transect
Lee Russell Canyon; Gila National Forest	18 June 1994		1/1.2-mi transect
Kerr Springs Canyon; Gila National Forest	18 June 1994		3/1.3-mi transect
Havre Gulch Allotment; San Francisco River.; Gila National Forest	24 June 1994		5/2-mile transect
LH Ranch Allotment; San Francisco River.; Gila National Forest	26 June 1994		5/1.75-mi transect
West Fork Gila River; Forest Service	28 June 1994		6/3-mi transect
Heart Bar Wildl. Area; West Fork Gila; New Mexico Dep. Game & Fish	27 June 1994		4/1.4-mi transect
West Fork Gila Reach #5; Gila National Forest	1 & 2 June 1994		20/7-mi transect

Table 2. Cont'd.

Study/location or habitat	Date of survey(s)	Density (N/40 ha)	Original units (if not N/40 ha)
Blue Creek, West Bank Blue Creek #1 & #2; Corral #3; Picnic Canyon (BLM; private)	16 June 1994		6/3-mi transect
Nichol's Canyon (BLM; Lower Gila Box)	2 July 1994		2/0.75-mi transect
Fort West Ditch (The Nature Conservancy)	3 July 1994		4/1.3-mi transect
Gila Bird Area (Forest Service)	29 June 1994		9/4-mi transect
Polonias Creek (South Fork) (BLM; private)	6 July 1994	14	5/34 acre
Percha Creek (BLM)	1 July 994	14	3/20.7 acre
Tierra Blanca Creek (BLM)	15 July 1994	108	3/2.75 acre
Sevilleta NWR; La Joya State Game Refuge	21-27 June 1994		16/5-mi transect
Bosque del Apache Unit 18A	10 June 1994		8 in a 15-by-60-m area
Bosque del Apache; East side of Rio Grande	14 June 1994		24 individuals counted
Bosque del Apache; South side half of unit #6	13 & 17 June 1994		7 individuals counted
Bosque del Apache	13 July 1994		17 individuals counted
Bosque del Apache; Unit 17	13 June 1994		5 individuals counted
Bosque del Apache; 13b1 & 14b	16 June 1994		9 individuals counted
Bosque del Apache; 13c, 13b1, 13a, & 13b2	17 June 1994		8 individuals counted
Three Rivers Campsite; Lincoln Nat. Forest	2 June 1994	200	4/0.8 ha
Laborlita Canyon (BLM; private)	13 June 1994		3/2-mi transect
Chance Canyon; Lincoln National Forest	8 June 1994	28	1/3.5 acre
Baltosser 1986			
Lower Gila River, riparian woodland	April 1975	9	
Lower Gila River, riparian woodland	May 1975	20	
Lower Gila River, riparian woodland	June 1975	43	
Hildebrandt and Ohmart 1982			
C/S type AT-VI[4]	Mar. - May 1980	1	
	Aug. - Sep. 1980	3	
C/S type CW-I	Mar. - May 1980	6	
	Jun. - July 1980	3	
C/S type CW-II	Dec. 1979 - Feb. 1980	3	
	Mar. - May 1980	9	
C/S type Saltcedar III	Mar. - May 1980	7	
	Jun. - July 1980	13	
C/S type Saltcedar IV	Mar. - May 1980	13	
	Jun. - July 1980	18	
	Aug. - Sep. 1980	4	
C/S type Saltcedar V	Mar. - May 1980	5	
	Jun. - July 1980	10	
C/S type Saltcedar VI	Mar. - May 1980	10	
	Jun. - July 1980	17	
	Aug. - Sep. 1980	2	
C/S type DC-strips	Mar. - May 1980	12	
	Jun. - July 1980	16	
C/S type OC-V/VI	Mar. - May 1980	1	
C/S type HM-V	Dec. 1979 - Feb. 1980	3	
	Jun. - July 1980	10	
C/S type HM-VI	Mar. - May 1980	1	
	Jun. - July 1980	1	
C/S type GC-VI	Jun. - July 1980	1	
C/S type "misc."	Mar. - May 1980	7	
	Jun. - July 1980	17	
	Aug. - Sep. 1980	1	

Table 2. Cont'd.

