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FINAL PERFORMANCE REPORT

FEDERAL AID GRANT NO. T-4-P-1

WILDLIFE DIVERSITY INVENTORY AND DEVELOPMENT OF SPECIES OF GREATEST CONSERVATION NEED MANAGEMENT PLANS

OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION

MARCH 24, 2003 through December 31, 2006

FINAL REPORT

State: Oklahoma **Grant Number:** T-4-P

Grant Program: State Wildlife Grants

Grant Name: Wildlife Diversity Inventory and Development of Species of Greatest Conservation Need Management Plans

Grant Period: March 24, 2003 through December 31, 2006

A. Abstract: Priority conservation activities identified by the wildlife diversity program staff and the Oklahoma Nongame Technical Advisory Committee include conducting wildlife diversity inventories on public lands such as state wildlife management areas (WMAs), and conducting status assessments for species of conservation interest. Four WMAs were surveyed under this project, Beaver River, Sandy Sanders, Pushmataha, and Spavinaw Hills. Additionally, wildlife habitat maps were generated from digital aerial photographs and field surveys for Beaver River, Sandy Sanders and Pushmataha WMAs. Population assessment information was collected for black-tailed prairie dog, swift fox, burrowing owl, long-billed curlew, mountain plover, and breeding grassland birds in the shortgrass High Plains region, and Mexican free-tailed bat on the Selman Bat Cave WMA. Habitat maps were generated from current USGS land use and land cover and historical vegetation were generated for the shortgrass High Plains region from existing digital databases. A draft outline for a conservation assessment and strategy for shortgrass and mixed grassland species of greatest conservation need was developed.

B. Objectives:

1) Using existing survey techniques, develop a series of survey protocols for conducting inventories of all vertebrate taxa (mammals, birds, reptiles, amphibians and fish). Conduct comprehensive vertebrate wildlife surveys on one Oklahoma Wildlife Management Area annually and compare each species' distribution relative to existing habitat types.

2) Develop conservation plans for black-tailed prairie dog and associated species and other short and mixed grassland species of greatest conservation need.

C. Need: Nongame and species of greatest conservation need wildlife issues have been a growing concern for several years. Baseline information regarding the distributions and population sizes is lacking or incomplete for most nongame wildlife species. There are many animal species that are either declining or are regional endemics whose status is largely unknown. Developing an accurate assessment of population sizes, distributions and trends for all nongame wildlife species is a task that far exceeds the funding available for wildlife diversity management. Several projects, however, have been identified as priority activities by the wildlife diversity program staff and an independent technical advisory committee. These activities include conducting wildlife diversity inventories on public lands such as state wildlife management areas, and conducting status assessments for species of conservation interest.

Wildlife Management Area Biological Inventory

To begin to address the need for current distribution information for wildlife species, we propose to conduct thorough biological inventories of state wildlife management areas. Across the state of Oklahoma, the Oklahoma Department of Wildlife Conservation owns 23 wildlife management areas and manages habitats and wildlife populations on an additional 31 areas under lease agreements with federal agencies. These wildlife management areas encompass representative habitats within each of the state's eleven ecological regions including shortgrass prairies, mesquite savannahs, mixed oak/pine and oak/hickory forests and bottomland hardwood forests. Each area is managed in such a way that it maintains the natural habitat conditions of the ecological region in which it exists, and therefore should support many of the species typical of that region historically. However, baseline biological inventory data do not exist for most wildlife management areas making it difficult to determine how well these areas provide for the suite of species that should occur in that region. Conducting biological inventories of these areas has multiple benefits including; 1) establishment of a baseline biological condition for these areas, 2) collecting information regarding habitat use that can be used to determine the habitat affinities and needs of each species, 3) identifying populations of species of greatest conservation need on these areas that can be maintained or enhanced through habitat management, and 4) evaluating how existing land management practices affect nongame wildlife populations. All of these data can be used to ensure that wildlife management areas benefit entire suites of native species, identify methods by which the management for game and nongame species can be integrated, and demonstrate specific land management practices that conserve regional biological diversity. The first wildlife management areas that will be chosen for inventory work, will be those that occur in ecological regions that support relatively large numbers of regional endemic species (species unique to these regions) and species which are classified as species of special concern under state regulations. The ecological regions of greatest conservation concern include the short grass High Plains, southwestern tablelands, Ouachita Mountains and gulf coastal plain.

High Plains Species of Greatest Conservation Need Management Plans

Four species are either proposed or candidates for listing under the Endangered Species Act (ESA) in the High Plains region of Oklahoma, including the black-tailed prairie dog, mountain plover, lesser prairie chicken, and Arkansas darter. Species of concern for the region also include swift fox, burrowing owl, ferruginous hawk, long-billed curlew, Texas horned lizard, lesser earless lizard, flathead chub, Arkansas River speckled chub, plains minnow, and sturgeon chub. Additionally, regional endemics whose species is largely unknown included spotted ground squirrel, silky pocket mouse, American avocet, buff-breasted sandpiper, Sprague's pipit, lark bunting, Cassin's sparrow, McCown's longspur, chestnut-collared longspur, western hognose snake, Kansas glossy snake, plains blackhead snake, green toad, and Great Plains toad.

Black-tailed prairie dogs impact the prairie ecosystem in multiple ways. Many species of wildlife depend on black-tailed prairie dogs as a food source or for their habitat. Among those animals associated with prairie dogs and their colonies that are considered species of greatest conservation need are, burrowing owl, mountain plover, ferruginous hawk, and swift fox. In addition to their burrows serving as shelter for other species such as burrowing owls; prairie dog burrowing activity works to loosen and churn up the soil, increasing its ability to sustain plant life. Prairie dog foraging activities enable a more nutritious diverse mixture of grasses and forbs

to grow, and the enriched vegetation attracts a vast array of wildlife to their colonies. Black-tailed prairie dogs also play an integral role in the food chain and are a critical food source for such animals as the endangered black-footed ferret, ferruginous hawk, and other mammalian and avian predators.

Although factors associated with species declines vary, all species of greatest conservation need within the short and mixed grasslands would benefit from habitat improvement and restoration. In order to solve problems of declining populations of individual wildlife species, we must restore the health of the grassland ecosystems upon which they depend. Development of management strategies that can stem the tide of declining species in the short and mixed grasslands can only be achieved through an ecosystem-based conservation assessment and conservation strategy (CACS). Coordinated research and management strategies for short and mixed grasslands species of greatest conservation need would reduce the impacts to private landowners, and integrate existing species specific CACSs within a larger conservation strategy framework.

The black-tailed prairie dog (*Cynomys ludovicianus*) was petitioned on July 30, 1998 for listing as a threatened species under the ESA throughout its range. The USFWS published a 12-month finding on February 3, 2000, stating that although the black-tailed prairie dog warranted listing as a threatened species under the ESA, the USFWS was precluded from doing so by other higher priority species. On March 17, 1999 the 11state wildlife agencies within the black-tailed prairie dog's range formed the interstate Black-tailed Prairie Dog Conservation Team (BTPDCT). The BTPDCT produced, in cooperation with private, tribal, federal, and other state agencies, the Interstate Black-tailed Prairie Dog Conservation Agreement in November, 1999 (Van Pelt 1999). The purpose of the Conservation Agreement is to manage, maintain, and enhance habitat and populations of black-tailed prairie dogs throughout its historic range and reduce the number of threats impacting their viability through the cooperation of private, tribal, federal, and state landowners. In October, 1999, the Oklahoma Department of Wildlife Conservation (ODWC) convened the Oklahoma Black-tailed Prairie Dog State Working Group (SWG), to assist with the development of a prairie dog state management plan. The SWG represents a broad coalition of stakeholders affected by prairie dog management. As a result, a diverse array of opinions, concerns, and ideas were considered in the evolution of the state management plan.

D. Approach:

1) A list of the vertebrate taxa known to occur or likely to occur in the ecological regions where Wildlife Management Areas (WMA) are to be surveyed will be compiled. Existing survey protocols for mammals, birds, reptiles, amphibians and fish will be reviewed and evaluated to determine which methods are most likely to be productive and cost effective for inventorying the vertebrate fauna of the region. A survey protocol will be developed that will be a compilation of these survey techniques. This will ensure that all surveys will be conducted using standard methods that can be repeated by other biologists in the future.

2) One WMA will be surveyed each year using the survey protocol. Sampling trips will be made throughout the year to ensure that data are collected for species which exhibit seasonal variation in their activity. As examples, many amphibian species are most active in late winter and early

spring, many songbirds are most active in early summer and some predatory mammals and birds are most easily surveyed in late summer and early fall. Vertebrate inventories will occur on the Sandy Sanders WMA during fiscal year 2003. Pushmataha WMA, in southeastern Oklahoma will be surveyed during 2004 and the Spavinaw Hills WMA survey will take place in 2005. Also in fiscal year 2003, we will complete the vertebrate survey of the Beaver River WMA. Portions of the Beaver River WMA survey will be repeated in 2003 as a result of low mammal and amphibian captures in 2002 that we attribute to the on-going regional drought. Should unusually wet or dry weather conditions prevail during the years that other wildlife management areas are surveyed, we may carry the data collection into the following year if necessary.

3) Where feasible, surveys will be conducted in such a way that the number of individuals of each species can be quantified (e.g. number of individuals per unit time for taxonomic groups where this is possible). By using quantitative survey techniques, these surveys may serve as a baseline for future surveys or monitoring programs. These methods also may help to evaluate the relative abundance of sets of species which may be useful as a basis for comparison in future years.

4) A set data collection procedures will be created to automate and streamline the process of collecting nongame species and habitat field data with GPS data collectors. This will allow all data to be incorporated into the Department's GIS.

5) Vector-based GIS data layers of baseline habitats on each WMA will be created from digital aerial photographs and ground verification. Qualitative habitat data will be collected at species' survey locations and existing habitat conditions will be documented through photographs. The habitat information can be used to document the habitat affinities of particular species and can serve as a basis for comparison for measuring changes in habitat structure over time. This information will be used as a basis for making habitat management recommendations to integrate conservation efforts for nongame species of greatest conservation need with existing management for game species.

6) Baseline population data will be collected for priority species of greatest conservation need identified for the short and mixed grasslands. These species may include, but not be limited to, the mountain plover, Mexican free-tailed bat, long-billed curlew, black-tailed prairie dog, Texas horned lizard, and burrowing owl. When feasible, historical data will be gathered and interpreted for quality of the information.

7) By using habitat inventories and landscape analysis of suitable habitat, identify constraints and opportunities for species of greatest conservation need population maintenance and expansion within the state. Identify focus areas for conservation efforts designed to enhance or improve suitable habitat.

8) Focus areas for intensive black-tailed prairie dog management will be delineated to maximize the potential of developing complexes 1,000 acres or greater. Landownership categories will be mapped and overlayed onto prairie dog colony and complex data. Areas on public lands that could be used to enhance existing colonies or for new prairie dog acreage creation will be

identified. Areas of suitable habitat on non-public lands that could be associated with existing occupied acreage to enhance colony size and viability voluntarily with incentive dollars will be identified.

9) A reporting and monitoring protocol for detecting the occurrence of sylvatic plague epizootics in wild rodents will be developed. Protocols for handling and lab examination of carcasses, burrow swabbing methods and lab analysis for areas with suspected plague outbreaks will be established. Baseline information on the existence of plague in the short and mixed grasslands will be collected.

E. Results and Discussion:

Wildlife Management Area Biological Inventory

Vector-based layers of current habitats on each WMA were created from digital aerial photographs and were ground truthed. The habitat information will be used to document the habitat affinities of particular species and serve as a basis for comparison for measuring changes in habitat structure over time. This information will be used as a basis for making habitat management recommendations to integrate conservation efforts for nongame species of greatest conservation need with existing management for game species.

Vertebrate Inventory of Spavinaw Hills Wildlife Management Area, Pushmataha Wildlife Management Area and Sandy Sanders Wildlife Management Area.

This portion of Federal Assistance Grant # T-4-P (State Wildlife Grants) continues the biological inventory work that was initiated under Federal Assistance Grant # R-6-R (Wildlife Conservation and Restoration Program) in 2001. In April of 2003, the grant activities that were performed under grant R-6-R were transferred to Federal Aid Grant T-4-P. During the grant period for T-4-P, biological surveys were conducted on the Sandy Sanders Wildlife Management Area (WMA) in southwestern Oklahoma, the Pushmataha WMA in the Ouachita Mountains of southeastern Oklahoma, and the Spavinaw Hills WMA in the Ozark Plateau of northeastern Oklahoma. The results of these surveys are provided in this report. The Beaver River Wildlife Management Area was surveyed in 2002 and 2003 under federal aid grant R-6-R. The results for those earlier surveys were presented in the Final Report for R-6-R, though a habitat map for the WMA was prepared under this current grant and is shown in Figure 1.

Personnel working on this project were wildlife diversity biologists Mark Howery, Julianne Hoagland, and Melynda Hickman. We would like to thank Ron Smith, Scott Webb and Russell Perry for their assistance at Sandy Sanders WMA, Jack Waymire for his assistance at Pushmataha WMA and Scott Cox and Tony Crawford for their help at Spavinaw Hills WMA. These biologists were a wealth of information and were able to direct us toward productive survey locations on their areas. We also would like to thank several volunteers from the Oklahoma City Zoo who helped us with the wildlife survey including Vonceil Harmon, Brian Acone, Tony Sibille, Eddie Witte, and Darcy Henthorn, and Mike Caywood from Alabaster Caverns State Park.

Biological inventories were conducted throughout most of the year, however we did not conduct surveys during the most active seasons (October through December, and early April) when recreational use of the WMAs was high and we were concerned with disrupting those activities. Each survey was targeted toward one to three taxonomic groups that were especially active at that season. Most survey methods were quantitative or semi-quantitative meaning that the data collected reflect the number of animals that were seen/heard/captured during a specific unit of time or distance. By collecting quantitative data, it will be possible for biologists to repeat these surveys in the future and compare the current animal communities to their future condition. Additionally, we recorded incidental observations of non-targeted animal groups (e.g. reptiles seen during breeding bird surveys). Our survey techniques were based upon those researched and recommended in Simpson et. al. (1996) and other sources. Several reference books were used to generate a list of the vertebrate species that were likely to occur on each of the three wildlife management areas and to aid in the identification of species that were seen or captured. These references included: (mammals: Burt 1976 and Caire et.al. 1989; birds: Baumgartner and Baumgartner 1992, Peterson 1980, Reinking 2004, Sibley 2000, Sutton 1967, Tyler 2005; reptiles and amphibians: Conant and Collins 1998, Crother et. al. 2000, Sievert and Sievert 2005, Trauth et. al. 2004, Webb 1975, Werler 2000; fish: Miller and Robison 2004, Page and Burr 1991, Pigg and Hill 1974).

Mammal surveys were conducted primarily during the winter and spring months, though incidental observations were recorded during other seasons. Four methods were used to survey mammals - track searches, nocturnal spotlight surveys, live trapping using baited Sherman traps, and nocturnal mist-netting for bats. Track searches were conducted during the morning and consisted of a biologist searching for tracks and other mammal signs along dirt roads and in areas of bare soil. Track searches were used to detect the presence or absence of species in a specific location but could not be used to assess the number of individuals of each species. Track searches were conducted for approximately fifteen minute at each location and were most useful in detecting the presence of medium sized carnivores. Spotlighting surveys were conducted along WMA roads between dusk and approximately midnight. Biologists drove slowly along roads and used a hand-held spotlight to locate mammals moving about or foraging in habitats near these roads. This method was useful for locating lagomorphs, deer and some medium-sized mammals. Live trapping was conducted using collapsible Sherman traps placed along fence lines or other areas of relatively high rodent activity. Traps were baited with peanut butter and rolled oats, or with black oil sunflower seeds and apple, and were set out shortly before dusk and checked the following morning (American Society of Mammalogists 1987). All trapped mammals were recorded and released at the site of their capture. Trapping success was variable, but this is the most efficient method for identifying the presence of small rodents. Pole-mounted mist nets were set up during the afternoon at locations that looked suitable for encountering foraging bats (Kunz 1988). These locations were either at potential watering areas (small streams or ponds), or in forest clearings. The nets were opened approximately 30 minutes before sundown and watched continuously until the evening temperatures dropped below 59 degrees Fahrenheit (usually three to four hours after dark). As bats were captured, they were removed from the nets, recorded and released.

Bird surveys were conducted using two types of timed searches. During all seasons, but especially during the fall and winter when birds are less vocal, we conducted visual searches for birds in specific habitat types. During these searches, we recorded the number of minutes spent in that particular habitat type and all birds that were seen or heard. During the month of June, we conducted point counts as a more quantitative survey technique to assess the breeding bird community. Our point counts were a modification of Hamel et. al. (1996) in which the count duration was shortened to five minutes to increase the number of counts that we could conduct in a morning. Point counts were conducted at 0.4 mile intervals along WMA roads. This distance interval minimized the potential for counting the same individual bird twice and placing the point count stations along roads increased the number of counts that could be conducted during a morning by decreasing the amount of time needed to travel between stations. Point counts were conducted between sunrise and 1100 hours and again during the last 2.5 hours of daylight (1830 - 2100 hours) to ensure that all counts were made during periods of peak singing behavior. During each point count, we recorded all adult birds that were seen or heard during a five minute period within a 250 yard radius of the observer. Timed searches and point counts were effective methods for surveying most birds, particularly terrestrial species. An effort was made to listen for nocturnal birds (e.g. Common Poorwill, owls) opportunistically during evening surveys for reptiles and amphibians. We did not use the play-back of taped bird calls as a survey method. This can be useful for detecting nocturnal species and secretive marsh birds, but had limited applicability on the wildlife management areas surveyed during this project.

Four methods were used to survey reptiles and amphibians - timed searches, evening and morning road cruises/searches, aquatic turtle trapping and nocturnal calling surveys. Timed searches were the most widely used method and consisted of biologists walking through habitat for a specific unit of time and recording all reptiles and amphibians flushed from vegetation or found under rocks, logs and other structures (Heyer et. al. 1994, Renken 1995). Timed searches were conducted in all habitat types and at all times of the day in which the air temperature was between approximately 60 F and 90 F. Evening road searches were conducted during the summer months between dusk and approximately midnight. During these searches, biologists slowly drove WMA roads looking for reptiles and amphibians basking on or foraging along roads. This survey technique was most useful for locating toads and some species of snakes. A variation of this technique that we also used was to slowly drive WMA roads during the mid-morning and late afternoon hours searching for lizards, snakes and turtles that were basking on roads. This technique was particularly useful for locating Texas Horned Lizards (*Phrynosoma cornutum*), racerunners (*Cnemidophorus*) and Fence Lizards (*Sceloporus undulatus*). Aquatic turtle traps were baited to partially opened cans of sardines and placed in streams and ponds overnight to capture turtles. Nocturnal calling surveys were conducted in the spring and early summer months between dusk and midnight, and consisted of listening for calling toads and frogs in five-minute time periods around permanent and seasonal wetlands.

Fish were surveyed using a combination of seining, dip-netting and minnow trapping. A seine was used to survey fish in streams and small pools. Where possible, two biologists drug a seine through a 100-yard segment of stream and identified all fish collected. Dip nets were used to sample fish in small pools or in locations in streams where the aquatic vegetation was too thick to effectively use a seine. Minnow traps, either un-baited or baited with bread, were placed in

streams at night as another method of collecting fish. Fish were identified to species in the field and released.

On each of the wildlife management areas that were surveyed, we assessed the plant communities on the area and noted the habitat used by each vertebrate species. For many species of birds, our sample sizes were sufficiently large to detect patterns in plant community associations. For most mammals, reptiles and amphibians, our sample sizes were small or there were not obvious associations at the scale of plant communities. We used the publication "The Vegetation of Oklahoma: A Classification for Landscape Mapping and Conservation Planning" (Hoagland 2000) to assist us in delineating plant communities (a.k.a. habitat types). Woody plant identifications were based upon Little (1991).

Spavinaw Hills Wildlife Management Area

Our survey of the Spavinaw Hills Wildlife Management Area spanned the period from April 2005 through September 2006. Biological inventories were conducted on the dates listed below, and the results of these inventories are listed in Table 1. The total search effort (number of hours dedicated to each survey type) is listed by habitat type in the footnote to Table 1.

25 April 2005: surveys for migrating and breeding birds
7, 8 & 9 June 2005: surveys for breeding birds and for reptiles
8, 9 & 10 March 2006 - surveys for winter birds, small mammals and amphibians
18, 19 & 20 April 2006 - surveys for bats and reptiles
12 & 13 September 2006 - surveys for bats, migrating birds and reptiles

The Spavinaw Hills Wildlife Management Area contains approximately 13,800 acres of native habitat immediately south of Spavinaw Reservoir. The WMA is situated over the county line between Mayes and Delaware counties in such a way that approximately 3,600 acres on the west end of the area occur in Mayes County while the remaining acreage (approximately 10,200 acres) occurs in Delaware County. The Spavinaw Hills WMA occurs in a heavily dissected portion of the Springfield Plateau of the Ozark Highlands. Most of the rugged portions of the wildlife management area are forested, with dry oak-pine forest occupying the ridges and other upland areas while mixed hardwood forest occupies the more mesic slopes and hollows. Several of the hollows have been partially cleared of trees and planted to pasture land that is dominated by exotic herbaceous vegetation such as Johnson Grass (*Sorghum halepense*), vetch (*Vicia* or *Coronilla* species), brome (probably Smooth Brome (*Bromus inermis*)), and Orchard Grass (*Dactylis glomerata*). Much of this clearing had been conducted prior to ODWC acquiring the property, and the clearings were maintained to provide forage for American Elk and White-tailed Deer. A remnant tract of native tallgrass prairie, known as Cochran Prairie, occurs on the western end of the wildlife management area. Adjacent to the north and east sides of this prairie is an area of upland forest and woodland that is dominated by Post Oak (*Quercus stellata*), Blackjack Oak (*Quercus marilandica*) and Black Hickory (*Carya texana*).

For purposes of the vertebrate surveys, we groups the habitat types on the WMA into three larger types: Upland Oak-Pine Forest, Mesic Hardwood Forest and Upland Woodland, Savannah and Prairie Complex.

Upland Oak-Pine Forest: The Upland Oak-Pine Forest habitat grouping is comprised of forested sites on ridges, plateaus and slopes that have a canopy closure of 80% or more and are dominated by oaks and pines. Dominate canopy trees include Post Oak (*Quercus stellata*), Black Oak (*Quercus velutina*), Shortleaf Pine (Pinus echinata), and Black Hickory (*Carya texana*) with lesser numbers of White Oak (*Quercus alba*), Blackjack Oak (*Quercus marilandica*), Chinkapin Oak (*Quercus muehlenbergii*), Mockernut Hickory (*Carya alba*) and Winged Elm (*Ulmus alata*). Woody understory plants include Redbud (*Cercis canadensis*), Lowbush Blueberry (*Vaccinium pallidum*) and Mexican Plum (*Prunus mexicana*), and the herbaceous understory is sparse.

Mesic Hardwood Forest: This is a diverse plant community that occurs in hollows, ravines and lower slopes throughout the WMA. This is a fairly common habitat on the area and its abundance may be positively influenced by the nature of the WMA sloping toward Spavinaw Creek and having a northern aspect. This community is dominated by hardwood trees including White Oak (*Quercus alba*), Northern Red Oak (*Quercus rubra*), Shumard Oak (*Quercus shumardii*), Chinkapin Oak (*Quercus muehlenbergii*), Mockernut Hickory (*Carya alba*), Sugarberry (*Celtis laevigata*) with lesser numbers of Black Walnut (*Juglans nigra*), Bitternut Hickory (*Carya cordiformis*), Black Cherry (*Prunus serotina*), Black Gum (*Nyssa sylvatica*), and White Ash (*Fraxinus americana*). Common woody understory plants include Flowering Dogwood (*Cornus florida*), Redbud (*Cercis canadensis*), Vernal Witch-hazel (*Hamamelis vernalis*), Downy Serviceberry (*Amelanchier arborea*), Mexican Plum (*Prunus mexicana*). This community also supports two uncommon and regionally endemic plants - the Ozark Chinkapin (*Castanea ozarkensis*) and the Ozark Spiderwort (*Tradescantia ozarkana*). In some areas, the understory is dominated by the introduced shrub Amur Honeysuckle (*Lonicera maackii*). Into this habitat grouping we also included narrow man-made openings that were dominated by exotic herbaceous vegetation. These areas were generally small and the wildlife species that used them appeared to inhabit the adjacent forest or the thickets that occurred in the transition between the openings and the forest. We did not document any species that appeared to be restricted to the openings, though several species including the American Elk, Indigo Bunting and American Goldfinch may have been positively influenced by the presence of these openings.

Upland Woodland, Savannah and Prairie Complex: This habitat grouping occurred primarily on the southern and western edges of the Spavinaw Hills WMA. The southern boundary of the WMA, south of Cochran Prairie Road, is subject to periodic fires (including fires that were set south of the WMA but moved onto the area). Over time, these fires have returned the structure of this upland area to an oak-pine woodland with an abundance of understory shrubs and herbaceous vegetation. (This is primarily in portions of Sections 31, 32 and 33, T22N, R22E). The plant community is comprised of scattered mature Shortleaf Pines (*Pinus echinata*), Post Oak (*Quercus stellata*), White Oak (*Quercus alba*) and Black Oak (*Quercus velutina*). The understory is dominated by Winged Elm (*Ulmus alata*), sumac (*Rhus copallina* and *Rhus glabra*), Sassafras (*Sassafras albidum*), Persimmon (*Diospyros virginiana*), Roughleaf Dogwood (*Cornus drummondii*), blackberries (*Rubus* species), Big Bluestem (*Andropogon gerardii*) and numerous forbs. West of these Sections, in portions of Sections 25, 26, 27 an 36, T22N, R21E, pine trees are sparse or lacking and the woodland canopy is dominated by Post Oak, Blackjack Oak (*Quercus marilandica*), Black Hickory (*Carya texana*) and Black Oak. These Sections includes Cochran Prairie, a tallgrass prairie remnant which is bordered by Post Oak Savannah.

Birds:

Ninety-eight species of birds were documented during the inventory of the Spavinaw Hills WMA. We believed that we have documented most of the breeding and wintering species on the area as well as representative sample of the most common migrant species that pass through the area during the fall and spring. Most of these birds were located during timed searches spent observing or listening for birds from either a vehicle or on foot. During June of 2005, we conducted a series of 5-minute point counts at 55 locations across the WMA to specifically quantify the breeding bird community. The results of these point counts are shown in Table 2., and these same observations also are included in the overall summary in Table 1. Fifty-five of the 73 species of birds suspected of nesting on the WMA were detected during these surveys. The remaining 18 species were primarily nocturnal or were species that occurred in low numbers on the WMA. The breeding bird point counts were a good method for detecting the more common species on the area and examining differences in relative abundance between habitat types. The most common breeding birds across the area were Red-eyed Vireo, Tufted Titmouse, Summer Tanager and Indigo Bunting. Each of these was common in all habitat types. The Pine Warbler was commonly detected in the upland oak-pine forest sites, while the White-eyed Vireo, Northern Parula and Kentucky Warbler were each common in the mesic bottomland sites. The woodland habitat supported relatively high numbers of Eastern Wood Pewees, Blue-gray Gnatcatchers, Yellow-breasted Chats, and Brown-headed Cowbirds.

Water Birds: Because standing water on the wildlife management area is limited to a few man-made ponds and several ephemeral streams, waterfowl, shorebirds, wading birds and other aquatic species were rare. We documented only four species of wading birds - American White Pelican, Great Blue Heron, Cattle Egret and Green Heron. In each case, the birds were observed flying over the WMA, probably en route to or from Spavinaw Reservoir or Eucha Reservoir. The Wood Duck was the only species of waterfowl that we observed on the WMA. Wood Ducks should be present year-round on the area year round and small numbers appear to use the small ponds on the area as foraging sites. Because of the WMA's close proximity to Spavinaw Reservoir, we expect that several other species of waterfowl should use the WMA's ponds during the winter months. No shorebirds were documented on the wildlife management area and almost no suitable habitat exists for them with the exception of a few small ponds and seasonally wet portions of Cochran Prairie. Based upon birder observations in nearby portions of Hudson, Spavinaw and Eucha reservoirs, the most likely shorebirds to be encountered, though in relatively small numbers, would be Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Solitary Sandpiper, Spotted Sandpiper and Wilson's Snipe. It is possible that the American Woodcock nests on the area, though we did not detect any during the dry winter/spring of 2006. This is a species which should be looked for in future years when weather conditions are more favorable

Vultures and Diurnal Raptors: We observed both Turkey and Black Vultures in all seasons on the WMA, though Turkey Vultures appear to be more abundant. Both species were seen in all habitat types and most individual vultures were observed as they soared overhead. We did encounter one small roost of Black Vultures in a wooded area on the southwest side of Cochran Prairie during our winter survey. The Red-shouldered Hawk was the most commonly seen hawk on the area, especially in the mesic forest habitat. Small numbers of Broad-winged Hawks were

seen in both upland and mesic forest habitat and Red-tailed Hawks were seen in the vicinity of clearings in both the woodland and mesic forest habitats.

Game Birds: Wild Turkeys were fairly common on the WMA but were not detected in large numbers by the survey techniques that we used. Turkeys are fairly wary in forested habitat and not easily seen. Also, our breeding bird survey was conducted in June several weeks after the peak breeding season for turkeys. Northern Bobwhite were heard frequently in the woodland habitat surrounding Cochran Prairie, though we did not physically see any birds. Mourning Doves were most frequently see and heard around clearings in the mesic forest habitat and the woodland habitat.

Nocturnal Birds: We heard and/or saw three species of owls - Great Horned Owl, Barred Owl and Eastern Screech Owl. We did not gather a sufficient number of detections to assess the habitat associations of each species, but both the Barred Owl and Eastern Screech Owl appeared to be common in both upland and mesic forest habitats. We heard three species of nightjars - Whip-poor-will, Chuck-wills-widow and Common Nighthawk. Whip-poor-wills appear to be the most common of the three species and were widespread in all three habitat types. A single Common Nighthawk was observed in oak woodland habitat adjacent to Cochran Prairie. The timing of our bat surveys did not help us to better document the abundance of nightjars. Our spring survey in April was too early for most of the returning birds and neither the Whip-poor-wills nor Chuck-wills-widows were calling during our September survey.

Spring / Fall Migrating Songbirds: Approximately 30 species of songbirds annually migrate through the Ozark Region of Oklahoma. Spring migrants are often more easily documented because the window of time for spring migration is shorter than that of fall migration and birds are both 1) more concentrated and 2) more easily seen. Most migrants pass through Oklahoma between the first week in April and the third week in May (roughly 7 weeks), whereas fall migration may run from the third week of August through the last week of October (10 weeks). Additionally, male songbirds may sing and be vocal during spring migration, but are typically silent during fall migration. We chose to concentrate on the spring migration season during our surveys because we believed that our time would be more productive and we could conduct surveys for amphibians and reptiles during those same trips. During our spring migration surveys we documented eight species: Swainson's Thrush, Blue-headed Vireo, Tennessee Warbler, Nashville Warbler, Orange-crowned Warbler, Yellow Warbler, Blackburnian Warbler and Lincoln's Sparrow. Based upon birder observations around Spavinaw Lake and Eucha Lake, other common migrants through this area should include Least Flycatcher, Alder Flycatcher, Tree Swallow, Philadelphia Vireo, Gray Catbird, Gray-cheeked Thrush, Veery, Magnolia Warbler, Black-throated Blue Warbler, Black-throated Green Warbler, Chestnut-sided Warbler, Blackpoll, Ovenbird, Northern Waterthrush, Mourning Warbler, Wilson's Warbler, Bobolink, and Rose-breasted Grosbeak.

Breeding and Wintering Diurnal Land Birds: We documented 60 species of songbirds, seven species of woodpeckers, the Yellow-billed Cuckoo, Chimney Swift and Ruby-throated Hummingbird which breed and/or spend the winter months on the WMA. Because of the number and diversity of land bird species, they will be summarized as communities under each of

the three habitat types. Of these 69 species, 19 were year-round residents on the area - Red-headed Woodpecker, Red-bellied Woodpecker, Downy Woodpecker, Hairy Woodpecker, Pileated Woodpecker, American Crow, Blue Jay, Carolina Chickadee, Tufted Titmouse, White-breasted Nuthatch, Carolina Wren, Eastern Bluebird, Pine Warbler, Northern Cardinal, Eastern Towhee, Field Sparrow, Chipping Sparrow, Eastern Meadowlark and American Goldfinch. Eleven species were present only during the winter months - Yellow-bellied Sapsucker, Brown Creeper, Ruby-crowned Kinglet, Golden-crowned Kinglet, Hermit Thrush, Yellow-rumped Warbler, Dark-eyed Junco, White-throated Sparrow, Swamp Sparrow, Song Sparrow, and Fox Sparrow. Three species were found only during the winter months but might be year-round residents - Northern Flicker, American Robin and House Finch. Four other species were found primarily in the summer months, but are known to successfully winter in the region - Eastern Phoebe, Fish Crow, Brown Thrasher and Brown-headed Cowbird. The remaining 33 species are breeding species that winter well to the south of Oklahoma - Yellow-billed Cuckoo, Chimney Swift, Ruby-throated Hummingbird, Eastern Wood Pewee, Acadian Flycatcher, Great Crested Flycatcher, Eastern Kingbird, Scissor-tailed Flycatcher, Northern Rough-winged Swallow, Barn Swallow, White-eyed Vireo, Red-eyed Vireo, Yellow-throated Vireo, Blue-gray Gnatcatcher, Black and White Warbler, Northern Parula, Yellow-throated Warbler, Prairie Warbler, Louisiana Waterthrush, American Redstart, Kentucky Warbler, Worm-eating Warbler, Prothonotary Warbler, Common Yellowthroat, Yellow-breasted Chat, Summer Tanager, Scarlet Tanager, Blue Grosbeak, Indigo Bunting, Painted Bunting, Dickcissel, Lark Sparrow and Orchard Oriole.

Mesic Forest Land Birds: At least 46 species of breeding birds were documented in the mesic forest habitat. Common species characteristic of this habitat type included White-eyed Vireo, Red-eyed Vireo, Tufted Titmouse, Carolina Wren, Blue-gray Gnatcatcher, Northern Parula, Kentucky Warbler, Summer Tanager and Indigo Bunting. The Acadian Flycatcher, Yellow-throated Vireo, Prothonotary Warbler, Louisiana Waterthrush, and American Redstart were found exclusively in this habitat type, while the Red-eyed Vireo, Yellow-throated Warbler, Northern Parula, Kentucky Warbler and Scarlet Tanager reached their greatest abundances here. The relative abundance of shrubs and herbaceous vegetation in the understory was probably the key habitat feature that influenced the densities of several species (e.g. Acadian Flycatchers, White-eyed Vireos, Carolina Wrens and Kentucky Warblers). Similarly, it is interesting to note that the densities for White-eyed Vireo, Blue-gray Gnatcatcher, and Northern Cardinal - each associated with shrubs and understory vegetation - were roughly the same between the mesic forest habitat and the more open oak-pine woodland habitat.

During the winter months, at least 29 species were found in the mesic forest habitat type. This included all of the year-round resident species as well as the addition of most of the wintering species (e.g. Hermit Thrush, White-throated Sparrow, Fox Sparrow). During our winter survey, most of the bird species appeared to be more abundant in the mesic forest habitat than in either of the other two habitats. We suspect that this might have been due to a combination of greater protection from the wind in the low valleys and greater visibility of the birds due to the reduced abundance of Short-leaf Pine.

Upland Oak-Pine Forest Land Birds: Thirty-one species of breeding birds were detected in the upland oak-pine forest habitat. Characteristic species of this habitat type included Eastern Wood

Pewee, Red-eyed Vireo, Tufted Titmouse, Black and White Warbler, Pine Warbler, Summer Tanager and Indigo Bunting. Though many breeding species were found in the upland forest habitat type, only the Worm-eating Warbler was unique to this habitat and only the Pine Warbler appeared to have its highest density here. The Worm-eating Warbler records are noteworthy because in both cases where singing males were detected, the birds occupied an area where a small scale thinning (1-2 acres) had taken place, and tall understory shrubs such as sassaffrass, plum and dogwood had become abundant. The increased abundance of tall shrubs created by the selective thinning of some canopy trees, appears to create the habitat conditions with which this species associated (Hanners and Patton 1998). Other species documented at these thinned upland sites included the Yellow-throated Warbler and Black and White Warbler.

Twenty-one species were documented in upland oak - pine forest during the winter months. This community included all of the breeding species which were year-round residents, plus the more common winter residents such as the Golden-crowned Kinglet, Yellow-rumped Warbler and Dark-eyed Junco.

Oak-Pine and Oak Woodland Land Birds: Forty-three species of breeding birds were detected in the oak-pine woodland and savannah habitat during our breeding bird point-count survey. Additionally, singing male Dickcissels and Eastern Meadowlarks were located in Cochran Prairie within this community. Common birds found in the complex of woodland and savannah communities were Eastern Wood Pewee, Great Crested Flycatcher, Tufted Titmouse, Blue-gray Gnatcatcher, Yellow-breasted Chat, Indigo Bunting and Field Sparrow. Ten breeding species were found only in this community: Northern Bobwhite, Eastern Bluebird, Brown Thrasher, Prairie Warbler, Common Yellowthroat, Painted Bunting, Eastern Towhee, Dickcissel, Eastern Meadowlark and Orchard Oriole. Northern Bobwhite and Prairie Warbler were fairly common and found at several locations; the other species were uncommon and found at only one or a few sites. The Yellow-billed Cuckoo, Eastern Wood Pewee, Great Crested Flycatcher, Blue-gray Gnatcatcher, Yellow-breasted Chat, Indigo Bunting, Field Sparrow and American Goldfinch were found in multiple habitat types, but reached their greatest abundance in the woodland/savannah complex. The Prairie Warbler and Northern Bobwhite are especially noteworthy in this community because both species have shown significant range wide declines over the past forty years, but appear to have manageable populations on the southern and western sides of the Spavinaw Hills WMA.

Mammals:

Based upon the geographic ranges depicted in Mammals of Oklahoma (Caire et. al. 1989), approximately 37 species of mammals potentially occur on the Spavinaw Hills WMA, of which our surveys confirmed the presence of 21. The majority of species were encountered only a few times, therefore, for the majority of species, we can not make accurate inferences regarding their habitat associations beyond confirming their presence on the WMA.

Track surveys were difficult to conduct on much of the area because most of the WMA roads were comprised of chert and gravel and were poor substrates for tracking. Our most successful locations for locating and identifying tracks were in the vicinity of ponds where tracks were left

in silty substrate. At these locations we were able to document tracks for Virginia Opossum (*Didelphis virginiana*), Raccoon (*Procyon lotor*), Coyote (*Canis latrans*), Bobcat (*Lynx rufus*) and White-tailed Deer (*Odocoileus virginianus*).

We set up pole-mounted mist-nets at six location over four evenings (two evenings and two sites in April 2006; two evenings and four sites in September 2006). At each mist-netting location, the nets were placed in a clearing over or next to water. Four of these sites were on roads through wooded areas in which a water-filled rut or depression existed. During these surveys, we netted and released three Northern Long-eared Myotis (*Myotis septentrionalis*), 10 Eastern Pipistrels (*Pipistrellus subflavus*), 11 Evening Bats (*Nycticeius humeralis*) and 22 Red Bats (*Lasiurus borealis*). Additional Eastern Pipistrels were observed roosting in a small cave in Groundhog Hollow. During the evening bat surveys, one Southern Flying Squirrel (*Glaucomys volans*) was captured in a net and a second individual was observed gliding in front of the net.

Most of our mammal observations were made during timed searches for birds, reptiles and amphibians. We documented Eastern Mole (*Scalopus aquaticus*), Nine-banded Armadillo (*Dasypus novemcinctus*), Eastern Chipmunk (*Tamias striatus*), Eastern Gray Squirrel (*Sciurus carolinensis*), Fox Squirrel (*Sciurus niger*), Woodchuck (*Marmota monax*), Eastern Cottontail (*Sylvilagus floridanus*), Hispid Cotton Rat (*Sigmodon hispidus*), Texas Brush Mouse (*Peromyscus attwateri*), American Elk (*Cervus elaphus*) and White-tailed Deer (*Odocoileus virginianus*) during daylight and evening timed searches. Three of our timed searches involved the examination of a small cave in Ground Hog Hollow during different seasons (spring, summer and fall). During these surveys, we documented roosting Eastern Pipistrels (*Pipistrellus subflavus*) and an Eastern Woodrat (*Neotoma floridana*).

Fourteen additional species are likely to occur on the WMA but were not detected by us: Elliot's Short-tailed Shrew (*Blarina hylophaga*), Least Shrew (*Cryptotis parva*), Gray Bat (*Myotis grisescens*), Big Brown Bat (*Eptesicus fuscus*), Swamp Rabbit (*Sylvilagus aquaticus*), Plains Pocket Gopher (*Geomys bursarius*), Fulvous Harvest Mouse (*Reithrodontomys fulvescens*), White-footed Mouse, (*Peromyscus leucopus*), Deer Mouse (*Peromyscus maniculatus*), Woodland Vole (*Microtus pinetorum*), Red Fox (*Vulpes vulpes*), Gray Fox (*Urocyon cinereoargenteus*), Mink (*Mustela vison*) and Striped Skunk (*Mephitis mephitis*). There is also a small chance that the Eastern Spotted Skunk (*Spilogale putorius*), a rare species in Oklahoma, might occur on the area. Additional survey effort, especially live trapping and track searching, is needed to complete the mammal survey.

Amphibians:

Based upon museum records and published range maps (Sievert and Sievert 2006), 22 species of amphibians potentially occur on the wildlife management area. These species include nine salamanders and thirteen frogs as follows: Central Newt (*Notophthalmus viridescens louisianensis*), Spotted Salamander (*Ambystoma maculatum*) Small-mouthed Salamander (*Ambystoma texanum*) Dark-sided Salamander (*Eurycea longicauda melanopluera*), Cave Salamander (*Eurycea lucifuga*) Gray-bellied Salamander (*Eurycea multiplicata griseogaster*) Western Slimy Salamander (*Plethodon albagula*) Ozark Salamander (*Plethodon angusticlavius*)

and Grotto Salamander (*Typhlotriton spelaeus*) Dwarf American Toad (*Bufo americanus charlesmithi*), Woodhouse's Toad (*Bufo woodhousii*) Eastern Narrowmouth Toad (*Gastrophryne carolinensis*) Blanchard's Cricket Frog (*Acris crepitans*) Gray Treefrog (*Hyla versicolor*) Cope's Gray Treefrog (*Hyla chrysoscelis*) Spring Peeper (*Pseudacris crucifer*) Upland Chorus Frog (*Pseudacris feriarum*) Crawfish Frog (*Rana areolata*), Green Frog (*Rana clamitans melanota*) Southern Leopard Frog (*Rana sphenocephala utricularia*) , Bullfrog (*Rana catesbeiana*) and Pickerel Frog (*Rana palustris*). During our surveys, we found evidence for at least four species of salamanders and ten species of frogs and toads. Both 2005 and 2006 were drought years in northwestern Oklahoma and the drought was especially severe during the winter of 2005 and the spring of 2006. Dry weather and soil conditions hampered our ability to locate amphibians during our later winter/early spring survey which should have been the most productive time to find these species. The WMA received nearly one inch of rain during the time of our survey, however, this rain barely penetrated through the leaf litter though it did stimulate calling by male Northern Spring Peepers and Western Chorus Frogs. Additional survey work, especially around rock outcrops during wet early spring weather, is needed to better assess the area's amphibian community.

We located four Western Slimy Salamanders and one Cave Salamander in a cave in Groundhog Hollow. Presumably these species are fairly common but may retreat to subterranean refuges during dry weather and extreme temperatures. We netted adult and larval Central Newts from two small fishless pools on the WMA. Two masses of eggs that we believe to be those of Spotted Salamanders were found in April 2006 in one pool on the area. These eggs appeared to have been laid later in the spring than is normal for this species and we attribute that to the extremely dry conditions. Seven larval salamanders form the genus *Eurycea* were netted from a spring and pool in Chicken Hollow, but we could not determine the species. These larvae had flattened heads which resembled those of Grotto Salamander larvae and larval Grotto Salamanders are known to inhabit surface springs and streams. This pool had a direct ground water connection through fractured limestone which may have allowed the larval salamanders to move between the surface and underground passages. The pool, however, was dry during our subsequent survey and we could not collect any more developed larval or juvenile salamanders.

We located eleven Dwarf American Toads and one Woodhouse's Toad. These were found along roads during the evening or around two small ponds. We also found toad eggs (presumably of the Dwarf American Toad) in a flooded rut on Reno Road. Our Dwarf American Toads were widespread on both mesic and upland sites. This appears to be common species on the WMA. Eastern Narrowmouth Toads were limited to one site around a small pond during our June survey. These toads were heard calling, but not seen, and their identification is based upon their call and the geographic location (there are no Great Plains Narrowmouth Toads known from this area of the state). Western Chorus Frogs and Northern Spring Peepers were heard in early spring around two and four sites respectively. These should be common frogs on the WMA, but their abundance may be limited by the scarcity of suitable breeding sites. The Blanchard's Cricket Frog was the most numerous frog found during our surveys. They were found around all ponds, including two that supported fish populations, and around flooded ruts on Reno and Cochran Prairie roads. We could not accurately distinguish between the calls of Gray and Cope's Treefrogs, therefore all treefrogs were recorded as Gray Treefrog complex. We heard calling

males at four locations (despite dry weather conditions) and found tadpoles in two fishless ponds and a temporarily flooded road rut on Cochran Prairie Road. Like the Western Chorus Frog and Spring Peeper, this appears to be a common frog on the area and its abundance may be limited by the availability of suitable breeding ponds. We found Southern Leopard Frogs at two ponds in the oak woodlands surrounding Cochran Prairie and away from water during along roads during our evening surveys. One or two Pickerel Frogs were found during each of our three surveys into Groundhog Hollow cave. This species is somewhat of a mystery because we do not know of any potential breeding ponds within two miles of that cave, yet at least two frogs occupied the site. This species may be more numerous that we expect because the WMA may be underlain by many small, impassible caves and limestone passages based upon the numerous limestone outcrops that we saw. More survey work is needed around these outcrops during wet weather conditions to search for Pickerel Frogs as well as other frogs and salamanders.