Study/location or habitat	Date of survey(s)	Density (N/40 ha)	Original units (if not N/40 ha)
Schwarz 1994			
Copper Canyon, Magdalena Mountains	June 1993	2 individuals counted	
Sawmill Canyon, Magdalena Mountains	June 1993	4 individuals counted	
Sawmill Canyon, Magdalena Mountains	June 1994	3 individuals counted	
Tajique Canyon, Manzano Mountains	June 1993	9 individuals counted	
Tajique Canyon, Manzano Mountains	June 1994	5 individuals counted	
Perra Canyon, Manzano Mountains	June 1993	7 individuals counted	
Perra Canyon, Manzano Mountains	June 1994	7 individuals counted	
Mills Canyon, Kiowa/Rita Blanca National Grassland	June 1993	6 individuals counted	
Mills Canyon, Kiowa/Rita Blanca National Grassland	June 1994	4 individuals counted	
Perico Creek, Kiowa/Rita Blanca National Grassland	June 1993	10 individuals counted	
Perico Creek, Kiowa/Rita Blanca National Grassland	June 1994	5 individuals counted	
Manzano Mountains	June 1994	2 individuals counted	
Pole Canyon, Zuni Mountains	June 1994	1 individual counted	

[1] Mean of two counts: 21 June and 5 July 1994.

[2] Counts conducted during first survey period, but 2-4 July.

[3] Mean of two counts: 6 and 15 July.

[4] Definitions of avain survey locations.

C/S: community/structure type.

AT-VI: four-winged saltbush; variable foliage height, usually little volume above 1.5 m, includes all areas recently disturbed by plowing and burning, and areas with very sparse vegetation.

CW-I: cottonwood-dominated communities, trees 12-18 m high, with substantial amount of foliage above 12 m.

CW-II: cottonwood-dominated communities, scattered trees above 9 m but lacking substantial foliage above 12 m.

Salt Cedar-III: saltcedar dominated communities, very few trees above 9 m but having substantial foliage between 4.6 and 7.6 m.

Salt Cedar-IV: saltcedar dominated communities, little foliage above 4.6 m, dense between 1.5 and 4.6 m.

Salt Cedar-V: saltcedar dominated communities, little foliage above 3 m, generally rather sparse, often with open areas between trees or groups of trees.

Salt Cedar-VI: saltcedar dominated communities, variable foliage height, usually little volume above 1.5 m, includes all areas recently disturbed by plowing and burning, and areas with very sparse vegetation.

DC-strips: uncleared strips of saltcedar approximately 15-20 m wide adjacent and parallel to Pecos River.

OC-V/VI: cleared communities dominated by various annual and perennial weeds and shrubs, little foliage above 3 m, generally rather sparse, often with open areas between trees or groups of trees, and variable foliage height, usually little foliage above 1.5 m, includes all areas recently disturbed by plowing and burning, and areas with very sparse vegetation.

HM-V: honey mesquite dominated communities, little foliage volume above 3 m, generally rather sparse, often with open areas between trees or groups of trees.

HM-VI: honey mesquite dominated communities, variable foliage height, usually little volume above 1.5 m, includes all areas recently disturbed by plowing and burning, and areas with very sparse vegetation.

GC-VI: cleared communities dominated by grasses, variable foliage height, usually little volume above 1.5 m, includes all areas recently disturbed by plowing and burning, and areas with very sparse vegetation.

Table 3. Densities (N/40 ha) of brown-headed cowbirds estimated during avian surveys in New Mexico.

Author	Region	Date	Mean density	SE
Freehling 1982	Middle Rio Grande Valley	May - July 1979	31.9	7.16
		Aug. - Sept. 1979	1.4	0.41
		May - July 1980	38.5	3.69
U.S. Bureau of Land Management 1981	Middle Rio Grande Valley	17 June 1980	8	not a mean
Hildebrandt and Ohmart 1982	Pecos River Valley	Dec. 1979 - Feb. 1980	6	not a mean
		March - May 1980	72	not a mean
		June - July 1980	106	not a mean
		August - September 1980	10	not a mean
		October - November 1980	0	not a mean
Hoffman 1990	Middle Rio Grande Valley	June-early Aug., 1987 & 1989	45	not given
Farley et al. 1994	Middle Rio Grande Valley	spring 1992	3[1]	not given
		summer 1992	2[1]	0.4
Thompson et al. 1994	Rio Grande floodplain	summer 1992 & 1993	5[2]	not a mean
		summer 1992 & 1993	122[2]	not a mean
Schwarz 1994	Cibola National Forest; tributaries to the Rio Grande	summer 1993	38[2]	not a mean
		summer 1994	24[2]	not a mean
Finch et al. 1995	Middle Rio Grande Valley	spring 1994	0.76[3]	0.03