Reptiles:

Though eight species of turtles occur in the Ozark Highlands of Oklahoma (Common Snapping Turtle (*Chelydra serpentina*), Stinkpot (*Sternotherus odoratus*), Ouachita Map Turtle (*Graptemys ouachitensis ouachitensis*), Mississippi Map Turtle (*Graptemys pseudogeographica kohnii*), Eastern River Cooter (*Pseudemys concinna concinna*), Three-toed Box Turtle (*Terrapene carolina triunguis*), Ornate Box Turtle (*Terrapene ornata*) and Red-eared Slider (*Trachemys scripta elegans*)), most of these are unlikely to occur on the WMA. Most of the water flow on the WMA is subsurface through beds of deep gravel and this limited amount of perennial surface water seems to limit the diversity and abundance of the turtle community. While there are at least six species of aquatic turtles in the region, our surveys only confirmed one species, the Red-eared Slider, which was represented by three individuals at two ponds adjacent to the Cochran Prairie. It is unlikely that any other species of basking turtle occurs on the area, though a population of Stinkpots (Common Musk Turtles) could be present - we did not use our aquatic turtle traps on this WMA. The only other species of turtle located during our survey was the Three-toed Box Turtle. Three individuals were located at three sites, and the habitat on the area appears to be suitable to support a large population, especially in areas where the soil is sufficiently deep to allow burrowing.

Based upon museum records and published range maps, eight species of lizards potentially occur on the Spavinaw Hills WMA: Eastern Collared Lizard (*Crotaphytus collaris*) Northern Fence Lizard (*Sceloporus undulatus hyacinthinus*), Prairie Racerunner (*Cnemidophorus sexlineatus viridis*), Southern Coal Skink (*Eumeces anthracinus pluvialis*), Broad-headed Skink (*Eumeces laticeps*), Common Five-lined Skink (*Eumeces fasciatus*), Brown Skink (*Scincella lateralis*), and Western Slender Glass Lizard (*Ophisaurus attenuatus*). During our surveys, we documented four of these species. The Northern Fence Lizard was the most commonly seen lizard during our surveys. Seven were seen in a variety of locations but usually while sunning on logs, in roads and on the trunks of trees. Three Prairie Racerunners were found along the roads surrounding Cochran Prairie, and appeared to be associated with the open woodland and prairie habitats where there was an open canopy and an abundance of grassy/herbaceous vegetation. Five Brown Skinks were found while raking leaf litter, and this species is probably the most common lizard on the WMA. We found it in leaf litter in upland oak/pine forest and in the mesic forest found in

hollows and valleys. Two Common Five-lined Skinks were found in rocky mesic forest in Chicken Hollow. This likely would have been shown to be a common species if additional timed searches had been performed. Though we did not confirm the presence of the Southern Coal Skink, there appears to be an abundance of the rocky mesic forest habitat in which it is typically found elsewhere in Oklahoma. Additional timed searches, especially in the spring, are needed to determine whether it is present on the area. There are relatively few records for Broad-headed Skinks in the Ozark region of Oklahoma, but seemingly suitable habitat exists for this species on the WMA and additional timed searches are needed strengthen this position.

Based upon museum records and published range maps (Sievert and Sievert 2006), twenty-three species of snakes may occur on or in the vicinity of the Spavinaw Hills WMA as follows: Western Wormsnake (*Carphophis vermis*), Yellow-bellied Racer (*Coluber constrictor flaviventris*), Prairie Ring-necked Snake (*Diadophis punctatus arnyi*), Black Ratsnake (*Elaphe obsoleta obsoleta*), Eastern Hog-nosed Snake (*Heterodon platirhinos*), Prairie Kingsnake (*Lampropeltis calligaster*), Speckled Kingsnake (*Lampropeltis getula holbrooki*), Red Milksnake (*Lampropeltis triangulum syspila*), Eastern Coachwhip (*Masticophis flagellum flagellum*), Plain-bellied Watersnake (*Nerodia erythrogaster*), Northern Watersnake (*Nerodia sipedon*), Northern Rough Greensnake (*Opheodrys aestivus aestivus*), Bullsnake (*Pituophis melanoleucus sayi*), Ground Snake (*Sonora semiannulata*), Texas Brownsnake (*Storeria dekayi texana*), Red-bellied Snake (*Storeria occipitomaculata*), Flat-headed Snake (*Tantilla gracilis*), Western Ribbonsnake (*Thamnophis proximus*), Red-sided Gartersnake (*Thamnophis sirtalis parietalis*), Rough Earthsnake (*Virginia striatula*), Copperhead (*Agkistrodon contortrix*), Western Cottonmouth (*Agkistrodon piscivorus leucostoma*), and Timber Rattlesnake (*Crotalus horridus*) Four species of snakes were documented during our surveys of the area and two additional species (Copperhead and Timber Rattlesnake) were confirmed by Scott Cox and Tony Crawford. A single Rough Greensnake was observed in shrubbery along Cochran Prairie Road during our June survey. Considering the habitat conditions on the WMA, this should be a common species. We spent only a small amount of time turning over rocks during our spring surveys (when we should have had the greatest likelihood of success in finding small snakes and salamanders), but we were unsuccessful in locating any reptile or amphibian species. Our poor success may have been caused, in part, by the extremely dry weather and soil conditions in 2006 which would have limited animal activity. Six other species of small snakes are likely to occur on the area - Flat-headed Snake, Ring-necked Snake, Brown Snake, Red-bellied Snake, Ground Snake and Rough Earthsnake - but additional timed searches spent turn over rocks and logs or raking leaf litter would be needed to document these.

We confirmed the presence of three species of larger snakes. Two Northern Watersnakes were found at small ponds on the WMA. Because of the lack of perennial streams and the presence of only a few small ponds, it is likely that the Northern Watersnake may be the only species of aquatic snake on the WMA. Three Eastern Racers were seen during our spring and fall surveys. This is an adaptable species found in both forested and prairie habitats and it appears to be fairly common on the WMA. The third large species of snake found was the Eastern Hognose Snake. A single individual was found in an area of oak woodland habitat during a spring survey. Scott Cox and Tony Crawford informed us of multiple sightings of Copperheads and Timer Rattlesnakes. Copperheads appear to be common throughout the WMA and are seen regularly

around the headquarters and on WMA roads. Timber Rattlesnakes are uncommon but seen occasionally, especially during summer evenings when they have been seen on roads during spotlight surveys for deer. Several other species of the larger snakes should be fairly common on the area even though our surveys did not detect them. Many snake species are secretive and occur in low densities, therefore a great deal of time and effort is required to document and quantify the snake community. As would be expected, most of our encounters with snakes were opportunistic and not always part of timed searches for other reptiles and amphibians.

Table 1. Summary of Vertebrate Observations on the Spavinaw Hills WMA Arranged by Season and Habitat Type.
- Bird species which are followed by an asterisk (*) are likely to breed on or in the immediate vicinity of the Spavinaw Hills WMA
- Species which are marked with an "X" were identified based upon tracks, nests or other signs but not by an actual sighting.

	Oak and Oak/Pine Woodland [a]		Upland Oak/Pine Forest [b]		Mesic/Bottomland Forest [c]	
Species' Common Name	Winter / Early Spring	Late Spring Summer, Fall	Winter Early Spring	Late Spring Summer Fall	Winter / Early Spring	Lt Spring, Summer, Fall
American White Pelican		44				
Great Blue Heron *		X		1		
Cattle Egret						2
Green Heron *						1
Black Vulture *	17			2		
Turkey Vulture *	6	3	7	14	8	5
Wood Duck *			6			
Sharp-shinned Hawk	1					
Red-tailed Hawk *		2			1	
Red-shouldered Hawk *	1				5	5
Broad-winged Hawk *				2		2
Wild Turkey *		X		3		
Northern Bobwhite *		7				
Mourning Dove *		6			1	3
Yellow-billed Cuckoo *		5		2		5
Eastern Screech Owl *				1	2	1
Great Horned Owl *	1					

	Oak and Oak/Pine Woodland [a]		Upland Oak/Pine Forest [b]		Mesic/Bottomland Forest [c]	
Species' Common Name	Winter / Early Spring	Late Spring Summer, Fall	Winter Early Spring	Late Spring Summer Fall	Winter / Early Spring	Lt Spring, Summer, Fall
Barred Owl *				1	2	2
Whip-poor-will *		1		5		3
Chuck-wills-widow *				1		2
Common Nighthawk *		1				
Chimney Swift *		6		2		3
Ruby-throated Hummingbird *		1				4
Red-headed Woodpecker *		3			4	1
Red-bellied Woodpecker *	2	5	2	4	6	18
Downy Woodpecker *	2	2	4	3	12	6
Hairy Woodpecker *			1			1
Yellow-bellied Sapsucker					1	
Northern Flicker	3		5		3	
Pileated Woodpecker *	1	1	3	3	1	4
Eastern Wood Pewee *		19		16		6
Acadian Flycatcher *						7
Eastern Phoebe *		1			6	9
Great Crested Flycatcher *		11		9		14
Eastern Kingbird *		3				5
Scissor-tailed Flycatcher *		2				
Northern Rough-winged Swallow *		2				2
Barn Swallow *		2				
White-eyed Vireo *		9				19
Red-eyed Vireo *		9		30		51
Yellow-throated Vireo *						7
Blue-headed Vireo				1		
American Crow *	1	7	3	2	13	5

	Oak and Oak/Pine Woodland [a]		Upland Oak/Pine Forest [b]		Mesic/Bottomland Forest [c]	
Species' Common Name	Winter / Early Spring	Late Spring Summer, Fall	Winter Early Spring	Late Spring Summer Fall	Winter / Early Spring	Lt Spring, Summer, Fall
Fish Crow *				1		1
Blue Jay *	5	2	4	11	9	1
Carolina Chickadee *	11	5	14	8	43	16
Tufted Titmouse *	6	21	9	46	39	50
White-breasted Nuthatch *	1	7	3	6	10	11
Brown Creeper					1	
Carolina Wren *	1	16	4	12	19	35
Blue-gray Gnatcatcher *		16		19		42
Ruby-crowned Kinglet		1				3
Golden-crowned Kinglet			2		4	
Eastern Bluebird *	8	12	1		10	2
American Robin					3	
Hermit Thrush			1	1	1	
Swainson's Thrush				3		1
Brown Thrasher *		2				
Orange-crowned Warbler						2
Nashville Warbler						3
Tennessee Warbler						1
Black and White Warbler *		6		16		19
Northern Parula *		2		6		23
Yellow-throated Warbler *				4		5
Pine Warbler *	3	6	14	26	4	2
Prairie Warbler *		12				2
Blackburnian Warbler				1		
Yellow-rumped Warbler			3	6		2
Yellow Warbler						3
Louisiana Waterthrush *		1				8

	Oak and Oak/Pine Woodland [a]		Upland Oak/Pine Forest [b]		Mesic/Bottomland Forest [c]	
Species' Common Name	Winter / Early Spring	Late Spring Summer, Fall	Winter Early Spring	Late Spring Summer Fall	Winter / Early Spring	Lt Spring, Summer, Fall
American Redstart *						4
Kentucky Warbler *		3		3		25
Worm-eating Warbler *				2		
Prothonotary Warbler *						1
Common Yellowthroat *		4				2
Yellow-breasted Chat *		22		3		4
Summer Tanager *		16		36		25
Scarlet Tanager *		1		3		7
Northern Cardinal *	6	7	3	4	17	21
Blue Grosbeak *		7		1		2
Indigo Bunting *		45		20		51
Painted Bunting *		2				
Eastern Towhee *		2				
Dickcissel *		4				
Field Sparrow *	11	18		2	2	
Chipping Sparrow *		8	4	14	4	20
Lark Sparrow *		3				2
Dark-eyed Junco	21		23		75	
White-throated Sparrow			3		69	9
Lincoln's Sparrow						5
Swamp Sparrow					1	
Fox Sparrow					5	
Song Sparrow	3		2		5	
Eastern Meadowlark *	2	2				
Brown-headed Cowbird *		13		7		3
Orchard Oriole *		3				
House Finch					3	

	Oak and Oak/Pine Woodland [a]		Upland Oak/Pine Forest [b]		Mesic/Bottomland Forest [c]	
Species' Common Name	Winter / Early Spring	Late Spring Summer, Fall	Winter Early Spring	Late Spring Summer Fall	Winter / Early Spring	Lt Spring, Summer, Fall
American Goldfinch *	4	14		1	17	11
Virginia Opossum		1			1	
Nine-banded Armadillo					X	2
Eastern Mole						X
Northern Long-eared Myotis						3
Eastern Pipistrel		1	1		123 (in cave)	43 (34 in cave)
Evening Bat		2		1		8
Red Bat		6		4		12
Eastern Chipmunk			1	1	1	1
Eastern Gray Squirrel	2		2	3	8	6
Fox Squirrel		1		2	3	
Southern Flying Squirrel						2
Woodchuck						1
Texas Brush Mouse						1
Hispid Cotton Rat						2
Eastern Woodrat					X	
Eastern Cottontail	1	2				1
Raccoon		X		1		
Coyote		4		3		
Bobcat					X	
White-tailed Deer	4	8	4	5	17	15
American Elk					2	13
Central Newt				7		1

	Oak and Oak/Pine Woodland [a]		Upland Oak/Pine Forest [b]		Mesic/Bottomland Forest [c]	
Species' Common Name	Winter / Early Spring	Late Spring Summer, Fall	Winter Early Spring	Late Spring Summer Fall	Winter / Early Spring	Lt Spring, Summer, Fall
Spotted Salamander				2 egg masses		
Cave Salamander						1 (in cave)
unidentified *Eurycea* Salamander larvae					7	
Western Slimy Salamander						4 (in cave)
Dwarf American Toad			6	2 adults 525 tads	4	2
Woodhouse's Toad			1			
Eastern Narrowmouth Toad				1		
Blanchard's Cricket Frog		4		9		19 adult 4 tadpoles
Western Chorus Frog			2		2	
Northern Spring Peeper			10		12	
Gray Treefrog complex		2		4 adults 30+ tad.		1 adult, 40+ tadpole
Pickerel Frog					1 (in cave)	3 (in cave)
Southern Leopard Frog		2				2
Green Frog			48 tad.	2 adults 31 tad.	64 tadpoles	1 adult
Three-toed (Eastern) Box Turtle		1		1		
Red-eared Slider		4				
Northern Fence Lizard		4		3		1
Prairie Racerunner		3				
Common Five-lined Skink						2
Ground Skink				1		3
Northern Rough Green Snake				1		
Northern Watersnake				2		
Eastern Yellowbelly Racer		2				1

	Oak and Oak/Pine Woodland [a]		Upland Oak/Pine Forest [b]		Mesic/Bottomland Forest [c]	
Species' Common Name	Winter / Early Spring	Late Spring Summer, Fall	Winter Early Spring	Late Spring Summer Fall	Winter / Early Spring	Lt Spring, Summer, Fall
Eastern Hognose Snake		1				
Copperhead				X		X
Timber Rattlesnake				X		

[a] cumulative total based upon: 4.0 hours nocturnal mist-netting on one night at one location; 6.5 hours of diurnal vehicle-based timed searches; 1.0 hour of nocturnal vehicle-based timed searches; 240 minutes diurnal timed searches on foot; 11 5-minute point counts

[b] cumulative total based upon: 3.5 hours nocturnal mist-netting on one night at one location; 8.0 hours of diurnal vehicle-based timed searches; 3.0 hours of nocturnal vehicle-based timed searches; 255 minutes of diurnal timed searches on foot; 19 5-minute point counts

[c] cumulative total based upon: 13.5 hours of nocturnal mist-netting on four nights at four locations; 12.5 hours of diurnal vehicle-based timed searches; 5.0 hours of nocturnal vehicle-based timed searches; 390 minutes of timed searches on foot; 25 5-minute point counts

Table 2. Summary of Breeding Birds on the Spavinaw Hills WMA
The first number listed in each cell is the actual number of birds detected; the number in (parentheses) is the average number of birds of each species seen at point count locations in each habitat type.

Common Name	Mesic Hardwood Forest (n=24)	Dry (Upland) Oak & Pine Forest (n=18)	Oak & Pine Woodland (n=13)
Broad-winged Hawk	1 (0.04)		
Red-shouldered Hawk	2 (0.08)		
Red-tailed Hawk			2 (0.15)
Northern Bobwhite			5 (0.38)
Mourning Dove			2 (0.15)
Yellow-billed Cuckoo	3 (0.13)	2 (0.11)	5 (0.38)
Eastern Screech Owl		1 (0.06)	
Chimney Swift	1 (0.04)	2 (0.11)	4 (0.31)
Ruby-throated Hummingbird	3 (0.13)		1 (0.08)
Red-headed Woodpecker	1 (0.04)		

Common Name	Mesic Hardwood Forest (n=24)	Dry (Upland) Oak & Pine Forest (n=18)	Oak & Pine Woodland (n=13)
Red-bellied Woodpecker	9 (0.38)	2 (0.11)	4 (0.31)
Downy Woodpecker	3 (0.13)	2 (0.11)	
Pileated Woodpecker	2 (0.08)	1 (0.06)	1 (0.08)
Eastern Phoebe	1 (0.04)		
Eastern Wood Pewee	6 (0.25)	16 (0.89)	18 (1.38)
Acadian Flycatcher	7 (0.29)		
Great Crested Flycatcher	9 (0.38)	9 (0.50)	10 (0.77)
Eastern Kingbird			1 (0.08)
Northern Rough-winged Swallow			1 (0.08)
White-eyed Vireo	13 (0.54)		7 (0.54)
Red-eyed Vireo	39 (1.63)	23 (1.28)	9 (0.69)
Yellow-throated Vireo	7 (0.29)		
Blue Jay		5 (0.28)	1 (0.08)
American Crow	3 (0.13)	2 (0.11)	7 (0.54)
Fish Crow	1 (0.04)	1 (0.06)	
Carolina Chickadee	9 (0.38)	3 (0.17)	2 (0.15)
Tufted Titmouse	28 (1.17)	29 (1.61)	17 (1.31)
White-breasted Nuthatch	9 (0.38)	4 (0.22)	7 (0.54)
Carolina Wren	16 (0.67)	9 (0.50)	11 (0.85)
Brown Thrasher			1 (0.08)
Blue-gray Gnatcatcher	23 (0.96)	10 (0.56)	15 (1.15)
Eastern Bluebird			4 (0.31)
Black and White Warbler	8 (0.33)	11 (0.61)	6 (0.46)
Prothonotary Warbler	1 (0.04)		
Prairie Warbler			9 (0.69)
Pine Warbler	1 (0.04)	16 (0.89)	5 (0.38)
Yellow-throated Warbler	4 (0.17)	1 (0.06)	
Northern Parula	22 (0.92)	5 (0.28)	2 (0.15)
Worm-eating Warbler		2 (0.11)	

Common Name	Mesic Hardwood Forest (n=24)	Dry (Upland) Oak & Pine Forest (n=18)	Oak & Pine Woodland (n=13)
Kentucky Warbler	19 (0.79)	3 (0.17)	3 (0.23)
Louisiana Waterthrush	5 (0.21)		1 (0.08)
Yellow-breasted Chat	2 (0.08)	3 (0.17)	17 (1.31)
Common Yellowthroat			3 (0.23)
Summer Tanager	16 (0.67)	18 (1.0)	13 (1.0)
Scarlet Tanager	6 (0.25)		1 (0.08)
Northern Cardinal	8 (0.33)	1 (0.06)	4 (0.31)
Blue Grosbeak	2 (0.08)	1 (0.06)	2 (0.15)
Indigo Bunting	30 (1.25)	14 (0.78)	27 (2.08)
Painted Bunting			1 (0.08)
Eastern Towhee			2 (0.15)
Field Sparrow		2 (0.11)	10 (0.77)
Chipping Sparrow	3 (0.13)	2 (0.11)	6 (0.46)
Brown-headed Cowbird	3 (0.13)	7 (0.17)	13 (1.0)
Orchard Oriole			2 (0.15)
American Goldfinch	5 (0.21)	1 (0.06)	7 (0.54)

Vertebrate Inventory of the Pushmataha Wildlife Management Area

The inventory of the Pushmataha Wildlife Management Area spanned the period from March 2004 through March 2006. Surveys were conducted during eight survey trips covering 15 days. The total search effort was: 30 hours and 50 minutes of diurnal timed searches by vehicle; 17 hours and 25 minutes of nocturnal timed searches by vehicle; 26 hours of diurnal timed searches on foot (34 locations); 56 5-minute point counts, 38 3-minute point counts; 84 small mammal trap nights. Below is a list of the survey dates and the taxonomic groups that were targeted during each survey:

5 March 2004: surveys for wintering birds and amphibians
25 & 26 March 2004: surveys for birds and amphibians
10 June 2004: surveys for breeding birds, amphibians & reptiles
15, 16 & 17 June 2004: surveys for breeding birds, calling amphibians
22 September 2004: surveys for migrating birds and reptiles
3, 4 & 5 May 2005: surveys for migrating birds, small mammals and amphibians
20 & 21 June 2005: surveys for breeding birds, amphibians and reptiles
28 & 29 March 2006: surveys for wintering birds, small mammals and amphibians

In the early decades of the twentieth century, the forested land on and surrounding the Pushmataha WMA was subject to widespread timber harvest. This activity was followed by nearly a century of landscape-scale fire suppression. The combination of heavy timber harvest in the past and long-term fire suppression has resulted in an abundance of densely stocked, second-growth forest stands on and surrounding the WMA. These stands have dense canopies and mid-stories, but relatively little under story or herbaceous vegetation. Over the past ten years, there has been an effort to increase the diversity of forest stand structure by conducting prescribed burns during the late winter and thinning mid-story trees. To aid in this effort, trees have been cleared or thinned within 100 meters of many roads on the WMA which has created a large, accessible area of forest edge or early successional vegetation dominated by grasses, forbs, oak sprouts and woody shrubs.

Forest stands comprised of a mix of shortleaf pine, oaks and hickories dominate most of the upland acreage on the wildlife management area. The relative abundance of pines versus hardwood trees is variable, however there are very few upland stands that are strongly dominated by pines or by hardwoods. Based upon our knowledge of the life histories of most vertebrate species in the Ouachita Mountains, there are few that would be expected to rely exclusively on purely pine or hardwood stands with the possible exceptions of Red-cockaded Woodpecker, Brown-headed Nuthatch and Pine Warbler. However, Red-cockaded Woodpeckers are absent for the Pushmataha WMA, and the Brown-headed Nuthatch and Pine Warbler persist in mixed forests that have some component of pine. Because the relative dominance of pines versus hardwood trees, within the range of variation we observed on the WMA, did not appear to influence most species we did not make a distinction between pine dominated and oak dominated stands when recording our data. We did, however, distinguish forest stands in riparian sites which tended to be dominated by hardwood trees. We had several species which were closely associated with forest stands along perennial and intermittent streams, though we don't know if it was because of the mesic soil conditions, the dominance of hardwood trees or other physical attributes. For purposes of this report, we classified the habitats on the Pushmataha Wildlife Management Area into three broad categories: 1) upland oak-pine forest, 2) riparian deciduous forest, and 3) oak-pine woodland and shrubby openings. Embedded within the upland oak-pine forest and oak-pine woodland/edge habitats are numerous small ponds and seasonal wetlands which were not treated as a separate habitat type, but which were the centers of activity for several amphibian and semi-aquatic species.

As part of this project, a digital map was created of the plant communities (habitat types) on the Pushmataha WMA. This map was based upon a combination of remote imagery and ground verification (Figure 2). Using a combination of satellite imagery and aerial photographs, five terrestrial plant communities were discernable: 1) Disturbed Forest (synonymous with thinned forest and brushy forest edge), 2) Black Gum-Red Maple Forest; 3) Shortleaf Pine-Southern Red Oak-Black Oak Forest; 4) Shortleaf Pine-Post Oak-Blackjack Oak Forest, 5) Post Oak-Blackjack Oak-Black Hickory Forest. Because of the wide variation in the relative composition of Shortleaf Pines, Oaks and Hickories across the WMA, we combined forest types 3, 4 and 5 for our data collection.

Upland Oak-Pine Forest: The Upland Oak-Pine Forest habitat grouping is comprised of forested sites on ridges and upper slopes that have a canopy closure of 80% or more and are dominated by oaks and pines. Dominate canopy trees include Post Oak (*Quercus stellata*), Blackjack Oak

(*Quercus marilandica*), Shortleaf Pine (*Pinus echinata*), and Black Hickory (*Carya texana*) with lesser numbers of White Oak (*Quercus alba*), Southern Red Oak (Quercus falcata), Black Oak (*Quercus velutina*), Mockernut Hickory (*Carya alba*) and Winged Elm (*Ulmus alata*). Woody understory plants are few but include Lowbush Blueberry (*Vaccinium pallidum*), Farkleberry (*Vaccinium arboreum*) and Mexican Plum (*Prunus mexicana*),while the herbaceous understory is sparse. This habitat type occupies the largest percentage of acreage on the Pushmataha WMA. It is synonymous with the Shortleaf Pine-Southern Red Oak-Black Oak Forest, Shortleaf Pine-Post Oak-Blackjack Oak and Post Oak-Blackjack Oak-Black Hickory forest types shown in Figure 2.

Riparian Hardwood Forest: This plant community was uncommon and occurred along ravines, stream channels and lower slopes. Most of these sites were interconnected and associated with the Caney (Cedar) Creek and its tributaries. This community was dominated by deciduous trees including Black Gum (*Nyssa sylvatica*), White Oak (*Quercus alba*), Southern Red Oak (*Quercus falcata*), Mockernut Hickory (*Carya alba*), Red Maple (*Acer rubrum*), with lesser numbers of Black Oak (*Quercus velutina*), Sycamore (*Platanus occidentalis*), Sweetgum (*Liquidambar styraciflua*), Black Cherry (*Prunus serotina*), Shortleaf Pine (*Pinus echinata*), and Post Oak (*Quercus stellata*). Common woody understory plants include American Hornbeam (*Carpinus caroliniana*), Flowering Dogwood (*Cornus florida*), Silky Dogwood (*Cornus amomum*), Hazel Alder (*Alnus serrulata*) and Mexican Plum (*Prunus mexicana*). This habitat type is synonymous with the Black Gum-Red Maple forest types mapped in Figure 2.

Oak-Pine Woodland and Shrubby Edge: This habitat grouping occurred along all of the main roads and in patches along the secondary roads across the WMA. This habitat type includes some sites where past thinning and prescribed burning has maintained small savannahs and open woodlands of oaks and hickories with a grassy/herbaceous understory. It also includes long zones of shrubby grassland habitat 100 to 200 yards wide along ridgetops and roads. These cleared zones are dominated by native grasses (primarily Big Bluestem (*Andopogon gerardii*), Little Bluestem (*Schizachyrium scoparium*) and Broomsedge Bluestem (*Andropogon virginicus*)), sumacs (*Rhus copallina* and *Rhus glabra*), blackberries (*Rubus* species), Winged Elm (*Ulmus alata*), Persimmon (*Diospyros virginiana*) and stump sprouts from oaks and hickories. Along the WMA roads, there also were small openings that were created early in the history of the WMA as forage plots for elk and deer. These have been planted to a variety of native and non-native grasses and forbs over the years, particularly cool season plants such as Orchardgrass (*Dactylis glomerata*), clovers and Wildrye. We frequently saw American Elk, White-tailed Deer, Chipping Sparrows and Indigo Buntings in these clearings, but otherwise their use by most species was limited. The woodland and shrubby edge habitat type is synonymous with the "Disturbed" community shown in Figure 2.

Table 3. Summary of Seasonal and Habitat Distribution of Vertebrates on the Pushmataha WMA
- Bird species which are followed by an asterisk (*) are likely to breed on or in the immediate vicinity of the Pushmataha WMA.
- Species which are marked with an "X" were identified based upon tracks and other signs, or by a reported observation but not by an actual sighting by project personnel.

	Oak-Pine Woodland and Shrubby Edge		Oak-Pine Upland Forest		Riparian Deciduous Forest	
Species' Common Name	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall
Great Blue Heron *		1		1	1	
Great Egret				1		
Green Heron *		2				
Yellow-crowned Nightheron*						1
Black Vulture *				1		
Turkey Vulture *	8	2	7	5		
Wood Duck *	2					
Ring-necked Duck			2			
Hooded Merganser			1			
Sharp-shinned Hawk	1		1		1	
Cooper's Hawk *				1		
Red-tailed Hawk *	1	2				
Red-shouldered Hawk *	1		5	5	2	4
Broad-winged Hawk *						1
American Kestrel	2					
Wild Turkey *	6	4	3	5		
Northern Bobwhite *	4	45				
Mourning Dove *	5	19	1	1		
Yellow-billed Cuckoo *		6		26		4
Eastern Screech Owl *				1		
Barred Owl *				1	1	
Chuck-wills-widow *		11		35		5

	Oak-Pine Woodland and Shrubby Edge		Oak-Pine Upland Forest		Riparian Deciduous Forest	
Species' Common Name	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall
Chimney Swift *				3		
Ruby-throated Hummingbird *		1		1		
Belted Kingfisher					2	
Red-headed Woodpecker *	2	13		5		
Red-bellied Woodpecker *			6	13	8	3
Downy Woodpecker *		3	4	10	2	
Hairy Woodpecker *				2		
Yellow-bellied Sapsucker					2	
Northern Flicker *	8	2	5			
Pileated Woodpecker *	1	2	3	13	4	4
Eastern Wood Pewee *		20		25		1
Acadian Flycatcher *						1
Eastern Phoebe *	2	7			3	
Great Crested Flycatcher *		8		30		10
Eastern Kingbird *		7				
Scissor-tailed Flycatcher *		4				
Northern Rough-winged Swallow				1		
White-eyed Vireo *		2				2
Red-eyed Vireo *		14		129		34
Yellow-throated Vireo *						3
Blue-headed Vireo				2		
American Crow *	6	8	5	23	2	
Blue Jay *	3	3	6	12	1	1
Carolina Chickadee *	7	3	33	32	12	6
Tufted Titmouse *	6	18	51	65	23	15

	Oak-Pine Woodland and Shrubby Edge		Oak-Pine Upland Forest		Riparian Deciduous Forest	
Species' Common Name	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall
White-breasted Nuthatch *	2	4	7	21	2	3
Brown-headed Nuthatch *				1		
Carolina Wren *	8	11	18	55	11	14
Winter Wren					1	
Blue-gray Gnatcatcher *	1	9	4	29	2	7
Ruby-crowned Kinglet			3		3	
Golden-crowned Kinglet			1		1	
Eastern Bluebird *	26	43	6	2	3	
American Robin *	2	1				
Hermit Thrush					1	
Swainson's Thrush				1		
Brown Thrasher *		2				
Gray Catbird				1		
Cedar Waxwing			20	9		
Orange-crowned Warbler				1		
Nashville Warbler				1		
Black and White Warbler *			4	5	6	7
Northern Parula *						3
Yellow-throated Warbler *					1	1
Pine Warbler *	7	33	36	121	6	7
Prairie Warbler *		62		1		
Black-throated Green Warbler				1		
Chestnut-sided Warbler				1		
Yellow-rumped Warbler			3		1	
Louisiana Waterthrush *					1	
Kentucky Warbler *				2		3

	Oak-Pine Woodland and Shrubby Edge		Oak-Pine Upland Forest		Riparian Deciduous Forest	
Species' Common Name	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall
Hooded Warbler *				1		
Wilson's Warbler				1		
Ovenbird						1
Common Yellowthroat *		64		2		11
Yellow-breasted Chat *		46		3		
Summer Tanager *		37		142		13
Scarlet Tanager *		1		15		2
Northern Cardinal *	9	18	8	3	10	5
Blue Grosbeak *		64		1		
Indigo Bunting *		269		45		14
Painted Bunting *		1				
Bachman's Sparrow *	1	36	2			
Field Sparrow *	14	3	5			
Chipping Sparrow *	66	48	26	11	2	
Lark Sparrow *		2				
Savannah Sparrow	2					
Dark-eyed Junco	18		26		6	
White-throated Sparrow	16	1	27		19	
White-crowned Sparrow	1	13				
Lincoln's Sparrow		3				
Swamp Sparrow	2				1	
Fox Sparrow			1			
Song Sparrow	4		1		2	
Red-winged Blackbird		1				
Eastern Meadowlark	1					
Brown-headed Cowbird *	1	8		3		
Orchard Oriole *		16		1		

	Oak-Pine Woodland and Shrubby Edge		Oak-Pine Upland Forest		Riparian Deciduous Forest	
Species' Common Name	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall
Purple Finch					2	
American Goldfinch	6		1		4	
Virginia Opossum					X	
Nine-banded Armadillo		1				
Northern Long-eared Myotis						X
Evening Bat				X		X
Red Bat		2		4		X
Hoary Bat				X		X
unidentified bat		6		5		
Eastern Mole					1	
Eastern Chipmunk						1
Eastern Gray Squirrel			1		1	2
Fox Squirrel	5	7	1	1		
White-footed Mouse		2				
Brush Mouse		1				
Hispid Cotton Rat		2				
Eastern Cottontail	1	16		3	2	
Striped Skunk	2	3		1		
River Otter					X	
Raccoon			1		X	X
Gray Fox			X			
Coyote	X					
Bobcat			X			
White-tailed Deer	11	12	24	6	1	
American Elk	5	6	1	2		

	Oak-Pine Woodland and Shrubby Edge		Oak-Pine Upland Forest		Riparian Deciduous Forest	
Species' Common Name	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall
Central Newt	6		4	34		3
Western Slimy Salamander						3
Dwarf American Toad	1300 tad 42 adults	10	600 tad. 12 adults	12 800 tad.		11 adults 300 tad.
Woodhouse's Toad		4				
Eastern Narrowmouth Toad		76	2	111		26
Blanchard's Cricket Frog	19	28	3	69	69	41
Western Chorus Frog	82 300 tad.	24	44	50 30 tad.	16	11
Northern Spring Peeper	3		53		2	
Gray Treefrog complex	1	39	28 adults	92 adults 26 tad	2	49
Green Treefrog		3		4		3
Pickerel Frog	3 ?					
Southern Leopard Frog	63 tads 14 adults		1	8		8
Green Frog		11 adults 25 tad.	33 tad. 1 adults	27 adults 16 tad.	6 tad.	17
Bullfrog	2			2	1	1
Mississippi Mud Turtle				1		
Three-toed (Eastern) Box Turtle		1				
Eastern River Cooter			2		3	4
Northern Fence Lizard	4	11	5	14	1	5
Prairie Racerunner	1	6				1
Five-lined Skink				2		2
Coal Skink						1

	Oak-Pine Woodland and Shrubby Edge		Oak-Pine Upland Forest		Riparian Deciduous Forest	
Species' Common Name	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall	Late Winter / Early Spring	Late Spring, Summer, Early Fall
Brown Skink				2		2
Ring-necked Snake	1			1		
Northern Rough Green Snake			1			
Red-bellied Snake						1
Flathead Snake			1	5		
Texas Black Ratsnake		1				
Plain-bellied Watersnake		2		1		2
Copperhead				1		
Western Cottonmouth						3
Redfin Pickerel					1	
Central Stoneroller					65	
Striped Shiner					20	
Bigeye Shiner					6	
Mosquitofish					7	
Brook Silverside					9	
Green Sunfish	3		13			
Orangebelly Darter					5	

Survey Results and Discussion:

Bird:

The majority of bird surveys consisted of timed searches conducted from a slowing moving vehicle or on foot while walking trails and stream beds. During June, 2004, we conducted 56 five-minute point counts along Pine Tree Circle, Dogwood Trail, Divide Trail, Refuge Road and Redbud Road - all interior roads within the Pushmataha WMA - to assess the breeding bird community. Of these points, 6 were located on sites dominate by deciduous trees (e.g. along West Caney Creek and its tributaries), 7 were located in upland mixed forest of shortleaf pine, oaks and hickories, and the

remaining 43 sites contained a combination of both upland oak-pine forest and forest edge habitats. At these 43 sites, we recorded whether each bird was detected from within the forest or from within the forest edge vegetation. In June of 2005, we followed up on this breeding bird survey by conducting 38, three-minute point counts at different locations along Refuge Road and Pine Tree Circle. The results of both the 2004 and 2005 breeding bird point count surveys are included in Table 3. Fifty-three breeding bird species were detected at these point count stations, and another 13 potentially breeding birds were recorded incidentally between stations (Great Blue Heron, Green Heron, Black Vulture, Cooper's Hawk, Belted Kingfisher, Acadian Flycatcher, Eastern Kingbird, Brown Thrasher, Painted Bunting and Red-winged Blackbird) or during the evening amphibian calling surveys (Yellow-crowned Night Heron, Barred Owl, Chuck-wills-widow). The most numerous species detected during the point counts were the Indigo Bunting, Red-eyed Vireo, Summer Tanager and Pine Warbler. These species were indicative of the upland mixed forest and brushy forest edge communities that dominated the point count stations. Breeding birds of particular interest were the Bachman's Sparrow, Prairie Warbler, Scarlet Tanager and Brown-headed Nuthatch. The Bachman's Sparrow and Prairie Warbler are Partners In Flight species of conservation concern and appear to be responding positively to the increased amount of brushy forest edge and woodland habitat that has been created on the WMA since the mid 1990s. The Brown-headed Nuthatch is restricted to pine and mixed pine/hardwood forests and occurs near the northwestern edge of its range in Pushmataha County. The Scarlet Tanager is a songbird of mature hardwood and mixed pine/hardwood forests and appears to be present as a result of the increasing acreage of mature forest on the WMA.

Water Birds: Four species of herons were located during our surveys - Great Blue Heron, Great Egret, Green Heron and Yellow-crowned Night Heron. All four species were located during the spring and summer which suggests that breeding populations of each are probably found in the vicinity of the WMA. Great Egrets were only seen flying over the area and probably had a nesting colony near the Kiamichi River off the WMA. Similarly, Great Blue Herons were seen flying over the area and foraging along Cedar Creek. This species too probably maintained a nesting colony near, but not on the WMA. Green Herons and a Yellow-crowned Night Heron were found (seen or heard) along Caney (Cedar) Creek and a few of the area's ponds. Both of these are solitary-nesting herons and one or a few pairs of each probably nested on the WMA. The Belted Kingfisher appears to be a rare species on the WMA and was represented by two birds seen during early spring along Cedar Creek. Due to the limited amount of suitable nesting sites on the WMA for kingfishers, it is unlikely that more than a few birds occur on the area in any season. Three species of ducks were located during our surveys - Wood Duck, Ring-necked Duck and Hooded Merganser. Each of these species is typically found in forested wetlands and streams, and on the WMA they were located on small ponds at forest edges. The Wood Ducks were seen during spring and indicate that a small resident population probably nests on the area. The Ring-necked Ducks and Hooded Merganser were seen during the winter months and these species are probably winter visitors on the area. Other species of ducks probably winter on the WMA, but numbers are probably small because of the small acreage and scattered distribution of ponds and wetlands.

Diurnal Raptors and Vultures: Eight species of hawks, falcons and vultures were seen on the wildlife management area during our surveys: Sharp-shinned Hawk, Cooper's Hawk, Red-shouldered Hawk, Red-tailed Hawk, Broad-winged Hawk, American Kestrel, Black Vulture, and

Turkey Vulture. Raptors typically maintain relatively large territories or home ranges and as a result only small numbers of each species were found on the WMA. The Sharp-shinned Hawk appears to be a relatively common raptor that can be found in all habitat types on the management area during the winter months. The Cooper's Hawk was detected only once, during a summer survey, and should be considered a rare year-round resident in forested habitats. The Red-shouldered Hawk was the most commonly seen hawk during our surveys. It occurred in all forested habitats throughout the year, and appeared to be more common in riparian deciduous forest (e.g along Cedar Creek and its tributaries) than in upland mixed pine -hardwood forest. The Red-tailed Hawk was relatively uncommon but one or two pairs appear to occur year-round on the WMA. Red-tailed Hawks were only seen in the forest edge habitat near roads, which is typical of the habitat in which they occur elsewhere in Oklahoma. The Broad-winged Hawk was represented in our survey by a single individual that was seen during the summer in riparian deciduous forest. This species of hawk is widespread in the eastern U.S. and is typically associated with forested habitats. Despite the abundance of forested habitat on and surrounding the WMA, this appears to be an uncommon species in this area. The American Kestrel was represented by a two individuals that were observed several times during a winter/early spring survey hunting in brushy clearings along Pine Tree Circle. It appears that the American Kestrel is an uncommon winter visitor in this area and associated with forest edges and openings. Turkey Vultures were relatively common and Black Vultures were relatively uncommon based upon our survey. In all cases, vultures were only seen soaring over habitats on the WMA and it is impossible to determine whether either species exhibits any habitat selection.

Game Birds: The Northern Bobwhite was common in the extensive brushy woodland edge that has been created along the major WMA roads. Bobwhite were commonly heard, but rarely seen, during the breeding bird survey and incidentally during the spring and summer. Because of this species' cryptic behavior, we did not detect it during the winter months, however this non-migratory bird is certain to occur on the area year-round and would benefit from further woodland/shrubland restoration efforts. Wild Turkeys were seen in small numbers in all habitats and seasons. This is a more common species on the WMA than our surveys would suggest, and it has been the focus of several Federal Aid in Wildlife Restoration projects. The substantial population of Wild Turkeys (Eastern race) that occur on and in the vicinity of the WMA, are present year-round and move across relatively large home ranges that encompass all habitat types including mixed pine/hardwood forest. The Mourning Dove was found in all seasons on the WMA but appears to be more common during the summer months. It was a fairly common bird, and associated with forest edges and clearings. Nearly all of the individuals that we detected were observed foraging for seeds or grit along WMA roads or were heard calling from trees along forest edges.

Nocturnal Birds: We did not conduct surveys specifically for nocturnal birds, but did record these during nocturnal surveys for calling amphibians and during early morning breeding bird surveys. During the project, we documented two species of owls (Eastern Screech Owl and Barred Owl) and numerous Chuck-wills-widows. Owls as a group are difficult to survey because of their nocturnal behavior and low population density. We located only one calling Eastern Screech Owl in mixed hardwood-pine forest during a summer survey. Despite the scarcity of detections, this is probably a fairly common, year-round resident on the WMA. Calling Barred Owls were heard on two occasions, once in bottomland forest and once in upland forest. As with the Eastern Screech Owl,

this is almost certainly a more common species than our surveys suggest and it should be present in all forested habitats year-round. We did not detect any Great Horned Owls during our survey, however, this species is common and widespread in Oklahoma and one or a few pairs are likely to nest on the WMA. The Chuck-wills-widow was the only member of the nightjar family that we detected on the WMA. Fifty-one calling birds were detected during our evening surveys suggesting that this is a common species with a large population on the WMA. Most Chuck-wills-widows were heard calling from within forests near roads, but some appeared to be calling from forest edge habitat and a few were flushed from roads in the evenings and early mornings. Though we did not detect any Common Nighthawks or Whip-poor-wills, it is possible that both of these species may occur on the area in small numbers.

Migrant Songbirds: Based upon the records summarized in Oklahoma Birdlife (Baumgartner and Baumgartner 1992), approximately 30 species of songbirds pass through the Ouachita Mountains Region of Oklahoma during their spring and/or fall migrations moving to and from their breeding grounds north of Oklahoma. We did not place any emphasis in detecting migrating songbirds because of their transient status on the area, and because we believe that the habitat need for these species can be met through habitat management for breeding and wintering songbirds which are more dependent upon the area. Our surveys detected ten species of migrating songbirds: Blue-headed Vireo, Swainson's Thrush, Gray Catbird, Orange-crowned Warbler, Nashville Warbler, Black-throated Green Warbler, Chestnut-sided Warbler, Ovenbird, Wilson's Warbler and Lincoln's Sparrow. The Gray Catbird and Ovenbird may be rare breeding species on or in the vicinity of the WMA, but we did not document either species during the heart of the nesting season between mid-May and early July. Many other species are likely to pass through the WMA annually but the effort to document all of them would be excessive. The relative scarcity of migrants detected during our surveys was probably a function of several factors: 1) migrants are present for only a short period of time in any one locations so their detection tends to be "hit or miss;" 2) migrants are not concentrated and are difficult to detect in the large forested tracts that occur on the WMA; and 3) many migrants tend to be quiet and are difficult to detect by any means other than sight.

Songbirds/Land Birds: Seventy species of songbirds, woodpeckers, cuckoos, swifts and hummingbirds that are resident on the WMA during the breeding season and/or during the winter months, were documented during our survey. Because of the number and diversity of species, these will be discussed as groups with similar habitat associations.

Upland Oak-Pine Forest Habitat:
Thirty-three species were documented in the upland pine/hardwood forest habitat (Table 3) during the nesting season. Of these, we considered 29 species to be characteristic of the upland mixed pine-hardwood forest community because they were either commonly encountered in this habitat type, or because the majority of our observations of these species were made in upland mixed forest. The remaining species were either shrubland or forest edge birds that were detected in small numbers within forested habitat, or too uncommon on the WMA to accurately assess their habitat associations. The most commonly detected breeding birds in upland mixed pine/hardwood forest were Summer Tanager, Pine Warbler and Red-eyed Vireo. These three species were detected at the majority of the breeding bird point-count locations within this habitat type. Other common breeding birds included ten year-round resident species: Red-bellied Woodpecker, Downy

Woodpecker, Pileated Woodpecker, American Crow, Blue Jay, Carolina Chickadee, Tufted Titmouse, White-breasted Nuthatch, Carolina Wren and Chipping Sparrow. Each of these was widespread and found in both upland and riparian forests; none was restricted to the upland forest habitat type. Also present commonly, were six species of Neotropical migrant birds (in addition to the Red-eyed Vireo and Summer Tanager listed above): Yellow-billed Cuckoo, Eastern Wood Pewee, Great Crested Flycatcher, Blue-gray Gnatcatcher, Scarlet Tanager and Indigo Bunting. These 19 species are characteristic of forested habitats across the southeastern U.S. with the exception of the Scarlet Tanager which occurs locally in the Ouachita Mountains and appears to have a substantial population on the management area. The Eastern Wood Pewee, Blue-gray Gnatcatcher, Indigo Bunting and Chipping Sparrow are more characteristic of woodland habitats rather than closed-canopy forest, and their abundance on the wildlife management area appears to have been enhanced by the recent creation of brushy openings and the restoration of periodic fires on the area.

Six of the species in the mixed pine/hardwood breeding bird community were species that were more typically found in shrubland or woodland (open canopy) habitats but were detected several times within the hardwood-pine forest habitat: Red-headed Woodpecker, Eastern Bluebird, Common Yellowthroat, Yellow-breasted Chat, Northern Cardinal, and Blue Grosbeak. Some of these are described in greater detail in the shrubland/forest edge habitat section. The remaining eight species were relatively uncommon species in the upland mixed pine/hardwood forest community: Chimney Swift, Ruby-throated Hummingbird, Hairy Woodpecker, Northern Rough-winged Swallow, Brown-headed Nuthatch, Black and White Warbler, Kentucky Warbler and Hooded Warbler.

Chimney Swifts were found on three occasions as they foraged over upland pine/hardwood forest habitat during the summer. Across much of its range, the Chimney Swift commonly nests in man-made structures such as chimneys. However swifts were not found in the vicinity of buildings during our surveys which suggests that a small number of Chimney Swifts may nest on the area in hollow tree cavities. Ruby-throated Hummingbirds appear to be uncommon on the WMA though we saw them commonly in the Kiamichi River valley around Clayton. Their scarcity on the WMA may be a reflection of less suitable habitat or a reduced abundance of Trumpet Creeper (*Campsis radicans*) and other preferred nectar sources.

We located two Hairy Woodpeckers in upland mixed pine/oak forest and this species is probably uncommon but widespread on the WMA. Hairy Woodpeckers are uncommon across most of their range, relative to other woodpecker species of similar size, and tend to forage most frequently on tree trunks. This more specialized feeding behavior is believe to be the reason why their territories are larger and their population densities are smaller than other woodpeckers. The Brown-headed Nuthatch is a year-round resident bird of pine and mixed pine/hardwood forests across the southeastern U.S. We located only one individual during the survey, suggesting that this is an uncommon or rare songbird. It is possible that the Brown-headed Nuthatch's preference for pine woodlands limits its abundance on the WMA.

Black and White Warblers were uncommon during our breeding season surveys, but they may nest more commonly than our survey results suggest. Black and White Warblers are one of the first

Neotropical migrant songbirds to return to their breeding grounds in the spring and they were very active and vocal during late March and early May surveys. This species raises only one brood of chicks per year and nests earlier in the spring than most songbirds, therefore some nesting pairs may have completed their nesting cycle by the time of our June survey and ceased to sing. Where we did find Black and White Warblers, they typically occupied stands of mature forest dominated by hardwood trees. Kentucky Warblers were uncommon but appeared in habitat that was similar to that used by Black and White Warblers. Singing Kentucky Warblers were detected in deciduous forest near riparian areas more often than in upland forest, but at the two locations where they were found in mixed pine/hardwood forest were on north-facing slopes where the forest was dominated by deciduous trees. The Hooded Warbler was detected only one time during our survey in a dense young stand of pine and oak trees, that appeared to be a regrowth following a small scale timber harvest or severe fire. In Oklahoma, Hooded Warblers are typically found in mesic forest habitat with a thick understory of shrubs and small trees; this type of habitat is more common at lower elevation sites off the WMA such as the Kiamichi River valley. The location where this bird was found may have resembled the thick understory conditions that this bird uses in other parts of its range. The Hooded Warbler appears to be a rare breeding species on the WMA and could be found in small numbers along Cedar Creek, the Kiamichi River and north-facing mountain slopes if more surveys were conducted.

The wintering bird community in the upland mixed pine/hardwood forest habitat included twenty-four species. Of these, 13 were year-round residents that used this habitat type during both the breeding and wintering seasons: Red-bellied Woodpecker, Downy Woodpecker, Hairy Woodpecker, Pileated Woodpecker, American Crow, Blue Jay, Carolina Chickadee, Tufted Titmouse, White-breasted Nuthatch, Carolina Wren, Pine Warbler, Northern Cardinal and Chipping Sparrow. The winter bird community was augmented by the presence of seven wintering species - Northern Flicker, Ruby-crowned Kinglet, Golden-crowned Kinglet, Cedar Waxwing, Yellow-rumped Warbler, Dark-eyed Junco, and White-throated Sparrow. Four additional species that were typical of shrubland and woodland habitats were found in the cover of upland forest habitat during the winter months - Eastern Bluebird, Bachman's Sparrow, Field Sparrow and American Goldfinch.

Deciduous Riparian Forest:

The breeding and wintering bird communities of the deciduous-dominated riparian habitat is difficult to quantify because of the relatively small acreage of this habitat present on the WMA. There was a great deal of overlap between the species present in the riparian forest community and the surrounding upland forest community. Of 25 species found in the riparian forest community during the summer, 20 were also found breeding in the adjacent upland mixed pine/hardwood forest community. However, five breeding species were unique to the riparian deciduous forest community - Acadian Flycatcher, Yellow-throated Vireo, Northern Parula, Yellow-throated Warbler and Louisiana Waterthrush. These five species are typically associated with riparian and bottomland forest communities in eastern Oklahoma, but they are uncommon in relatively narrow riparian communities such as occurs along Caney (Cedar) Creek and its tributaries. Another three other species - White-eyed Vireo, Black and White Warbler and Kentucky Warbler - appeared to occur more commonly in the riparian community than in the other habitat types on the WMA. All three species nest on or near the ground and across their ranges, they are usually associated with

mesic sites supporting an abundance of shrub cover. All eight species would probably benefit from management for mature, uneven-aged deciduous forest habitat with increased shrubby understory.

A similar pattern of high species overlap occurred during the winter season between the riparian and upland forest habitats. Of 25 species detected in the riparian deciduous forest community during the winter, 20 were also found in the upland forest community. The five species which appeared unique, or at least more common, in the riparian forest community in winter were Yellow-bellied Sapsucker, Eastern Phoebe, Winter Wren, Hermit Thrush and Purple Finch. The single Eastern Phoebe observed during late winter may have over-wintered on the WMA or may have been an early-returning migrant. It was observed hunting insects over Caney Creek and its presence on the area was probably tied to the presence of insects emerging from the creek. The other four species are probably not restricted to riparian forests, but they may be more common in this community due to structural attributes of riparian areas (greater shrub cover and moist soil), or to differences in tree species composition. The Purple Finches were found feeding on seeds in Sweet Gums, a tree which was found only in riparian areas. The Winter Wren and Hermit Thrush are both insectivorous birds that forage near the ground; they may be more common in riparian areas due to the greater shrub cover or soil moisture there.

Oak-Pine Woodland and Shrubby Edge:
The woodland and shrubby edge habitat type supported a very different bird community than either of the two forested habitat types. Though historically common, woodlands and shrubby edges are an uncommon habitat type in southeastern Oklahoma where much of the landscape is either mixed pine/hardwood forest, pine plantation or converted pastureland. On Pushmataha WMA, the thinning and clearing of forest along most of the major roads has resulted in the creation of shrubby habitat of native grasses and forbs, oak and hickory stump sprouts and woody vines and shrubs. During the breeding season, 38 species of songbirds and similar birds were detected in this habitat type including sixteen species that were common and/or unique. Eight species were fairly common to abundant - Red-headed Woodpecker, Eastern Bluebird, Prairie Warbler, Common Yellowthroat, Yellow-breasted Chat, Blue Grosbeak, Indigo Bunting, Bachman's Sparrow; while the other ten were rare and represented by only one to four individuals - Eastern Phoebe, Eastern Kingbird, Scissor-tailed Flycatcher Painted Bunting Field Sparrow Red-winged Blackbird, Brown-headed Cowbird and Orchard Oriole. At least sixteen species found in the woodland and shrubby edge community were more commonly found in forested habitats (e.g. Red-eyed Vireo, Tufted Titmouse and Summer Tanager). However two species, the Eastern Wood Pewee and Great Crested Flycatcher, may have been equally dependent upon the presence of both forest and shrubland habitat because they were most commonly detected perched at forest edges.

The winter bird community in the woodland and shrubby edge habitat included at least 26 species of songbirds and woodpeckers. This included 18 species of year-round residents (including observations of one Bachman's Sparrow and two Eastern Phoebes that may have been early-returning breeding season birds), and eight species that were documented primarily during the winter months - Savannah Sparrow, Dark-eyed Junco, White-throated Sparrow, White-crowned Sparrow, Swamp Sparrow, Song Sparrow, Eastern Meadowlark, and American Goldfinch. The White-crowned Sparrow, Savannah Sparrow and Eastern Meadowlark were uncommon winter

residents and found only in this habitat type. The Chipping Sparrow, Field Sparrow and Song Sparrow appeared to winter more common in this habitat than any other.

Missed Birds: A few species of birds are likely to occur on the Pushmataha Wildlife Management Area but were not detected during our surveys. The Greater Roadrunner is a year-round resident that occurs in low densities in the Ouachita Mountains Region; this is likely to be an uncommon resident in the open habitats along the WMA roads. The Brown Creeper and Eastern Towhee are uncommon winter residents in the Ouachita Mountains and should have been detected if greater survey effort were expended during the winter months.

Mammals:
Table 3. depicts the species of mammals and the number of individuals of each that were located during this survey. Many of the mammals that we documented were observed incidentally during road-based surveys for birds and calling amphibians. Spot-light surveys were effective for locating deer and elk but were not effective for small species as a result of dense herbaceous vegetation along the WMA roads. Fifty-four White-tailed Deer (*Odocoileus virginianus*) and 14 American Elk (*Cervus elaphus*) were documented during the survey using a combination of night-time spotlighting and opportunistic observations during daylight hours. White-tailed Deer were found in all habitats and there was no obvious indication of habitat preferences. American Elk were found primarily in shrubland/woodland habitat, but their greater present there could be an artifact of better visibility in this habitat type. Searches for tracks and scat along roads and in areas of bare soil were effective for determining the presence of carnivores but numbers of individuals could not be determined. Virginia Opossum (*Didelphis virginiana*), Gray Fox (*Urocyon cinereoargenteus*), Coyote (*Canis latrans*), River Otter (*Lutra canadensis*) and Bobcat (*Lynx rufus*) were documented in this way and their presences is signified by and "X" in the appropriate cell in Table 3. Two additional carnivore species - one Raccoon (*Procyon lotor*) and six Striped Skunks (*Mephitis mephitis*) - were located opportunistically along roads during evening and early morning surveys.

During road-based evening surveys we observed 17 bats flying/foraging over upland forest and shrubland habitats. Based upon size and coloration, we determined that at least six of these bats were Red Bats (*Lasiurus borealis*), but the identify of the remaining 11 bats was undetermined. We did not attempt to set up mist nets to capture bats on the area because we located mist-netting data that had been collected on the WMA in 1985 by Dr Bill Caire at the University of Central Oklahoma and in 1994 by Drs. Bryan and Brenda Clark of Southeastern Oklahoma State University. Collectively, these two surveys represented 15 net nights at eight locations and appeared to be a reasonably thorough examination of the WMA's bat community. Thirty-seven Red Bats, 21 Evening Bats (*Nycticeius humeralis*), two Hoary Bats (*Lasiurus cinereus*) and one Northern Long-eared Myotis (*Myotis septentrionalis*) were caught during those surveys.

Live trapping of small mammals using baited Sherman traps met with limited success. Eighty-six trap nights results in the capture of one White-footed Mouse (*Peromyscus leucopus*), one Texas Brush Mouse (*Peromyscus attwateri*) and one Hispid Cotton Rat (*Sigmodon hispidus*). Each of these individuals was trapped in the shrubland/woodland habitat type. An additional White-footed Mouse and Hispid Cotton Rat were observed during road-based surveys, also in shrubland/woodland habitat. The Nine-banded Armadillo and the majority of the 22 Eastern

Cottontails that we documented were observed during the evening and early morning road surveys. The Eastern Mole was documented by the presence of numerous tunnels and a single dead individual located on a road in a riparian area. The four Eastern Gray Squirrels, 12 Fox Squirrels and single Eastern Chipmunk were documented during timed searches on foot and by vehicle. Fox Squirrels appeared to be common and were typically found in oak woodlands and upland mixed pine/hardwood forest. The Eastern Gray Squirrel was less common and appears to have a preference for the riparian, deciduous-dominated forest habitat.

Other mammals that might be present on Pushmataha WMA but were not documented during our survey include: Elliot's Short-tailed Shrew (*Blarina hylophaga*), Least Shrew (*Cryptotis parva*), Eastern Pipistrel (*Pipistrellus subflavus*), Swamp Rabbit (*Sylvilagus aquaticus*), Southern Flying Squirrel (*Glaucomys volans*), American Beaver (*Castor canadensis*), Fulvous Harvest Mouse (*Reithrodontomys fulvescens*), Cotton Mouse, (*Peromyscus gossypinus*), Deer Mouse (*Peromyscus maniculatus*), Eastern Woodrat (*Neotoma floridana*), Woodland Vole (*Microtus pinetorum*), Red Fox (*Vulpes vulpes*), Black Bear (*Ursus americanus*), Mink (*Mustela vison*) and Eastern Spotted Skunk (*Spilogale putorius*). Three species, Swamp Rabbit, Red Fox and Black Bear are uncommon on the WMA, but have been documented by Jack Waymire. The Southern Flying Squirrel is highly nocturnal and difficult to detect, but it appears to be common throughout the Ouachita Mountain and should be common on the area. Additional effort at live-trapping small mammals or searching for tracks is needed to determine the presence or absence of most of the remaining species.

Amphibians:
A multi-year, regional drought hampered the effectiveness of our surveys for amphibians throughout the grant period. We especially had difficulty in finding salamanders. Of the seven species of salamanders that could potentially occur on the Pushmataha WMA, we were able to confirm the presence of only two - the Central Newt (*Notophthalmus viridescens louisianensis*) and the Western Slimy Salamander (*Plethodon albagula*). The Central Newt appears to be a common salamander on the WMA. We netted 43 adults and four larval newts from eight fishless ponds scattered across the area in and adjacent to upland mixed pine/hardwood forest. The Western Slimy Salamander was represented in our survey by three adults that were found by raking deciduous leaf litter in a mesic forest site near Caney (Cedar) Creek and Divide Trail. This salamander may be locally common in mesic forest habitat, but is probably not common across much of the WMA. Slimy Salamanders undergo complete development within the egg and resemble miniature adults when they hatch. Because they do not lay their eggs in water or undergo an aquatic larval stage, they are not strongly tied to ponds or vernal pools but do require sheltered, mesic sites. Five additional salamander species potentially occur on or in the vicinity of the Pushmataha WMA but we did not find evidence for these. Three of these species are part of the mole salamander group (family Ambystomatidae): Spotted Salamander (*Ambystoma maculatum*), Marbled Salamander (*Ambystoma opacum*) and Small-mouthed Salamander (*Ambystoma texanum*). These species breed in vernal pools after rains in the fall or early spring and the dry weather pattern during 2005 and 2006 may have hindered their reproduction. Additionally, these are burrowing salamanders that spend much of their lives underground, and are difficult to find except during wet weather. The thin rocky soils on the WMA may limit the distribution and abundance of each of these species on the area.. The remaining two salamander species are highly aquatic, lungless salamanders - the Ouachita Dusky Salamander (*Desmognathus brimleyorum*) and the Many-ribbed Salamander

(*Eurycea multiplicata multiplicata*). Both of these species lay their eggs in water during the spring in headwater creeks, springs and seeps. We checked several sites in the headwaters of Peterson, Jerusalem and Caney creeks but found only two larval salamanders. Both of these escaped capture and we can not be certain whether they were larval Many-ribbed Salamanders or larval Central Newts. Additional survey work is needed for salamanders on the WMA; at a minimum, a population of Many-ribbed Salamanders should be present.

Our efforts at documenting frog and toad populations were much more successful as a result of fortuitous rainfall events during two of our surveys. We were able to confirm the presence of ten out of thirteen species of frogs and toads that potentially occur on or near the WMA. We also documented the presence of an eleventh species, the Green Treefrog (*Hyla cinerea*), which we did not expect to find. Our records represent a small range extension of approximately 30 miles for this species. We also heard what we believe were vocalizations for a twelfth species - the Pickerel Frog (*Rana palustris*) - but we were not able to visually confirm their presence. We conducted multiple evening calling surveys for frogs and toads during the months of March, May and June, which helped us to document a seasonal shift in the calling frequencies of some species. For example, the only Northern Spring Peepers (*Pseudacris crucifer crucifer*) and the three possible Pickerel Frogs that we detected were heard during the March surveys. Conversely, the only Green Treefrogs that we heard were during our June surveys, and this survey period also encompassed nearly all of the calling activity for Eastern Narrowmouth Toads (*Gastrophryne carolinensis*) and Green Frogs (*Rana clamitans melanota*). Our March surveys were preceded by a strong storm front and heavy rains which triggered a high level of calling activity by Dwarf American Toads (*Bufo americanus charlesmithi*), Northern Spring Peepers, and Western Chorus Frogs (*Pseudacris triseriata*). Also, during the night prior to our first morning of breeding bird point counts in June of 2004, the region received over one inch of rain. This rainfall event stimulated calling activity throughout the day and evening by Eastern Narrowmouth Toads, Gray Treefrogs (*Hyla vericolor/chrysoscelis*), Western Chorus Frogs, Cricket Frogs (*Acris crepitans blanchardi*) and Green Frogs. During a two day/evening period, we recorded a minimum of 156 calling male Eastern Narrowmouth Toads, 84 Western Chorus Frogs and 177 Gray Treefrogs that were heard calling around temporary wetlands, fishless ponds and stream headwaters throughout the WMA.

The Dwarf American Toad was by far the more common of the two toad species found on the WMA. At least 87 adults were seen or heard in all habitat types on the area and thousands of tadpoles were netted in at least ten ponds and three stream headwaters. A second toad species, the Woodhouse's Toad (*Bufo woodhousii*) was represented by four adults that were found along WMA roads in predominately open, shrubland habitat. Narrowmouth toads were heard abundantly after rains in June (214 of the 215 narrowmouth toads detected were heard in June), but we never physically saw any specimens. Based upon the calling pattern and the geographic range of the two species in Oklahoma, we considered all of the narrowmouth toads that we heard to be Eastern Narrowmouth Toads, though it is possible that both this species and the Great Plains Narrowmouth Toad (*Gastrophryne olivacea*) were present. Narrowmouth toads appear to be common in all habitat types on the WMA due to the presence of numerous fishless ponds and small temporary pools. The Blanchard's Cricket Frog was common around the small man-made ponds on the area and along Caney Creek and its tributaries. A total of 169 adults and 60 recently metamorphosed juveniles were found during our surveys. The Northern Spring Peeper appeared to be common, at

least in forested habitat on the WMA. We heard at least 58 calling males during our late winter/early spring surveys, mostly in temporary pools within or adjacent to forested habitats. Gray Treefrogs were another common species on Pushmataha WMA. We could not readily distinguish between the calls of tetraploid species *Hyla versicolor* and the diploid species *Hyla chrysoscelis*, therefore we did not attempt to differentiate between the two and classified all Gray Treefrogs as being part of the "Gray Treefrog complex." Two hundred and eleven calling Gray Treefrogs were heard during our evening surveys and several of their red-tailed tadpoles were netted from area ponds. An unexpected find was the presence of at least ten calling Green Treefrogs at three separate ponds. As with most of the frogs and toads, we did not see any of these individuals, but their call is a very distinctive honk-like noise that we were familiar with because of surveys that we had conducted on Red Slough WMA several years earlier. The survey extends the range of the Green Treefrog slightly into Pushmataha County, and it is likely that this species is more common and widely spread along the Kiamichi River than earlier believed.

During our March surveys we heard three calling frogs at two ponds which sounded like Pickerel Frogs. Despite our attempts to capture them, we were not able to see and confirm them. We recommend future late winter/early spring survey work to confirm whether a breeding population exists for this regionally uncommon species. Southern Leopard Frogs (*Rana sphenocephala utricularia*) were fairly common on the area in the vicinity of ponds and Caney Creek. We never heard large choruses, but they were vocal throughout the spring and early summer and a total of 31 were seen or heard. The Green Frog was the most common of the *Rana* species on the WMA. We never heard large choruses of this species, but small numbers of Green Frogs or Green Frog tadpoles were found at nearly all of the ponds that we searched. A total of 56 adults and several dozen tadpoles were documented. The American Bullfrog (*Rana catesbeiana*) was found in small numbers (6) around three ponds on the WMA. This is the largest of the Rana frogs and tends to prey upon other species of frogs, therefore it may be beneficial to overall frog diversity on the wildlife management area that this species is uncommon.

Only two species of frogs with the potential to occur on the WMA were not found - Hurter's Spadefoot (*Scaphiopus hurterii*) and Crawfish Frog (*Rana areolata*). Neither of these species is likely to occur on the area because both are typically found in woodlands and prairies with deep soil - a condition lacking on the WMA. Additionally, both species are difficult to document in areas where they do occur. The Hurter's Spadefoot is an irruptive breeder that has a short breeding season after heavy rains. The Crawfish Frog too has a short breeding season early in the spring (March and April).

Reptiles:
Seven species of turtles have the potential to occur on Pushmataha WMA: Mississippi Mud Turtle (*Kinosternon subrubrum hippocrepis*), Razor-backed Musk Turtle (*Sternotherus carinatus*), Stinkpot (*Sternotherus odoratus*), Ouachita Map Turtle (*Graptemys ouachitensis ouachitensis*), Eastern River Cooter (*Pseudemys concinna concinna*), Three-toed Box Turtle (*Terrapene carolina triunguis*), and Red-eared Slider (*Trachemys scripta elegans*). During this survey, we found turtles, as a group, to be uncommon, and we confirmed only three species. We encountered one Mississippi Mud Turtle crossing a WMA road in the vicinity of a small pond shortly after a summer storm. This species is probably common in the small ponds on the area, but because of its secretive

nature (it is not a basking turtle) we did not detect it more often. We observed a total of eleven basking turtles in four pools along Caney (Cedar) Creek and we were able to identify seven of these. All seven were Eastern River Cooters and this appears to be the most common, and possibly the only basking turtle on the WMA. Another two basking turtles on a large pond on the WMA also turned out to be Eastern River Cooters. Though the Red-eared Slider is common across most of Oklahoma, we did not find any during our surveys of the WMA's ponds. Box turtles also appeared to be relatively uncommon. We located one adult Three-toed Box Turtle in a brushy edge near upland oak/pine forest, and the shells of two long-dead box turtles in upland oak/pine forest stands. Though the vegetation structure appears suitable for box turtles, it is possible that the rocky soils of the WMA may limit their abundance. We did not attempt to set any aquatic turtle traps during our surveys; such trapping might have revealed other turtle species such as the Stinkpot which is common in the Ouachita Mountain region.

Based upon published range maps and museum records for the Ouachita Mountain region, eight species of lizards could potentially be found on the Pushmataha WMA: Northern Green Anole (*Anolis carolinensis*), Eastern Collared Lizard (*Crotaphytus collaris*), Northern Fence Lizard (*Sceloporus undulatus hyacinthinus*), Prairie Racerunner (*Cnemidophorus sexlineatus viridis*), Southern Coal Skink (*Eumeces anthracinus pluvialis*), Broad-headed Skink (*Eumeces laticeps*), Common Five-lined Skink (*Eumeces fasciatus*), and Brown Skink (*Scincella lateralis*). During our surveys, we documented five of these. The Northern Fence Lizard appears to be a very common lizard on the WMA and was found during every spring and summer survey trip. Fence lizards were commonly seen sunning on logs, rocks and the trunks of trees, and appear to be the most common reptile on the area. Eight Prairie Racerunners were found along roads in the brushy and grassy openings that have been created along Pine Tree Circle. All of our sightings occurred on the northern portion of the circle closest to the WMA headquarters where these openings have been in existence for the longest period of time. A single Southern Coal Skink was found while turning rocks in a dry portion of the Caney (Cedar) Creek stream bed near Divide Trail. This species is probably fairly common along tributaries and other rocky areas on the WMA. Four Common Five-lined Skinks were found in leaf litter or sunning on logs at several locations within forested habitat. This species appears to be common on the WMA. Similarly, three Brown Skinks were found while raking leaf litter, and this species too is probably common on the WMA. Despite our searches, we were not able to locate any Green Anoles. This anole is fairly common in the Ouachita Mountains in McCurtain County thirty miles south and east of the WMA, but it does not appear to range this far west. We also searched for Eastern Collared Lizards without success. Collared Lizards have been reported at a rock quarry less than 10 miles from the WMA and it is possible that small numbers of Collared Lizards occur on the WMA but are not readily visible because of the abundant herbaceous ground cover.

The Pushmataha WMA potentially supports up to twenty-four species of snakes as follows: Western Wormsnake (*Carphophis vermis*), Yellow-bellied Racer (*Coluber constrictor flaviventris*), Prairie Ring-necked Snake (*Diadophis punctatus arnyi*), Texas Black Ratsnake (*Elaphe obsoleta lindheimeri*), Eastern Hog-nosed Snake (*Heterodon platirhinos*), Prairie Kingsnake (*Lampropeltis calligaster*), Speckled Kingsnake (*Lampropeltis getula holbrooki*), Red Milksnake (*Lampropeltis triangulum syspila*), Eastern Coachwhip (*Masticophis flagellum flagellum*), Plain-bellied Watersnake (*Nerodia erythrogaster*), Northern Diamond-backed Watersnake (*Nerodia rhombifer*

rhombifer), Northern Watersnake (*Nerodia sipedon*), Northern Rough Greensnake (*Opheodrys aestivus aestivus*), Texas Brownsnake (*Storeria dekayi texana*), Red-bellied Snake (*Storeria occipitomaculata*), Flat-headed Snake (*Tantilla gracilis*), Western Ribbonsnake (*Thamnophis proximus*), Red-sided Gartersnake (*Thamnophis sirtalis parietalis*), Rough Earthsnake (*Virginia striatula*), Western Smooth Earthsnake (*Virginia valeriae elegans*), Copperhead (*Agkistrodon contortrix*), Western Cottonmouth (*Agkistrodon piscivorus leucostoma*), Timber Rattlesnake (*Crotalus horridus*), and Western Pygmy Rattlesnake (*Sistrurus miliarius streckeri*). Eight of these species were documented during our surveys of the area and a ninth species (Timber Rattlesnake) was confirmed by Jack Waymire.

Four small species of snakes were found by turn over rocks and logs (Flat-headed Snake, Ring-necked Snake, Rough Greensnake) or by raking leaf litter around trees (Red-bellied Snake). Each of these appears to be common on the WMA, especially Flat-headed Snake of which six were found in two locations in the spring by turning rocks, and the Ring-necked Snake which Jack Waymire reported as seeing regularly. The forested habitat on the WMA is also likely to support two other small insect-eating snakes - the Rough Earthsnake and the Smooth Earthsnake - though we did not document these species during our survey.

The Plain-bellied Watersnake appears to be the most common non-venomous watersnake on the area. Five of these snakes were found around ponds and along Caney (Cedar) Creek. Similarly, the Western Cottonmouth appears to be common, at least along Caney (Cedar) Creek where two adults and a juvenile were found. Two other large species of snakes were documented during our surveys. A Copperhead approximately 3 feet in length was found on a WMA road adjacent to an upland forested area during one summer evening. An adult Black Ratsnake measuring over four feet was found sunning on Pine Tree Circle late on a summer morning. Though large, this individual showed very little black coloration and had well defined dark brown blotches on its back that strongly resembled the pattern of the Texas race of the Black Ratsnake. Several other large species of snakes are probably common on the area though our surveys did not detect them. Many snake species are secretive and occur in low densities such that timed searches may not be very effective for locating them. Both of our large terrestrial snakes were located as a result of opportunistic encounters.

Fish

Based upon previous collections in the Kiamichi River (summarized in Pigg and Hill 1974), at least 88 species of fish occur in the Kiamichi River watershed, though only about 30 of these are likely to occur in the headwater streams on the Pushmataha WMA. These 30 species include: Gizzard Shad (*Dorosoma petenense*), Redfin Pickerel (*Esox americanus*), Central Stoneroller (*Campostoma anomalum*), Steelcolor Shiner (*Cyprinella whipplei*), Striped Shiner (*Luxilus chrysocephalus*), Redfin Shiner (*Lythrurus umbratilis*), Golden Shiner (*Notemigonus crysoleucas*), Emerald Shiner (*Notropis atherinoides*), Bigeye Shiner (*Notropis boops*), Kiamichi Shiner (*Notropis ortenbergeri*), Rocky Shiner (*Notropis suttkusi*), Mimic Shiner (*Notropis volucellus*), Bluntnose Minnow (*Pimephales notatus*), Bullhead Minnow (*Pimephales vigilax*), Creek Chubsucker (*Erimyzon oblongus*), Freckled Madtom (*Noturus nocturnus*), Black-spotted Topminnow (*Fundulus olivaceous*), Mosquitofish (*Gambusia affinis*), Brook Silverside (*Labidesthes sicculus*), Green Sunfish (*Lepomis cyanellus*), Orange-spotted Sunfish (*Lepomis humilis*), Bluegill (*Lepomis*

macrochirus), Longear Sunfish (*Lepomis megalotis*), Spotted Bass (*Micropterus punctulatus*), Slough Darter (*Etheostoma gracile*), Johnny Darter (*Etheostoma nigrum*), Cypress Darter (*Etheostoma proeliare*) Orangebelly Darter (*Etheostoma radiosum*), Logperch (*Percina caprodes*), and Dusky Darter (*Percina sciera*). We had limited success in capturing fish, and additional work is needed beyond that which was conducted under this grant. Fish habitat on the area consisted of several man-made ponds and Caney (Cedar) Creek. The substrate of Caney Creek is comprised of cobble, boulders and exposed bedrock, therefore it was difficult to seine as compared to sandy-bottom and gravel-bottom streams. Our greatest success in capturing fish was through the use of dip net. Through limited dip net and seine surveys in pools along the Caney (Cedar) Creek during low-flow conditions in the fall, we confirmed nine species of fish - Redfin Pickerel, Central Stoneroller, Striped Shiner, Bigeye Shiner, Mosquitofish, Brook Silverside, Green Sunfish, Longear Sunfish and Orangebelly Darter. Additionally, Green Sunfish were netted from three of the larger ponds on the WMA during amphibian surveys.

Vertebrate Inventory of Sandy Sanders Wildlife Management Area

Our surveys of the Sandy Sanders Wildlife Management Area spanned the period from January 2003 through September 2005. The survey dates and targeted taxonomic groups for each survey are listed below. The results of these surveys are summarized in Table 4, and the cumulative search effort is shown in the table's footnotes.

9 and 10 January 2003: road-based timed searches for wintering birds
13 and 14 March 2003 road and foot-based timed searches for birds, evening calling surveys for amphibians
28, 29 & 30 May 2003: timed searches for amphibians and reptiles, netting for fish
16, 17 & 18 June 2003: breeding bird point counts, timed searches for reptiles and amphibians
23 October 2003: track searches for mammals, timed searches for fall-migrating birds
9 December, 2003: live trapping of small mammals
14 and 15 April, 2004: small mammal trapping, road-based timed searches for birds and reptiles, and evening calling surveys for amphibians
30 December 2004: timed searches for wintering birds
14 February 2005: timed searches for wintering birds
11, 12 & 13 April 2005: mist-net survey for bats; timed searches for migrating birds, amphibians and reptiles
20, 21 & 22 September 2005: mist-net survey for bats; timed searches for reptiles; netting and minnow traps for fish

The Sandy Sanders Wildlife Management Area is comprised of approximately 18,300 acres of native rangeland and shrubland. in southern Beckham and northwestern Greer counties. Prior to its acquisition by the Oklahoma Department of Wildlife Conservation in the late 1980s, this property had been privately owned ranch land. The area lies within an portion of the Central Mixed-grass

Prairie ecological region known as the Red Rolling Hills and is comprised of a series of small escarpments and buttes cut by numerous small, but steep, canyons. The WMA is dominated by two general habitat types: Honey Mesquite (*Prosopis glandulosa*) shrubland/savannah and Redberry (Pinchot) Juniper (*Juniperus pinchotii*) woodland (Hoagland 2000).

Redberry (Pinchot) Juniper woodlands occupy roughly 6,700 acres on the WMA, primarily on rocky, gypsum escarpments and canyons in the western and central part of the WMA. This habitat is comprised of scattered junipers with an understory of Hairy Grama (*Bouteloua hirsuta*), Sideoats Grama (*Bouteloua curtipendula*), Little Bluestem (*Schizachyrium scoparium*), cacti (*Opuntia macrorhiza* & *Opuntia phaeacantha*), Soapweed Yucca (*Yucca glauca*) and Wooly Paperflower (*Psilostrophe villosa*). Less common woody plants include Skunkbrush (*Rhus aromatica*), Honey Mesquite, and Netleaf Hackberry (*Celtis reticulata*). Juniper densities are variable and their canopy cover ranges from roughly 20% to more than 60%. All stands of Redberry (Pinchot) Juniper woodland also include some component of Honey Mesquite in the canopy. In a few low-lying areas in the transition between juniper-dominated and mesquite-dominated habitats, there were patches of bare or sparsely vegetated tight clay soil that appeared to be a result of either past overgrazing or naturally occurring soil infertility (e.g. high alkalinity). These were primarily on the eastern and southern parts of the WMA.

Honey Mesquite shrubland and savannah occupies roughly 11,700 acres on the northern, eastern and southern portions of the WMA. These sites are generally more level and less rocky than the sites dominated by Redberry Juniper. Honey Mesquite sites have an understory of grasses and forbs dominated by Hairy Grama (*Bouteloua hirsuta*), Silver Bluestem (*Bothriochloa saccharoides*), Little Bluestem (*Schizachyrium scoparium*), Yellow Prairie Indian Paintbrush (*Castilleja purpurea* var. *citrina*), Dotted Blazing Star (*Liatris punctata*), and Soapweed Yucca (*Yucca glauca*). Small numbers of Pinchot Juniper are also present and most stands of Honey Mesquite-dominated habitat also include some component of Redberry Juniper. The mesquite shrubland and savannah habitat is variable in terms of the percentage of canopy cover (20% - 70%) and the dominate grasses that comprised the under story (little bluestem, hairy grama and silver bluestem). We did not attempt to tease apart all of the fine-scale variability in grass composition and canopy cover, but future investigators may wish to conduct more in-depth studies of these kinds of finer-scale habitat preferences by some species of wildlife.

Within these two larger habitat types, there are several narrow riparian woodlands along intermittent and ephemeral streams and around man-made ponds. These narrow bands of riparian vegetation are often sparse and comprised of American Elm (*Ulmus americana*), Sugarberry (*Celtis laevigata*), Plains Cottonwood (*Populus deltoides*), Western Soapberry (*Sapindus drummondii*) and Black Willow (*Salix nigra*). The WMA lies within the watershed of the Elm Fork of the Red River, and encompasses an approximately 1.5 mile section of the Elm Fork which meanders through the southern edge of the area. Contrary to its name, this reach of the Elm Fork is not bordered by significant native riparian vegetation. The Elm Fork is saline and its riparian zone consists of a narrow band of Saltcedar (*Tamarix chinensis*) scrub. The western portion of the WMA drains to Fish Creek, a small, intermittent to perennial tributary of the Elm Fork River. Fish Creek and its tributaries have riparian zones of variable width and condition. Portions of Fish Creek have poorly developed riparian zones comprised of scattered and often isolated Plains Cottonwood and

American Elm trees. Its tributary, Minnow Creek, has a well developed, though narrow, riparian zone of American Elm, Sugarberry, and Chittamwood (*Bumelia lanuginosa*) trees. Deer Creek meanders through and drains the northeastern and eastern portions of the WMA. Through most of its length, Deer Creek has an incised channel with a narrow band of woody riparian vegetation dominated by American Elm, Black Willow, Sugarberry and Western Soapberry. The central portion of the WMA drains to the Elm Fork River through two unnamed intermittent streams. Neither of these streams has significant riparian vegetation. In addition to these streams, there are approximately 23 man-made ponds ranging in size from approximately 0.25 to 3.0 acres. Most of the larger ponds have been stocked with sport fish (e.g. Bluegill, Largemouth Bass); a few of the smaller ponds do not hold water every year and lack fish populations.

In addition to the native habitats and man-made ponds listed above, there are three locations in the southeastern portion of the WMA where a mosaic of shelter belts and food plots have been planted. These areas occur in relatively close proximity, on low, level land near Deer Creek and the Elm Fork River. The shelter belts in these areas are approximately 15-25 years old and are comprised of rows of Black Locust (*Robinia pseudoacacia*), Redbud (*Cercis canadensis*) , Western Soapberry, Lacebark Elm (*Ulmus parvifolia*), Sugarberry, Asian Mulberry (*Morus alba*), Osage Orange (*Maclura pomifera*), Plains Cottonwood and Russian Olive (*Eleagnus angustifolia*). The food plots are narrow rectangles between shelter belts which have been planted to wheat, oats, milo and sunflower.

During the biological surveys, we recorded the general habitat within which each individual vertebrate was associated. For purposes of this project, we categorized the habitats into four broad communities: 1) Redberry Juniper Woodland, 2) Mesquite Shrubland and Savannah, 3) Riparian Woodland & Shelter Belts, and 4) Aquatic Habitat (ponds, streams and the Elm Fork River channel). As mentioned above, Redberry (Pinchot) Juniper woodlands and Honey Mesquite shrublands/savannahs are variable in their structure and composition. There is some degree of overlap between these two general plant communities as most Redberry (Pinchot) Juniper sites contained some amount of Honey Mesquite, while most Honey Mesquite-dominated sites also contained some Redberry (Pinchot) Junipers.

As part of this project, a digital map was created of the plant communities (habitat types) on the Sandy Sanders WMA. This map was based upon remote imagery and ground surveys to verify the imagery (Figure 3). Using a combination of satellite imagery and aerial photographs, eight terrestrial habitat classifications were discernable: 1) Disturbed (synonymous with the areas comprised of shelter belts and food plots), 2) Grassland with Sparse Woody Vegetation (primarily mesquite), 3) Grassland, 4) Gypsum Outcrops with Sparse Vegetation, 5) Mesquite and Redberry Juniper Woodland, 6) Mesquite Woodland, 7) Redberry Juniper Woodland, and 8) Riparian Woodland. Because of the variable densities of Honey Mesquite and Redberry (Pinchot) Juniper, we lumped several of these habitat classifications during our field data collection. The Redberry (Pinchot) Juniper Woodland in this report is synonymous with the Mesquite and Redberry Juniper Woodland and Juniper Woodland classifications mapped in Figure 3. The Honey Mesquite Shrubland and Savannah habitat in this report is synonymous with four habitats combined: Grassland with Sparse Woody Vegetation, Grassland, Gypsum Outcrops and Mesquite Woodland. There were too few grassland sites without scattered Honey Mesquites for us to meaningfully

distinguish a grassland community or habitat. In this report, we combined the Riparian Woodland habitat classification with the Disturbed habitat classification. The Disturbed habitat was comprised of food plots and shelter belts. The shelter belts were planted to deciduous trees that are typical of riparian habitats in western Oklahoma (e.g Plains Cottonwood, Sugarberry, Osage Orange), and both the acreage occupied by both shelter belts and riparian woodlands was similarly small.

Table 4. Summary of Sandy Sanders Wildlife Management Area Surveys.

-Bird species marked with an asterisk (*) are likely to nest on the WMA.

-This table includes small mammals, reptiles and amphibians observed by Dr. Laurie Vitt and his herpetology students during a field trip in May 2004, and from crew of Oklahoma State University students conducting small mammal trapping under State Wildlife Grant project T-23-P during the summer of 2005. These observations are marked with an "X"in the appropriate cell.