[1] *mean no. individuals*

[2] *no. individuals*

[3] *bird/survey/ha*

In addition to estimates of abundance and species composition, habitat associations have been examined. More birds were found in riparian habitats with mid- and overstory woody vegetation than in adjacent uplands. Hunter et al. (1988) and Thompson et al. (1994) found that exotic woody vegetation, such as saltcedar and Russian olive, were used by some bird species. Birds associated with human activities and habitats (e.g., agricultural fields) were increasing, while birds associated with mid-story willows were declining (Thompson et al. 1994). Woody riparian habitats supported many bird species during both migration and breeding seasons.

We found only one study on the nesting ecology of cowbirds and their hosts in New Mexico, and it was conducted in upland habitat (table 4). All other studies on rates and impacts of brown-headed cowbird parasitism have been conducted elsewhere in the Southwest and southern California (table 4). Nesting ecology studies conducted in riparian habitats elsewhere in the Southwest and West indicate that cowbird parasitism affects the nesting success of hosts. Rates of parasitism ranged from 0 to 100%. Although rates of parasitism in habitats with and without cattle varied, they did not exhibit a noticeable trend. When cowbirds were trapped intensively in least Bell's vireo habitat, rates of parasitism dropped from 47% to 0% (Griffith and Griffith 1993). Results from the parasitism studies reported in table 4 can not be compared directly because different methods of estimating nesting success were used. In addition, nest success rates estimated by directly counting the number of nests with ≥1 fledglings produced relative to the number of nests with ≥1 eggs, are biased by not considering nests, eggs, and fledglings not found by the observer (Mayfield 1961).

Bird species responded differently to restoration of native riparian vegetation along the lower Colorado River; densities of most permanent resident species increased quickly (<1 yr) in response to vegetation changes (Anderson et al. 1989). Revegetation benefitted insectivorous more than granivorous species, and early-season more than mid- or late-season breeders. Insect collections from blooming riparian vegetation along the upper Colorado River indicated that some exotic plant species (e.g., saltcedar, white sweetclover [*Melilotus alba*]) successfully attracted insects (Carothers and Sharber 1976). However, insect densities were lower on saltcedar than on native plant species when not blooming, suggesting that saltcedar has not been incorporated evenly into the riparian ecosystem. Densities of insect species declined markedly from

Table 4. Rates of brood parasitism by the brown-headed cowbird on host species in the Southwest and southern California.