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
Mammals					
Opossum			tracks		
Cave Myotis			6		X (3)
Big Brown Bat			8		
Pallid Bat			4		
unidentified bat			12		
Nine-banded Armadillo		2	2, + tracks		
Eastern Cottontail	15, + tracks	23, + tracks	5		X (1)
Black-tailed Jack Rabbit		13, + tracks			
Thirteen-lined Ground Squirrel		1			
Black-tailed Prairie Dog		colony of 16 to 24 individuals			
Plains Pocket Gopher			mounds		
Silky Pocket Mouse					X (23)
Hispid Pocket Mouse					X (32)
White-footed Mouse	1				X (56)
Deer Mouse		5	1		X (11)
Northern Grasshopper Mouse					X (10)
Hispid Cotton Rat		1			X (30)

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
Southern Plains Woodrat		2			X (24)
Porcupine			1	tracks	
Beaver				1	
Coyote	4, + tracks	4, + tracks	tracks	tracks	
Raccoon			3, + tracks	tracks	
Badger		tracks			
Striped Skunk	3, + tracks	2	2, + tracks	tracks	
Bobcat	tracks		tracks		
Mule Deer		12			
White-tailed Deer	14	24	13		
Birds					
Double-crested Cormorant				1 (summer)	
Great Blue Heron *				2 (spring/fall) 1 (summer)	
Snowy Egret				4 (spring/fall) 9 (summer)	
Little Blue Heron				2 (spring/fall) 8 (summer)	
Green Heron *			1 (summer)	3 (spring/fall) 3 (summer)	
Turkey Vulture *	6 (spring/fall) 5 (summer)	12 (spring/fall) 4 (summer)	4 (spring/fall) 3 (summer)		
Snow Goose				1 (winter)	
Canada (Cackling) Goose				61 (winter)	
Mallard				27 (winter) 6 (spring/fall)	
Gadwall				3 (winter)	
American Wigeon				9 (winter) 32 (spring/fall)	
Canvasback				1 (winter)	

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
Redhead				7 (winter) 38 (spring/fall)	
Ring-necked Duck				37 (winter) 40 (spring/fall)	
Hooded Merganser				2 (winter)	
Common Merganser				8 (winter)	
Mississippi Kite *	6 (summer)	3 (summer)	3 (spring/fall) 6 (summer)		
Northern Harrier		3 (winter) 1 (spring/fall)			
Sharp-shinned Hawk	4 (winter)				
Red-tailed Hawk *	1 (winter) 1 (spring/fall)	1 (winter) 2 (spring/fall) 2 (summer)	2 (spring/fall)		
Swainson's Hawk		1 (summer)	1 (spring/fall)		
American Kestrel *	3 (winter) 4 (spring/fall)	4 (winter) 8 (spring/fall) 2 (summer)	6 (winter) 6 (spring) 2 (summer)		
Wild Turkey *	7 (spring/fall) 2 (summer)	3 (spring/fall) 7 (summer)	2 (winter) 94 (spring/fall) 9 (summer)		
Northern Bobwhite *	7 (winter) 8 (spring/fall) 36 (summer)	9 (winter) 59 (spring/fall) 84 (summer)	13 (winter) 5 (spring/fall) 17 (summer)		
Scaled Quail *		5 (spring/fall)			
Sandhill Crane				2 (spring/fall)	
American Coot				2 (spring/fall)	
Killdeer *		2 (winter) 2 (spring/fall) 4 (summer)	1 (spring/fall)	4 (winter) 27 (spring/fall) 8 (summer)	
Greater Yellowlegs				6 (winter) 6 (spring/fall)	
Spotted Sandpiper				2 (spring/fall)	
Upland Sandpiper			3 (spring/fall)		

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
Mourning Dove *	6 (spring/fall) 22 (summer)	1 (winter) 59 (spring/fall) 62 (summer)	34 (winter) 18 (spring/fall) 43 (summer)		
Yellow-billed Cuckoo *	13 (summer)	21 (summer)	15 (summer)		
Greater Roadrunner *	1 (winter) 3 (spring/fall) 2 (summer)	5 (spring/fall)			
Barn Owl *		1 (summer)	1 (spring/fall)		
Eastern Screech-Owl *			4 (spring/fall)		
Great Horned Owl *		2 (winter)			
Burrowing Owl		1 (spring/fall)			
Common Nighthawk *	10 (summer)	4 (spring/fall) 31 (summer)	3 (summer)		
Common Poorwill *	1 (spring/fall) 6 (summer)	14 (spring/fall) 7 (summer)	4 (spring/fall)		
Belted Kingfisher *				4 (winter) 5 (spring/fall) 3(summer)	
Golden-fronted Woodpecker *		1 (winter) 1 (spring/fall) 2 (summer)	4 (winter) 2 (spring/fall) 4 (summer)		
Ladder-backed Woodpecker *	1 (winter) 2 (spring/fall) 2 (summer)	4 (winter) 3 (spring/fall) 5 (summer)	1 (winter) 1 (summer)		
Northern Flicker *	11 (winter) 5 (spring/fall) 1 (summer)	3 (winter) 6 (spring/fall) 2 (summer)	1 (winter) 19 (spring/fall) 6 (summer)		
Eastern Phoebe *		1 (spring/fall) 2 (summer)	6 (spring/fall) 3 (summer)		
Say's Phoebe		2 (spring/fall)			
Ash-throated Flycatcher *	1 (summer)	19 (summer)	1 (summer)		
Great Crested Flycatcher *	4 (summer)	4 (summer)	10 (summer)		
Scissor-tailed Flycatcher *		15 (spring/fall) 5 (summer)	2 (spring/fall) 3 (summer)		
Horned Lark		2 (winter)			

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
Northern Rough-winged Swallow *			2 (spring/fall)		
Cliff Swallow *	6 (summer)	4 (spring/fall) 33 (summer)	6 (spring/fall) 154 (summer)		
Barn Swallow *		13 (spring/fall) 21 (summer)	4 (spring/fall) 6 (summer)		
Blue Jay *	2 (summer)		4 (spring/fall) 1 (summer)		
American Crow *	3 (winter) 11(spring/fall) 7 (summer)	12 (winter) 4 (summer)	3 (spring/fall) 4 (summer)		
Carolina Chickadee *	5 (winter) 8 (spring/fall) 7 (summer)		2 (winter) 2 (spring/fall) 4 (summer)		
Rock Wren *	1 (spring/fall)	2 (spring/fall) 1 (summer)			
Bewick's Wren *	8 (winter) 22(spring/fall) 35 (summer)	1 (spring/fall) 4 (summer)	1 (winter) 4 (spring/fall) 8 (summer)		
Ruby-crowned Kinglet	7 (winter)		2 (winter) 1 (spring/fall)		
Blue-gray Gnatcatcher	1 (winter)				
Eastern Bluebird *		5 (winter) 2 (summer)	4 (spring/fall)		
Mountain Bluebird	95 (winter)	28 (winter) 3 (spring/fall)	7 (winter)		
American Robin	208 (winter) 9 (spring/fall)	15 (winter) 4 (spring/fall)	23 (winter) 31 (spring/fall)		
Gray Catbird			1 (fall)		
Northern Mockingbird *	12 (winter) 4 (spring/fall) 10 (summer)	2 (winter) 4 (spring/fall) 23 (summer)	1 (winter) 4 (spring/fall) 2 (summer)		
Sage Thrasher		1 (winter)			
Brown Thrasher *	2 (spring) 9 (summer)		2 (summer)		
Cedar Waxwing	872 (winter)				

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
European Starling	2 (winter)				
Loggerhead Shrike *		2 (winter) 5 (spring/fall) 2 (summer)			
Yellow-rumped Warbler			2 (winter) 7 (spring/fall)		
Northern Cardinal *	22 (winter) 28(spring/fall) 46 (summer)	1 (spring/fall) 15 (summer)	18 (winter) 12 (spring/fall) 16 (summer)		
Blue Grosbeak *	6 (summer)	15 (summer)	8 (summer)		
Painted Bunting *	61 (summer)	40 (summer)	10 (summer)		
Dickcissel *		4 (summer)	11 (summer)		
Cassin's Sparrow *	1 (summer)	9 (spring/fall) 48 (summer)	1 (summer)		
Rufous-crowned Sparrow *	6 (winter) 1 (summer)	2 (summer)			
American Tree Sparrow			17 (winter)		
Chipping Sparrow	15 (winter) 17(spring/fall)		25 (spring/fall)		
Field Sparrow *	30 (winter) 14(spring/fall) 3 (summer)	8 (spring/fall) 5 (summer)	18 (winter) 13 (spring/fall) 7 (summer)		
Vesper Sparrow		24 (spring/fall)			
Lark Sparrow *	14(spring/fall) 42 (summer)	57 (spring/fall) 86 (summer)	10 (spring/fall) 16 (summer)		
Savannah Sparrow		8 (winter) 3 (spring/fall)	3 (winter)		
Baird's Sparrow		1 (spring/fall)			
LeConte's Sparrow		2 (winter)	1 (winter)		
Grasshopper Sparrow *		1 (spring/fall) 2 (summer)	1 (spring/fall)		
Song Sparrow	4 (winter)		11 (winter) 11 (spring./fall)		

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
White-crowned Sparrow	7 (winter)	6 (spring)	5 (winter) 17 (spring/fall)		
Harris' Sparrow	13 (winter)		2 (winter)		
Dark-eyed Junco	262 (winter) 54(spring/fall)	56 (winter) 41 (spring/fall)	135 (winter) 74 (spring/fall)		
Red-winged Blackbird *		2 (summer)	9 (winter) 7 (summer)	18 (winter) 3 (summer)	
Eastern Meadowlark *	2 (winter) 13(spring/fall) 14 (summer)	18 (winter) 69 (spring/fall) 94 (summer)	21 (winter) 64 (spring/fall) 19 (summer)		
Western Meadowlark *		1(winter) 6 (spring/fall) 14 (summer)	1(spring/fall)		
Brewer's Blackbird			8 (winter)		
Common Grackle *	3 (summer)	2 (summer)	3 (spring/fall) 8 (summer)		
Brown-headed Cowbird *	4 (spring/fall) 12 (summer)	3 (spring/fall) 19 (summer)	6 (spring/fall) 5 (summer)		
Pine Siskin	29 (winter)				
American Goldfinch	31 (winter)		8 (winter)		
House Sparrow			4 (spring/fall)		
Amphibians					
Barred Tiger Salamander (*Ambystoma tigrinum*)					
Woodhouse's Toad (*Bufo woodhousii*)		1		2	
Green Toad (*Bufo debilis*)		2			
Red-spotted Toad (*Bufo punctatus*)	2	7	2	2	X (3)
Couch's Spadefoot Toad (*Scaphiopus couchii*)		4			
Great Plains Narrowmouth Toad (*Gastrophryne olivacea*)		5			X (1)

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
Blanchard's Cricket Frog (*Acris crepitans*)		3		42	
Spotted Chorus Frog (*Pseudacris clarkii*)	1	1	1		
Plains Leopard Frog (*Rana blairi*)				13 adults 430 juvs.	
Bullfrog (*Rana catesbeiana*)				5 adults 80 juvs.	
Reptiles					
Common Snapping Turtle (*Chelydra serpentina*)				2	
Yellow Mud Turtle (*Kinosternon flavescens*)				1	
Red-eared Slider (*Trachemys scripta elegans*)				83	
Ornate Box Turtle (*Terrapene ornata)*		1	1		
Spiny Softshell Turtle (*Apalone spiniferus*)				7	
Collared Lizard (*Crotaphytus collaris*)	12	32			X (2)
Fence (Prairie) Lizard (*Sceloporus undulatus*)	1	4	2		X (1)
Texas Horned Lizard (*Phrynosoma cornutum*)	5	35			X (2)
Texas Spotted Whiptail (*Cnemidophorus gularis*)	11	10	1		X (1)
Six-lined Racerunner (*Cnemidophorus sexlineatus*)	1	6			
Ground Skink (*Scincella lateralis*)			4		
Great Plains Skink (*Eumeces obsoletus*)		1			X (6)

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
Slender Glass Lizard (*Ophisaurus attenuatus*)		1	1		
New Mexico Blind Snake (*Leptotyphlops dulcis*)					X (5)
Eastern Hognose Snake (*Heterodon platyrhinos*)					X (1)
Plains Blackhead Snake (*Tantilla nigriceps*)					X (1)
Texas Night Snake (*Hypsiglena torquata*)					X (3)
Ground Snake (*Sonora semiannulata*)					X (14)
Coachwhip (*Masticophis flagellum*)		1			
Yellow-bellied Racer (*Coluber constrictor*)		1			X (1)
Great Plains Rat Snake (*Elaphe guttata*)		1			
Prairie Kingsnake (*Lampropeltis calligaster*)		1	1		
Bullsnake (*Pituophis melanoleucus sayi*)		1	1		
Western Ribbon Snake (*Thamnophis proximus*)		1	1	1	X (2)
Checkered Garter Snake (*Thamnophis marcianus*)					X (2)
Diamondback Water Snake (*Nerodia rhombifer*)				2	
Plain-bellied Water Snake (*Nerodia erythrogaster*)				2	
Western Massasauga (*Sistrurus catenatus*)		3			
Western Diamondback Rattlesnake (*Crotalus atrox*)	1	4			X (2)
Fish					

Common Name	**Redberry Juniper Woodland** [a]	**Mesquite Shrubland & Savannah** [b]	**Shelterbelt / Riparian** [c]	**Stream & Pond**	**Non-specific**
Red Shiner (*Cyprinella lutrensis*)				17	
Emerald Shiner (*Notropis atherinoides*)				83	
Red River Pupfish (*Cyprinodon rubrofluviatilis*)				2030	
Yellow Bullhead (*Ictalurus natalis*)				2	
Plains Killifish (*Fundulus zebrinus*)				177	
Mosquito Fish (*Gambusia affinis*)				533	
Largemouth Bass (*Micropterus salmoides*)				4	
Green Sunfish (*Lepomis cyanellus*)				26	
Bluegill (*Lepomis macrochirus*)				20	
Redear Sunfish (*Lepomis microlophis*)				1	

[a] cumulative total based upon: 22.5 hours of diurnal vehicle-based timed searches; 5.5 hours of nocturnal vehicle-based timed searches; 7.5 hours diurnal timed searches on foot; 20 5-minute point counts, 29 trap nights

[b] cumulative total based upon: 20.5 hours of diurnal vehicle-based timed searches; 7.5 hours of nocturnal vehicle-based timed searches; 6.5 hours diurnal timed searches on foot; 33 5-minute point counts, 33 trap nights

[c] cumulative total based upon: 6 nocturnal mist-net nights (18.0 hours) on four nights at three locations; 5.5 hours of diurnal vehicle-based timed searches; 4.0 hour of nocturnal vehicle-based timed searches; 9.5 hours diurnal timed searches on foot; 6 5-minute point counts, 19 trap nights

Mammals:

We documented 23 species of mammals on the Sandy Sanders WMA (Table 4). Another three species of rodents: Silky Pocket Mouse (*Perognathus flavus*), Hispid Pocket Mouse (*Perognathus hispidus*) and Northern Grasshopper Mouse (*Onychomys leucogaster*) were documented by student survey crew from Oklahoma State University who conducted a small mammal survey under a different federal assistance grant (State Wildlife Grant T-23-P). That crew placed out 400 small mammal traps on three consecutive nights (trap effort of 1,200 trap nights) on Sandy Sanders WMA during the summer of 2005 and documented seven species of rodents. Their captures are listed in

column six of Table 4.

During our track surveys, we documented ten species of mammals, plus unspecified deer. Tracks for Coyote (*Canis latrans*), Eastern Cottontail (*Sylvilagus floridanus*) and deer were the most frequently found. Tracks were the only evidence that we found to document Opossum (*Didelphis virginiana*), Badger (*Taxidea taxus*) and Bobcat (*Lynx rufus*). The Plains Pocket Gopher was documented only through the presence of its mounds, and this species appears to be common only in the relatively sandy flood plain of the Elm Fork of the Red River. Evening spot lighting had limited success because of the visual obstructions created by Redberry Juniper and Honey Mesquite shrubs, yet it was a useful technique for documenting Black-tailed Jackrabbit (*Lepus californicus*), Eastern Cottontail, Raccoon (*Procyon lotor*), Striped Skunk (*Mephitis mephitis*), Coyote, White-tailed Deer (*Odocoileus virginianus*) and Mule Deer (*Odocoileus hemionus*).

Our small mammal trapping efforts did not yield much success. In ** trap nights, we were successful only in capturing one White-footed Mouse (*Peromyscus leucopus*), six Deer Mice (*Peromyscus maniculatus*) and one Southern Plains Woodrat (*Neotoma micropus*). Many mammals were detected during diurnal timed searches targeted at birds and reptiles. Most of our observations for Eastern Cottontail were made during the morning and late afternoon hours, and Nine-banded Armadillo (*Dasypus novemcinctus*), Thirteen-lined Ground Squirrel (*Spermophilus tridecemlineatus*), Black-tailed Jackrabbit, Cotton Rat (*Sigmodon hispidus*), Southern Plains Woodrat, Porcupine (*Erethizon dorsatum*), Beaver (*Castor canadensis*), Coyote, Striped Skunk, White-tailed Deer and Mule Deer were all documented during daylight hours. One small colony of Black-tailed Prairie Dogs (Cynomys ludovicianus) occupied a small site (about 3 to 4 acres) in the south-central part of the WMA. We stopped at this colony site at least once during each of our survey visits and recorded 16 to 24 individuals visible at any one time. The size of this small colony probably fluctuated between 25 and 35 individuals during the grant period.

We set mist nets along Minnow Creek in the north-central portion of the WMA on four nights (two in April 2005 and two in September 2005). These nocturnal mist-netting attempts resulted in the capture of six Cave Myotis (*Myotis velifer*), suggesting that a suitable roosting cave exists on or in the vicinity of the WMA. During the bat surveys, we also observed four foraging Pallid Bats (*Antrozous pallidus*) but were unable to capture any of them. During these evenings, we detected at least eight Big Brown Bats (*Eptesicus fuscus*) based upon the frequencies of their echo-locations, but we did not net any of these either.

For most mammals, we recorded too few observations to reliably infer habitat associations. Several species appeared to be widespread and occupied all habitats (i.e. Eastern Cottontail, most carnivores and White-tailed Deer). A few species appeared to be restricted to the Mesquite Shrubland and Savannah habitat. For example, all of our observations for Black-tailed Jackrabbit and Mule Deer were restricted to this habitat type. The Thirteen-lined Ground Squirrel appears to be rare and my be restricted to just a few areas of relatively deep soil in mesquite/grassland habitat on the northern part of the WMA. The WMA's rocky soils also appeared to limit the abundance and distribution of other mammals. The Plains Pocket Gopher appeared to be limited to the area along the Elm Fork River, and we did not see or trap any Ord's Kangaroo Rats, a species which is very common in sandy soils elsewhere in western Oklahoma.

Birds:
The results of all of our surveys for birds are shown in Table 4. Some of these data are repeated in Table 5, which summarizes the results of 59 five-minute point counts that we conducted in June of 2003 to document the WMA's breeding bird community.

Our primary survey method for diurnal land birds during the winter season and the spring/fall migration period was the timed search - a combination of time spent on foot and time spent slowly driving roads in a vehicle. Winter season surveys were conducted over four days in December, January and February. Fifty-seven species were documented during the winter months. Additionally, there were six species: Great Blue Heron, Scaled Quail, Barn Owl, Eastern Screech Owl, Blue Jay, and Rock Wren which should occur during the winter on the WMA but were not recorded during our winter surveys.

During the summer breeding season, five-minute point counts were our primary survey method for diurnal land birds. On June 17 and 18, 2003, we conducted 59 five-minute point counts along interior roads on Sandy Sanders WMA. The habitat distribution of these points was 33 points in Mesquite shrubland and savannah, 20 points in Pinchot (Redberry) Juniper woodland and six points within or adjacent to shelter belts and riparian woodlands. The results of these surveys are shown in Table 5. Forty-four species of locally breeding birds were recorded during these counts, though one species - the Double-crested Cormorant - was probably a non-breeding transient. Eleven other breeding birds were missed on this survey but seen at other times during the summer or during the spring/fall period: Great Blue Heron, Red-tailed Hawk, Scaled Quail, Barn Owl, Great Horned Owl, Eastern Screech Owl, Common Poorwill, Belted Kingfisher, Northern Rough-winged Swallow, Rock Wren and Eastern Bluebird were missed by this survey. Each of these species was either nocturnal or uncommon on the WMA and it is not surprising that they might be missed. The most commonly detected species on the WMA during the point counts were Northern Bobwhite (109), Eastern Meadowlark (94), Mourning Dove (89), Lark Sparrow (89) and Painted Bunting (87). Among the more notable breeding birds were several western species that reach the eastern limits of their range in western Oklahoma including the Golden-fronted Woodpecker, Ladder-backed Woodpecker, Ash-throated Flycatcher, Rock Wren, Rufous-crowned Sparrow and Cassin's Sparrow. The Sandy Sanders WMA appears to support relatively large populations of Ladder-backed Woodpeckers, Ash-throated Flycatchers and Cassin's Sparrows. Rufous-crowned Sparrows and Rock Wrens were found only in the vicinity of eroded, rocky canyons and buttes, which were under represented in our road-based breeding bird survey.

Water Birds:
Though southwestern Oklahoma is a relatively hot and dry environment, Sandy Sanders WMA contains nearly two dozen small ponds and a portion of the Elm Fork of the Red River which provided sufficient habitat to support or temporarily attract several species of herons, waterfowl and shorebirds. We documented four species of herons and the Double-crested Cormorant. It is likely that a few pairs of Green Herons nest on the WMA, and one or more small colonies of Great Blue Heron, Snowy Egret and Little Blue Heron are likely to occur in close proximity. During the one of the mornings of our breeding bird survey, we noted a small congregation of Snowy Egrets and Little Blue Herons in a small stand of tall Plains Cottonwoods around a small pond near Deer Creek. We could not confirm any nests, but the number of herons and egrets that we saw suggests that they

were nesting in the area.

It is unlikely that any species of waterfowl nest on Sandy Sanders WMA, but we documented ten species of waterfowl and the American Coot on the area's ponds during the winter months. Most of these observations were made in late winter after the close of waterfowl season and cessation of most hunting activities on the WMA. Mallard, American Wigeon, Redhead and Ring-necked Duck were the species seen most regularly on the area's ponds. The Elm Fork River was the site for most of our shorebird observations. We documented four species of shorebirds and the Sandhill Crane along the river. The wintering observations for the Greater Yellowlegs (at least six individuals) were unexpected. It is uncommon for the Greater Yellowlegs to winter as far north as Oklahoma, but we speculate that the saline water of the Elm Fork may remain unfrozen for much of the winter and offer suitable foraging habitat. Had more of our surveys overlapped with the primary spring migration period for shorebirds (late April & early May), we likely would have documented additional species. A few Belted Kingfishers were found around the WMA's ponds during all seasons and it is likely that a few pairs nest on the area in eroded stream banks (e.g such as occur along Minnow and Deer creeks).

Vultures and Diurnal Raptors:
The Turkey Vulture was common on the WMA in the spring and summer. They were observed in all habitat types and suitable nesting sites (e.g. rock outcrops and cliffs) appear to be common in the eroded buttes that comprise much of the Redberry Juniper Woodland habitat. Raptors in general were not very common. We observed only a few Red-tailed Hawks and probably no more than two or three pairs nest on the WMA. We spotted Swainson's Hawks only twice, one of which may have been a spring migrant. Though Swainson's Hawks are common in western Oklahoma, they appear to be rare in the area around Sandy Sanders WMA. American Kestrels, however were common, especially during the winter months, and a few appear to nest in riparian habitat during the summer. We located a pair of American Kestrels repeated entering and exiting a large hole in a utility pole near Deer Creek where they appeared to have a nest. Mississippi Kites too were fairly common during the summer months. Most of the kites that we observed were in tall deciduous trees (especially cottonwoods) in shelter belts or around ponds. Several Sharp-shinned Hawks were observed in the Redberry Juniper Woodland habitat during the winter surveys when large numbers of American Robins, Cedar Waxwings, Mountain Bluebirds and Dark-eyed Juncos were present.

Nocturnal Birds:
We located small numbers of four species of owls during the survey. We found a pair of Great Horned Owls attending a nest under a rock ledge on the side of a butte during our February survey. Eastern Screech Owls were heard calling along Minnow Creek during each of our evening bat surveys. Barn Owls are uncommon in Oklahoma, but they appear to occupy the barn at the WMA Headquarters and we heard a second one calling from a canyon during our bat survey. A single Burrowing Owl was observed in the Black-tailed Prairie Dog colony during a spring survey. This bird appeared to be a migrant or transient, but Burrowing Owls have been documented in this prairie dog colony in past years and could nest there periodically. We observed numerous Common Nighthawks and Common Poorwills during our evening surveys. Both species occupy all habitats on the area, but Common Nighthawks were more frequently found in association with Mesquite Savannah sites.

Diurnal Land birds:
We documented 64 species of land birds during our surveys. Because of the timing of our surveys, most were either year-round residents, or present during either the summer breeding season or the winter months. Because of the number and diversity of species, land birds will be discussed as groupings under the habitat types in which they occurred, except for the transient/migrant species.

We observed only five species that were likely to be migrants or transient species: Say's Phoebe, Blue-gray Gnatcatcher, Gray Catbird, Vesper Sparrow and Baird's Sparrow. The Vesper Sparrow was commonly seen in Mesquite Shrubland and Savannah habitat during the spring and fall surveys. We observed a single Baird's Sparrow during a spring survey. Baird's Sparrows are rare and have only been documented a few times in Oklahoma (Baumgartner and Baumgartner 1992). This individual was observed at close range, under good light conditions for over five minutes. The Baird's Sparrow is a species of the short and mixed-grass prairies but typically occurs in stands of taller grasses. This Baird's Sparrow was found in an area of mesquite savannah with a tall grassy understory of Little Bluestem and Silver Bluestem. Relatively tall grasses occurred over much of the WMA at the time of our sighting and we speculated that this may have been the result of a combination of late growing season rains the previous August and the lack of grazing on the area during the fall and winter (cattle are not pastured on the WMA between September and March to avoid potential conflicts during the fall hunting seasons and to maintain winter cover for wildlife). The Blue-gray Gnatcatcher was another very unusual observation. One individual was observed during our February survey traveling with a mixed flock of Carolina Chickadees, Chipping Sparrows and Dark-eyed Juncos. It is unclear whether this bird overwintered on the WMA or was an early migrant. The winter of 2004/05 was a mild one with relatively little snow or ice and no prolonged periods of cold weather, therefore it is possible that this bird remained on the area through the winter. However, our observation was made only four weeks earlier than the beginning of the Blue-gray Gnatcatcher's normal spring migration into Oklahoma, and this was most likely an early migrant.

Redberry (Pinchot) Juniper Woodland:
Thirty-nine species of diurnal land birds were observed during the breeding and/or wintering seasons in the Redberry Juniper woodland habitat type. The Pinchot Juniper woodland habitat was a difficult habitat to survey because the dense, evergreen cover concealed many individuals. The birds that we located were usually heard singing or calling from within vegetation, flushed from the vegetation near the WMA roads, or seen as flocks moving between groups of trees.

During the winter months, the Redberry Juniper woodlands appeared to support that largest populations of birds on the WMA, due primarily to the large numbers of American Robins, Mountain Bluebirds, Cedar Waxwings and Dark-eyed Juncos. Characteristic birds of this habitat during the winter included Northern Flicker, Bewick's Wren, Ruby-crowned Kinglet, Mountain Bluebird, American Robin, Cedar Waxwing, Northern Mockingbird, Northern Cardinal, Chipping Sparrow, Field Sparrow, Harris's Sparrow, Dark-eyed Junco, Pine Siskin and American Goldfinch. Many of these species such as the Mountain Bluebird, American Robin, Cedar Waxwing, Northern Mockingbird, and Pine Siskin appeared to have been attracted by the availability of fleshy juniper cones on which they feed. Most of these frugivorous species are considered eruptive species during

the winter months (e.g. Mountain Bluebird, Cedar Waxwing, Pine Siskin) meaning that their abundances can change dramatically from winter to winter. The Mountain Bluebirds was much more common during our surveys in the winter of 2002/2003 than they were in the winter of 2004/2005, while the Pine Siskins and Cedar Waxwings which were common during the winter of 2004/2005 were completely absent in the winter of 2002/2003. The large numbers of frugivorous birds within these woodlands in both winters appeared to increase the attractiveness of this habitat to the Sharp-shinned Hawk. This specialized hawk feeds primarily upon small to medium sized songbirds and it was observed only in the juniper woodland habitat type. Other species may have been attracted to this habitat because of the cover and food resources provided by the evergreen foliage (e.g. Ruby-crowned Kinglet, Bewick's Wren), and may have fed also on juniper cones (e.g. Northern Cardinal, Dark-eyed Junco, American Goldfinch). The Dark-eyed Junco was by far the most numerous wintering sparrow in the juniper woodlands and accounted for nearly 80% of the sparrows seen there. We were surprised to find Chipping Sparrows apparently wintering on the WMA. This species is a rare winter resident in Oklahoma, but it does winter in north Texas and in the Ouachita Mountains of southeastern Oklahoma. It is a common breeding species in pinyon pine/juniper woodlands in the Rocky Mountains, but was not detected on Sandy Sanders WMA during our summer surveys. Field Sparrows too were more common than we expected based upon their numbers on the area during the breeding season, and we suspect that many of these were wintering birds that nest farther north rather than locally breeding sparrows. Field Sparrows were typically found in mixed flocks with Dark-eyed Juncos and Chipping Sparrows.

During the summer, characteristic breeding species in the Redberry Juniper woodlands included Northern Bobwhite, Mourning Dove, Yellow-billed Cuckoo, Bewick's Wren, Northern Mockingbird, Brown Thrasher, Northern Cardinal, Painted Bunting and Lark Sparrow. The Bewick's Wren, Brown Thrasher, Northern Cardinal and Painted Bunting each reached their greatest densities in the juniper woodland habitat. Rufous-crowned Sparrows occupied steep rocky slopes with thickets of skunkbrush within the juniper habitat, but their specialized and restricted habitat was difficult to access and was largely missed by our survey method. A few species, most notably the Rock Wren, nest early in the breeding season and were quiet and difficult to detect during our June survey.

Honey Mesquite Shrubland and Savannah:
During the winter months, birds in general appeared to be uncommon in this habitat. The few birds that we did see tended to be grassland species (as opposed to mesquite-dependent species) such as Savannah Sparrow, Eastern Meadowlark, Northern Bobwhite and Northern Harrier. Most of the bird species in this habitat type, tend to remain low to the ground and often hidden in vegetation, therefore bird abundance was probably higher than it would appear based upon our survey. As an example, we flushed three LeConte's Sparrows from two stands of tall grass with minimal effort. Had more time been spent walking fields, our numbers could have been much higher. One unexpected species that we found in this habitat was a single Sage Thrasher. This is a rare winter visitor to western Oklahoma, and the bird that we found was in a small group of Redberry Junipers within a larger area of Mesquite Savannah, Despite our searches in Redberry Juniper woodlands, we did not find any other Sage Thrashers and have to assume that this is a rare species on the WMA.

The breeding bird community of the Mesquite Shrubland and Savannah habitat was much more diverse than the wintering community and at least 29 land bird species were seen or heard. Characteristic breeding birds included Northern Bobwhite, Mourning Dove, Yellow-billed Cuckoo, Ash-throated Flycatcher, Northern Mockingbird, Cassin's Sparrow, Lark Sparrow, and Eastern Meadowlark. Smaller numbers of Northern Cardinal, Blue Grosbeak, Painted Bunting, Western Meadowlark and Brown-headed Cowbird were also present. Lark Sparrows and Eastern Meadowlarks reached their greatest densities in this habitat type, while Ash-throated Flycatcher, Cassin's Sparrow and Western Meadowlark were essentially restricted to this habitat. Three other uncommon species - Scaled Quail, Loggerhead Shrike and Grasshopper Sparrow - were found only in areas of Mesquite savannah.

Shelter Belts and Riparian Woodland:
The shelter belts surrounding the food plots and the narrow riparian corridors along Minnow Creek and Deer Creek harbored many of the same species, perhaps as a result of their similarity in tree species composition and physical structure. Riparian woodland and shelter belts were limited in acreage but were used as foraging habitat or shelter by at least 46 land birds, nearly 80% of the species found on the WMA. Most of the species in this habitat were common species that could be found over a large portion of Oklahoma including Wild Turkey, Mourning Dove, Eastern Phoebe, Northern Cardinal, Song Sparrow and Common Grackle. One unique species in southwestern Oklahoma that appeared to reach its greatest abundance in this habitat was the Golden-fronted Woodpecker - the southwestern counterpart to the Red-bellied Woodpecker. The Golden-fronted Woodpecker was frequently found where riparian woodlands abutted mature mesquite trees..

During the summer breeding season, shelter belts and riparian woodlands supported Wild Turkeys, Mourning Doves, Yellow-billed Cuckoos, Northern Flickers, Golden-fronted Woodpeckers, Great Crested Flycatchers, and Blue Grosbeaks which, along with the less common Carolina Chickadee, reached their greatest densities in this habitat type. Additionally, the Northern Bobwhite, Northern Cardinal, Painted Bunting and Lark Sparrow were common here, but were not at their highest densities. Several species that we expected in the riparian habitat type appeared to be absent from Sandy Sanders WMA. We expected the Eastern Kingbird, Western Kingbird, Warbling Vireo, Bullock's Oriole and Baltimore Oriole to be fairly common as they are in other parts of western Oklahoma. Similarly, we had hoped to find at least a few pairs of Red-headed Woodpeckers, Bell's Vireos and Orchard Orioles but these three were absent as well. We can not fully explain the absence or rarity of these eight riparian species, but perhaps the lack of large blocks of riparian habitat may be a contributing factor. Additionally, cottonwood and willow trees, two species that appear to be important to the orioles and vireos, were scarce in the narrow riparian zones on the WMA. Enhancement of riparian woodlands through increased width or species composition, may be needed to attract a subset of these species.

Table 5. Breeding Bird Survey Results for Sandy Sanders Wildlife Management Area
(First number listed is the actual number of birds seen; the number in (parentheses) is the average number of birds of that species seen in each habitat type during the point-count survey.)

Common Name	Mesquite Shrubland & Savannah (n = 33 point counts)	Redberry Juniper Woodland (n = 20 point counts)	Shelter Belts and Riparian Habitats (n = 6 point counts)
Green Heron			1 (0.17)
Turkey Vulture	4 (0.12)	3 (0.15)	1 (0.17)
Mississippi Kite	1 (0.03)	2 (0.10)	5 (0.83)
American Kestrel	2 (0.06)		
Wild Turkey	2 (0.06)		4 (0.67)
Northern Bobwhite	68 (2.06)	30 (1.50)	12 (2.00)
Killdeer	3 (0.09)		
Mourning Dove	49 (1.48)	22 (1.1)	18 (3.00)
Yellow-billed Cuckoo	17 (0.52)	11 (0.55)	10 (1.67)
Greater Roadrunner		1 (0.05)	
Common Nighthawk	14 (0.42)	6 (0.30)	3 (0.50)
Golden-fronted Woodpecker	2 (0.06)		2 (0.33)
Ladder-backed Woodpecker	5 (0.15)	3 (0.15)	
Northern Flicker	2 (0.06)	1 (0.05)	5 (0.83)
Eastern Phoebe	2 (0.06)		
Great Crested Flycatcher	4 (0.12)	6 (0.30)	6 (1.00)
Ash-throated Flycatcher	12 (0.36)		1 (0.17)
Scissor-tailed Flycatcher	3 (0.09)		1 (0.17)
American Crow	4 (0.12)	6 (0.30)	4 (0.67)
Blue Jay		2 (0.10)	1 (0.17)
Barn Swallow	1 (0.03)		4 (0.67)
Cliff Swallow	33 (1.0)	6 (0.30)	2 (0.33)

Common Name	Mesquite Shrubland & Savannah (n = 33 point counts)	Redberry Juniper Woodland (n = 20 point counts)	Shelter Belts and Riparian Habitats (n = 6 point counts)
Carolina Chickadee		3 (0.15)	3 (0.50)
Bewick's Wren	3 (0.09)	20 (1.0)	7 (1.17)
Northern Mockingbird	20 (0.61)	9 (0.45)	1 (0.17)
Brown Thrasher		9 (0.45)	2 (0.33)
Loggerhead Shrike	1 (0.03)		
Northern Cardinal	14 (0.42)	28 (1.4)	8 (1.33)
Blue Grosbeak	12 (0.36)	6 (0.30)	5 (0.83)
Painted Bunting	36 (1.09)	45 (2.25)	6 (1.0)
Dickcissel	7 (0.21)		2 (0.33)
Rufous-crowned Sparrow	2 (0.06)	1 (0.05)	
Cassin's Sparrow	38 (1.15)	1 (0.05)	1 (0.17)
Field Sparrow	3 (0.09)	3 (0.15)	
Grasshopper Sparrow	1 (0.03)		
Lark Sparrow	57 (1.73)	30 (1.5)	2 (0.33)
Eastern Meadowlark	72 (2.18)	11 (0.55)	11 (1.83)
Western Meadowlark	8 (0.24)		
Red-winged Blackbird	2 (0.06)	3 (0.15)	
Common Grackle	2 (0.06)	3 (0.15)	3 (0.50)
Brown-headed Cowbird	17 (0.52)	7 (0.35)	3 (0.50)
Double-crested Cormorant - flyover (1)			
Snowy Egret - flyover (6)			
Little Blue Heron - flyover (4)			

Amphibians and Reptiles:

Our surveys for amphibians and reptiles were conducted between March and June and again in September. Extremely dry and hot weather conditions in July and August caused us to cancel planned survey trips during those months, and very little reptile and amphibian activity was observed during our October survey - many of these species may have entered their winter dormancy. Amphibian surveys in general were less productive than we anticipated as a result of dry spring and early summer weather conditions. We located eight species of frogs and toads out of the possible 11 species that we expected to find, but did not document the presence of Barred Tiger Salamander (*Ambystoma tigrinum mavortium*) which is the only salamander present in far western Oklahoma. We conducted nocturnal anuran calling surveys that documented six species - Woodhouse's Toad (*Bufo woodhousii*), Red-spotted Toad (*Bufo punctatus*), Great Plains Narrowmouth Toad (*Gastrophryne olivacea*), Blanchard's Cricket Frog (*Acris crepitans blanchardi*), Plains Leopard Frog (*Rana blairi*) and Bullfrog (*Rana catesbeiana*) - but two others - the Green Toad (*Bufo debilis debilis*) and Couch's Spadefoot (*Scaphiopus couchii*) were only detected visually during evening road surveys. The Blanchard's Cricket Frog was widespread and common on the area and was by far the most common species detected during our nocturnal calling surveys. Plains Leopard Frogs and Bullfrogs were similarly common along streams and ponds. The Red-spotted Toad was widespread around rocky ravines and ephemeral stream, but it was a cryptic species and only two of the 13 individuals that we recorded were seen - each of the others was identified based upon its call. The Green Toad, Woodhouse's Toad, Great Plains Narrowmouth, Couch's Spadefoot and Spotted Chorus Frog were probably all more common than our survey results suggest, but dry weather conditions limited their activity. The Texas Toad (*Bufo speciosa*) should be present on the area, but addition survey effort following future spring and early summer rains is needed to confirm this. Our surveys missed Great Plains Toad (*Bufo cognatus*) and Plains Spadefoot (*Spea bombifrons*), however the WMA may not support the habitat needed by both species. These toads are usually found in areas with deep and/or sandy soils, which are generally lacking on Sandy Sanders WMA

The habitats on the WMA are likely to support as many as six species of turtles, nine species of lizards and 24 species of snakes (Sievert and Sievert 2006). We were successful in finding five species of turtles - Common Snapping Turtle (*Chelydra serpentina*), Yellow Mud Turtle (*Kinosternon flavescens*), Ornate Box Turtle (*Terrepene ornata*), Red-eared Slider (*Trachemys scripta elegans*) and Spiny Softshell (*Apalone spiniferus*). The Red-eared Slider was common and found around at least seven of the nine ponds that we searched (including one pond that had at least 43 individuals). Spiny Softshells were common in Minnow and Deer creeks, and were probably present in some ponds though we did not find any there. We found only one Yellow Mud Turtle and two Common Snapping Turtles, but we did not attempt to trap aquatic turtles and both of these species are cryptic, non-basking turtles. They are both probably more common than our results suggest. We found only two Ornate Box Turtles and expected this species to be more common. Our theory is that the rocky soils and rough terrain on the WMA may limit the area that is suitable for box turtles. The Ornate Box Turtle takes shelter in burrows and appears to need deep, friable soils. It was very common on Beaver River WMA where the soils are sandy, but rare on Sandy Sanders WMA where sandy soil is limited.

We located eight of the nine species of lizard expected on the WMA. Three species - the Collared Lizard (*Crotaphytus collaris*), Texas Horned Lizard (*Phrynosoma cornutum*), and Texas Spotted Whiptail (*Cnemidophorus* (*Aspidoscelis*) *gularis*) appear to be especially common and were frequently found basking on rocks and bare soil in the morning and late afternoons along the WMA roads in May and June. We detected relatively few reptiles (and amphibians) during our timed searches on foot, however morning road surveys were very effective for locating Collared Lizards, Texas Horned Lizards, and whiptails. Collared Lizards were found throughout the WMA where there was rocky cover (nearly everywhere). Texas Horned Lizards were common in relatively level, mesquite-dominated shrubland and savannah, and appeared to be much more common in that habitat than in the rugged juniper woodlands. Texas Spotted Whiptails were about equally common in both mesquite and juniper dominated habitats, and we were more likely to find them in areas with sparse ground vegetation. All three species were much less visible during our September surveys than they were during our May and June surveys. Many of the lizards that we found in the fall were juveniles, which suggested to us that adults were more cryptic in their behavior in the fall or entered dormancy sooner. Grasshoppers and other insects were abundant in the late summer and early fall and this abundance may have allowed lizards to forage more efficiently and avoid detection by us (and their predators).

We also observed seven whiptails that we believed to be Prairie Racerunners (*Cnemidophorus* (*Aspidoscelis*) *sexlineatus*). We feel certain that at least three of these were Prairie Racerunners because we either captured them or observed them at close range. The others we saw briefly and identified them by the relatively greater amount of green coloration on their tails and bodies. It is possible that some of these were greenish-colored Spotted Whiptails. The Prairie Racerunners were all found in grassy areas, mostly in the Mesquite shrubland and savannah habitat type. We encountered four Brown Skinks (*Scincella lateralis*) while conducting timed searches in riparian areas. These individuals represented a slight range extension of about 25 miles. This species may be fairly common in riparian areas but are probably not widespread. We located one Great Plains Skink (*Eumeces obsoletus*) while turning rocks during a timed search in a mesquite savannah. This is probably a very common lizard on the area, but most of our timed searches occurred during dry conditions and we did not turn very large rocks. The Slender Glass Lizard (*Ophisaurus attenuatus*) was found twice but is generally difficult to detect during timed searches. One of these lizards was a first record for Beckham County and a slight range extension. The one lizard species that we expected but missed was the Lesser Earless Lizard (*Holbrookia maculata*). We expected to find this species in some of the sparsely vegetated gypsum outcrops, but we need to conduct additional timed searches in this habitat in May and June to confirm this.

Our success in documenting snakes was modest. We believe that dry weather conditions hampered the effective our timed searches on foot and we were not able to document any of the small snake species (e.g. Plains Blackhead Snake (*Tantilla nigriceps*) or Ground Snake (*Sonora semiannulata*). Larger snakes are difficult to locate because they often occur at low densities and are very mobile, however we were able to document single individuals of Coachwhip (*Masticophis flagellum testaceus*), Yellow-bellied Racer (*Coluber constrictor flaviventris*) and Plains Ratsnake (*Elaphe guttata emoryi*), and two individuals each of Prairie Kingsnake (*Lampropeltis calligaster*), Bullsnake (*Pituophis melanoleucus sayi*), Northern Diamond-backed Watersnake (*Nerodia rhombifer*) and Blotched Watersnake (*Nerodia erythrogaster transversa*). Because of the limited

number of observations, we can't determine any substantial habitat relationships for these species. Three species of snakes were found in greater numbers. We found three Western Ribbon Snakes (*Thamnophis proximus*) all in close proximity to either a pond or creek. We found three Western Massasaugas (*Sistrurus catenatus tergeminus*) all along the WMA roads in the late afternoon and evening in rocky, mesquite savannah. We also found five Western Diamond-backed Rattlesnakes (*Crotalus atrox*) in a variety of rocky habitats.

In May of 2004, Drs. Laurie Vitt and Janalee Caldwell took their herpetology class out to Sandy Sanders WMA on a class field trip. They conducted timed searches (about 8 to 12 hours which are not included in this report), and documented 16 species of reptiles and amphibians including six species of snakes that we did not find. The results from their field work are shown in the sixth column in Table 4. The timing of their trip was less than 10 days after a substantial rainfall event and the weather and soil conditions during their survey were conducive to finding small reptiles. They spent most of their time turning rocks and located three Red-spotted Toads, six Great Plains Skinks, five New Mexico Blind Snakes (*Leptotyphlops dulcis*), a Plains Blackhead Snake, three Texas Night Snakes (*Hypsiglena torquata*) and a surprising 14 Ground Snakes (*Sonora semiannulata*). They also located two species larger snakes that we missed - one Eastern Hognose Snake (*Heterodon platyrhinos*) and two Checkered Garter Snakes (*Thamnophis marcianus*).

Fish:
We used seines, dip nets and minnow traps baited with bread to conducted fish surveys in the Elm Fork River, Deer Creek, Minnow Creek and Fish Creek. We also visually noted Bluegill (*Lepomis macrochirus*), Green Sunfish (*Lepomis cyanellus*) and Largemouth Bass (*Micropterus salmoides*) two man-made ponds. The reach of the Elm Fork River on Sandy Sanders WMA is a large, sandy-bottomed saline stream. We used a seine at several locations and the only species of fish that we collected were Red River Pupfish (*Cyprinodon rubrofluviatilis*) and Plains Killifish (*Fundulus zebrinus*). The Plains Killifish was common in the river, but the Red River Pupfish was abundant. We seined up over 1,000 pupfish in the shallow water and observed over 1,000 more.

Fish Creek is known to be saline and the only fish that we observed in the upper reach of the creek (above its confluence with Minnow Creek) were a few Red River Pupfish. Minnow Creek is a small, freshwater tributary of Fish Creek and it had a higher species diversity. Using a combination of dip nets and minnow traps, we collected and released Red Shiner (*Cyprinella lutrensis*), Emerald Shiner (*Notropis atherinoides*), Yellow Bullhead (*Ictalurus natalis*), Plains Killifish, Mosquito Fish (*Gambusia affinis*), Green Sunfish (*Lepomis cyanellus*) and on Redear Sunfish (*Lepomis microlophis*), in addition to several dozen Bullfrog tadpoles. Minnow Creek was also the location where we found one Western Ribbon Snake, one Blotched Watersnake, one Diamond-backed Watersnake and several Blanchard's Cricket Frogs, Plains Leopard Frogs and Bullfrogs. Deer Creek was difficult to survey because its channel is steeply incised along most of its length. We were able to dip net and visually identify Red Shiners, Plains Killifish, Mosquito Fish and Green Sunfish. There was a small pond at one location which was created by a Beaver dam. In this pond, we noted over 300 Mosquito Fish, plus seven Red-eared Sliders, three Spiny Softshell Turtles and on Common Snapping Turtle.

High Plains Species of Greatest Conservation Need Management Plans

Black-tailed prairie dog colony data from the 2002 aerial survey was compared to other data sources to produce a GIS baseline data layer for the shortgrass High Plains region. The database included prairie dog colonies recorded during the 2002 aerial survey that were also observed by at least one of the following methods: ground verification in 2003, 2000 aerial survey, 1998 ground verification of 1989 colonies, 1995 digital orthophoto quarter quads (DOQQ), or Shackford's (1989) ground survey. Colony verification was completed for the three panhandle counties, but continues for Harper, Ellis, and Woodward counties.

The baseline data set currently contains 665 confirmed active prairie dog colonies, occupying 48,289 acres, with an average colony size of 72.6 acres (based on 2002 aerial survey flight size estimation). In the three panhandle counties, 144 colonies, 50 acres or greater in size, were recorded during the 2002 aerial survey but were not visible on the 1995 DOQQs. These 144 colonies were ground truthed in late summer and early fall, 2003. Fifty colonies (34.7%) were not found from the ground. An additional 43 colonies (29.9%) were in areas that were inaccessible to verify one way or the other. Of the 51 colonies that were examined, 39 colonies (76.4%) were active while 12 (23.6%) were inactive. Further verification of the 2002 aerial survey continued during this past year with the mapping of detected prairie dog colonies from 2003 digital aerial photographs (NAIP DOQQs). To date, all known aerial survey colonies in Cimarron County were mapped from 2003 NAIP DOQQs, encompassing 30,066 occupied acres with an average colony size of 129.59 acres (range 2.53 to 3,407.13 acres).

Identification of focus areas for black-tailed prairie dog management was attempted with limited success. As a first step, prairie dog complexes were delineated from the prairie dog colony baseline data by using the 7 km rule (Luce 2002). A large linear complex connected 459 (87%) colonies from west to east across all three panhandle counties, encompassing 35,831 acres. In an effort to narrow the focus area beyond that of the entire panhandle region, prairie dog colonies were examined in relation to historical distribution of shortgrass High Plains vegetation communities, soil classes, and current untilled herbaceous range in the shortgrass High Plains region was undertaken (Figure 4). Within the panhandle region, 405,395 ha were identified as grassland restoration focus areas. An additional 286,751 ha were identified as grassland enhancement or protection focus areas (Figure 4). Legal descriptions within these focus areas were generated and forwarded onto the Landowner Incentive Program (LIP) coordinator for consideration in targeting LIP funds toward private lands in these focus areas for grassland management.

Swift fox track surveys were completed during the summer of 2004 in 102 townships across the shortgrass High Plains region. The survey was conducted to determine the current status of the swift fox in the region, and to determine if the survey can detect swift fox population changes over time. Track searches were conducted in portions of five counties (Cimarron, Texas, Beaver, Harper, and Ellis)in order to investigate the species' current distribution within its historic range. Swift fox tracks were found in 57 out of 102 townships surveyed (Figure5). Tracks were detected for the first time in three townships in Harper County and one township in Ellis County (Figure 5).

When comparing swift fox track results across the shortgrass High Plains region among years, 2004

yielded the greatest proportion of townships with swift fox tracks detected (56%, n=57), while 2000 had the lowest proportion (32%, n=35; Table 3). The average time to first track, however, was nearly the same for all three years for which complete data were available, range 42 to 49 minutes (Table 3). Year 2004, however, did show a greater number of townships with tracks found within the first 30 minutes of survey time and townships with more than one set of swift fox tracks found within the first 30 minutes (Table 3).

Table 3. Comparison of swift fox track detection variables throughout the shortgrass High Plains region for years 1999, 2000 and 2004.

Swift Fox Tracking Variables Recorded	1999	2000	2004
Townships Surveyed	114	109	102
Townships with swift fox tracks (% of total)	43 (38%)	35 (32%)	57 (56%)
Average time to first track in minutes	49	43	42
Townships with tracks observed within first 30 minutes	14	19	30
Townships with >1 set of swift fox tracks observed	3	2	13

Track search survey results indicated that environmental conditions play an important part in swift fox track detection rates. For all years, the percentage of track sites with good to excellent tracking conditions increased as the percentage of surveys conducted within one to three days of a rain event increased (Table 4). Likewise, the greater the percentage of surveys conducted more than seven days following a rain event, the lower the percentage of sites with good to excellent tracking conditions (Table 4). Wind, however, appears to have no affect on tracking conditions (Table 4). Because the majority of track search surveys were conducted during morning hours, the percentage of surveys conducted with winds greater than 15 miles per hour was very low.

Table 4. Soil tracking conditions, days since last rain, and wind conditions recorded during swift fox surveys throughout the shortgrass High Plains from 1999 to 2004.

Environmental Conditions	1999	2000	2004
Percentage of sites with good to excellent tracking conditions	39%	24%	40%
Percentage of surveys conducted within 1 to 3 days of a rain event	54%	8%	34%
Percentage of surveys conducted > 7 days following a rain event	21%	65%	30%
Percentage of surveys conducted with winds 1 to 5 mph	48%	59%	41%
Percentage of surveys conducted with winds >15 mph	6%	11%	6%

The summer of 2004 proved to be unique climatologically, with a very dry April and May, followed by a very wet June, and average precipitation in July and August (Schneider and Garbrecht

2004). Rain totals in the Oklahoma southern High Plains for June ranged from 3 to 8 inches, with 4 to 5 inch totals across 50% of the shortgrass High Plains region (Schmidt and Lawrence 2005). Cool and wet weather prevailed across the Oklahoma Panhandle during July, 2004. Several record low and minimum high temperatures were broken across Oklahoma and north Texas during that time. August was the third month in a row in which cool and wet conditions were prominent. Throughout the swift fox's Oklahoma historic range, 2 to 6 inches of rain fell in July and 1.5 to 8 inches in August, 2004 (Schmidt and Lawrence 2005).

Land use and land cover were digitally mapped within swift fox home range circles drawn around track locations from the 2004 survey, by using USGS Land Use and Land Cover shapefiles (USGS 1990) overlayed onto 2003 NAIP DOQQs. Home range circles drawn around the 57 track locations detected in 2004 were compared to those of the 1999 and 2000 surveys years for which there were complete data. Land use and land cover were examined for 192,187 ha during 2004 (Table 5). The proportion of each land use and land cover type within the swift fox track home range circles remained similar over the three years (Table 5). Herbaceous range comprised 49.0% of the 2004 home range buffer circles while 48.0% of the area contained agricultural land (Table 5). Within the agricultural lands, 35.5% consisted of Conservation Reserve Program (CRP) lands. The other 64.5% of the agricultural land included cropland, consisting primarily of winter wheat, milo, center pivot corn, and fallow.

Table 5. Land use and cover categories found within 3 km radius circles around swift fox track points for 3 years for which entire shortgrass High Plains region data were available. CRP is the percentage of the total agricultural land.

Land Use and Cover Category	1999 (n=43)		2000 (n=36)		2004 (n=57)	
	Area (ha)	% Total	Area (ha)	% Total	Area (ha)	% Total
Agricultural Land	55,060	44.9%	37,356	39.0%	92,257	48.0%
CRP	19,154	33.7%	16,679	44.6%	32,742	35.5%
Herbaceous Range	62,223	50.8%	57,125	59.6%	94,172	49.0%
Mixed Range	4,331	3.5%	655	0.9%	3,695	1.9%
Other	759	0.7%	646	0.9%	2,063	1.1%
TOTAL	122,562		95,822		192,187	

Center pivot irrigated crop fields often grow crops, such as corn, that contribute to the loss and fragmentation swift fox habitat because of the increased vegetation density and height associated with these fields. Future projects include the mapping of these fields on DOQQs and comparing changes in the amount and location of center pivot crop fields over time and how these relate to swift fox track locations. Changes in CRP fields also affect swift fox habitat. Based on overlap with swift fox track buffer circles from 1999 and 2000 with 2004, loss of CRP fields was measured. Both Cimarron and Beaver counties exhibited a measurable loss of CRP between 2000 and 2004

(299 ha in Cimarron and 816 ha in Beaver counties).

Swift fox tracks were detected readily throughout the shortgrass High Plains region. In 2004, swift fox tracks were detected in the far eastern portion of this region in Ellis and Harper counties. Swift fox tracks, however, were observed more frequently, and within shorter time frames, further west within the region (Figure 5). Although this and other information (e.g. road kill swift fox) indicates the presence of swift fox in the main body of the state, the extent to which the species occurs in the far eastern reaches of the shortgrass High Plains region or beyond is unknown.
In general, the terrain in the Panhandle portion of the shortgrass prairie region is flatter than that of the main body of the state. From west to east across the region, a greater proportion of the available herbaceous range occurs in more rugged terrain where land conversion to cropland was not as economically feasible. On the flatter terrain in the western portion of the region winter wheat was the predominant land use, while in the main body of the state, a greater proportion of the flatter terrain occurred as mixed range. Because of the increasing vegetation density and height in the mixed herbaceous/shrub range, this land use and cover type is not considered suitable for swift fox when compared to the relatively shorter, herbaceous rangeland vegetation that occurs further west. Thus, the amount of optimal swift fox habitat decreases from west to east through the shortgrass High Plains region in Oklahoma.

The project initiated by Oklahoma State University (OSU) in 2003 to look at abundance and habitat associations of the swift fox in Oklahoma was completed in December 2004. Objectives of the study were: to estimate density of swift foxes throughout the Oklahoma Panhandle; to develop quantitative relationships between density estimates and indices of relative abundance; and to assess habitat suitability for swift fox by linking density estimates and survey results to landscape and habitat characteristics with GIS analyses. The OSU study examined correlations of swift fox density estimated by mark-recapture with timed-track surveys, scat surveys, and catch-per-unit effort indices. Their efforts were focused in Cimarron and Texas counties in the western part of the Panhandle. A total of 79 swift foxes (42 male, 37 female) were captured in 10,240 trapnights between May 2003 and December 2004. Density estimates, based on mark-recapture data from autumn 2004, were 1 fox/4.76 km^2 in Texas County and 1 fox/5.26 km^2 in Cimarron County. All survey indices were moderate to strong (r^2 = 0.44–0.76) predictors of fox density. Based on the study's results, surveys of scat deposition rates and time-to-track encounters can be used to monitor trends in population abundance over extensive areas of western Oklahoma. The project's Final Report is attached as Appendix A.

Burrowing Owl surveys on selected known black-tailed prairie dog colonies were delayed for first segment year because of the limited number of landowners enrolled in the Landowner Incentive Program for black-tailed prairie dogs. During the project's second year, Burrowing Owl information was collected from a variety of sources. Presence of burrowing owls was noted at four out of 39 active prairie dog colonies involved in the 2003 ground truthing of the 2002 aerial prairie dog survey. Since much of the ground truthing was conducted in the fall, however, Burrowing Owl migration probably limited the number of owls seen. Twenty-two Burrowing Owls were observed during the Rocky Mountain Bird Observatory grassland bird monitoring program within the shortgrass prairie region during May 2003 (Hanni and McLachlan 2004). Seventeen of these owls were seen on prairie dog colonies, while the remaining five appeared to have no association with

prairie dog colonies. Forty-two Burrowing Owls were observed during the Rocky Mountain Bird Observatory grassland bird monitoring program within the Cimarron and Texas counties during May 2004. Density of Burrowing Owls calculated for Oklahoma was 5.05 birds/km^2 (CV= 19%, n=24). Additionally, 132 Burrowing Owls were observed during Mountain Plover and Long-billed Curlew surveys conducted during May, 2004 (Appendix C).

The approach for conducting Burrowing Owl surveys on selected known black-tailed prairie dog colonies was changed in spring 2005 because of the small number of properties enrolled in the Landowner Incentive Program for black-tailed prairie dogs. Instead, surveys were conducted in May and June, 2005, to record presence of Burrowing Owls on known prairie dog colonies, within 1/8 of a mile of a public road in Cimarron, Texas and Beaver counties. One hundred and twenty-four prairie dog colonies were surveyed in 2005, 75 of which had Burrowing Owls observed (Figure 6). A total of 201 owls was observed, ranging from 1 to 10 owls at any given prairie dog colony. Of the 75 prairie dog colonies with positive Burrowing Owl sightings, 26 were from the 2002 aerial prairie dog survey. These 26 colonies ranged in size from 2 to 600 acres with an average colony size of 84.5 acres. Forty-nine of the prairie dog colonies where owls were observed were colonies that were not in the 2002 aerial survey database. Of the 49 prairie dog colonies which were surveyed but Burrowing Owls were not observed, 11 were from the 2002 aerial survey. These 11 colonies ranged in size from 10 to 160 acres with an average colony size of 67.3 acres. Thirty-eight of the prairie dog colonies where no owls were observed were colonies not in the aerial survey database. The Burrowing Owl surveys will continue under SWG T-33 and future analyses will include comparison of prairie dog colony size to detected presence of owls and number of owls observed.

Selman Bat Cave WMA – Monitoring Mexican Free-tailed Bat Population

Wildlife biologists who manage Mexican Free-tailed bat maternity caves in the surrounding states were contacted and methods for estimating colony size were compared and discussed. Bat Conservation International provided the published report from a workshop, held in 1999, which standardized count methods for determining bat populations for a wide range of bat species. Based on the results from a workshop on monitoring trends in bat populations (Interim Report: "Workshop on Monitoring Trends in U.S. Bat Populations: Problems and Prospects" Estes Park, Colorado, September, 1999) we were able to write monitoring protocol for the Mexican Free-tailed bat population occurring at Selman Bat Cave. The protocol was based on recommendations for counting a large bat emergence by videotaping the emergence and counting bats/ frame. The protocol includes addressing the behavior of the observers, designing the count technique (length of time, position of camera, etc.), developing a depletion count technique (e.g. stop count when less than a designated proportion of the colony is observed exiting over a 15-minute period), designing a standardized form (GPS location, # of bats counted, moon phase, wind, humidity, sunset, noise level, e.g.), and scheduling dates to conduct the counts (first count should be when population is most stable [adults only]; second count when both adults and pups are flying).

The monitoring system was designed to videotape the emergence from above the cave entrance. A digital camcorder with a wide angle lens would be secured to a telescoping pole that would be anchored to the bluff above the cave.

A grid, 10 wide by 30 long, constructed of ½" PVC pipe, would be placed at the base of the cave entrance and would provide a unit of measure against which the bats would be videotaped and later counted. The grid width was calculated by using the speed of the bats emerging (~ 20 mph) and the recording speed of the digital camera. At a speed of 20 mph, a bat moves ~ 30 (29.333') per second. The camera records 30 frames per second. With a grid width of 10 a different group of bats would be within the grid every 3 seconds. The cave entrance is approximately 40 at its widest. Based on several observations of the exit flight at the cave entrance, a 30 length would include the width of the bat's exit column. Some bats were observed circling (flying out a short distance from the entrance and returning to the cave) within a 10' area along the north side of the entrance. The 30' length would exclude that area of circling bats.

Since the entire bat emergence is videotaped, consideration needed to be made regarding both daylight and nighttime videotaping. At dusk, the camera will be switched to the Night Shot feature, and the bat column will be illuminated from either side of the canyon for 1 minute every 5 minutes using a Q-beam with an infrared lens directed at the column.

Once the count technique and monitoring system were approved, researching camcorders and telescoping poles began and a list of materials and other equipment needs were formulated as preparations for counting the bat population continued.

Located near Selman Bat Cave is Alabaster Caverns (ACSP), a ¾ mile cavern formed of gypsum, making it the largest natural gypsum cave in the world open to the public. The cavern serves as a hibernacula for such bat species as cave myotis *(Myotis velifer)*, eastern pipistrelle *(Pipistrellus subflavus)* and big brown bat *(Eptesicus fuscus)*. In the summer a bachelor colony of approximately 3000 male Mexican free-tailed bats use the upper rooms as daytime roosts. Because of their interest and work in bat conservation, staff from ACSP were involved in the planning, constructing, and implementing the monitoring system.

The monitoring system was constructed with the help of an ODWC employee that designed and welded a metal sleeve in which to slide the telescoping pole. The camera is secured to the end of a telescoping fiberglass pole (Crain 36 ft. from Sandpiper Technologies, Inc.) and the pole is then telescoped out over the canyon. A center guide wire is secured from the end of the fiberglass pole (where the camera is secured) to the top of a rod that is welded vertically to the metal sleeve. Guide wires from either side of the camera are extended out and anchored in the ground on either side of the metal sleeve. (Figure 7.)

The digital video camera selected for this project is the Sony DCR-TRV50. Attached to the camera is a video cable that is connected to a portable black and white TV. The TV, positioned on the bluff, is used as a monitor to insure that the camera is operating properly. (Figure 8.) The 10' x 30' PVC grid was erected by sinking electric fence rods about every 3 feet in the ground and bolting the ½" PVC to the rods. (Figure 9). Figure 10 shows the bat emergence during the first test run of the monitoring system. We were able to video tape only about 45 minutes of the bat emergence (about two-thirds of the actual emergence time) due to some complications with the set-up of the monitoring system.

We contracted with Parallax Media, Inc. to convert the initial video of the bat emergence to DVD and to make comments/recommendations regarding the system/quality of the video-taping. Parallax, during the conversion process, will be creating "chapters" every five minutes, allowing for one minute time segments in which to count bats/frame. The creation of "chapters" on the DVD will allow us to quickly move from one count segment to the next. After reviewing the test video, Parallax made recommendations concerning the contrast and count grid. They recommended that we create a better contrast between the background (floor of the canyon at cave entrance) and the bats. They also recommended that, if possible, we extend the camera farther out over the canyon in order to get a more complete view of the grid.

The following spring we began implementing changes to the monitoring system to create a better background contrast to the bats and to move the camera out farther over the canyon. To "lighten" the ground, we secured light-colored tarps below the existing PVC grid. Then we darkened the grid by spray-painting the PVC a dark color.

We had difficulty, however, at extending the camera farther out over the canyon. The weight of the camera combined with the additional length of the telescoping pole extending out of the metal sleeve, created a problem in straightening out the pole enough to secure a longer center guide wire. We, therefore, decided to modify the metal sleeve so that it would pivot on a vertical rod below the sleeve. With this modification, we are able to attach the camera, extend the fiberglass pole, and secure the center guide wire on the ground. The pole is then pivoted out over the canyon and guide wires are secured on either side of the metal sleeve.

We also had difficulty with the tarp/ PVC pipe assemblage at the cave entrance. A rock collapse at the cave entrance destroyed the entire assemblage. We decided to totally dismiss the tarp/PVC assemblage and instead, using a water-based paint, paint the 10' x 30' grid area white. We cover the paint with tarps to protect the paint between videotaping. It will be simple to touch up areas from year to year.

However, due to an unusually wet fall and spring, we were unable to paint the canyon floor at the cave entrance. In order to accomplish a second test run, an idea, provided by ACSP was attempted. The Park uses a black and white, high-resolution security camera at both the entrance and exit to the cavern. The resolution (380 horizontal TV lines) and minimum illumination (0.05 lux) of the camera might provide a better contrast than the SONY camera. One of the Park cameras was positioned over the canyon on the telescoping pole. The contrast was much improved. The same security camera was purchased for the project (Security First MN: SFS-124) and a second test run was conducted. The entire emergence was taped (55 minutes) on June 21, 2005. The resulting bat count should provide an estimate of colony size at its most stable, prior to parturition.

The videotape of the emergence was converted to DVD. Chapters representing every five minutes were created, allowing for one minute time segments in which to count bats/frame. (The creation of "chapters" on the DVD allowed us to quickly move from one count segment to the next.) The results, provided in Table 1, should be considered a preliminary estimate, at best. The contrast between bats and the canyon floor was still poor but better than the first test run. Estimates were calculated for a sample time equal to one minute of video and then extrapolated for that particular 5

minute "chapter". As only half of the 10′ x 30′ grid was visible and bats could be seen swirling on the far left side of the grid, a count was made of bats every ninth frame (equal to3 seconds and representing a different group of bats) outside of the "swirl zone" and multiplied by a factor of "2" to equal the entire area of the grid. Counting bats was concluded after 50 minutes (Chapters 11 & 12) as most of the bats were swirling across the entire grid from that time forward. The preliminary estimate was 1.260,000 female Mexican free-tailed bats. Again, this estimate represents a conservative count.

Table 1. June 21, 2005. Emergence starts: 8:42 pm. Temperature: 95°, Humidity: 91%; Official Sunset: 8:59 p.m.; Official Moonrise: 9:08 p.m.; Moon phase: Full Moon.
* bats counted every ninth frame (equals 3 seconds) ** multiplied by 1200 frames/ minute, multiplied by 5 minutes for each chapter.

Chapter #	Minutes	Comments	# bats/frame*	Total Bats for Chapter**
1	0- 5	Very concentrated numbers	40	240,000
2	5 – 10	Not as concentrated	30	180,000
3	10 – 15		25	150,000
4	15 – 20		30	180,000
5	20 – 25		25	150,000
6	25 – 30		25	150,000
7	30 – 35		20	120,000
8	35 – 40	Increased swirling	5	30,000
9	40 – 45	More swirling	5	30,000
10	45 – 50	Started using Q-beams with red lens	5	30,000
11	50 – 55	Swirling is across grid area	-	-
12	55 – 60	Swirling is across grid	-	-
		Total		**1,260,000**

Many bat cave managers cautioned ODWC on the amount of time and effort (trial and error) it would probably take to design a monitoring system customized for the Selman Bat Cave. It has taken a considerable amount of time, effort, ingenuity, and creativity to arrive with the first preliminary estimate of the female population of Mexican free-tailed bats in Selman Bat cave. The contrast between the bats and the canyon floor still needs to be improved in order to calculate a more accurate census. The project will continue under another State Wildlife Grant in which we hope to increase the contrast between the bats and the canyon floor and to continue videotaping the emergence before parturition as well as including emergence when volant pups are present.

ODWC would like to acknowledge the staff at Alabaster Caverns State Park for all of their time and efforts in planning, constructing and implementing the monitoring system for censusing the bat population at Selman Bat Cave. Also, Venture Crew #393, chartered by ACSP, provided much of the labor involved in installing the monitoring system. We would also like to acknowledge ODWC fisheries technician, Kim Dale for his design and welding of the metal sleeve that anchors the monitoring apparatus.

Mountain Plover Studies

A cooperative agreement was entered into with Oklahoma State University to conduct surveys for mountain plover, long-billed curlew and other shortgrass prairie birds of greatest conservation need in Cimarron and Texas counties. Field work began in April, 2004. Their final report for the contract is attached as Appendix B.

A draft outline was developed for a Conservation Assessment and Conservation Strategy (CACS) for Oklahoma Comprehensive Wildlife Conservation Strategy (OCWCS) Shortgrass Prairie Region species of greatest conservation need and their associated habitats and is included as Appendix C. Completion of the CACS, including identification of species data gaps and priority research needs, will be done under State Wildlife Grant T-33.

E. Significant Deviations: Individual species conservation plans will be rolled into one Conservation Strategy for the all the species of greatest conservation need in the Shortgrass Prairie Region, as identified in the OCWCS.

F. Costs:

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H. Date: 20 March 2007

I. Approved by: _____
John Stafford, Federal Aid Coordinator
Oklahoma Department of Wildlife Conservation

J. Literature Cited:

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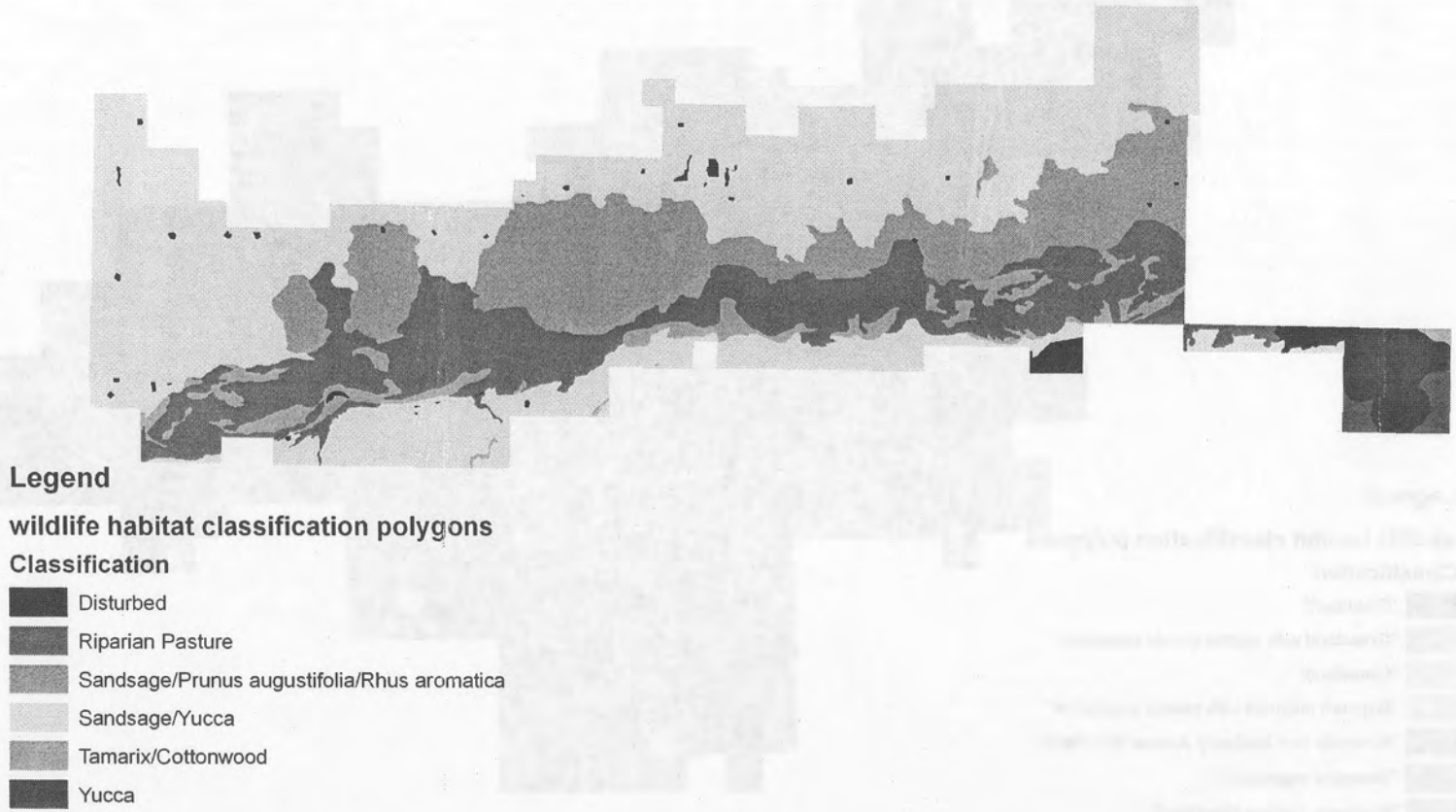

Figure 1. Wildlife habitat classification polygons digitized for Beaver River WMA.

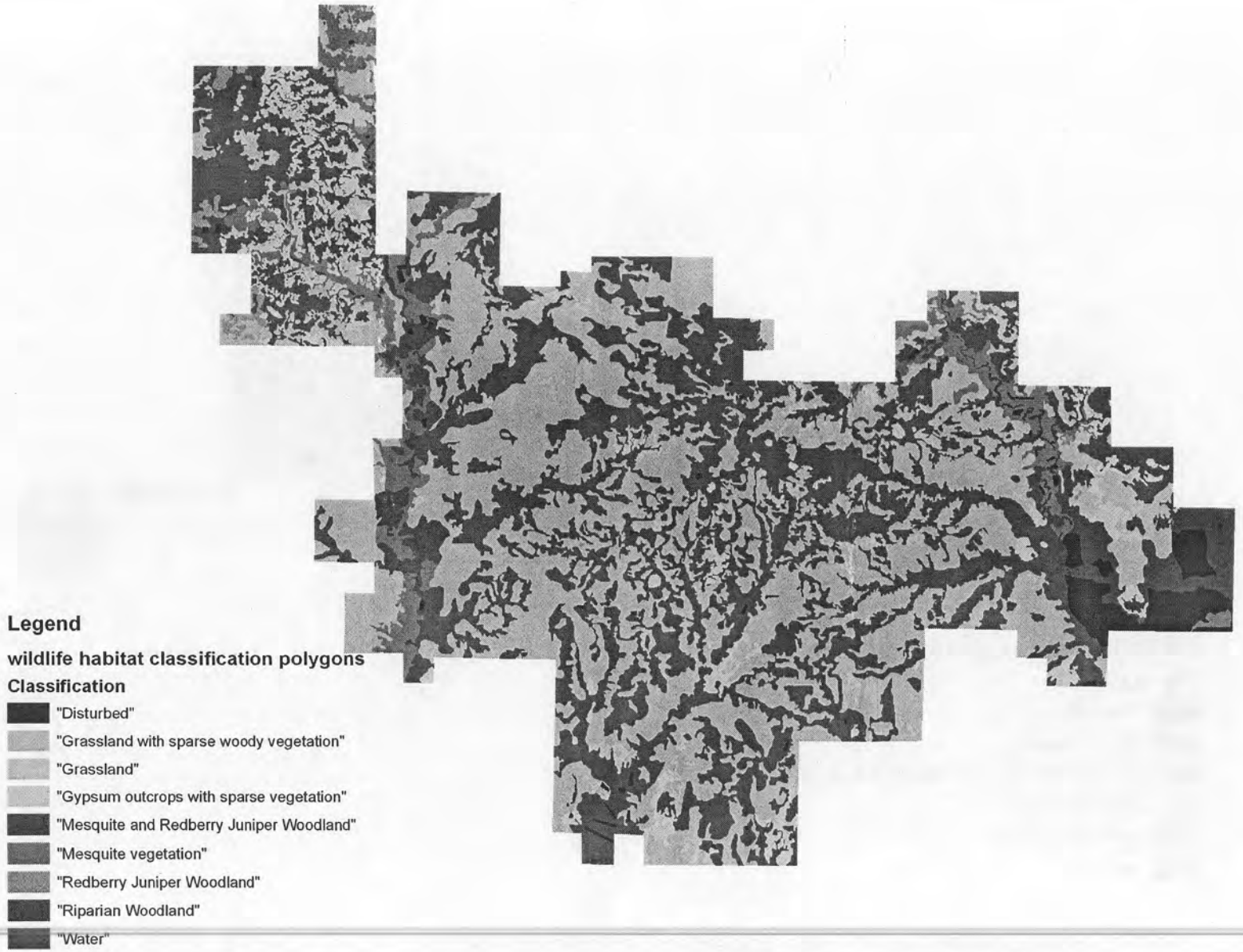

Figure 2. Wildlife habitat classification polygons digitized for Sandy Sanders WMA.

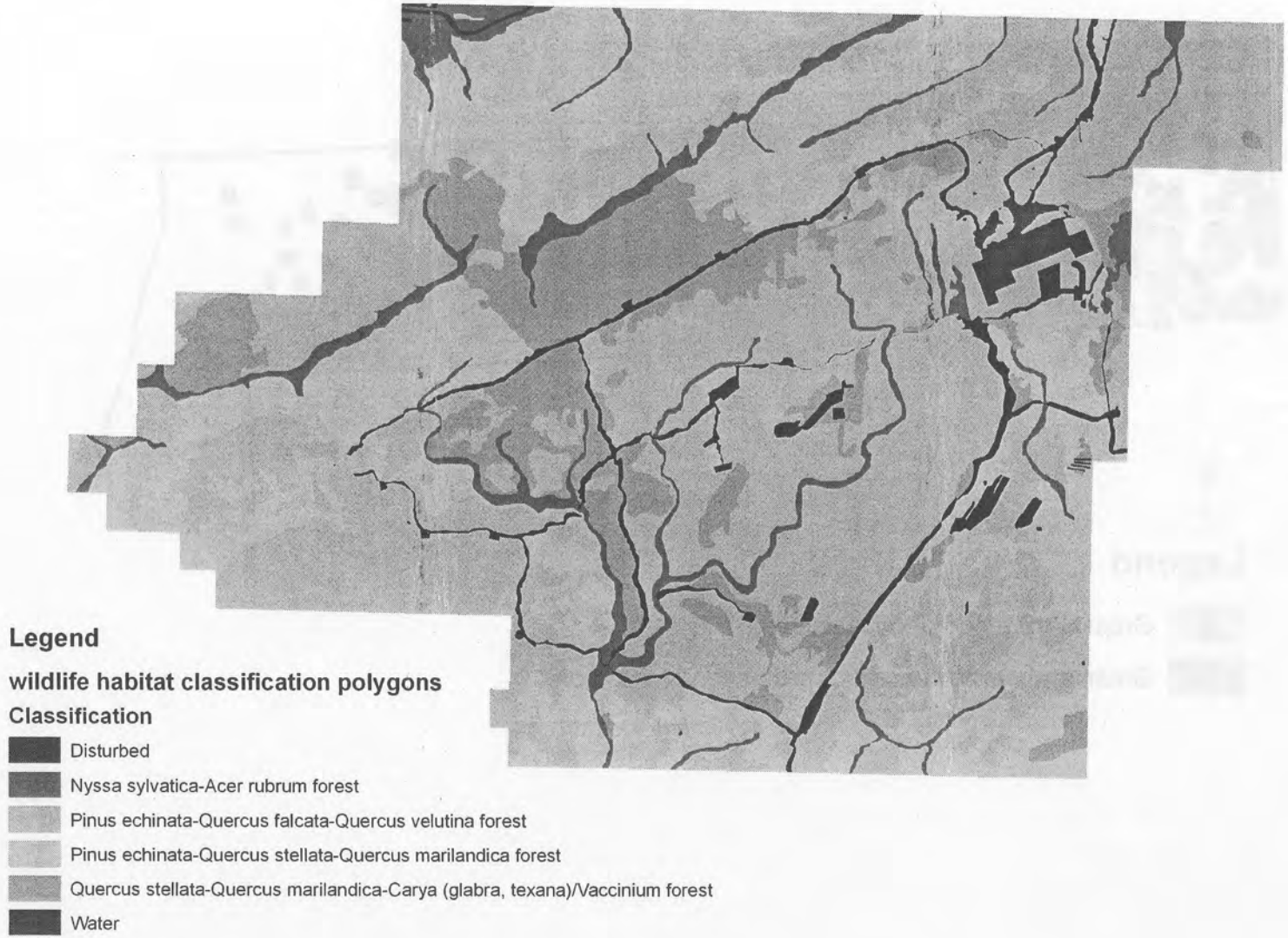

Figure 3. Wildlife habitat classification polygons digitized for Pushmataha WMA.

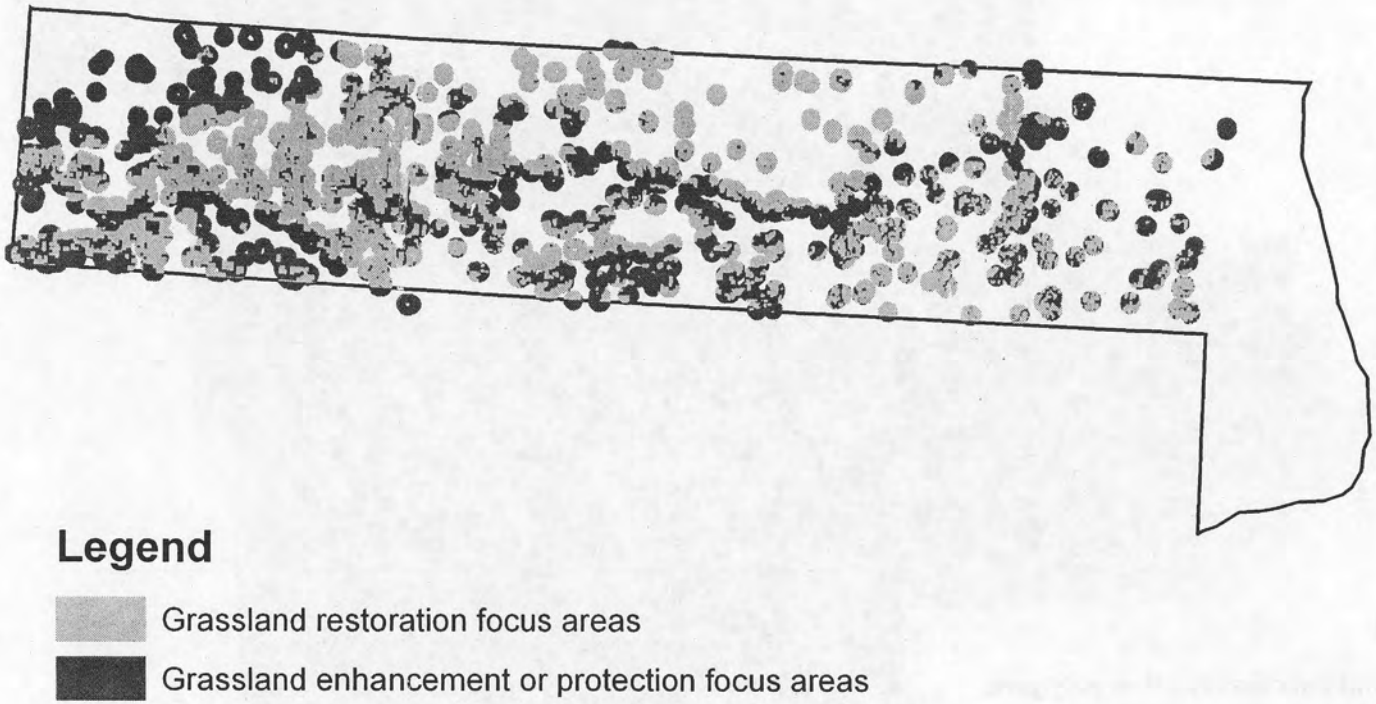

Figure 4. Preliminary management focus areas based on active prairie dog colonies recorded from the 2002 aerial survey.

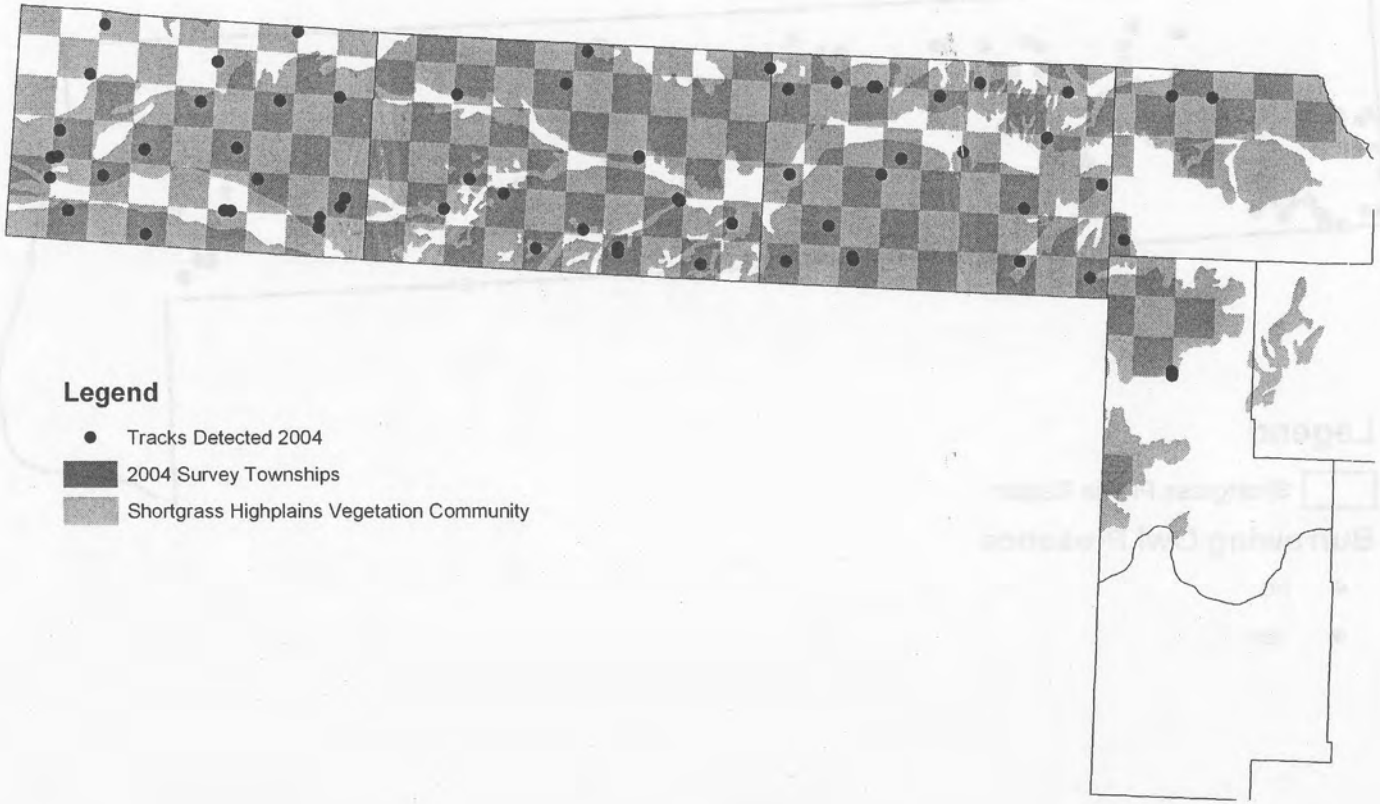

Figure 5. Swift fox track distribution across townships surveyed within the shortgrass High Plains region.

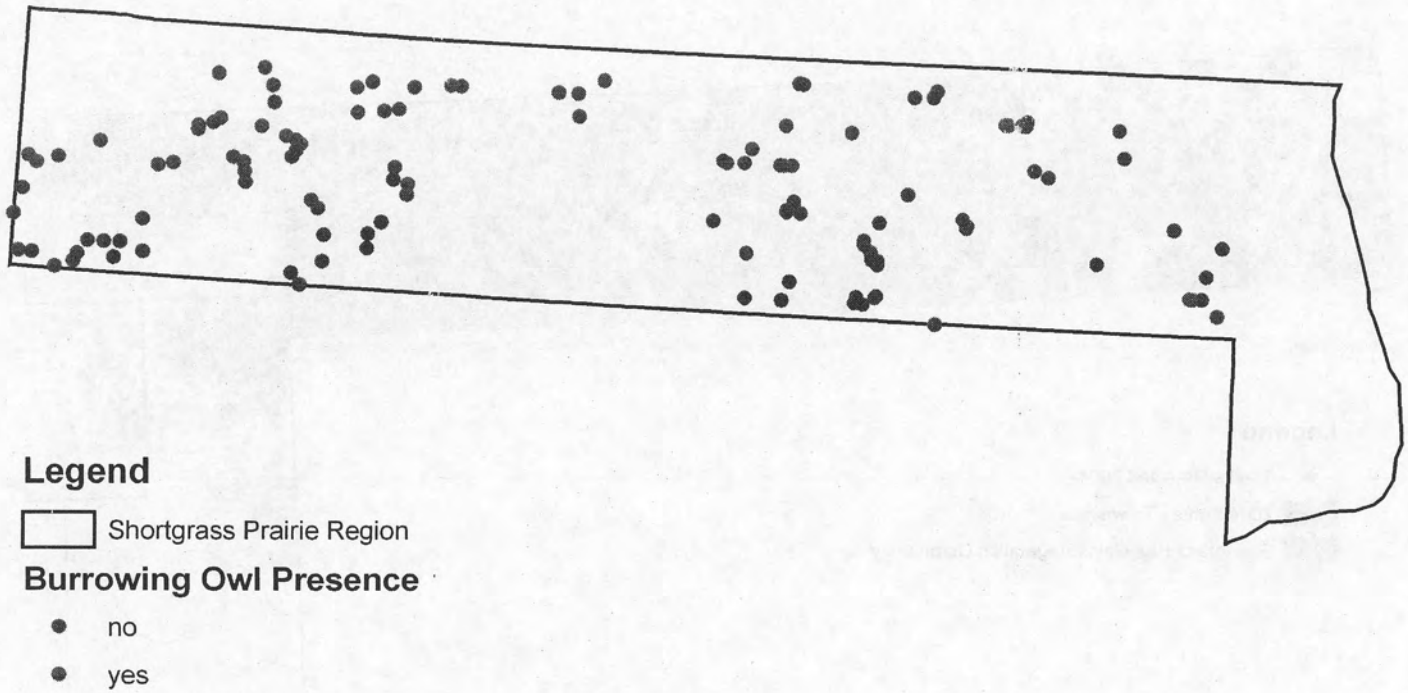

Figure 6. Burrowing owl presence at selected prairie dog colonies within the shortgrass High Plains region in 2005.

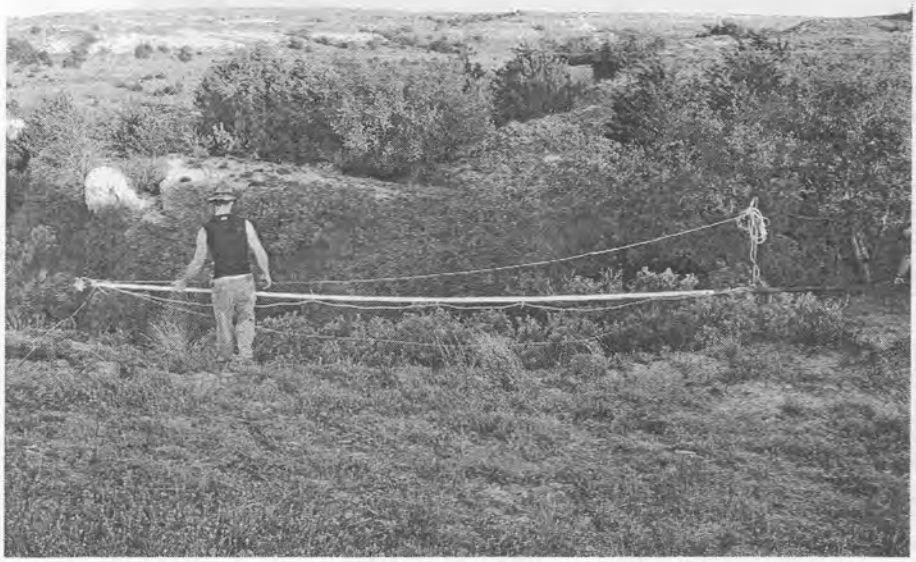

Figure 7. The white telescoping pole has been inserted into metal sleeve (on right). The whole assembly is then pivoted out over the canyon and secured with guide wires.

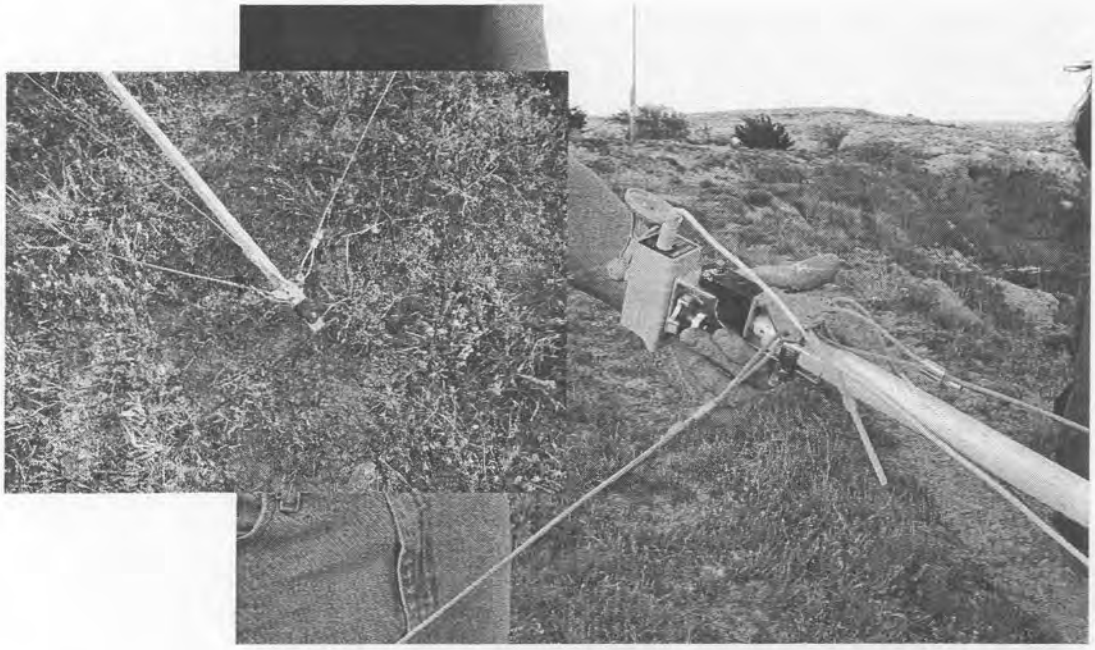

Figure 8. The camera is mounted on the telescoping pole with a custom-made mount. Insert shows how the guide wires stabilize the camera end of the assembly.