State	Location	Habitat type	Host species	Year	Rate of parasitism (%)	Success of parasitized nests (%)	Method used to calculate nest success
Texas[1]	Kendall County	Upland: cedar brakes; ash juniper canyons	Golden cheeked warbler	1962 1963 1964	57.6	27.3	% of young fledged
Texas[2]	Fort Hood, central Texas	Upland: Texas hill country; gypsum canyons	Black-capped vireo	a) 1987-90 (no trapping) b) 1991, 1992 (trapping)	a) mean range 61.6-90.9 b) 38.8, 29.2	a) 2.4-25.5 b) 42.2, 48.4	not provided
Texas[3]	Kerr Wildlife Management Area	Upland:Texas hill country; gypsum canyons	Black-capped vireo	a) 1986 (no trapping) b) 1993 (trapping)	a) 71 b) 55 (no cattle), 11 (cattle)	not provided	not provided
Colorado[4]	Arapaho National Wildlife Refuge, North Park	Riparian:shrub willows, floodplain of Illinois River	Willow flycatcher	1985 1986	40.7	18.2(parasitized) 56.3 (not parasitized)	≥1 flycatcher fledged per nest
New Mexico[5]	East of Sangre de Cristo Mountains	Upland:pinyon pine, one-seed juniper, short-grass prairie	Solitary vireo	1992 1993	100 (no cattle) 80 (cattle)	33.3 (no cattle) 7.7 (cattle)	Mayfield 1961, 1975
			Western tanager	1992 1993	92 (no cattle) 78 (cattle)	33.3 (no cattle) 54.5 (cattle)	Mayfield 1961,1975
			Blue-gray gnatcatcher	1992 1993	63 (no cattle) 75 (cattle)	44.4 (no cattle) 25.0 (cattle)	Mayfield 1961, 1975
			Chipping sparrow	1992 1993	13 (no cattle) 0 (cattle)	43.8 (no cattle) 54.5 (cattle)	Mayfield 1961, 1975
			Rufous-sided towhee	1992 1993	0 (no cattle) 25 (cattle)	59.1 (no cattle) 60.0 (cattle)	Mayfield 1961, 1975
			Western wood-peewee	1992 1993	0 (no cattle) 14 (cattle)	64.3 (no cattle) 85.7 (cattle)	Mayfield 1961, 1975
Arizona[6]	Colorado River: Grand Canyon National Park, Glen Canyon Recreation Areas	Riparian: 389 km corridor; Glen Canyon Dam to Diamond Creek	Willow flycatcher	1982-1987 (5 yrs)	50 (*n*=8 nests)	not provided	not provided
			Bell's vireo	1982-1987	7 (*n*=57 nests)	not provided	not provided
			Blue-gray gnatcatcher	1982-1987	32.1 (*n*=28 nests)	not provided	not provided
			Lucy's warbler	1982-1987	23.1 (*n*=13 nests)	not provided	not provided
			Yellow warbler	1982-1987	22.7 (*n*=22 nests)	not provided	not provided
			Common yellowthroat	1982-1987	55.6 (*n*=9 nests)	not provided	not provided
			Yellow-breasted chat	1982-1987	10.8 (*n*=37 nests)	not provided	not provided
			Blue grosbeak	1982-1987	60 (*n*=5 nests)	not provided	not provided
			Overall rate for study area:		**17.9 (*n*=207 nests)**	not provided	not provided

Table 4. Cont'd.

State	Location	Habitat type	Host species	Year	Rate of parasitism (%)	Success of parasitized nests (%)	Method used to calculate nest success
California[7]	southern California	Riparian: coastal and desert slope; low-growth vegetation	Least Bell's vireo	1977 1978	50 (*n*=14 nests)	21	no. nests producing ≥1 fledgling, ÷ total no. nests
California[8]	The Nature Conservancy's Kern River Preserve	Riparian:moist, low-lying areas; thickets	Willow flycatcher with dense willow	1987	68 (*n*=19)	not provided	not provided
California[9]	Marine Corps Base Camp Pendleton	Riparian habitat	Least Bell's vireo	a) 1981, 1982 (no trapping) b) 1987 (trapping) c) 1990 (trapping)	a) 47 b) 17 c) 0	not provided	not provided
California[10]	The Nature Conservancy's Kern River Preserve	Riparian:willow-cottonwood woodland	Southwestern willow flycatcher	1989, 1990, 1991	60.2	26.1	(no. nests successfully fledging ≥1 SWWF) ÷ (total no. nests found with ≥1 egg)
	USDA Forest Service, South Fork Wildlife Area	Riparian:willow-cottonwood woodland	Southwestern willow flycatcher	1989, 1990, 1991	78.6	17.9	same as above
	The Nature Conservancy's Kern River Preserve	Riparian:willow-cottonwood woodland	Southwestern willow flycatcher	1993, 1994 (trapping)	17.4	41.6	same as above
	USDA Forest Service, South Fork Wildlife Area	Riparian:willow-cottonwood woodland	Southwestern willow flycatcher	1993, 1994 (trapping)	56.3	43.8	same as above

[1]*Pulich 1976*

[2]*Hayden et al. 1993*

[3]*Armstrong 1993*

[4]*Sedgwick and Knopf 1988*

[5]*Goguen 1994*

[6]*Brown 1994*

[7]*Goldwasser et al. 1980*

[8]*Harris 1991*

[9]*Griffith and Griffith 1993*

[10]*Whitfield 1995*

the more richly vegetated riparian zone to the terrace and talus slope (Carothers and Sharber 1976).

Densities of the brown-headed cowbird in New Mexico during the breeding season (May-July) for the last 15 years range from about 8 to 106 birds/40 ha, and average about 45.9 ± 16.3 SE birds/40 ha (table 3). Most earlier accounts stated that the brown-headed cowbird was fairly common to common during the breeding season, especially in riparian habitats.

An analysis of Breeding Bird Survey (BBS) data collected from 1966 to 1995, indicated a significant ($P<0.05$) 2.5% increase in number of cowbirds per year for New Mexico (U.S. Breeding Bird Lab, Worldwide Web Site 1997). The shorter term (1966 to 1979 and 1980 to 1995) trend analyses are not significant (H_0: $ß_1=0$; $P>0.05$). The results of various surveys conducted throughout riparian and upland habitats reported in table 3 do not appear to support the BBS suggestion that cowbird populations have increased over the last 30 yr. However, surveys conducted during independent studies of riparian communities and those conducted for the BBS used different counting methods and were located in different habitats, so the results are not directly comparable. Perhaps the cowbird population increased since the late 1960s, but not in all habitat types of New Mexico.

We found no published studies conducted in New Mexico to determine rates and impacts of cowbird parasitism on riparian-dependent host species. Riparian habitats in New Mexico have been greatly reduced, and populations of host species would be impacted further by increasing rates of parasitism. The least Bell's vireo and southwestern willow flycatcher, both endangered, are riparian-dependent, long-distance migratory songbirds and frequent hosts for the brown-headed cowbird throughout the Southwest (table 4). Currently, biologists are collecting data on the abundance and distribution of these hosts in New Mexico. Future studies should quantify cowbird abundance and distribution, and rates of parasitism on hosts, especially hosts listed as rare, threatened, or endangered.

Management Implications

Data yielded by research projects will provide guidance for managers concerned with restoration of populations of rare avian species and their habitats. If cowbirds are a significant factor affecting small, isolated populations of rare species, then immediate management actions should be taken (Schweitzer et al. 1996). However, habitat enhancement, restoration, and preservation must be incorporated into any management plan to address the ultimate problem facing migratory songbirds in the Southwest— habitat loss (Laymon 1987, Robinson et al. 1993, Robinson et al. 1995).

Management that mitigates the loss of riparian habitat functions due to invasion of exotic plant species has been successful in the lower Colorado River Valley. Anderson and Ohmart (1979, 1984) enhanced and established native riparian vegetation on disturbed sites along the lower Colorado River in Arizona and California. Subsequently, avian density and diversity in their renovated sites were greater than in unmodified sites. High horizontal and vertical foliar diversity enhanced avian species diversity and abundance (Anderson et al. 1979). Vegetation structure was more important to birds in winter than in summer (Anderson and Ohmart 1980). Anderson and Ohmart (1980) found that successful habitat improvement plans must consider the seasonal bird-vegetation relationships of both permanent and migratory species. Briggs et al. (1994) suggested that research on the effectiveness of riparian revegetation has been too small scale (one study site) and short-term (2 to 3 years post-restoration); they encouraged long-term studies that considered survival of planted trees and perennial plants.

Before populations of brown-headed cowbirds are removed from an area, and before extensive habitat restoration plans are implemented in efforts to improve conditions for rare neotropical migratory songbirds, surveys and quantitative studies must determine whether these actions are necessary. Our review of existing literature suggested that data on parasitism rates are lacking and that songbirds may adapt to and use exotic vegetation in riparian habitat.

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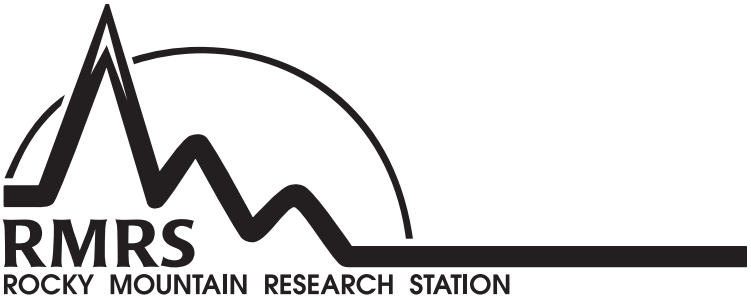

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