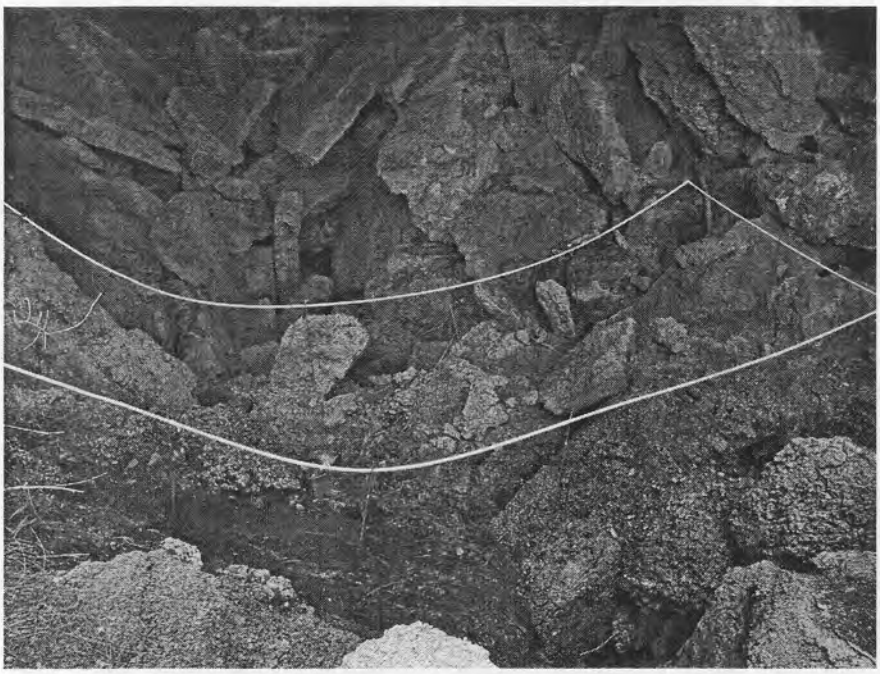

Figure 9. A view of the PVC grid from at the cave entrance.

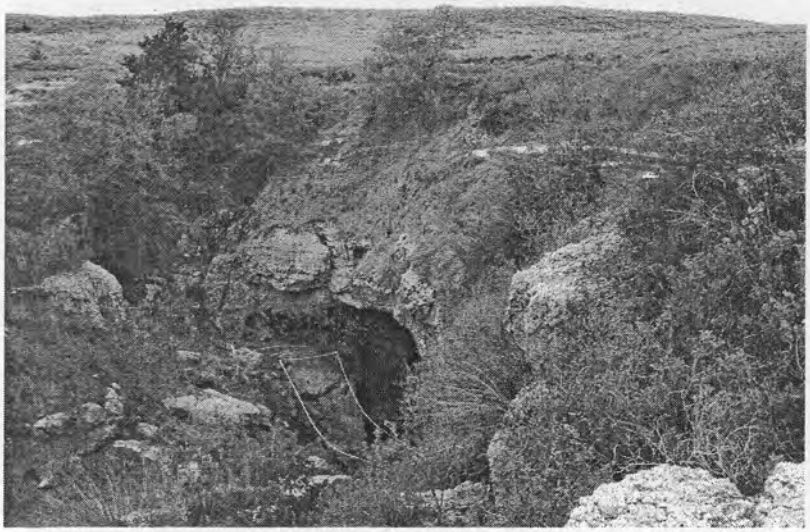

Figure 10. A view of the videotaping during the first test run.

APPENDIX A

FINAL REPORT

STATE: OKLAHOMA **GRANT NUMBER**: T-4-P

GRANT TITLE: Abundance and Habitat Associations of the Swift Fox (*Vulpes velox)* in Oklahoma

GRANT DATES: 1 January 2003 through 31 December 2004

ABSTRACT

The swift fox (*Vulpes velox*), a small canid native to shortgrass prairie ecosystems of North America, has been the subject of much conservation and research interest during the last decade as a result of restricted distribution and low densities. Previous studies have described distribution of the species in Oklahoma, but data on abundance and density are required to adequately monitor population trends and to validate indices of relative abundance. We examined correlations of swift fox density estimated by mark-recapture with timed-track surveys, scat surveys, and catch-per-unit effort indices to facilitate efficient monitoring of swift fox in Oklahoma. We focused our efforts in Cimarron and Texas Counties in the western part of the Oklahoma Panhandle. A total of 79 swift foxes (42 male, 37 female) were captured in 10,240 trapnights between May 2003 and December 2004. Density estimates, based on mark-recapture data from autumn 2004, were 1 fox/4.76 km^2 (0.21 foxes/km^2) in Texas County and 1 fox/5.26 km^2 (0.19 foxes/km^2) in Cimarron County. All survey indices were moderate to strong (r^2 = 0.44–0.76) predictors of fox density. We recommend surveys of scat deposition rates and time-to-track encounters to monitor trends in population abundance over extensive areas of western Oklahoma. Mark-recapture surveys are useful for intensive study of fox population dynamics and ecology in specific areas (ca. 100–200 km^2).

I. OBJECTIVES

1. To estimate density of swift foxes throughout the Oklahoma Panhandle.
2. To develop quantitative relationships between density estimates and indices of relative abundance (e.g., timed track surveys) for the swift fox in Oklahoma.
3. To assess habitat suitability for swift foxes in the Oklahoma Panhandle by linking density estimates and survey results to landscape and habitat characteristics with GIS analyses.

II. INTRODUCTION

The swift fox (*Vulpes velox*) is one of North America's smallest canids (approximately 2 kg) and

historically occurred across the shortgrass and mixed-grass prairie coincident with North American bison (*Bison bison*; Smeeton and Weagle 2001), wolves (*Canis lupus*; Guathier and Licht 2003), and black-tailed prairie dogs (*Cynomys ludovicianus*). Its distribution in the United States is now limited to eastern parts of Montana, Wyoming, Colorado, and New Mexico, and western parts of Nebraska, Kansas, Oklahoma, Texas, and the Dakotas (Scott-Brown et al. 1987, Cypher 2003).

The swift fox was abundant before European settlement, but by the late 1800's, its distribution and abundance had declined. Major factors attributed to this decline were conversion of prairie habitat to cultivated farmland, initiation of rodent and predator-control programs, and unregulated hunting and trapping (Bailey 1926, Hoffman et al. 1969, Carlington 1980, Scott-Brown et al. 1987). A changing prey base and competitive interactions with coyotes (*Canis latrans*) and red fox (*Vulpes vulpes*) also may have kept the swift fox in isolated populations until the mid-1900s (Hillman and Sharps 1978, FaunaWest 1991, Kahn et al. 1997). Populations began to recover at this time because of changes in predator control, farming, and ranching practices (Floyd and Stromberg 1981). Although relatively widespread, the present range of the swift fox is still restricted (Giddings 1997, Kahn et al. 1997, Roy 1998, Schmitt 2000) to about 40% of its historic range based on presence surveys (Federal Register 1995). However, they may underestimate fox presence if foxes were present in an area but not detected.

In 1992, the United States Fish and Wildlife Service (USFWS) was petitioned to list the swift fox as endangered. The USFWS found that listing was "warranted but precluded by other higher priority actions" (Federal Register 1995). The Swift Fox Conservation Team (SFCT) was formed by state and federal wildlife agencies to coordinate future research, monitoring, and management of swift fox. Although conservation actions led to the removal of the swift fox from the candidate list (Federal Register 2001), the need to monitor and manage the species remains.

In Oklahoma, the swift fox is classified as a furbearer with a year-round closed season and is designated as a state species of greatest conservation need. The Oklahoma Department of Wildlife Conservation (ODWC) conducted a landowner survey in 1988 that produced 21 swift fox sightings and 8 den locations in the Panhandle (Kocka 1989). Biologists from the ODWC also reported 5 swift fox sightings from Cimarron, Texas, Beaver, and Roger Mills counties between 1988 and 1994 (Hoagland 2002). Distribution, relative abundance, and general habitat associations of swift foxes in Oklahoma have been described in recent work (Lomolino and Shaughnessy 1997, Hoagland 2002).

These earlier studies have offered useful information on distribution of the swift fox in Oklahoma, but data on density and abundance are still lacking, making it difficult to monitor population trends. Schauster et al. (2002*b*) established relationships between density and several canid census techniques to find cost-effective methods. They found that a combination of mark-recapture estimates and scent station indices was the best predictor of swift fox density and were economical and reliable for monitoring populations of swift fox. However, the combination of scent-station indices and scat deposition surveys were almost as reliable and less costly. We examined correlations of swift fox density estimated by mark-recapture with timed-track surveys, scat surveys, and catch-per-unit effort indices to facilitate efficient monitoring of swift fox in

Oklahoma.

III. STUDY AREA

Trapping and surveys were conducted in Beaver, Cimarron, and Texas counties of the Oklahoma Panhandle. The Panhandle is approximately 267 km from east to west and 55 km north to south. The Panhandle region was historically dominated by shortgrass prairie consisting of blue grama (*Boutelona gracilis*), buffalograss (*Buchloe dactyloides*), and prairie three-awn (*Aristida oligantha*). Substantial areas have been converted to agriculture. Extensive monoculture, cattle grazing, and the decline of prairie dog towns have had a profound impact on the ecology of the historical shortgrass prairie (Shaughnessy 2000).

The Panhandle consists of 4 major habitat types relative to swift fox biology: mesa, rangeland, agricultural land, and riparian corridors. Mesa habitat (87,399 ha) occurs in the northwestern corner of Cimarron County and is dominated by pinyon pine (*Pinus edulis*) one-seed juniper (*Juniperus monosperma*), thickleaved hackberry (*Celtis reticulata*), cholla (*Opuntia imbricata*) cactus, and scrub oak (*Quercus undulata*). In limited areas, ponderosa pine (*Pinus ponderosa*) is found. The grasses found include buffalograss (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*), and hairy grama (*Bouteloua hirsuta*). Four major riparian corridors (85,595 ha) dominated by eastern cottonwood (*Populus deltoides*) run roughly west to east across the Panhandle. Existing rangeland (636,349 ha) occurs mostly as patches of herbaceous range within large expanses of agricultural land. In areas with rugged terrain and sandy soils, sandsage grasslands persist. The buffalograss and blue grama vegetation community dominates the herbaceous range, while sand sage grasslands are dominated by sand sagebrush (*Artemisia filifolia*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), sand plum (*Prunus angustifolia*), and skunkbrush (*Rhus trilobata*). Lastly, agricultural lands (742,280 ha) include lands that have been tilled. The dominant agricultural crops are wheat, winter wheat, center-pivot irrigated corn, sorghum, and milo. Conservation Reserve Program (CRP) fields are planted primarily with exotic grasses such as old world bluestem (*Bothriochloa ischaemum*). New CRP enrollments are encouraging native grasses, but grass species are generally mid to tall grasses, such as little bluestem and switchgrass (*Panicum virgatum*), rather than buffalograss and grama grasses.

IV. MATERIALS AND METHODS

Experimental Design

Our original design called for trapping 20 transects of 20 trapsites, with spacing of 0.5 km between traps, in summer 2003 and 2004 (Fig. 1). Each trap site had a single trap or 2 alternately facing traps as described by Kamler et al. (2002*a*). Those transects were located in Beaver County ($n = 4$), Cimarron County ($n = 8$), and Texas County ($n = 8$). Transects occurred in geographically adjacent pairs of rangeland- and cropland-dominated areas (as in Sovada et al. 1998, 2001). Extremely low capture rates (0.2% trap success) in summer 2003 led to revisions of the project design midway through trapping season in summer 2003. Transects on which no foxes

were marked during the initial trapping period were not retrapped later in the summer. New transects were placed in areas of abundant fox sign and trapped during August. New transects also were trapped in December 2003 and retrapped in January 2004, then trapped subsequently in summer and autumn 2004. For summer and autumn 2004, 6 transects of 20 traps each were sampled on 5 separate trapping occasions for 8 days on each occasion (Table 1) . These transects were located in Cimarron County ($n = 4$) and Texas County ($n = 2$; Figs. 2-3). We did not trap in Beaver County in 2004.

Motion-activated cameras were used to survey for swift fox presence. We used a stratified random design to survey the Panhandle. Townships throughout the Panhandle were clustered into groups, then townships within groups were randomly selected. We selected 15 townships in Beaver county, 35 townships in Texas county, and 34 townships in Cimarron county for placement of camera transects. Each camera transect consisted of 3–5 cameras that collected photographs for 7 days. Exact placement of each transect depended on landowner permission and access.

Capture and Handling

We captured swift foxes in Tomahawk wire-mesh traps of 2 sizes (25 by 30 by 81 cm and 24 by 24 by 66 cm; Tomahawk Trap Company, Tomahawk, Wisconsin) baited with sardines and/or raw chicken. On each transect, we deployed traps at 0.5-km intervals along 10-km routes for 20 trapsites/transect. We checked traps daily. During summer, traps were shut in the morning after checking and reopened in the evening to reduce heat stress resulting from possible daytime captures. Trapping was conducted in May, July, September, October, and November-December. Foxes were handled with Kevlar™ thick leather gloves as described by Schauster et al. (2002*b*) or with an intramuscular injection of Telazol™ (Fort Dodge Animal Health, Fort Dodge, Iowa) administered by handheld syringe or jabstick at a dose rate of 10 mg/kg (Kreeger 1996). All foxes were weighed, sexed, aged by tooth wear and body size, eartagged, and released. Tissue (ear plugs) and hair samples were collected from each fox for deposition in the Collection of Vertebrates at Oklahoma State University.

We anesthetized nontarget mesocarnivores with Telazol at a dose of 8 mg/kg using a jabpole syringe. All captured mesocarnivores were marked with single ear tags in each ear. Animals were sexed, aged, weighed, measured, and released.

We conducted timed-track surveys in August to coincide with ODWC track surveys throughout the Panhandle (Hoagland 2002). Minutes-to-first-track observed and tracks/min were calculated for each survey route. Survey routes occurred in the same study sites as trapping routes. Track searches were conducted on each route for > 30 min and < 2 h. Time of search was recorded after a swift fox track was found. If a track was found during the first 30 min of the search period, we continued searching or moved to the next route after the initial 30 min. Survey success was affected by time of day and weather conditions, so track searches were conducted when possible during morning hours and 24 h following a rainfall event (Hoagland 2002).

We calculated scat deposition rates as the number of scats deposited per kilometer per day. Each

trapping transect was divided into 3 3-km sections. We initially cleared each section of each transect of scats and rechecked them approximately 14 days later by walking and counting number of scats deposited. This survey technique was repeated twice per season, summer and autumn (Schauster et al. 2002*b*). We used the average seasonal daily rates of scat deposition per kilometer in subsequent regression analyses (Schauster et al. 2002b).

Data Analyses

We used the closed-capture model for heterogeneity (assuming individual heterogeneity of capture) in Program MARK (White and Burnham 1999) to estimate capture probabilities and abundance of swift foxes in our transects. We used data from the last 3 trapping occasions (September–December 2004) to meet assumptions of a closed population (no reproduction or mortality, no net immigration or emigration). Capture data from other times and transects were too sparse for analysis. We assumed that mortality of marked and unmarked foxes was similar. We estimated pooled abundance of foxes for Cimarron County and Texas County transects separately. We also had adequate data to estimate abundance for 3 individual transects: MOS and BEL in Cimarron County and FRE in Texas County (Table 1; Figs. 2–3). Abundance on the other 3 transects was estimated by subtraction from the pooled county estimate. We developed models that varied capture probability by time and county, by time only, by county only, and without time or county variation. Models were ranked using Akaike's Information Criterion (AIC; Burnham and Anderson 1998).

We estimated effective trapping area by placing a buffer equal to the average radius of swift fox ranges in shortgrass habitats (1.93 km) around the survey route. That value represented the average radius of home ranges of swift fox in similar habitat in Colorado, Kansas, and Texas (Kitchen et al. 1999, Kamler et al. 2003*a*, Sovada et al. 2003). We divided population estimates of the transects by the effective trapping area to determine density of individual transects and pooled transects by county. We regressed density estimates on data from timed-track surveys, scat deposition surveys, and catch-per-unit effort indices (e.g., trapping success) to examine the effectiveness of these indirect methods to predict fox density. For the regression of density vs. trapping success, number of trapnights/transect/season totaled 320 in summer and 480 in autumn.

Landscape and Habitat Analyses

We sampled trap and camera locations during 2003 and 2004 for vegetation characteristics. Our sampling was conducted during September–November 2003 and July–August 2004. We sampled vegetation cover using a standard Daubenmire (20 cm x 50 cm) frame (Daubenmire 1959) and a modified 1m x 1m frame. We collected visual obstruction (VO) measurements using a modified Robel pole as described by Uresk et al. (2002). Data are being entered to perform statistical analyses of vegetation sampling sites.

We will examine swift fox habitat-density relationships using vegetation and landscape data from a concomitant study (State Wildlife Grant T–4–P: Surveys of the Swift Fox [*Vulpes velox*] in Western Oklahoma) and results of the 2 recent reports on distribution of the species in the Oklahoma Panhandle (Hoagland 2002, Lomolino and Shaughnessy 1997). The earlier of these

reports (Lomolino and Shaughnessy 1997), which was based on visitation to tracking plates, indicated an affinity of swift foxes for pinyon-juniper mesa habitats and adjacent prairie dog towns, and a negative relationship with the presence of coyotes (*Canis latrans*). The second report (Hoagland 2002), based on track surveys, provided evidence that swift foxes were relatively more abundant in herbaceous rangeland than cropland and increased in abundance from east to west in the Panhandle. This report, however, explains that this result may be biased because rangeland was surveyed over cropland whenever it was available.

We will develop predictive relationships among density, survey data, and landscape/habitat associations in the range of the swift fox in the Panhandle. For example, presence/absence data from track surveys will be modeled with habitat-type or landscape-level data using logistic regression. Similarly, density estimates will be modeled with multiple regression using a variety of landscape variables found in our defined study sites.

V. RESULTS

Trapping and Density Estimates

We trapped during the following periods: 19 May–11 August 2003, 13 December 2003–9 January 2004, 12 May–10 August 2004, and 3 October–16 December 2004. During summer 2003, 8 individual swift fox were captured in 4,000 trap nights (0.2% trap success; Table 1); no recaptures were made. Two foxes were captured in Texas County, and 6 foxes were captured in Cimarron County. During winter trapping in 2003–2004, 19 swift fox were captured in 1,440 trap nights (1.32% trap success) on 4 transects in Cimarron County (Table 1). Trapping during summer 2004 resulted in 14 captures in 1,920 trapnights (0.73% trap success), whereas autumn trapping resulted in 108 captures in 2,880 trapnights (3.75% trap success). Overall captures totalled 150 of 79 (42 males, 37 females) individuals in 10,240 trapnights (1.45% trap success).

Data from all trapping periods except the 3 occasions in autumn 2004 were too sparse to estimate population size by mark-recapture analysis. For all estimates of abundance using the closed-captures-with-heterogeneity model, the selected model contained no variation in capture probability by county or by capture occasion. Population estimates for pooled transects within Texas and Cimarron counties were 40.0 (95% CI: 30–65) and 61.2 (95% CI: 47–94) swift foxes, respectively, which translated to density estimates of 1 fox/4.76 km^2 (0.21 foxes/km^2) in Texas County and 1 fox/5.26 km^2 (0.19 foxes/km^2) in Cimarron County for areas enclosed by a 1.93-km buffer around the transects. Individual transect estimates ranged from 1 fox/12.5 km^2 to 1 fox/2.27 km^2 (0.08 to 0.44 foxes/km^2; Table 2).

Nontarget mesocarnivores were captured on 14 transects (Table 3). We captured 152 striped skunks (*Mephitis mephitis*), 60 raccoons (*Procyon lotor*), and 1 American badger (*Taxidea taxus*).

Relative Abundance-density Relationships

Track surveys were conducted during August 2003 on transects that were trapped during summer

(some transects were trapped more than once). Fox sign (track or scat) was detected on 13 of 20 transects (65%), and on transects where swift fox sign was detected, it took an average of 25.4 min to detect the first sign (range: 5–87 min). Sign was detected on 0 of 4 transects in Beaver county, 6 of 8 transects in Texas county, and 7 of 8 transects in Cimarron county. Track surveys also were conducted in 2004 on the 6 summer and autumn transects. Fox tracks were detected on all 6 transects and took an average of 27.3 min to detect (range: 0–93 minutes). Scat deposition rates were calculated on the 2004 transects ($n = 6$) and ranged from 0.0 to 0.79 scats/km/night (Table 4). A total of 303 fox scats were collected on the transects in summer, ranging from 3 on the CRO transect to 143 on the FRE transect. In autumn, 503 scats were collected, ranging from 0 on the CRO transect to 213 on the FRE transect.

Captures during summer 2003 were not sufficient to perform mark-recapture estimates. A plot of capture rates (foxes/1,000 trapnights) vs. minutes to detection of first fox sign showed a weak negative relationship (Fig. 4). Track surveys from 2004 and scat-deposition rates were moderate ($r^2 = 0.44$–0.53) predictors of estimated density of swift foxes (Figs. 5–6). However, these regression relationships did not reach statistical significance ($p = 0.10$–0.15). In 2004, trapping success was a strong predictor of autumn density, explaining 75-76% of autumn fox densities ($p = 0.02$–0.03; Fig. 7).

Camera survey effort equaled 503 camera-nights in Beaver county, 1,300 camera-nights in Texas county, and 1,266 camera-nights in Cimarron county. Zero pictures of swift foxes were collected in Beaver county compared to 19 and 107 pictures in Texas and Cimarron counties, respectively. A detailed analysis of these survey data, along with microhabitat and landscape correlates of camera sites, is forthcoming in the final report for State Wildlife Grant T–4–P (Surveys of the Swift Fox [*Vulpes velox*] in Western Oklahoma).

Landscape and Habitat Characteristics

Vegetation analyses at the microhabitat level were completed for 489 trapsites and camera sites. Those data were collected using 1-m^2 Daubenmire frames to assess cover composition and Robel poles to assess visual obstruction. Analyses of microhabitats and landscape characteristics surrounding successful and unsuccessful trap and camera sites have not been completed, although a GIS database for future modeling is being developed for presentation in a concomitant study (State Wildlife Grant T–4–P: Surveys of the Swift Fox [*Vulpes velox*] in Western Oklahoma).

VI. DISCUSSION

Trapping and Density Estimates:

Trapping success was affected greatly by season. We found that autumn provided the greatest success rate (3.75%), followed by winter (1.32%), and being minimal in summer (0.2 % and 0.73%). Some of the increase in success was due to improvements in trapping methods, but we hypothesize that most of the increase resulted from food availability. The summer season provides abundant resources in small mammals and arthropods, and foxes may likely pass up bait

in a trap setting when plenty of other choices exist. In autumn and winter, with a reduction in invertebrate and small mammal prey, swift fox may be more likely to risk entering a trap for a small piece of fish or chicken. During autumn trapping, more naïve juveniles also are available for capture after they have left their natal dens in August and are dispersing or establishing home ranges.

Other studies have reported seasonal changes in trapping success, although not to the degree that we observed in our project. Harrison et al. (2002) reported that capture success varied seasonally for unique fox captures, with success peaking in autumn and early winter. No new foxes were captured (in 88 trapnights) during an April–June trapping period. However, capture rates (including recaptures) never dropped below 2.4% in any season. These authors trapped at "conspicuous locations such as road, fence, and trail intersections." Traps on our transects were systematically placed. Our trapping design was modeled after Schauster et al. (2002*b*), who also placed traps systematically along transects. These authors did not analyze seasonal changes in trapping success but reported that trapping success varied from 0 to 31% across transects and that 2 trap transects failed to catch any foxes when foxes were known to be in the area. Trapping success also was related negatively to fox density during one pup-rearing season (15 April–15 August). Increased wariness by adult foxes and lower absolute numbers of foxes may explain that result.

Density estimates for autumn 2004 varied widely by transect, but average densities were similar to those reported by Schauster et al. (2002*a*, 2002*b*), which ranged from 1 fox/10.52 to 1 fox/3.32 km^2 (0.095 to 0.301 foxes/km^2) in a native shortgrass prairie ecosystem in southeastern Colorado. They also reported that densities varied seasonally, being lowest in the pup-rearing season (15 April–15 August) and highest in the dispersal season (15 August–14 December). Our estimates were twice as high as those reported by Harrison et al. (2002; 1 fox/14.29 to 1 fox/9.52 km^2; 0.070–0.105 foxes/km^2) in a shortgrass prairie system in northeastern New Mexico during November–March time periods.

Relative Abundance-density Relationships

Evaluation of survey methods have been reported from swift fox studies in southeastern Colorado (Schauster et al. 2002*b*) and New Mexico (Harrison et al. 2002, 2004). In both study areas, intensive mark-recapture (or mark-resighting) methods were the most accurate predictors of density and the most expensive. Relative to indices that we examined in our study, Schauster et al. (2002*b*) found that scat deposition surveys outperformed activity index (a type of track visitation index) in predicting fox density, whereas Harrison et al. (2004) reported that scat collection along transects was a useful technique to index populations of swift foxes. The latter authors surveyed the entire distribution of swift foxes in New Mexico by collecting scats during late winter–early spring in 17 days on 99 16-km transects. Sample sizes of transects were adequate to detect rangewide declines of 20% in percentage of transects containing fox scats (Harrison et al. 2004). Verification of identity of swift fox scat using DNA analysis was considered necessary under certain condition, such as when ≤ 3 scats/transect were found or when inexperienced observers were collecting scats.

Our timed-track surveys provided moderate ($r^2 = 0.4–0.5$) prediction of density estimates and were completed quickly in both years. These regression relationships likely did not reach statistical significance ($P \leq 0.05$) because of the low power of the test (i.e., $n = 6$ transects). Environmental conditions (e.g., rain events, tracking substrates, and vehicular traffic) likely reduced the predictive power of these relationships. Scat deposition rates predicted density of swift foxes slightly better than timed-track surveys. However, this method was more time-consuming than track surveys and may not be feasible for ODWC personnel because scat surveys cover smaller areas than timed-track surveys with the same amount of labor and the same transects are walked three times in a month. However, this method likely can be effectively used in conjunction with habitat suitability models on which we are currently working.

Trapping success was the best predictor of density that we evaluated. In contrast, this index was one of the lowest predictors of fox density in southeastern Colorado (Schauster et al. 2002*b*). On relatively small (100–200 km^2), intensively studied areas, mark-recapture trapping associated with radiotelemetry of marked individuals to determine social units and territory distribution will provide the most precise estimates of density (Schauster et al. 2002*b*). However, the cost of such efforts over extensive areas is prohibitive, and other indices are more practical.

VII. MANAGEMENT IMPLICATIONS

Our findings supported the recommendations of Schauster et al. (2002*b*) relative to the use of surveys for predicting population density and trends of swift fox. Those authors reported that a combination of scent-station surveys and scat deposition was nearly as reliable but far less costly than surveys involving mark-recapture estimates. We needed mark-recapture estimates to provide precise estimates of density in our study, but we found that both survey methods of relative abundance, timed-track surveys and scat deposition rates, explained approximately 50% of the variability in density of swift foxes on our study transects. We consider this level of prediction to be of biological significance, and suggest that larger samples will lead to statistically significant relationships among these predictors and density. These methods are noninvasive and injuries associated with trapping are eliminated. They also allow extensive coverage of area (especially the timed-track surveys) at low cost. Mark-recapture studies should be conducted for more detailed data on population dynamics and ecology of the species.

We support the use of timed-track surveys as conducted by ODWC in Hoagland (2002) for detecting presence or absence of foxes, and for assessing relative abundance of foxes in different regions. Surveys should be conducted annually and in the same areas to maintain continuity among years. They could be expanded in area if new sightings of swift foxes suggest their occurrence elsewhere. The x-intercept of the equation in Figure 2 is about 95 min; this value suggests that if tracks have not been observed after 95 min of walking, the probability of swift fox being detected at that time is low. Hoagland (2002) reported that tracks were seen after periods as long as 105 min in 1998, 103 min in 1999, and 117 min in 2000. However, time-to-track detection by observers averaged 39, 46, and 36 min in 1998, 1999, and 2000, respectively. Tracks were rarely found after 60 min of walking.

VIII. SIGNIFICANT DEPARTURES AND LIMITATIONS

We did not fully address objective 3 on habitat suitability. Microhabitat data have been collected at ca. 500 trapsites and camera survey sites. All sites also have been georeferenced, and landscape characteristics surrounding these points will be described using GIS. In an upcoming report on a concomitant study (State Wildlife Grant T–4–P: Surveys of the Swift Fox [*Vulpes velox*] in Western Oklahoma), we will use logistic regression to model presence or absence of the swift fox in the Oklahoma Panhandle using capture data from trapsites and camera surveys in combination with microhabitat and landscape-level data. Similarly, we will model fox density with multiple regression, using a variety of landscape variables found in our defined study sites.

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15 February 2005

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Table 1. Trapping success (captures/trapnight) for swift foxes for all transects in Beaver, Texas, and Cimarron counties, Oklahoma from May 2004 to December 2004.

County	Transect	May 03	Jul 03	Dec 03	Jan 03	May 04	Jul 04	Oct 04	Nov 04	Dec 04	Total	% success
Beaver	KNO	0/200	0/200								0/400	0.0
	BEA	0/200	0/200								0/400	0.0
Texas	HIT	0/200	0/200								0/400	0.0
	LAN	0/200	0/200								0/400	0.0
	STE	0/200									0/200	0.0
	FRE1	2/200									2/200	1.0
	FRE2		0/200			2/160	3/160	13/160	8/160	5/160	31/1000	3.1
	SKE		0/200			0/160	2/160	1/160	2/160	2/160	7/1000	0.7
Cimarron	FOR	0/200									0/200	0.0
	HOL	0/200									0/200	0.0
	SHA1	1/200									1/200	0.5
	SHA2		0/200	2/160	3/200	0/160	0/160	1/160	1/160	1/160	8/1360	0.6
	CRO1	0/200									0/200	0.0
	CRO2			0/160	1/200	0/160	0/160	0/160	0/160	2/160	3/1160	0.3
	MOS		3/200	4/160	3/200	4/160	2/160	17/160	17/160	17/160	67/1360	4.9
	BEL		0/200	4/160	2/200	0/160	1/160	11/160	7/160	4/160	29/1360	2.1
	KEN		2/200								2/200	1.0
Total		3/2000	5/2000	10/640	9/800	6/960	8/960	43/960	35/960	31/960	149/10240	1.5

Table 2. Effective trapping area, number of animals trapped, estimated population size, and estimated density of swift foxes on transects trapped in Cimarron and Texas counties, Oklahoma, during autumn 2004.

County	Transect	Effective trapping area (km^2)[a]	Animals trapped (*n*)	Estimated population sizeb	Estimated density foxes/km^2	km^2/ fox
Cimarron	CRO	77.8	2	6	0.08	12.5
	SHA	100.4	3	8	0.08	12.5
	MOS	63.9	16	25	0.39	2.6
	BEL	79.8	14	22	0.27	3.7
	All	315.2[c]	35	61	0.19	5.3
Texas	SKE	96.0	3	9	0.09	11.1
	FRE	71.4	20	31	0.44	2.3
	All	186.1[c]	23	40	0.21	4.8

[a] Determined by placing a buffer of 1.93 km around trapping grid

[b] Estimated using closed captures for heterogeneity model in program Mark (White and Burnham 1999)

[c] Total effective trapping area in a county does not equal sum of individual transect area due to buffer overlap or space enclosed within transects

Table 3. Number of captures of nontarget mesocarnivores trapped during swift fox trapping survey in Beaver, Texas, and Cimarron counties, Oklahoma, 2003-2004.

			2003		2004	
County	Transect	Species	Summer	Winter	Summer	Autumn
Beaver	KNO	striped skunk	6			
		raccoon	11			
		badger	1			
	BEA	striped skunk	4			
		raccoon	19			
Texas	HIT	raccoon	1			
	LAN	striped skunk	1			
	STE	raccoon	1			
	FRE1	raccoon	1			
	FRE2	striped skunk	1		5	12
		raccoon			1	
	SKE	striped skunk	2		7	15
		raccoon	1			
Cimarron	FOR					
	HOL					
	SHA1	striped skunk	1			
	SHA2	striped skunk	4	2	6	12
		raccoon	1	1	8	5

CRO1	striped skunk	5			
	raccoon	2			
CRO2	striped skunk		5	27	27
	raccoon		1	2	3
MOS	striped skunk		3	1	6
BEL	raccoon				2
KEN					

Table 4. Time-to-track results and scat deposition rates (scats/km/night) on swift-fox trapping transects in Cimarron and Texas counties, Oklahoma, during summer and autumn 2004.

		Time to first	Scat deposition rates	
County	Transect	Track (min)	Summer	Autumn
Cimarron	CRO	93	0.011	0.00
	SHA	27	0.019	0.114
	MOS	9	0.203	0.265
	BEL	12	0.099	0.273
Texas	FRE	23	0.235	0.341
	SKE	0	0.376	0.789

Figure Captions

Fig. 1. Map of Oklahoma Panhandle showing locations of transects used for trapping swift foxes in 2003–2004.

Fig. 2. Map of Texas county showing effective trapping area surrounding 2 trapping transects used to estimate density of swift foxes in autumn 2004.

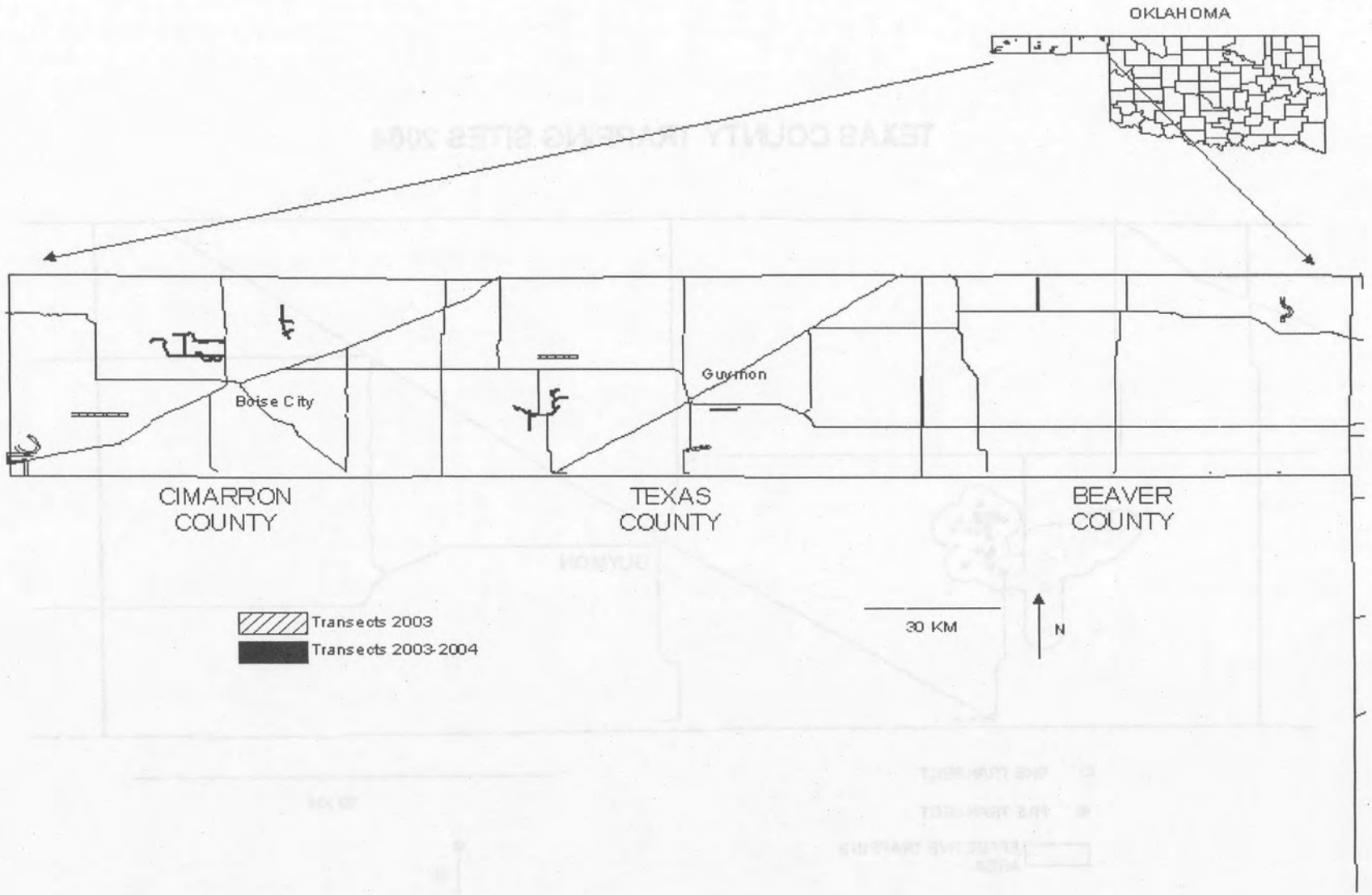
Fig. 3. Map of Cimarron county showing effective trapping area surrounding 4 trapping transects used to estimate density of swift foxes in autumn 2004.

Fig. 4. Plot of minutes to finding first sign of swift fox during track surveys to capture rates of foxes on 24 trap transects in the Oklahoma Panhandle, summer 2003.

Fig. 5. Regression of fox density by trapping transect to time (minutes) to sighting of first track.in August 2004, Cimarron and Texas counties, Oklahoma ($y = -0.0033x + 0.314$, $r^2 = 0.44$, $p = 0.11$).

Fig. 6. Regression of swift fox density to scat deposition rate during summer and autumn, 2004, in Cimarron and Texas counties, Oklahoma (summer: $y = 0.83x + 0.095$, $r^2 = 0.51$, $p = 0.11$; autumn: $y = 0.44\ x + 0.09$, $r^2 = 0.53$, $p = 0.10$). Autumn densities were used in each regression.

Fig. 7. Regression of swift fox density to trapping success (%) during summer and autumn, 2004, in Cimarron and Texas counties, Oklahoma (summer: $y = 0.175x + 0.0097$, $r^2 = 0.75$, $p = 0.03$; autumn: $y = 0.037\ x + 0.087$, $r^2 = 0.76$, $p = 0.02$). Autumn densities were used in each regression.


OKLAHOMA
Boise City
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TEXAS COUNTY
BEAVER COUNTY
Transects 2003
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30 KM
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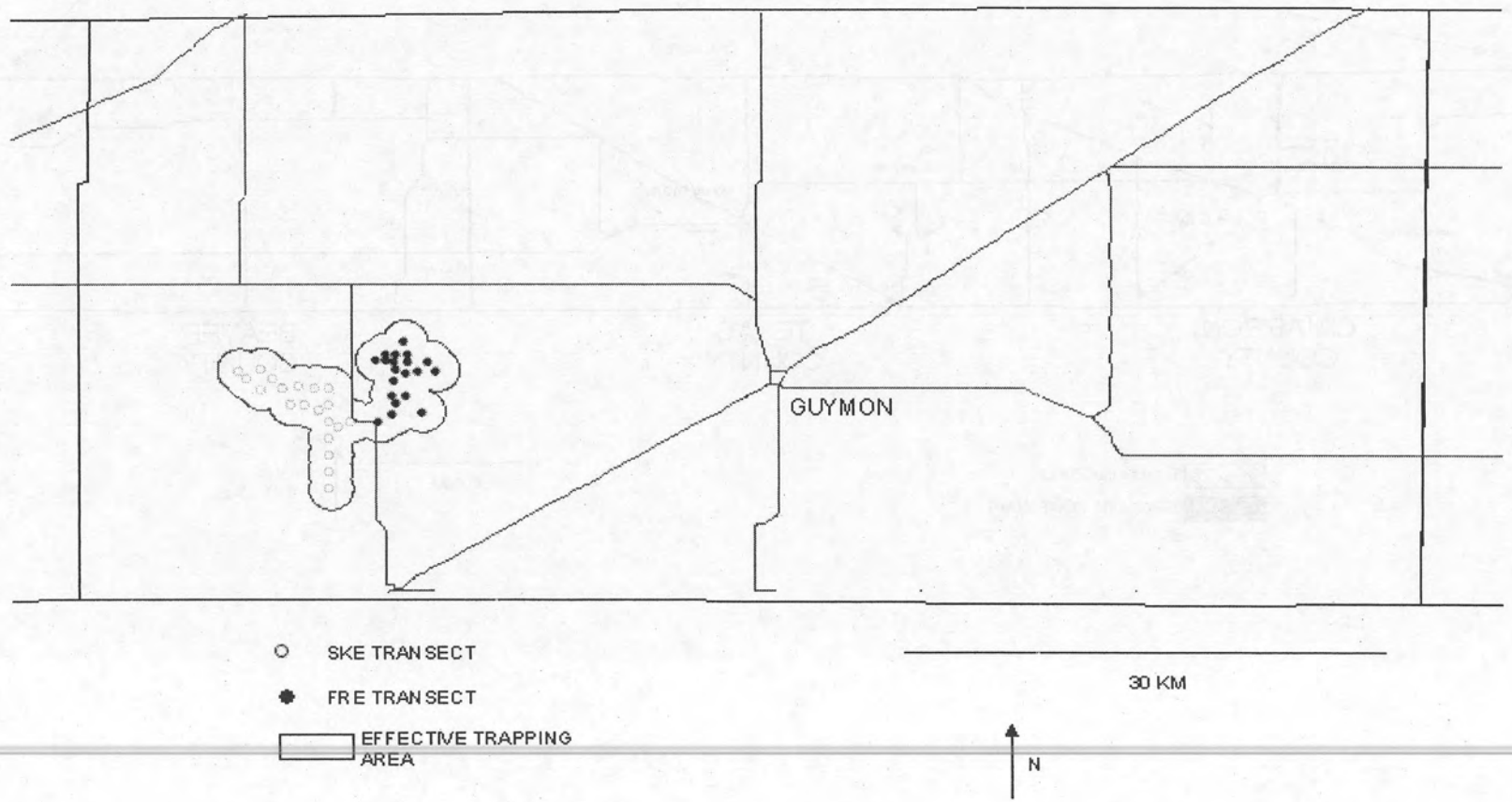
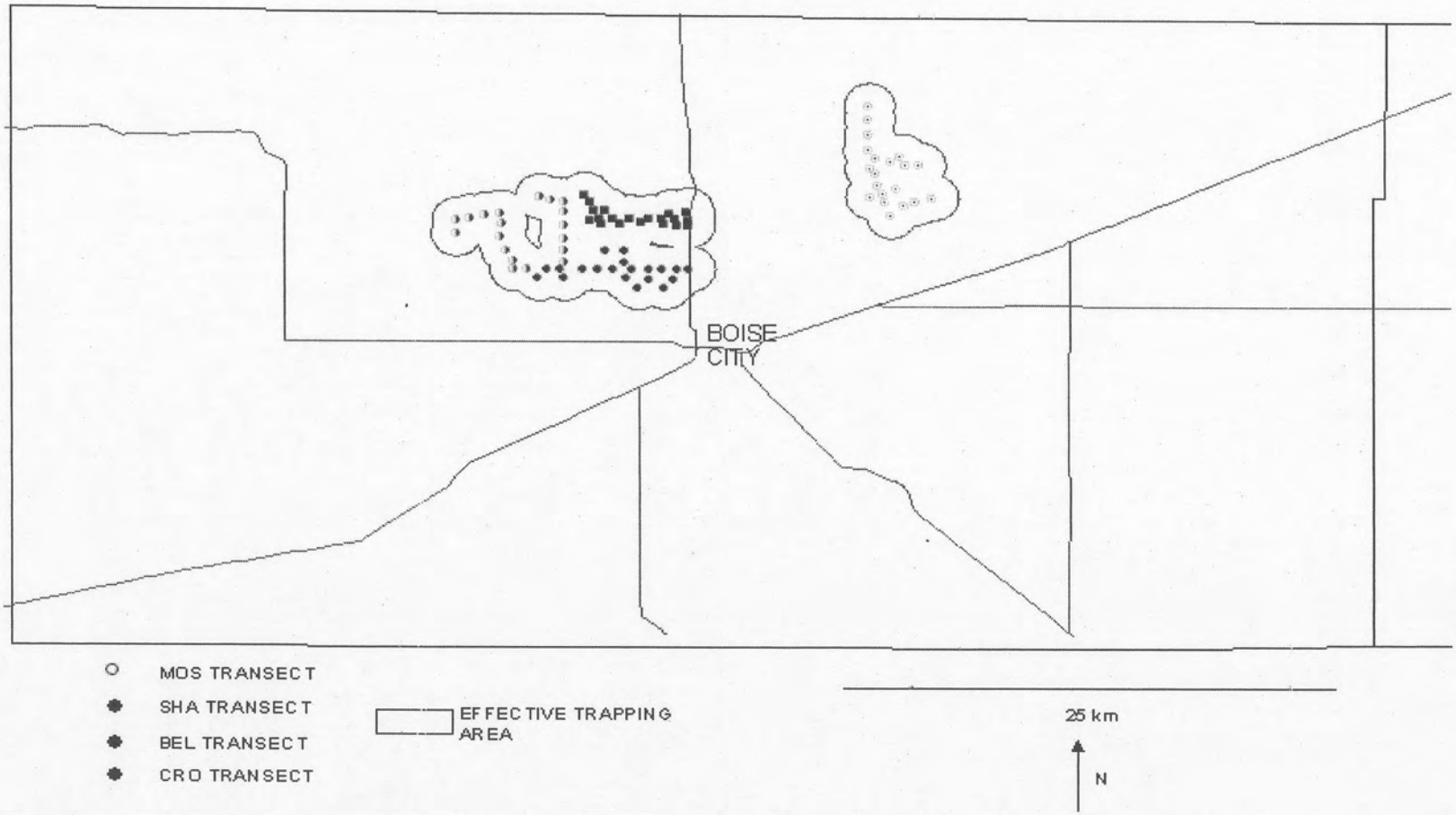
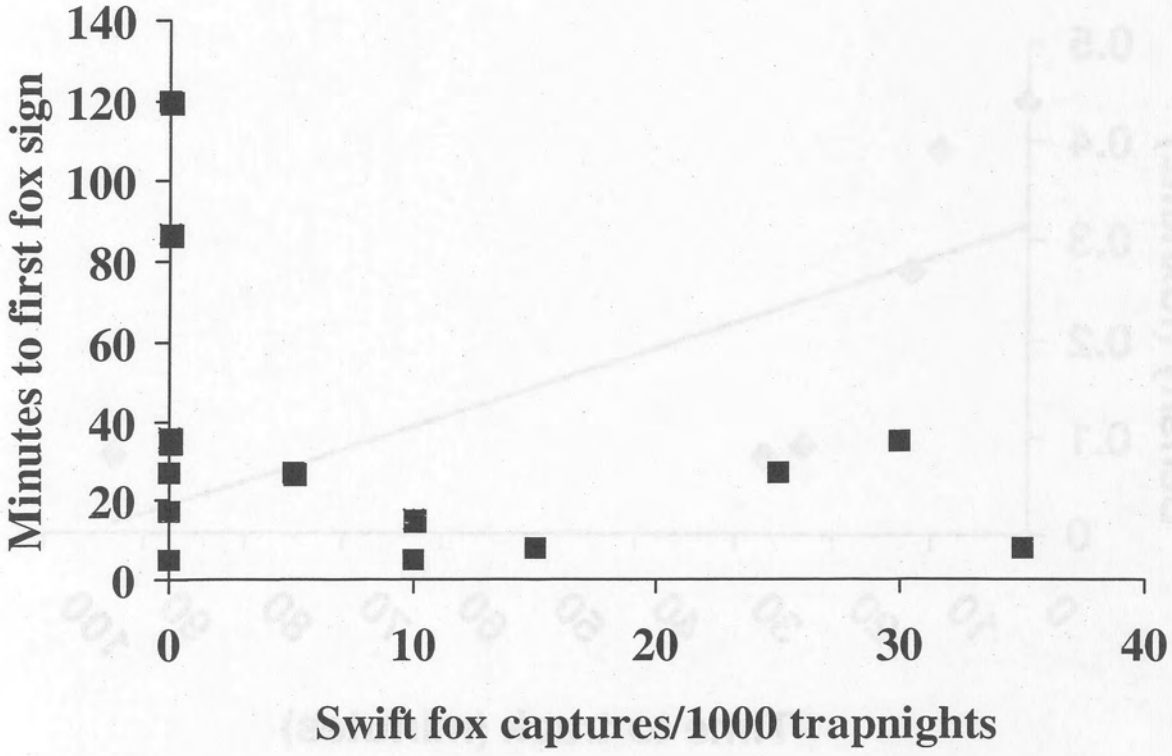
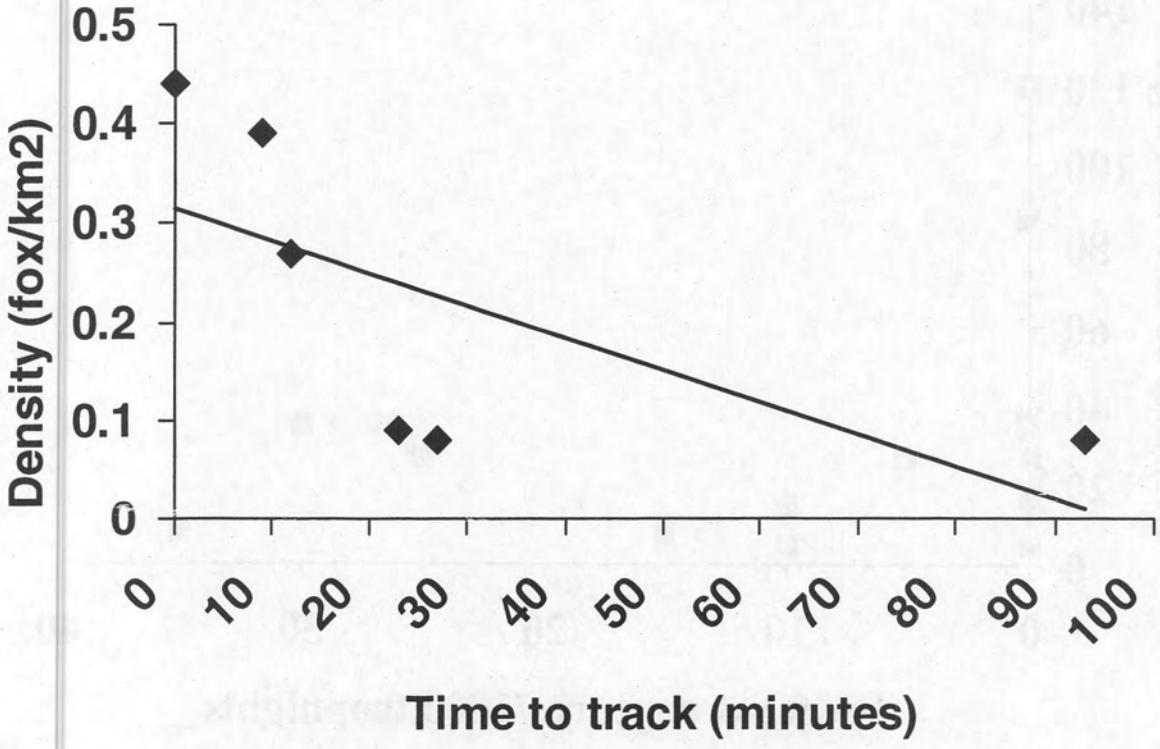
TEXAS COUNTY TRAPPING SITES 2004

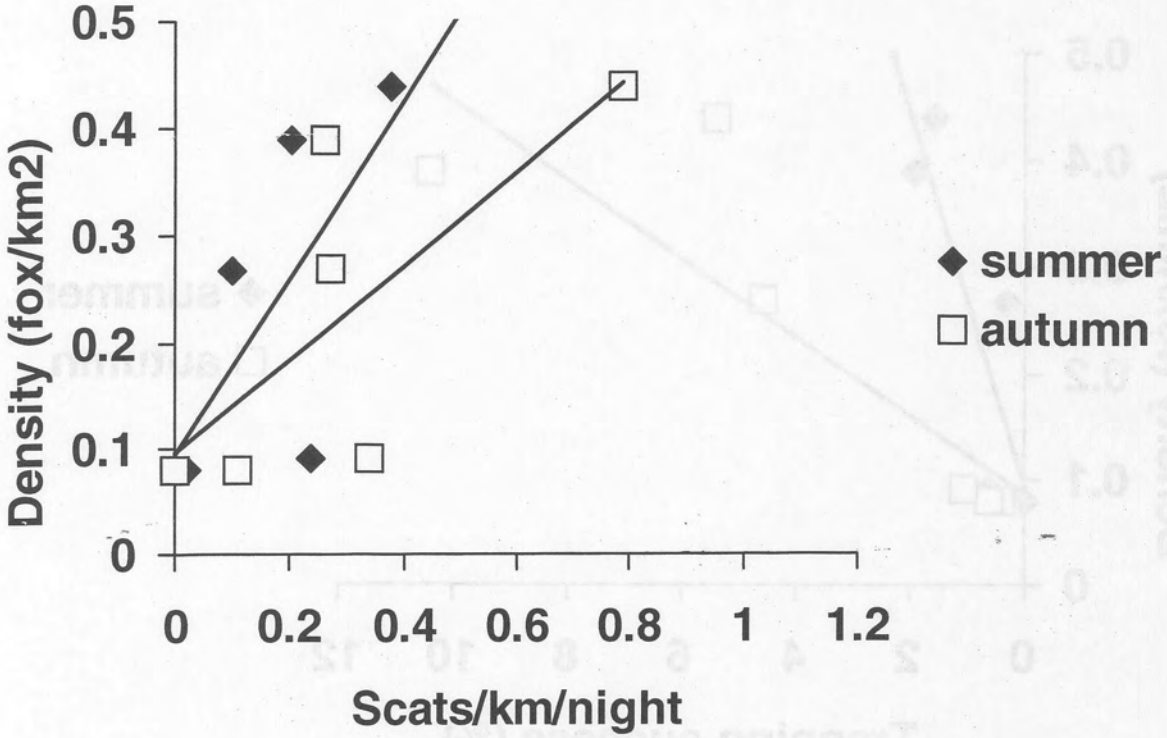


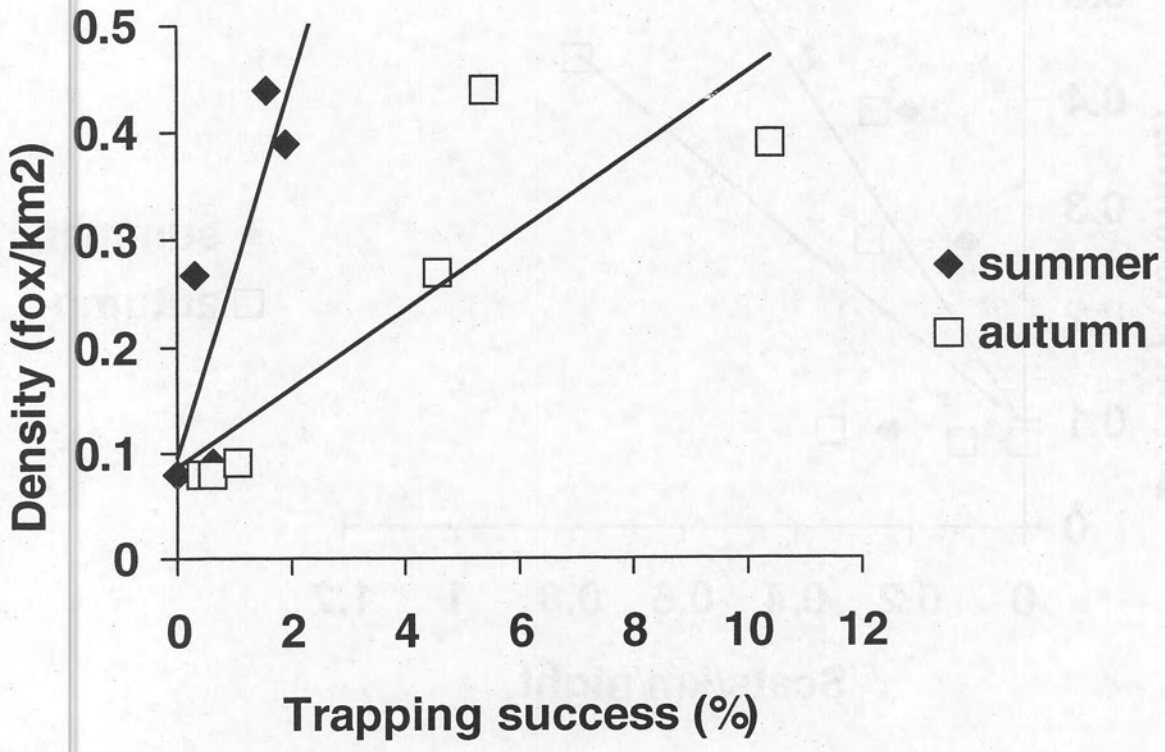
CIMARRON COUNTY TRAPPING SITES 2004




Minutes to first fox sign
140
120
100
80
60
40
20
0
0
10
20
30
40
Swift fox captures/1000 trapnights


0.5
0.4
0.3
0.2
0.1
0
Density (fox/km2)
0
10
20
30
40
50
60
70
80
90
100
Time to track (minutes)


0.5
0.4
0.3
0.2
0.1
0
Density (fox/km2)
0
0.2
0.4
0.6
0.8
1
1.2
Scats/km/night
summer
autumn


0.5
0.4
0.3
0.2
0.1
0
Density (fox/km2)
0
2
4
6
8
10
12
Trapping success (%)
summer
autumn

APPENDIX B

FINAL REPORT

State: Oklahoma **Grant Number**: T-4-P

Grant Program: State Wildlife Grants

Grant Name: Population status of the Mountain Plover and Long-billed Curlew in the Oklahoma Panhandle

Grant Period: 1 January 2004 –31 December 2007

A. Abstract:

This Final Report includes (1) a brief summary that highlights the research protocol, major results, and management recommendations from this study and (2) an Appendix that provides a complete account of the research in the form of a M.S. Thesis by Scott McConnell, titled "Habitat associations, ranges, and population estimates of selected bird species in Cimarron County, Oklahoma." In late spring and summer 2004 and 2005, we surveyed the known breeding habitat of Mountain Plovers in a 10-township area of Cimarron County and estimated that there could be as many as 115–125 Mountain Plovers in the breeding population. We discovered a new breeding area for Mountain Plovers in northwestern Texas County. Long-billed Curlews were both more widespread and more abundant than Mountain Plovers in the Oklahoma Panhandle, occupying most of the land area devoted primarily to crop production in Cimarron and western Texas counties. We obtained a raw count of 344 individual curlews during the 2004 and 2005 surveys. Additional research is needed to clarify if the breeding population of Mountain Plovers in Cimarron County is source or a sink for the overall population. Furthermore, interactions of the newly discovered breeding population of plovers in Texas County with the population in Cimarron County and those in Kansas need to be evaluated.

B. Objectives:

Assess the distributions and habitat affinities of the Mountain Plover and the Long-billed Curlew by systematic searches in Cimarron and Texas counties in the western one-half of the Oklahoma Panhandle, with particular focus on establishing population estimates for the Mountain Plover and distribution of the Long-billed Curlew.

C. Need:

Loss, degradation, and fragmentation of native prairie habitats have contributed to population declines in obligate prairie birds that are "steeper, more consistent, and more geographically widespread" than declines among any other ecological or behavioral group of birds in North America (Knopf 1996). Several of these endemic Great Plains species breed in the Oklahoma Panhandle, especially in Texas and Cimarron counties, and were

represented there as breeding birds during field work for Oklahoma's recent Breeding Bird Atlas (Reinking 2004). Despite the recent atlas work in the Panhandle, details of the specific population sizes, distributions, and habitat affinities of short-grass prairie endemics are not well known.

Due to absolute rarity and suggestive population declines, at least 10 species of prairie obligate birds that occur in western Oklahoma are conservation priorities (Tier I–VI species) for the Oklahoma Department of Wildlife Conservation. Most also are considered regional priorities for conservation in the larger short-grass prairie ecoregion according to the Partners in Flight priority-setting process (Carter et al. 2000). These species include Mountain Plover (*Charadrius montanus*) and Long-billed Curlew (*Numenius americanus*). Both are thought to be declining (Knopf 1996), but statistically significant trends are difficult to demonstrate due to a low density of Breeding Bird Survey routes within their respective ranges (Sauer et al. 2004).

Although a recent petition to list the Mountain Plover as federally threatened was withdrawn (U.S. Fish and Wildlife Service 2003), it remains a conservation concern due to its range-wide rarity (estimated global population size 5,000–11,000 individuals). Cimarron County occupies part of the current eastern breeding range limit for Mountain Plover. Based on some earlier work on this species in Oklahoma (Shackford 1986, Shackford et al. 1999), the basic breeding distribution (10 townships in Cimarron County) and propensity to breed in flat areas dominated by agricultural production were known. Much of this breeding distribution overlaps that of the Long-billed Curlew in Oklahoma.

To better delineate the breeding distribution, habitat affinity, and population size of Mountain Plover and Long-billed Curlew in Oklahoma, we conducted a 2-year survey for these and other prairie endemic birds in the 10 townships of Cimarron County that provided historical breeding records for Mountain Plover. Additional forays to surrounding townships and to western areas of Texas County provided supplementary information.

D. Approach

From May through July in 2004 and 2005, two observers (Scott McConnell and John Shackford) conducted road-based, point-count surveys for Mountain Plovers, Long-billed Curlews, and other prairie obligate species within a 10-township area of Cimarron County that contained the historical breeding distribution of Mountain Plovers in Oklahoma (Shackford 1986). Each township consisted of 36, 1-mile sections resulting in a primary survey area covering 360 square miles (932 km^2). We defined a "section survey" as including four, 10-minute point counts, one each from the midpoint on all four sides of a section. Of the 360 total sections in the 10-township study area, we included only those that provided road access on all four sides. Of those, we randomly selected 60 to survey in 2004 and 78 in 2005 (38% of the study area). No section was surveyed in both 2004 and 2005. We surveyed selected sections twice per season, once within the first 3 hours after local sunrise and once within the last 3 hours before local sunset. Thus, the total sampling effort included 138 (60 in 2004 and 78 in 2005) randomly selected sections that were surveyed twice for 276 total section surveys. The four, 10-minute point counts per section resulted in 1,104 point counts included in the dataset for this study.

Each point count lasted 10 minutes, and individuals were tallied as recorded in the first 3 minutes, the next 2 minutes, or the final 5 minutes. To increase the probability of detecting Mountain Plovers, we played a 1-minute recording of Mountain Plover calls from the 7th to the 8th minute of the survey time, and left the final 2 minutes of the survey for more passive listening and observing.

Due to the logistical difficulties of obtaining access permission from dozens of private landowners in the study, we elected to conduct stationary, roadside point counts from the mid-point of the road on each of the four sides of surveyed sections. The count area was a semicircle with a radius of 400 m from the road into the surveyed section. Four such counts per section summed to approximately 100 ha surveyed per section. We marked the location of each Mountain Plover observed on a cover type sketch of the area surveyed for each point count.

Because the estimated number of individuals in an area is a function of the number observed and the probability of detection (e.g., Thompson 2002; Rosenstock et. al 2002), we applied post-hoc analysis to raw numbers obtained from the field to modify our counts by individual detection rates between our two observers. We used a count removal method to estimate probability of detection based on the number of individuals detected in different time bands of timed counts (Farnsworth et al. 2002).

Following randomized surveys in the 10-township study area, we conducted forays into potentially appropriate Mountain Plover habitat elsewhere in Cimarron County and in western Texas County, east to approximately Guymon.

To describe habitat affinities, we analyzed habitat use at a fine scale, i.e., based on field-drawn habitat sketches of survey areas. We also examined habitat use at a broader scale by downloading locations of plovers and curlews into a GIS with land use, a digital elevation model, and soil maps, among other layers. For expanded descriptions of methods used in this study see Appendix D.

E. Results and Discussion

Systematic, random section surveys for Mountain Plovers provided an average of 22.67 (± 1.53 S.D.) individuals per round (i.e., on all sections surveyed in 2004 and 2005). By accounting for detection probabilities and extrapolating to the probability of occupancy of suitable habitat within the 10 survey townships, we estimated that there could be as many as 115–125 Mountain Plovers comprising the breeding population in the survey area. Detailed descriptions of the analytical approach are given in Chapter IV of Appendix D, titled "A habitat model and population estimate for Mountain Plovers in Oklahoma."

We also found some plovers outside of the 10-township survey area. Most were in proximity to the primary survey area (e.g., on adjacent sections in different townships) and were clearly part of the same occurrence of Mountain Plovers in Cimarron County. Our forays into western Texas County also yielded some plover observations and confirmed a new county breeding record (McConnell et al. 2005). We found five pairs in northwestern Texas County in 2004 and at least 14 individuals in the same area in 2005. Combining the results of randomized surveys in the 10-township study area with plovers encountered during

forays elsewhere in the Panhandle resulted in a statewide minimum of approximately 55 individuals (unextrapolated and unadjusted by detection probability), and an estimated maximum (adjusted by detection probability and extrapolated to a proportion of similar habitats) of 185 Mountain Plovers. Perhaps more informative than the absolute estimate, however, is the evidence of two discrete breeding locations, one larger in central Cimarron County and one smaller in northwestern Texas County.

Analysis of habitat affinity based on field sketch maps and GIS data indicated that Mountain Plovers in Oklahoma occurred disproportionately on bare, plowed fields compared with native short-grass prairies (with or without prairie dog towns). More than 90% of the plover locations in the primary study area were in bare fields at < 2% slope underlain by Sherm clay loam soils. In Texas County, Mountain Plovers also occurred on bare, flat fields in a related soil, Gruver clay loam. We found no Mountain Plovers on otherwise suitable bare, flat fields underlain by the sandier Dalhart fine sandy loam (U.S. Dept. of Agriculture 2005).

Long-billed Curlews were both more widespread and more abundant than Mountain Plovers in the Oklahoma Panhandle, occupying most of the land area devoted primarily to crop production in Cimarron and western Texas counties. Like the plovers, curlews were associated more strongly with the clay loam soil series than with the sandy loams. We obtained a raw count of 344 individuals combining 2004 and 2005 surveys. We observed curlews in at least 23 different cover types, but most frequently in bare fields, fields in which the vegetation had been turned under, and in wheat stubble. Approximately 40% of located curlews were in bare fields. Detailed descriptions of the analytical approach are given in Chapter V of Appendix D, titled "Long-billed Curlew breeding range and habitat associations in Cimarron County, Oklahoma."

We offer the following management recommendations:

1. Both Mountain Plover and Long-billed Curlew occur disproportionately in bare, flat fields of the western Panhandle that are devoted almost entirely to irrigated production agriculture, primarily for wheat. The propensity of these species to use crop fields for nesting can create the impression that appropriate habitat occurs in abundance, because fields occupy more space on the current Panhandle landscape than the historically used short-grass prairie and prairie dog towns. We do not know, however, to what extent these crop fields may be sources or sinks for nesting prairie obligate species. It also is unclear to what extent nesting in crop fields is an unusual situation for Mountain Plovers; breeding plovers rely more on prairie dog towns and other short-grass prairie habitats in the core of their range (e.g., Dinsmore et al. 2003). We recommend a 2–3 year field effort to quantify nest success, survivorship, and site fidelity of Mountain Plovers in Cimarron County. It is important to ascertain if the population of Mountain Plovers in western Oklahoma functions as a source or a sink.

2. Within the Mountain Plover population in Cimarron County, we observed a propensity for individual plovers to occur on Sherm or Gruver clay loam soils. It may be that this association stems from differences in nest success on loamy vs. sandy soils, i.e., sandy

soils rapidly cover eggs as a result of persistent winds in the area. An artificial nest study comparing viability of nests on sandy vs. loamy soils could provide some explanation for patterns of occurrence of Mountain Plovers in Oklahoma.

3. Our research led to the identification of a new breeding occurrence of Mountain Plover in northwestern Texas County, Oklahoma. Additional survey work devoted to this "population" and its potential interaction with breeding Mountain Plovers in Kansas is warranted.

F. Significant Deviations:

Timely completion of Mountain Plover and Long-billed Curlew surveys permitted us to survey nesting raptors in Cimarron County, adding an unexpected component to the this study. These observations are summarized in Chapters II and III of Appendix D. Additionally, Appendix D includes it own detailed appendices that provide summaries of all observations and locations of all non-target avian species encountered during the Mountain Plover and Long-billed Curlew surveys and while conducting searches for raptor nests.

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H. Date 14 February 2007

I. Approved by: John Stafford, Federal Aid Coordinator
Oklahoma Department of Wildlife Conservation

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APPENDIX C

Shortgrass Prairie Region Conservation Assessment and Conservation Strategy

The CWCS Shortgrass Prairie Region - (4,329,695 acres) ecologically known as Southern High Plains and Arkansas Tablelands (Bailey 1995), High Plains and Southwestern Tablelands (Omernik 1987), or Shortgrass High Plains and Pinyon-juniper Mesa with Distribution of *Pinus edulis* (Duck and Fletcher 1943).

- Development of the Southern High Plains Prairie:
  - The North American grasslands began to develop approximately five million years ago under the conditions dictated by a cool, wet climate. However, for the past 12,000 years, these conditions have steadily and progressively shifted to the warmer, drier climate of today.
  - As the mid-continental grassland developed under these more modern mesic conditions, two significant factors contributed to the successful stage of the prairie ecosystem. First, the expanse of grassland sustained large herds of grazing animals with some estimates as high as 50 million bison, 50 million pronghorn, and one billion or more prairie dogs. The prairie community became adapted to periodic grazing, and in some cases, dependent on this type of disturbance. Secondly, grasslands were subjected to periodic burning either by man or by natural causes such as lightning.
  - The High Plains was a shortgrass prairie that had developed under an influence of factors such as grazing by native herbivores, periodic fire, and climatic conditions which were characterized by a small amount of effective precipitation.
  - The climate of this region is characterized by low irregular precipitation, high evaporation rate, low relative humidity, and high average wind velocity. Summers are hot and winters moderate, with a mean annual temperature of 13.2 degrees centigrade. The average annual rainfall is between 43 and 61 centimeters. Normally most of the rainfall occurs in the late spring and summer months. A considerable amount of the moisture falls as sudden torrential rains resulting in heavy run-off. The growing season extends from 180 to 190 days.
  - The Shortgrass Prairie Region is an extensive plain with the gently sloping smooth lying surface interrupted by breaks on the larger stream borders. Geologically, the area consists of an apron of debris deposited from Tertiary times
- Settlement of the Southern High Plains
  - Between 1850 and 1890, what is now the Oklahoma panhandle was referred to as the Public Land Strip. The Public Land Strip was the seasonal home of nomadic plains Native Americans and was controlled by the Comanche from 1850 to 1875. By 1875, the last of the Native American tribes were sent to reservations and the southern buffalo herd had been decimated.
  - With the Comanche and buffalo removed from the Strip, Texas cattlemen moved into the unregulated area, and free-ranging ranches began appearing in the Public Land Strip by 1878. Because potential settlers believed incorrectly the Strip to be Indian Territory, the cattlemen operated without much competition for the land prior to 1885.
  - During 1885, the U.S. Land Office affirmed that the Public Land Strip was not a part of Indian Territory, but belonged instead to the federal public lands subject to squatter's rights. News of this opinion lead to a steady flood of farmers into the Strip. Little serious farming was attempted with most of the Strip's squatters practicing subsistence farming.
  - The Oklahoma Territory's 1890 Organic Act made the Strip part of Oklahoma Territory and brought it homestead rights. During 1890 and 1891 government surveyors partitioned the land into sections and corrected the squatters' self-surveyed quarter-section lines.
- vegetation communities of the shortgrass prairie region
  - shortgrass prairie
  - pinyon pine/juniper woodland or savannah and juniper/pinyon pine woodlands
  - herbaceous wetlandssand sagebrush/bluestem shrublands
  - small rivers
  - elm/cottonwood/willow/hackberry riparian forest linked with predominantly sandy bottom streams
  - mixed-grass prairie
  - sand plum/sumac shrubland

SHORTGRASS PRAIRIE COMMUNITY

Conservation Assessment

- distribution - found mainly in the three panhandle counties and western Harper, western Woodward, and Ellis counties, comprising 3,095,592 acres (Duck and Fletcher 1943).
- description - (Duck and Fletcher 1943)
  - The historical vegetation of this community consisted primarily of buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*), with little bluestem (*Schizachyrium scoparium*, wire grass (*Aristida spp.*), and side-oats grama (*Bouteloua curtipendula*) occurring in some places. Other plants such as scurfy pea (*Psoralea tenuiflora*), partridge pea (*Chamaecrista spp.*), blazing star, (*Liatris squarrosa*) day flower, bush morning glory, and gumweed occurred on more shallow soils. In the playas, smartweed, ironweed, door weed and snow-on-the-mountain (*Euphorbia marginata*) were found. Cultivated fields supported Russian thistle (*Salsola tragus*), common sunflower (*Helianthus annuus*), cocklebur (*Xanthium strumarium*), lamb's quarter (*Chenopodium album*), bindweed (*Convolvulus spp.*), western ragweed (*Ambrosia psilostachya*), and common sandbur (*Cenchrus incertus*). Prickly pear (*Opuntia polyacantha* and cholla (*Opuntia imbricata*) cactus have appeared on some pastureland as a result of close grazing. Today, sandsage (*Artemesia filifolia*) and yucca (*Yucca glauca*) can occur in dense patches. In the extreme eastern edge of the Type, eastern red cedar (*Juniperus virginiana*) encroachment is evident.
  - The vegetation classification for the Shortgrass Prairie Community within the Shortgrass Prairie Region is defined by Hoagland 2000.
    - **V.A.5.N.e. Short sod temperate or subpolar grassland (including sod or mixed sod-bunch graminoids, e.g. shortgrass prairie)** (Hoagland 2000)
      - BOUTELOUA GRACILIS HERBACEOUS ALLIANCE
        - Distribution: extensive far western and the Oklahoma Panhandle
        - *Bouteloua gracilis - bouteloua (curipendula/hirsuta)* herbaceous association
          - habitat: occupies a range of habitats, from coars, shallow soils to loamy or sandy soils
          - associates: *Bouteloua curtipendula, Muhlenbergia torreyi, Ratibida columnifera, Schedonnardus paniculatus, Sitanion hystrix, Sphaeralcea coccinea*
        - ***Bouteloua gracilis - Buchloe dactyloides* herbaceous association**
          - habitat: clay based soils
          - associates: *Ambrosia artemisiifolia, Aristida oligantha, Panicum obtusum, Machaeranthera tanacetifolia, Melampodium leucanthum, Muhlenbergia torreyi, Sporobolus asper, S. cryptandrus, Zinnia grandiflora*
          - **comments: most extensive shortgrass prairie vegetation type**
        - *Bouteloua gracilis - Hilaria jamesii* herbaceous association
          - distribution: northwestern Cimarron Co.
          - habitat: slopes and uplands
          - associates: *Bothriochloa saccharoides, Bouteloua eriopoda, Eriogonum jamesii, Melampodium leucanthum, Opuntia imbricata, Zinnia grandiflora*
        - *Bouteloua gracilis - Gutierrezia sarothrae* herbaceous association
          - distribution: west-central, western, and the Oklahoma panhandle
          - habitat: upland prairies and pastures
          - associates: *Buchloe dactyloides, Hordeum jubatum, Hymenopappus spinulosa, Salsola kali, Schendonnardus paniculatus*
          - **comments: this vegetation type represents degraded grasslands and pastures**
  - The soils are generally fertile, having developed under a grass cover and comparatively low rainfall. Nitrogen content is high and very little leaching has taken place.
- Evaluation and status of shortgrass prairie community
  - Regional Importance
    - 91% of the Shortgrass Prairie Community occurs within the Shortgrass Prairie Region 2,814,257 acres

    - dominant Region for this vegetation Community
  - 65% of the Shortgrass Prairie Region is comprised by the Shortgrass Prairie Community
    - dominant vegetation Community in the shortgrass prairie region
  - species of greatest conservation need
    - Baird's Sparrow
    - Barn Owl
    - Burrowing Owl
    - Cassin's Sparrow
    - Chestnut-collared Longspur
    - Ferruginous Hawk
    - Loggerhead Shrike
    - Long-billed Curlew
    - McCown's Longspur
    - Mountain Plover*
    - Peregrine Falcon
    - Prairie Falcon
    - Sandhill Crane
    - Scaled Quail
    - Short-eared Owl
    - Swainson's Hawk
    - Black-tailed Prairie Dog
    - Desert Shrew
    - Long-tailed Weasel
    - Mountain Lion
    - Swift Fox*
    - Rount-tailed Horned Lizard
    - Texas Gartersnake
    - Texas Horned Lizard
    - Texas Long-nosed Snake
    - Western Massasauga
  - two unique species to SGP community in SGP Region - mountain plover; swift fox
- Risk Assessment
  - Throughout the 19th and 20th centuries, permanent changes in the Shortgrass Prairie Community have taken place. These changes include the conversion of native grasslands to seeded pastures and croplands, urbanization and industrialization, energy exploration and development, intensive livestock grazing, alteration of fire regimes, and proliferation of non-native plant species. How these changes have affected shortgrass prairie wildlife species of greatest conservation need is difficult to determine since much information regarding these species is inadequate and changes may affect different species in different ways. Possible consequences, both positive and negative, of these impacts are presented below.
    - Land Conversion
      * conversion of native grasslands to seeded pastures and croplands - 73.4% of the Shortgrass Prairie Community within the SGP region has been tilled (based on TNC untilled landscape overlay of Duck and Fletcher SGHP Game Type) - 747,399 acres (26.6%) of shortgrass prairie community remain untilled in the SGP region.
      * Until this area was settled there was little cultivation of the land. Settlement began in the 1880s when ranches were established along streams and other sources of water. By the late 1800's farming was beginning to displace large portions of the original Shortgrass Prairie Region's natural prairies. Areas not suitable for farming were used as range for domestic livestock.
      * Most of the farm development took place after 1900 when farmers took homesteads. Early farming attempts, however, were sporadic. The most extensive crop production

in the Region took place just after World War I due to high grain prices. In the years following the Dust Bowl, the use of heavy machinery stimulated large scale farming, resulting in most of the land suitable for cultivation being broken at that time. Wheat and grain sorghums have been the principal crops throughout the entire Region, primarily in the Shortgrass Prairie Vegetation Community

* Wheat was the primary crop grown in the 1920s. The phenomenal crop of 1926 led to farmers purchasing tractors and combines in an effort to realize increasing yields and profits. As a result, farmers planted more dryland wheat. With the rising demand for wheat products, cattle grazing was reduced, and millions more acres were plowed and planted.
  + 1931 saw record wheat yields and profits but led to a market glut.
  + Wheat prices plummeted in July, 1931. Many farmers went broke and abandoned their fields all across the region.
* Drought
  + The existing soil under the shortgrass prairie is fine loess and prone to wind erosion once disturbed by overgrazing by cattle and sheep and then farmed. Among the natural elements, the strong winds of the region were particularly devastating, following the wide-spread damage caused by dry land farming and cattle grazing. Without their root systems in place when the prairie grasslands were plowed under, the wind blew the soil right out of the ground.
  + Between 1930 and 1940, the SGP Region suffered a severe drought. Dust storms were the result of drought and land that had been overused. With the onset of drought in 1930, the over-farmed and over-grazed land began to blow away, resulting in the Dust Bowl (1931-1939).
    - In Oklahoma, the Panhandle area was hit hardest by the drought of the 1930s. By 1934, the Shortgrass Prairie Region had become part of the Dust Bowl. The situation was so serious that, by 1935, the US government developed conservation programs to improve the Dust Bowl by changing the basic farming methods of the region. Because of this drought, farmers adopted new cultivation methods to help control soil erosion in dry land ecosystems.
    - Even with these measures, the Dust Bowl lasted about a decade and contributed to the length of the Great Depression of the 1930s.
  + Fueled by post-war economic stability and technological advancement, the 1950s represented a time of growth and prosperity in the SGP Region. In fewer than 50 years, (1900 - 1950) the complex grassland ecosystem of the Shortgrass Prairie Community within the SGP Region had been replaced with a highly mechanized monocrop agriculture dependent upon non-renewable groundwater (Elizabeth Brooks and Jacque Emel).
    - But during the early to mid-1950s, the SGP Region withstood a five-year drought. The 1950s drought was characterized by both low rainfall amounts and excessively high temperatures.
    - A drought of this magnitude created severe social and economic repercussions in the Region. The drought devastated the region's agriculture. Crop yields in some areas dropped as much as 50%. Excessive temperatures and low rainfall scorched grasslands typically used for grazing. With grass scarce, hay prices became too costly for ranchers.
  + The 1987-89 drought was the first widespread persistent drought since the 1950s. The increased vulnerability during this drought was due in part to farming on marginally arable lands and pumping of ground water to the point of depletion.

        * In recent years center-pivot irrigation has increased the production of corn and soybeans in the Region, primarily in response to the introduction of confined hog feeding operations and increased agricultural subsidies for crop diversification programs.
            + resulting in additional loss of shortgrass prairie to land conversion, and
            + further Shortgrass Prairie Community fragmentation
        * Conservation Reserve Programcurrent CRP grasses are too tall/thick
            • grasses historically have been exotic species (e.g. Old World bluestem)
            • recent native grass mixes encourage mid- to tall-grasses rather than buffalograss and blue gramma (or any gramma grasses)
        * urbanization/industrialization
    ■ Changes in the Shortgrass Prairie Vegetation Community
        * fire suppression
            + responsible for ecologically adverse shifts in the composition, structure and diversity of shortgrass prairie (e.g. increased woody/shrubby)
            + increases rderal species and the invasions by less fire-tolerant species
        * livestock grazing
            + By the early 1900's the original shortgrass prairie community had been heavily impacted by permanent agricultural operations. Species such as mesquite, prickly pear, redberry juniper, and cholla were quick to invade and establish on the disturbed rangeland.
            + In the ranching regions, overgrazing also destroyed large areas of grassland.
            + historically, the topsoil was damaged by the overgrazing of cattle and sheep.
            + fences
    ■ vegetation community loss and fragmentation
        * energy development exploration and extraction
        * center pivot crop irrigation current increase in habitat fragmentation from changes in crops grown from dryland wheat to increasing center pivot irrigated corn which fragments suitable habitat
            + hog farms are increasing the demand for center-pivot grown corn in the Region
- options for conservation
    - Historically, short and mixed grass prairies consisted of a complex pattern of distinct patches of grasses and forbs, created by disturbances. Factors shaping shortgrass prairie landscapes included fire, grazing and climate. The decrease in grassland habitat, due to destruction and/or lack of management, and the decline of wildlife species of greatest conservation need are directly related. Ideally, land management should replicate the timing, intensity, and distribution of natural disturbances that shaped the shortgrass prairie community. Below are several ways in which land managers can establish additional areas of shortgrass prairie and improve the quality of existing wildlife habitats in the shortgrass prairie vegetation community.
        ■ Today, livestock grazing is a major form of disturbance in the shortgrass prairie vegetation community. But domestic livestock grazing does not mimic the intense grazing and trampling by migratory herds of bison, under which the sod-forming perennial shortgrass prairie plant species evolved. Modern grazing tends to spread grazing intensity evenly, producing a comparatively uniform landscape. Managing for shortgrass prairie wildlife species of greatest conservation need requires a mosaic of habitats produced by varying grazing regimes across the landscape.
            * Rotational and other managed grazing patterns can help maintain prairie habitat for shortgrass prairie species of greatest conservation need as well as improve forage for livestock. Season-long grazing and overstocking can diminish habitat quality. These systems are managed by dividing pastures up into several paddocks and then grazing them rotationally or deferring grazing in some areas for a period of time. Because large grassland patches are more attractive to short grassland dependent species of

greatest conservation need, pastures and other grassland parcels should be managed as large units, with 50 ha (125 acres) considered a minimum. To achieve the patch mosaic required to attract certain species of greatest conservation need, some grazing allotments need to be grazed more intensely than others. Maintaining a variety of grazing regimes, including some heavy grazing and some idle pastures, on a rotational schedule, will provide the mosaic of structural conditions across the landscape beneficial to shortgrass prairie wildlife species of greatest conservation need.

    * Allow prairie dog colonies to expand into available unoccupied habitat

- Burning is also an effective tool in grassland management. Fire, however, played a smaller role in the shortgrass prairie than the more lush grassland systems found to the east. When applied properly, fire can control invasive and woody vegetation and cacti, maintain various stages of plant growth, and promote biodiversity and shortgrass prairie health. But shortgrass prairie grasses recover slowly from burning, requiring 2-3 years with normal precipitation for recovery. Managed burns should be conducted rotationally at intervals of five to eight years, allowing approximately 65-75% of grassland, in blocks at least one-half-mile wide, to remain undisturbed annually. Firebreaks should be used to contain fires on prescribed areas. Burning during the growing season, when vegetation is physiologically active, results in a significant declines in buffalograss, grama grasses, and forbs. Therefore, dormant-season burning may be the preferred method for restoring fire in shortgrass prairie ecosystems where fire has been excluded for a prolonged time period. Prescribed burning is a technical process that should be conducted under the direction of wildlife management professionals and in compliance with all state and local regulations.
- Emphasize dryland winter wheat production in crop fields rather than irrigated corn or soybeans.
    * some agriculture lands can benefit some species or at least not be detrimental - for some wildlife species it is the vegetation structure that is important rather than the actual plant species that are growing in an area.
        + plowed dryland winter wheat fields attract mountain plovers looking for nesting areas in Cimarron County
        + swift fox will den in dryland winter wheat field.
- Land Acquisition
- Reducing predation and competition may be necessary for some species of greatest conservation need. But this is difficult to accomplish and the management how-to's are not defined (e.g. how many coyotes to remove per what area size). Predator control for species of greatest conservation need should only be done in conjunction with habitat restoration and enhancement

o research needs
  - current vegetation and land use map
    -
  - baseline population surveys for those species for which this information is missing or incomplete
    - current information
      * swift fox track surveys (1998, 1999, 2000, 2004)
      * black-tailed prairie dog surveys (1989, 1998, 2000, 2002, 2003)
      * RMBO breeding bird survey
      * mountain plover, ferruginous hawk, long-billed curlew T-4 survyes in 2004
      * burrowing owl surveys - 2005, 2006

o literature citation/references

PINYON PINE/JUNIPER WOODLAND OR SAVANNAH AND JUNIPER/PINYON PINE WOODLANDS COMMUNITY

Conservation Asessment

- Distribution - The Pinyon Pine/juniper Woodland or Savannah and Juniper/pinyon Pine Woodlands Community occurs only in northwestern quarter of Cimarron County, comprising 216,225 acres, of which 61,697 acres support true piñon-juniper vegetation.
- Description
  - The Pinyon Pine/juniper Woodland or Savannah and Juniper/pinyon Pine Woodlands Community is characterized by extremely rugged relief resulting from the broad Cimarron River valley and ends abruptly at the base of the mesas. Soil development is at a minimum here except for the valley floor. The mesas, which rise to around 152.4 m above the valley floor, are formed by the Dakota sand stone of the Cretaceous system. Much of the area is state-owned as state school lands, and is leased by fairly large cattle ranching operations. Very little of this Type is in actual cultivation and the principal land use is cattle and sheep grazing. Irrigation, however, has allowed cultivation in the flat portions of the area.
  - This Community is characterized as semi-arid, and drought is regular in the region. The annual average precipitation is 45.5 cm but varies from year to year. The length of the growing season is 179 days, with an average annual temperature of 12.7 degrees centigrade Extremely cold spells occur during winter, however, they are usually of short duration.
  - The principal vegetation of this community is composed of piñon pine (*Pinus edulis*), one seed juniper (*Juniperus monosperma*), thickleaved hackberry (*Celtis reticulata*), cholla cactus, and scrub oak (*Quercus undulata*). In limited areas, ponderosa pine (*Pinus ponderosa*) is found. The grasses found in this Community are typical of the Shortgrass Prairie Vegetation Community, consisting mainly of buffalograss, blue grama, and hairy grama (*Bouteloua hirsuta*), with some tall grass species growing on the slopes in places.
  - The vegetation classification for the Pinyon Pine/juniper Woodland or Savannah and Juniper/pinyon Pine Woodlands Community within the Shortgrass Prairie Region is defined by Hoagland 2000.
    - **II.A.4.N.a. Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (e.g. pine, western juniper)**
      - JUNIPERUS MONOSPERMA WOODLAND ALLIANCE
        - *Juniperus monosperma/Bouteloua curtipendula* woodland association
          - Distribution: northwestern Cimarron County
          - Habitat: talus slopes, rocky and thin soils.
          - Associates: *Bothriochloa saccharoides, Bouteloua hirsuta, B. gracilis, Buchloë dactyloides, Cercocarpus montanus, Opuntia imbricata, Rhus aromatica, Yucca glauca*
        - *Juniperus monosperma - Pinus edulis/Bouteloua curtipendula* woodland association
          - Distribution: northwestern Cimarron County.
          - Habitat: talus slopes, rocky and thin soils.
          - Associates: *Bothriochloa saccharoides, Bouteloua hirsuta, B. gracilis, Buchloë dactyloides, Cercocarpus montanus, Opuntia polycantha, Quercus gambelii, Q. trilobata, Rhus aromatica, Yucca gluauca.*
- Evaluation and status of the Pinyon Pine/juniper Woodland or Savannah and Juniper/pinyon Pine Woodlands Community
  - Regional Importance
    - 5.0% of the Shortgrass Prairie Region is comprised of this Community (215,968 acres)
    - This Community is unique to this region (100% of the community occurs within this Region)
    - nearly 100% is untilled
    - Species of Greatest Conservation Need
      - Cassin's Sparrow
      - Juniper Titmouse
      - Lewis's Woodpecker

        - Loggerhead Shrike
        - Pinyon Jay
        - Prairie Falcon
        - Scaled Quail
        - Swainson's Hawk
        - Colorado Chipmunk
        - Desert Shrew
        - Hog-nosed Skunk
        - Mountain Lion
        - Ringtail
        - Western Big-eared Bat
        - Common Checkered Whiptail
        - Common Lesser Earless Lizard
        - Round-tailed Horned Lizard
        - Texas Horned Lizard
        - Western Diamon-backed Rattlesnake
    - six unique species
        - Colorado Chipmunk
        - Hog-nosed Skunk
        - Lewis's Woodpecker
        - Pinyon Jay
        - Juniper Titmouse
        - Round-tailed Horned Lizard
- Risk Assessment
    - land conversion
        - nearly 100% is untilled, so conversion of the vegetation community to agricultural or urban landscapes is negligible
    - vegetation changes
        - grazing
        - fire suppression
    - wildlife habitat fragmentation
- Conservation Actions
    - consider land acquisition, conservation easements, leases, etc., to conserve especially valuable tracts of this community
        - need to identify valuable areas
        - determine how state school lands could be used to conserve valuable areas in this community
    - encourage and facilitate prescribe fire on private lands
    - incentive programs to encourage landowners to restore and enhance existing habitat through prescribed fire and grazing management

HERBACEOUS WETLANDS COMMUNITY

Conservation Assessment

- Distribution - the majority of the Herbaceous Wetlands Community within the Shortgrass Prairie Region are in the form of playa lakes. Playas are scattered throughout the flat terrain within the Shortgrass Prairie Vegetation Community. Other seasonal wetlands occur in the flood plains of streams and the Beaver and Cimarron rivers in the SGP Region.
- Description
  - Playas are precipitation dominated shallow clay-lined depressions that form small, seasonally wet wetlands. Playa wetlands are small (average 17 acres in size) and are often separated from the next nearest playa by several miles.
    - **V.A.5.N.c Medium-tall sod temperate or subpolar grassland (includes sod or mixed sod-bunch graminoids)**
      - PANICUM OBTUSUM HERBACEOUS ALLIANCE
        - Distribution: central, wester, and Oklahoma panhandle
        - *Panicum obtusum - Buchloe dactyloides* herbaceous association
          - habitat: mesic soils in pastures, prairies, riparian areas, and **playa lakes**
          - associates: *Bouteloua gracilis, Iva axillaris, Pascopyrum smithii, Ratibida tagetes, Schedonnardus paniculatus*
    - **V.A.5.N.i. Intermittently flooded temperature or subpolar grassland (e.g. playa lakes)**
      - PASCOPYRUM SMITHII HERBACEOUS ALLIANCE
        - Distribution: NW OK and the Panhandle
        - *Pascopyrum smithii - Bouteloua gracilis* herbaceous association
          - habitat: wet-moist, well-drained bottomland soils and depressions
          - associates: *Aster subulatus, Buchloe dactyloides, Distichlis spicata, Hordeum jubatum, Polypogon monospeliensis*
        - *Pascopyrum smithii - Buchloe dactyloides (phyla cuneifolia - Oenothera canescens)* herbaceous association
          - distribution: Panhandle
          - habitat: common vegetation type of playa lake basins in rangeland conditions
          - associates: *Ambrosia grayii, Distichlis spicata, Euphorbia marginata, Iva axillaris, Panicum obtusum*
    - **V.A.5.N.j. Temporarily flooded temperate or subpolar grassland**
      - ELEOCHARIS MACROSTACHYA HERBACEOUS ALLIANCE
        - Distribution: W OK and Panhandle
        - *Eleocharis macrostachya - Marsilea vestita* herbaceous association
          - habitat: wet depressions, buffalo wallows, interdunal swales, and **playa lakes**
          - associates: *Ambrosia artemisiifolia, Coreopsis tinctoria, Cyperus sp., Echinochloa crus-galli, Iva ciliata*
    - V.A.5.N.l. **Semipermanently flooded temperate or subpolar grassland**
      - SCIRPUS AMERICANUS HERBACEOUS ALLIANCE
        - Distribution: greatest extent in W. OK and Panhandle
        - *Scirpus americanus - Eleocharis* sp. herbaceous association
          - habitat: floodplains, backswamp, and lake margins
          - associates: *Aster subulatus, Distichlis spicata, Eleocharis macrostachya, E. montevidensis, Juncus torreyi, Polypogon monospeliensis, Scirpus paludosus*
      - SCIRPUS TABERNAEMONTANI HERBACEOUS ALLIANCE
        - Distribution: less common in the Panhandle
        - *Scirpus tabernaemontani - Eleocharis (montevidensis, tenuis)* herbaceous association
          - Habitat: floodplains, backswamp, interdunal swales, and lake margins
          - associates: *Cephalanthus occidentalis, Eleocharis acuminata, Scirpus americanus, Salix nigra, Typha domingensis, T. latifolia*
- Evaluation and status of Herbaceous Wetland community

- Regional Importance
  - 37% (673 out of 1818 Oklahoma playas) occur in the Shortgrass Prairie Region (PLJV probable playa shapefile).
  - 49% of the total area occupied by Oklahoma probable playas occurs in the Shortgrass Prairie Region
  - 0.1% of the Shortgrass Prairie Region is comprised of playas
  - 6% (47)of the Shortgrass Prairie Region playas are untilled (TNC untilled landscapes).
  - Species of Greatest Conservation Need
    - American Golden Plover
    - American Woodcock
    - Baird's Sparrow
    - Bald Eagle
    - Barn Owl
    - Black Rail
    - Buff-breasted Sandpiper
    - Canvasback
    - Hudsonian Godwit
    - Interior Least Tern
    - LeConte's Sparrow
    - Lesser Scaup
    - Little Blue Heron
    - Long-billed Curlew
    - Northern Pintail
    - Piping Plover
    - Prairie Falcon
    - Sandhill Crane
    - Short-eared Owl
    - Solitary Sandpiper
    - Trumpeter Swan
    - Upland Sandpiper
    - Whooping Crane
    - Wilson's Phalarope
    - Yellow Rail
    - Spiny Softshell Turtle
  - No unique species
- Risk Assessment
  - The permanent changes that occurred throughout the Shortgrass Prairie Community throughout the 19th and 20th centuries also affected the playa wetlands that are widespread throughout this Community. These changes include the conversion of playas to croplands, intensive livestock grazing, and proliferation of non-native plant species. Flood plain wetlands in the SGP region have also been affected by cropland land conversion and livestock grazing, resulting in increased sedimentation. How these changes have affected playa wetland and flood plain herbaceous wetland species of greatest conservation need has not been fully ascertained. Possible consequences, both positive and negative, of these impacts are presented below.
    - Land Conversion
      - draining or filling playas for cropland development
    - Changes in vegetation community
      - playas
        - deepening playas to increase permanence of water for cattle watering
        - agricultural crop irrigation
          - lowering the water table
          - disruption of normal hydrological cycle

        + adjacent cropland
            • sedimentation
        + other?
    * flood plain wetlands
        + fire suppression
            • increases invasive species (e.g. salt cedar)
        + grazing
            • heavy grazing increases invasive species (e.g. salt cedar)
        + flood irrigation for cropland
            • can create this vegetation community as well as alter it negatively
    ■ species habitat fragmentation

o Options for Conservation

- playa protection
    ■ land acquisition or long-term conservation easements for especially valuable playas
        * use WRP
            + NRCS & landowner partners
    ■ fencing existing playas to keep cattle out
    ■ no new tilling of existing playas
- playa restoration - from plowed or overgrazed, or those that have been deepened to allow for livestock watering.
    ■ use WRP
        * NRCS & landowner partners
    ■ tax or financial incentives for to help landowners cover the cost of restoration and maintenance of playas
    ■ legislation to designate pumping for playas as a beneficial use of groundwater
- flood plain restoration
    ■ riparian buffer zones
        * grazing - riparian bank erosion
        * cropland sedimentation stormwater runoff
        * riparian salt cedar removal
        * restore to grassland riparian versus forested riparian

SAND SAGEBRUSH/BLUESTEM SHRUBLAND COMMUNITY

Conservation Assessment

- Distribution - found in scattered locations across most of the Shortgrass Prairie Region. Most common in the eastern third of the Region. Restricted to sites with deep sandy soils and stabilized dunes, primarily in the vicinity of the Beaver/North Canadian and Cimarron rivers.
- Description - (Duck and Fletcher 1943)
  - The Community is characterized by a rolling to dune-like relief. Although some areas are level enough for cultivation. Surface drainage is not well developed due to the porous nature of the soil. The soils supporting the Community's vegetation are for the most part, developed from Quarternary parent material which is found overlying the Permian red beds.
  - Includes all the sandy grasslands on which sand sage, *Artemisia filifolia,* forms an important part of the ground cover. The characteristic plant species include representatives of the short grass species on the tighter soils and weedy annuals in fallow fields.
  - The vegetation classification for sand sagebrush/bluestem shrubland community within the Shortgrass Prairie Region is defined by Hoagland 2000.
    - **III.A.4.N.a. Microphyllous evergreen shrubland (e.g. sagebrush)**
      - ARTEMISIA FILIFOLIA SHRUBLAND ALLIANCE
        - *Artemisia filifolia/Sporobolus cryptandrus - Schizachyrium scoparium* Association
          - Distribution - throughout western Oklahoma, including the Panhandle
          - Habitat - Sandy soils and stabilized dunes
          - Associates - *Andropogon hallii, Bouteloua curipendula, B. gracilis, Calamouilfa gigantea, Prunus angustifolia, Calylophus serrolatus, Cyperus schweinitzii, Eriogonum anuum, Rhus aromatica.*
- Evaluation and status of Sand Sagebrush/Bluestem Shrubland Community
  - Regional Importance
    - 49% of the Sand Sagebrush/Bluestem Shrubland Community occurs within Shortgrass Prairie Region, 906,147 acres
      - second most dominant Region for this Community
    - 20.9% of the Shortgrass Prairie Region is comprised by the Sand Sagebrush/Bluestem Shrubland Community
      - fourth dominant vegetation community in the Shortgrass Prairie Region.
    - Species of greatest conservation need
      - Barn Owl
      - Bell's Vireo
      - Burrowing Owl
      - Cassin's Sparrow
      - Ferruginous Hawk
      - Harris's Sparrow
      - Lesser Prairie Chicken
      - Loggerhead Shrike
      - Northern Bobwhite
      - Painted Bunting
      - Red-headed Woodpecker
      - Scaled Quail
      - Swainson's Hawk
      - Black-tailed Prairie Dog
      - Western Big-eared Bat
      - Common Lesser Earless Lizard
      - Texas Gartersnake
      - Texas Horned Lizard
      - Texas Long-nosed Snake
      - Western Massasauga

- one unique species to this Community within this Region
    - Common Lesser Earless Lizard
- Risk Assessment
    - Land Conversion
        - 596,030 acres of this Community remain untilled in the SGP region (65.9%)
        - cultivation is largely wheat and grain sorghums
    - grazing
        - cattle are grazed over the remainder of the Community that is not in cultivation
- Options for Conservation

SMALL RIVERS AND SLOUGHS/PONDS COMMUNITY

Conservation Assessment

- Distribution - The Cimarron and Beaver rivers.
- Description -
- Evaluation and status of Small Rivers and Sloughs/Ponds Community
  - Regional Importance
    - 10% of the Small Rivers and Sloughs/Ponds Community occurs within the SGP Region (336 miles)
    - Species of greatest conservation need
      - Bald Eagle
      - Canvasback
      - Interior Least Tern
      - Lesser Scaup
      - Little Blue Heron
      - Mountain Plover
      - Northern Bobwhite
      - Northern Pintail
      - Peregrine Falcon
      - Sandhill Crane
      - Snowy Plover
      - Solitary Sandpiper
      - Trumpeter Swan
      - Whooping Crane
      - Arkansas Darter
      - Arkansas River Shiner
      - Arkansas River Speckled Chub
      - Flathead Chub
      - Plains Minnow
      - Red River Shiner
      - Brazilian Free-tailed Bat
      - Western Big-eared Bat
      - Spiny Softshell Turtle
    - no unique species
  - Risk Assessment
  - Options for Conservation

SANDY-BOTTOM STREAMS AND ASSOCIATED RIPARIAN FOREST COMMUNITY

Conservation Assessment

- Distribution - only a small number of streams are found in this Region
- Description
  - most streams in this Region have a sandy or silty substrate except for a few locations in the Black Mesa area where streams may have a rocky or gravel substrate.
  - many streams are not perennial and water may cease to flow above ground during the driest periods of the summer.
  - many stream channels are lined with semi-aquatic vegetation such as cattails (*Typha angustifolia*), three-square bulrush (*Schoenoplectus pungens*), and spikerushes (*Eleocharis sp.*). The riparian areas along these streams are often woodlands dominated by eastern cottonwood (*Populus deltoides*), sandbar willow (*Salix exigua*), peachleaf willow (*S. Amygdaloides*), and sand plum (*Prunus angustifolia*). Herbaceous plands include switchgrass (*Panicum virgatum*), sweetscent (*Pluchea ordorata*) and germander (*Teucrium canadense*).
  - The vegetation classification for sand sagebrush/bluestem shrubland community within the Shortgrass Prairie Region is defined by Hoagland 2000.
    - II.B.2.N.b. Temporarily flooded cold-deciduous woodland
      - POPULUS DELTOIDES WOODLAND ALLIANCE
        - Distribution: localized on sandbars and streambanks in western Oklahoma.
        - *Populus deltoides - Salix exigua* woodland association
          - habitat: moist to wet soils in riparian corridors
          - associates: *Acer negundo*, *Chasmanthium latifolium*, *Teucrium canadense*, *Toxicodendron radicans*.
    - III.A.4.N.c. Temporarily flooded microphyllous shrubland
      - TAMARIX CHINENSIS SHRUBLAND ALLIANCE
        - Distribution: western Oklahoma and the Panhandle
        - *Tamarix chinensis* shrubland association
          - habitat: common along streams and margins of lakes and reservoirs
          - Associates: *Aster subulatus*, *Baccharis salicina*, *Distichlis spicata*, *Panicum virgatum*, *Populus deltoides*, *Salix exigua*.
          - Comments: *Tamarix chinensis* was introduced to North America from eastern Asia. It was used as an ornamental and for shelterbelt plant. It subsequently escaped from cultivation and is now considered a noxious weed in riparian areas.
    - III.B.2.N.d. Temporarily flooded cold-deciduous shrubland
      - SALIX EXIGUA SHRUBLAND ALLIANCE
        - Distribution: western Oklahoma along the Arkansas River
        - *Salix exigua / Panicum virgatum* shrubland association
          - habitat: occurs along the margin of streams and lakes
          - Associates: *Cephalanthus occidentalis*, *Eupatorium serotinum*, *Panicum virgatum*, *Parthenocissus quinquefolia*, *Pluchea odorata*, *Tamarix chinensis*, *Titis acerifolia*, *Salix amygdaloides* is a common associate in the Oklahoma Panhandle.
- Evaluation and status of the Sandy-bottom Streams and Associated Riparian Forest Community
  - Regional Importance
    - 28% of the Sandy-bottom Streams and Associated Riparian Forest Community occurs within the Shortgrass Prairie Region (243,135 acres)
    - 5.6% of the Shortgrass Prairie Region is comprised by the Sandy-bottom Streams and Associated Riparian Forest Community
    - species of greatest conservation need
      - Bald Eagle
      - Barn Owl
      - Bell's Vireo

- Bullock's Oriole
- Interior Least Tern
- Lesser Scaup
- Little Blue Heron
- Loggerhead Shrike
- Northern Bobwhite
- Northern Pintail
- Painted Bunting
- Peregrine Falcon
- Red-headed Woodpecker
- Sandhill Crane
- Arkansas Darter
- Plains Minnow
- Red River Shiner
- Brazilian Free-tailed Bat
- Long-tailed Weasel
- Mountain Lion
- Western Big-eared Bat
- Spiny Softshell Turtle
- Western Massasauga

- no unique species

- Risk Assessment
  - Land Conversion
    - 218,474 acres untilled in SGP region (89.9%) based on TNC Untilled Landscape
- Options For Conservation

MIXED-GRASS PRAIRIE COMMUNITY

Conservation Assessment

- Distribution
- Description - (Duck and Fletcher, 1943)
  - mixture a both tall and short grass species characterizes the original vegetation pattern with variation in the composition on the western and eastern edges where this community merges into the other two associated grassland communities.
  - vegetational composition is composed for the most part of short grass species, buffalo grass and blue gramma with side oats gramma abundant in places. Little bluestem, where moisture is sufficient and grazing not excessive, is an important species in the community.
  - The vegetation classification for the Shortgrass Prairie Community within the Shortgrass Prairie Region is defined by Hoagland 2000.
    - **V.A.5.N.c Medium-tall sod temperate or subpolar grassland (includes sod or mixed sod-bunch graminoids)**
      - BOTHRIOCHLOA SACCHAROIDES HERBACEOUS ALLIANCE
        - Distribution: central, western, and Oklahoma Panhandle
        - *Bothriochloa saccaroides* herbaceous association
          - habitat: upland prairies and pastures
          - associates: *Amphiachyris dracunculoides, Aristidda oligantha, Bouteluoa curtipendula, Helenium amarum, Hordeum jubatum*
          - comments: although the presence of *B. saccharoides* herbaceous vegetation often indicates disturbance, it also occurs on claypan or shallow soils
      - SCHIZACHYRIUM SCOPARIUM - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE
        - Distribution: common in central, western, and Oklahoma Panhandle
        - *Schizachyrium scoparium - Bouteloua curtipendula - Bouteloua gracilis* herbaceous association
          - habitat: well drained soils and rocky slopes
          - associates: *Andropogon gerardii, Aster ericoides, Helianthus hirsutus, Lesquerella ovalifolia, Sorghastrum nutans, Sporobolus asper*
    - **V.A.5.N.d. Medium-tall bunch temperate or subpolar grassland**
      - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE
        - Distribution: Panhandle and western Oklahoma
        - *Bouteloua curtipendula - Bouteloua gracilis - Buchloe dactyloides* herbaceous association
          - habitat: well drained soils and rocky slopes
          - associates: *Bouteloua hirsuta, Opuntia humifusa, O. imbricata* (in Cimarron Co.), *Schizachyrium scoparium, Yucca glauca*
- Evaluation and Status of Mixed-grass Prairie Community
  - Regional Importance
    - 2.6% of the Mixed-grass Prairie Community occurs within the Shortgrass Prairie Region (134,709 acres)
    - 3.1% of Shortgrass Prairie Region is comprised by the Mixed-grass Prairie Community
    - species of greatest conservation need
      - American Golden Plover
      - Baird's Sparrow
      - Barn Owl
      - Buff-breasted Sandpiper
      - Burrowing Owl
      - Cassin's Sparrow
      - Chestnut-collared Longspur
      - Ferruginous Hawk

- Harris's Sparrow
- LeConte's Sparrow
- Lesser Prairie Chicken
- Loggerhead Shrike
- McCown's Longspur
- Northern Bobwhite
- Peregrine Falcon
- Prairie Falcon
- Red-headed Woodpecker
- Sandhill Crane
- Scaled Quail
- Short-eared Owl
- Smith's Longspur
- Sprague's Pipit
- Swainson's Hawk
- Upland Sandpiper
- Whooping Crane
- Black-tailed Prairie Dog
- Brazilian Free-tailed Bat
- Desert Shrew
- Long-tailed Weasel
- Texas Gartersnake
- Texas Horned Lizard
- Texas Long-nosed Snake
- Western Massasauga

- no unique species

- Risk Assessment
  - Land Conversion
    - 26,593 acres untilled in SGP region (19.7%) based on TNC Untilled Landscape
- Options for Conservation

SAND PLUM/SUMAC SHRUBLAND COMMUNITY

Conservation Assessment

- Distribution
- Description
  - The vegetation classification for sand sagebrush/bluestem shrubland community within the Shortgrass Prairie Region is defined by Hoagland 2000.
    - III.A.4.N.a. Microphyllous evergreen shrubland
      - ARTEMISIA FILIFOLIA SHRUBLAND ALLIANCE
        - Distribution: throughout western Oklahoma, including the Panhandle
        - *Artemisia filifolia / Sporobulus cryptandrus - Schizachyrium scoparium*
          - habitat: sandy soils and stabilized dunes
          - Associates: *Andropogon hallii, Bouteloua curtipendula, B. gracilis, Calamovilfa gigantea, Prunus angustifolia, Calytophus serrulatus, Cyperus schweinitzii, Eriogonum annuum, Rhus aromatica.*
    - III.B.2.N.a. Temperate cold-decidous shrubland
      - PRUNUS ANGUSTIFOLIA SHRUBLAND ALLIANCE
        - Distribution: central and western Oklahoma, including Beaver County.
        - *Prunus angustifolia / Schizachyrium scoparium* shrubland association
          - habitat: sand dunes, old fields and disturbed areas. Often abundant in pastures where *Artemisia filifolia* has been removed.
          - Associates: *Andopogon hallii, Bouteloua curipendula, Gaillardia pulchellum, Prunus gracilis, Rhus aromatica.*
- Evaluation and Status of this Community
  - Regional Importance
    - only 1.2% of this habitat Type occurs in this Region
    - 0.2% of this Region is comprised of this Type (9,300 acres)
    - Species of greatest conservation need
      - Barn Owl
      - Bell's Vireo
      - Black-capped Vireo
      - Cassin's Sparrow
      - Harris's Sparrow
      - Kentucky Warbler
      - Lesser Prairie Chicken
      - Loggerhead Shrike
      - Northern Bobwhite
      - Painted Bunting
      - Prairie Warbler
      - Red-headed Woodpecker
      - Scaled Quail
      - Short-eared Owl
      - Brazilian Free-tailed Bat
      - Eastern Spotted Skunk
      - Mountain Lion
      - Western Big-eared Bat
      - Common Lesser Earless Lizard
      - Texas Gartersnake
      - Texas Horned Lizard
      - Texas Long-nosed Snake
      - Western Diamond-backed Rattlesnake
      - Western Massasauga

- Risk Assessment
  - 100% of the 9,300 acres of this habitat Type in this Region are untilled based on TNC untilled landscape
- Options for Conservation

SPRINGS COMMUNITY

Conservation Assessment

- Distribution - only a small number of springs and seeps are found in this region. Most are found in the area around Black Mesa or in proximity to streams. The most biologically significant springs occur in the Cimarron River watershed.
- Description
  - the ground around springs and seeps is often vegetated with herbaceous wetland plants such as three-square bulrush, spikerushes and cattails.
- Evaluation and status of springs community
  - Regional Importance
    - relative to springs community as a whole
    - relative to other communities within the Shortgrass Prairie Region
    - species of greatest conservation need
      - Arkansas Darter
      - Western Big-eared Bat
  - Risk Assessment
  - Options for Conservation

Appendix D

M.S. Thesis by Scott McConnell
Habitat associations, ranges, and population estimates of selected bird species in Cimarron County, Oklahoma

HABITAT ASSOCIATIONS, RANGES, AND POPULATION ESTIMATES OF SELECTED BIRD SPECIES IN CIMARRON COUNTY, OKLAHOMA

By

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POPULATION ESTIMATE AND HABITAT

AFFINITIES OF SELECTED BIRD SPECIES IN

CIMARRON COUNTY, OKLAHOMA

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The people of Cimarron County were friendly, courteous, and always interested in our work. Several ranchers in Cimarron County graciously granted us permission to access their lands and conduct bird searches. The Nolan and LeAnne Ottinger family in Boise City rented a house to John Shackford and I for our second field season, and we are grateful to them for their hospitality and for treating us like part of their family.

Many years ago, the late Charles M. "Cholly" Wonderly took an antsy, garrulous 8-year old boy under his wing and, as he did with countless others, nurtured a sense of wonder about all things natural.

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CHAPTER 1: INTRODUCTION AND OBJECTIVES

INTRODUCTION

Grassland bird abundance has declined steeply in North America (Knopf 1994; Vickery et al. 1999). The principle agents driving the decline of native grassland birds are changes in the historic grazing community, introduction of cereal grains and exotic grasses, wetland drainage, and encroachment of woody vegetation (Knopf 1994). The tallgrass prairie has been almost entirely eliminated; estimates range from 82–99% habitat lost since European settlement (Samson and Knopf 1994). The more western and arid shortgrass prairie has not been affected to the same extent but has seen changes in agricultural practices in the past 35 years that have negatively affected grassland birds (Knopf 1994; Knopf 1996). Analysis of North American Breeding Bird Survey (BBS) data indicates that 13 species of grassland birds have declined significantly between 1966 and 1996 (Peterjohn and Sauer 1999). Knopf (1994) noted that many of those species both breed and winter in North America, so that reasons for their decline are confined to that region.

Several declining grassland bird species breed in Oklahoma. Two of them, the Mountain Plover (*Charadrius montanus*) and the Long-billed Curlew (*Numenius americanus*), approach the eastern limits of their breeding range in the western part of the Oklahoma Panhandle. Burrowing Owls (*Athene cunicularia*), Ferruginous Hawks (*Buteo regalis*), and Swainson's Hawks (*Buteo swainsoni*), also considered declining, breed

throughout the Oklahoma Panhandle (Reinking 2004). The Long-billed Curlew and Ferruginous Hawk are listed as a Category 1 Species (especially vulnerable to extirpation) by the Oklahoma Department of Wildlife Conservation (ODWC); the Burrowing Owl and Swainson's Hawk are both Category 2 Species (possibly threatened with extirpation). None have federal status under the Endangered Species Act (ESA); however, all are protected under the North American Migratory Bird Treaty Act.

The Mountain Plover is listed as a Category 1 Species by the ODWC and as a Highly Imperiled Species by the United States Fish and Wildlife's (USFWS) U. S. Shorebird Conservation Plan (U.S. Shorebird Conservation Plan 2004). It was a candidate for listing under the Endangered Species Act; however, in September 2003, despite unanimous recommendations from five independent reviewers, the USFWS declined to list the Mountain Plover (USFWS 2003), maintaining that threats to the species and its habitat do not threaten it with extinction in the foreseeable future.

The population status of many Oklahoma breeding birds is poorly known, and at least 10 species that predominantly occur in western Oklahoma are of concern relative to their conservation status. Basic information on distributions, habitat affinities, and population sizes is lacking for the five species mentioned above. Mountain Plovers are sparsely distributed throughout their range, making population estimation difficult. Breeding Bird Survey routes are not evenly distributed across their breeding range (Knopf 1996); in Oklahoma, they are found on only one BBS route (Sauer et al. 2004). Previous studies in Oklahoma (e.g. Shackford 1986; Shackford and Leslie 2000) have investigated various aspects of the plover's breeding biology but have not provided a population estimate for Oklahoma.

STUDY AREA

I conducted this study in Cimarron County, Oklahoma, which was wholly contained within the Shortgrass Prairie Bird Conservation Region (Rich et al. 2004) and the Western Short Grasslands Ecoregion (Ricketts et al. 1999). Cimarron County occupies 4,769 km^2 and is 1,090–1,518 m in elevation, increasing from east to west. Most of the land area is flat, but the northwest portion of the county is dominated by mesas, including Black Mesa, the highest point in the state. From 1971–2000, average annual precipitation in the Boise City area was 47 cm (NOAA 2002).

In 2002, 96% of Cimarron County was farmland: cropland 40% and grazing land (almost entirely for cattle) 56%. Crops and area harvested in 2002 were: sorghum, 236 km^2; winter wheat, 228 km^2; corn, 88 km^2; and forage (hay, etc.), 65 km^2 (USDA 2004). Many of the agricultural sections have pivot irrigation systems drawing on the Oglala Aquifer. In 2004, Cimarron County had 641 km^2 enrolled in the Conservation Reserve Program (CRP; P. Toon, USDA, in litt. 2004).

Historically, the Western Short Grasslands were characterized by buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*) prairie; pastures dominated by these grasses persist in Cimarron County (Ricketts et al. 1999). On well-drained soils, sandsage (*Artemisia filifolia*) can become abundant and plains yucca (*Yucca glauca*) is conspicuous (Tyrl et al. 2002).

Trees are rare except along rivers and around human settlements. The Cimarron River cuts through the northern one-half of the county, while the Beaver River bisects the southern one-half. Cottonwood (*Populus deltoides*) groves and dense stands of salt cedar (*Tamarix gallica*) occur in riparian areas. In agricultural areas of Cimarron County, trees,

mostly Siberian elms (*Ulmus pumilla*), have been planted as windbreaks around homesteads.

OBJECTIVES

1) Estimate the Mountain Plover breeding population in Oklahoma and describe breeding range habitat characteristics e.g. elevation, soils, and topography.

2) Describe and compare nest site characteristics, including land use, elevation, and topography, for Swainson's, Red-tailed, and Ferruginous Hawks breeding in Cimarron County.

3) Define the breeding range for Long-billed Curlews in Oklahoma and describe breeding range habitat characteristics.

4) Create distribution maps for selected species in Cimarron County.

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CHAPTER 2: LAND COVER ASSOCIATIONS OF BREEDING HABITAT FOR THREE SYMPATRIC *BUTEO*S IN SHORTGRASS PRAIRIE

INTRODUCTION

In the U.S. Southern Plains, Red-tailed (*Buteo jamaicensis*), Swainson's (*B. swainsoni*), and Ferruginous (*B. regalis*) hawks breed sympatrically in shortgrass prairie habitats. In Oklahoma, the Red-tailed Hawk is a widely distributed and common breeder (Reinking 2004). Ferruginous and Swainson's hawks are more restricted in their breeding range in Oklahoma, with Swainson's Hawks largely confined to the western half of the state and Ferruginous Hawks found mostly in Texas and Cimarron counties in the Panhandle (Reinking 2004). Because these three congeners seek elevated nest sites and are diurnal hunters of small mammals, (Bechard and Schmutz 1995; England et al. 1997; Preston and Beane 1993), they can potentially compete for breeding territories.

Most published studies concerning habitat affinities of sympatric Red-tailed, Swainson's and Ferruginous hawks have been conducted in western North America. Cottrell (1981; Oregon), Bechard et al. (1990; Washington), and Schmutz et al. (1980; Alberta) all concluded that sympatrically breeding Red-tailed, Ferruginous, and Swainson's hawks coexisted by partitioning habitat, not prey. Relationships in the Southern Plains have received comparatively less attention, but Giovanni (2004) found high dietary breadth overlap between Swainson's and Ferruginous hawks in southern Cimarron County, Oklahoma and two adjacent counties in Texas (Dallam) and New Mexico (Union).

Pianka (1974) warned against the assumption that niche overlap indicates competition; abundant resources and/or niche modification could render competition irrelevant. Jaksic and Braker (1983) concluded that, in general, diurnal raptors do not adjust their diets in the face of competition, but rather partition their habitat use via agonistic encounters. This suggestion was supported by field observations of sympatric Swainson's and Harris' (*Parabuteo unicinctus*) hawk populations in New Mexico in which prey species overlap remained high even as prey biomass became limiting (Gerstell and Bednarz 1999). In that study, Swainson's Hawks aggressively excluded Harris' Hawks from Swainson's Hawk territories.

Due to the potential niche overlap among all three *Buteo*s in this region and the propensity for Swainson's Hawks to aggressively exclude other species, I examined the spatial partitioning of breeding territories in shortgrass prairie. Janes (1985) studied these same three species breeding sympatrically in California, Oregon, Idaho, and Utah, and compared such habitat features as ground cover, perch density, and topographical relief. I quantified and compared similar features of breeding territories to test the hypothesis that the three *Buteo* species partition habitats spatially in the Oklahoma Panhandle. Understanding distribution and dynamics of these species is a goal of the Oklahoma Comprehensive Wildlife Conservation Strategy (ODWC 2005), for which Swainson's and Ferruginous hawks are listed as Tier I and II conservation priorities, respectively. Swainson's Hawk was also listed as a species of conservation concern at the continental scale by Rich et al. (2004).

METHODS

Nest Searches

I conducted opportunistic nest searches from early May to early July in 2004 and 2005. I located nests while driving county roads and examining conspicuous trees; by walking ranches and riverbeds in search of nest trees; and I found some nests in the course of doing unrelated field work (songbird point counts). As a courtesy to other researchers conducting raptor research in the southwest part of the county (Rita Blanca National Grassland), I generally avoided searching there. Our total search effort included coverage of ≥50% of the sections in Cimarron County.

I considered only active nests for my analysis, defining "active" as the presence of juveniles or at least one incubating adult. In four instances, I included locations for Red-tailed Hawk nests where I found recently fledged young in trees along a riverbed but where no physical nest was located. In each of these cases, the riparian forest was surrounded by treeless prairie, so a slight inaccuracy in the actual nest location would make no difference in calculations of land-cover percentages for that location. A nest site used by the same species two years in a row was recorded as two separate entries in the total of nests analyzed for land use. I recorded nest locations using legal locations (range, township, section), but >80% of the locations were determined with a GPS unit (Garmin Geko 201, Garmin International, Olathe, Kansas,). I recorded nest tree species at 80% of my locations.

GIS Analysis

I imported all buteo nest locations for the two years of the study into ArcMap 9 (ESRI, Redlands, California). To examine land-cover patterns around the buteo nests, I

placed buffers of 500-, 1000-, and 2000 m radii (79-, 314-, and 1256 ha) around the nest locations and around 54 GIS-generated random points in Cimarron County. I used three scales of buffers to permit comparisons within the immediate vicinity of the nest out to a scale roughly the size of the home ranges reported for these species (Woodbridge 1991; Bechard 1982; Bechard and Schmutz 1995; Leary et al. 1998; Andersen and Rongstad 1989).

I imported the 1992 National Land Cover Dataset (NLCD) for Cimarron County (USGS 2004) into ArcMap and merged it with a layer delineating 2005 CRP land in Cimarron County that was provided by the Cimarron County Farm Service Agency (Fig. 1). I combined potentially redundant features from the NLCD into a smaller number of more general categories. I renamed the grasslands/herbaceous designation "prairie," and combined pasture/hay, row crops, and small grains into "agriculture" and all forested and shrub categories into "wooded." The latter grouping was necessary because many of the riparian areas in Cimarron County were heavily lined with large cottonwoods, but some of that was classified as "shrub." Similarly, an area of sandsage just east of Wheeless, Oklahoma, was classified as "shrub"; I reclassified it as prairie. I also imported land-cover data layers from the Oklahoma Gap Analysis Project (GAP; Fisher and Gregory 2001). I felt the NLCD data had greater overall accuracy, but the GAP data provided more specific prairie layers, including two sandsage categories that I combined into one.

I performed land use/land cover (LULC) analysis by clipping the nest area buffers to the NLCD/CRP and GAP layers and using a raster summary function to get the total number and proportions of the various land use type pixels in each buffer. To test the accuracy of the NLCD/CRP land use categories, I compared the NLCD/CRP

classifications of 100 GIS-generated random points with a National Agriculture Imagery Program (NAIP) 2003 photograph. I assumed that the land use in Cimarron County had not changed enough from 1992–2003 to cause serious discrepancies.

I used the same buffers created for land-cover analysis to investigate the topographical relief around each nest site and random point. I imported a Digital Elevation Model (DEM) from the USGS website (USGS 2004) and analyzed the mean maximum slope for all buffers (i.e., GIS calculated a percentage of slope for each 30- x 30-m pixel), and we analyzed means of the maximum slope in each buffer for each species. Maximum slope gave an indication of features such as ciiffs and rocky outcrops. Finally, I used the DEM to calculate elevation at each hawk nest.

Statistical Analyses

Because prairie and agricultural layers were strongly correlated ($r = -0.83$), I restricted land-cover analyses to mean percent cover for prairie, CRP, wooded, and, using GAP data, sandsage components. I tested for land-cover and topography differences with one-way analyses of variance (ANOVA). If Levene's tests on transformed means showed unequal variances, I used Mann-Whitney or Kruskal-Wallis tests. All tests were performed at $\alpha = 0.05$ in Minitab 13.20 (Minitab, Inc. 2000).

RESULTS

I found 168 Swainson's, 38 Red-tailed and 18 Ferruginous hawk nests during the two years of the study (Fig. 1). In the test of 100 random points, I found the land-cover layer to be ≥86% accurate; there were two misclassifications and 12 instances where accuracy could not be determined by comparison with the NAIP photograph. At the 314-ha scale, the land-cover percentages for the 54 points used for land-cover analysis were

within four percent of the values for Cimarron County in its entirety (i.e. all pixels in the county evaluated), so I considered the random sample as a good representation of the county as a whole.

Land-cover percentages surrounding nests and random points did not differ at the 79-, 314-, and 1256-ha scales among the hawk nests and the random points, except the wooded component around Red-tailed Hawk nests ($F_{2,95} = 3.48$, $P = 0.035$). Percent cover of wooded habitat around Red-tailed Hawk nests, however, ranged from only 2.3% to 4.2% across the three scales. Due to the overall similarities in land-cover composition around nests and random points at the three scales, I arbitrarily selected the 314-ha scale to perform specific comparisons among the different species and random points.

Because land-cover composition was similar among all Red-tailed Hawk nests, variances for this species were smaller than for the other three groups. Levene's tests on transformed means were significant when mean cover of CRP, prairie, and wooded vegetation for Red-tailed Hawks were included in analysis, but variances were homoscedastic when the three Red-tailed means were excluded. Therefore, I tested for differences in mean CRP, prairie, and wooded vegetation between Swainson's and Ferruginous hawk nests and the random points with ANOVA, then used nonparametric tests to look for differences with the Red-tailed means added. Untransformed means for sandsage cover were homoscedastic with all three species and the random points included.

I found no differences in percent CRP among random points and nest locations for Swainson's and Ferruginous hawks ($F_{2, 240} = 1.01$, $P = 0.366$). A Kruskal-Wallis test

including Red-tailed Hawk indicated a difference ($H_3 = 40.96$; $P < 0.001$; $d.f.=3$), with less CRP surrounding Red-tailed Hawk nests (Fig. 2).

Prairie cover differed among random points and locations for Swainson's and Ferruginous hawk nests ($F_{2, 240} = 5.93$, $P = 0.003$); however, only the Tukey's confidence interval for the difference between the hawk nests excluded zero. A Mann-Whitney test for the difference in prairie cover between Red-tailed and Ferruginous hawks was not significant ($U = 445$, $P = 0.236$), but the difference was significant comparing Red-tailed Hawk to Swainson's Hawk ($U = 15116$, $P < 0.001$) and to random points ($U= 2045$, $P < 0.001$).

The proportion of wooded cover was similar among random points and nest locations for Swainson's and Ferruginous hawks ($F_{2, 240} = 0.56$, $P = 0.574$). A Kruskal-Wallis test including Red-tailed Hawk indicated a difference ($H_3 = 49.78$, $P < 0.001$). Wooded cover was highest around nests for Red-tailed Hawk because it nested in relatively continuous riparian forest rather than in isolated trees as did the other two *Buteos*.

Sandsage cover was higher around Ferruginous Hawk nests compared with the other *Buteo* species ($F_{3,278} = 3.64$; $P = 0.013$) but did not differ from sandsage cover around random points (Tukey's confidence interval included zero).

In addition to land cover, I observed some differences in topography around nests. Mean slope differed within species at the different scales ($F \geq 3.42$; $d.f. \geq 53$; $P \leq 0.035$; all tests summarized), so I compared the log-transformed means at all three scales. The mean slope around Red-tailed Hawk nests was higher than the other three at all scales, and Swainson's and Ferruginous hawks were not different from random (Table 1).

To determine if Red-tailed Hawks chose areas with greater slope within prairie, I compared maximum mean slope around Red-tailed nests at the 314-ha scale with a "prairie"-classified subset ($n = 57$) of the 100 random points used to verify NLCD/CRP accuracy. The Red-tailed Hawk means were higher ($F_{1,94} = 13.16$; $P < 0.001$). Mean nest elevation ranged from 1239 to 1256 m and did not differ between species ($F_{3,279} = 0.4$; $P = 0.76$).

Eight Swainson's Hawk nests were ≤ 2 km from Boise City or Keyes, the two largest towns in the county. No Ferruginous Hawk nest was <8 km from those towns, and no Red-tailed nest was < 12 km away. I found four Swainson's Hawk nests in "yards" ≤ 170 m from a house occupied occasionally ($n = 1$) or continually ($n = 3$). One Red-tailed nest was 40 m from an occupied house.

I recorded tree species at 134 Swainson's, 31 Red-tailed, and 14 Ferruginous hawk sites. Most Swainson's nests were in Siberian elms, which were planted widely around homesteads in the agricultural areas. Most Red-tailed nests were in cottonwoods, which lined the riverbeds (Table 2).

DISCUSSION

My results suggest that Swainson's, Red-tailed, and Ferruginous hawks partitioned nesting habitat spatially. Red-tailed and Ferruginous hawks nested almost exclusively in the prairie habitats; I only observed one Red-tailed Hawk in an agricultural area, and that was an immature (presumably non-breeding) bird. Relative to the available habitat, Red-tailed Hawks disproportionately used riparian forest surrounded by prairie for nesting. Ferruginous Hawks also nested disproportionately in prairie habitat and were more likely to use areas with a high sandsage component.

Swainson's Hawks were more catholic in their nesting habitat use than the other *Buteos*. They tended to use available habitats in proportion to their availability and were the only *Buteo* nesting in the largely agricultural areas (Fig. 1). This result is similar to that reported by Bechard et al. (1990) in Washington, who also found Swainson's Hawk nests more likely to be associated with agriculture than either Ferruginous or Red-tailed hawks. In Alberta, Rothfels and Lein (1983) found Swainson's in agricultural areas and Red-taileds in the foothill parklands of the Rocky Mountains.

Swainson's Hawks were more likely to nest near towns and occupied homes in Cimarron County, and they have been found nesting in residential neighborhoods in California (England et al. 1995). Ferruginous Hawks are known to avoid human habitations (Olendorff 1993). Swainson's Hawk tolerance of a different kind of human activity is indicated by the 10 nests I found along major highways (<20 m from the road) in Cimarron County; no Ferruginous or Red-tailed nests were similarly located.

There was a potential sampling bias for finding higher numbers of Red-tailed Hawk nests than Swainson's Hawk nests along the riverbeds, and that bias could have reduced the percentage of prairie cover around Swainson's Hawk nests. The wooded floodplains of the Cimarron and Beaver rivers were frequently 0.50–0.75 km wide, and examination of each tree was prohibitive. Red-tailed Hawks usually announced the presence of a nest with loud protests aimed at the nest searcher, but Swainson's Hawks sometimes remained inconspicuous by sitting tight on a nest, even when the base of the nest tree was approached. Given their conspicuous nest-area behavior, I am confident that I discovered most, if not all, Red-tailed Hawk nests in the riverbeds investigated, but it is likely that at least some Swainson's Hawk nests were missed.

The overall pattern of nest locations (Fig. 1) indicated that Swainson's Hawks nested mainly in agricultural areas, Red-tailed Hawks nested in prairie areas, and Ferruginous Hawks occupied the interface. This interpretation is supported by the 314-ha buffer analysis in which Red-tailed Hawks exhibited a 95:1 ratio of prairie:agriculture affinity while for Swainson's Hawk that ratio was 51:31. For Ferruginous Hawk, mean percent CRP and agriculture (9%) were intermediate between those for Red-tailed and Swainson's hawk.

Agriculturally dominated areas in Cimarron County are flat, but the prairie areas have more hills and cliffs. This may be a contributing factor to spatial partitioning of prairie and agricultural habitat between Swainson's and Red-tailed hawks. Janes (1985) found that Red-tailed Hawk breeding sites had higher topographic relief and higher perch (telephone poles or trees ≥2 m tall) density, on average, than Swainson's Hawk sites. He attributed this to the lower relative wing loading and higher aspect ratio of Swainson's Hawk wings, which enabled them to soar-hunt more efficiently than Red-tailed Hawks. Janes (1985) believed that Red-tailed Hawks relied on declivity currents from outcrops and hills to enhance their soar-hunting ability. Significant differences in topographic relief among *Buteo* nest sites in Cimarron County indicate that these species may select habitats similar to those reported by Janes (1985). In particular, the higher maximum slope in buffers around Red-tailed Hawk nests support the contention that this species selected greater topographic relief relative to random sites (even random sites within prairie) or to habitats of the two congeners. Notably, I found two Red-tailed Hawk nests on cliffs in areas of extreme topographic relief; I found no cliff-nesting Ferruginous or Swainson's hawks.

I did not quantify perch density around each nest, but the significantly higher mean cover of wooded habitat around Red-tailed Hawk nests indicated a higher density of trees in their breeding areas. Most (83%) of the Red-tailed Hawk nests were located in timber along the Cimarron and Beaver rivers and associated drainages. Vast stretches of both rivers were heavily lined with cottonwoods and surrounded by prairie, enabling a hawk to access huge tracts of prairie hunting ground from a constant supply of perch trees. Most Swainson's Hawk nests, by contrast, were in agricultural areas, where trees were more sparsely distributed and generally occurred as windbreaks around widely dispersed homesteads. The low number of natural perches in the agricultural areas was augmented by utility poles, but they did not approach the density of perch trees along riverbeds.

Thurow and White (1983) found that Swainson's and Ferruginous hawks in Idaho often nested ≤ 0.8 km from each other (83% of 30 randomly chosen Ferruginous Hawk nests over two years). They suggested that the two species benefited from mutualistic nest defense. My random method of nest searching did not ensure that areas around all Ferruginous Hawk nests were examined out to 0.8 km; however, at least eight of 18 (44%) Ferruginous Hawk nests had an active Swainson's Hawk nest ≤ 0.8 km away, including four at < 300 m, paralleling the association noted by Thurow and White (1983).

In Oregon, Janes (1994) found that Swainson's Hawks returning from wintering grounds usurped edges of Red-tailed Hawk breeding territories in 29% of the Red-tailed territories studied, and Swainson's Hawks were dominant in interspecific encounters due to their ability to keep above Red-tailed Hawks while maneuvering in the air. I witnessed this on 24 May 2005 when a Swainson's Hawk drove a 1-year old Red-tailed Hawk out

of its territory; the Swainson's Hawk easily gained altitude over the Red-tailed and dove at it. Schmutz et al. (1980) found that Swainson's Hawks in Alberta reacted more aggressively to the introduction of tethered conspecifics and congeners than did Ferruginous Hawks. But by estimating the age of some Ferruginous Hawk and Red-tailed Hawk nestlings and back-counting to initiation of nesting, I conclude that both species were already on nests by the time Swainson's Hawks returned to breed in late March–early April. Bill Voelker (pers. comm.) has an unpublished 35-year dataset (through 2005) for the region on full-clutch dates of Ferruginous Hawks that averages 28 March–16 April. This suggests that Ferruginous and Red-tailed hawks were not excluded from agricultural areas via competitive interactions with Swainson's Hawks but rather selected nest sites in prairie habitats in the absence of territorial Swainson's Hawks.

In conclusion, I found species-specific differences in land cover around nests of Swainson's, Red-tailed, and Ferruginous hawks. These differences contributed to a pattern of spatial segregation of nest locations that may reduce interspecific competition in the relatively homogeneous landscapes in the study area. My observations do not, however, point to agonistic encounters among the three species as the proximate cause for the spatial segregation of nest locations, as suggested by Gerstell and Bednarz (1999) in their study of Swainson's and Harris's hawks. Rather, nest selection by Red-tailed and Ferruginous hawks in Cimarron County apparently occurred in advance of the arrival of Swainson's Hawks. The potential interspecific competition among these species could be addressed in studies of diet overlap and nest productivity (e.g., Giovanni 2004) and analysis of richness and habitat associations for *Buteo* prey species. Behavioral studies could determine the time allocation in each habitat type within a species' home range,

which may be just as important in determining spatial habitat use as the specific nest location.

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TABLE 1. Between species comparisons for slope percentage maximum means for 79-, 314-, and 1256 ha buffers around Swainson's (n=168), Red-tailed (n=38), and Ferruginous (n=18) hawk nests, and random points (n=54) in Cimarron County, Oklahoma. Results of ANOVA comparisons and Tukey intervals are given. * indicates a significant difference at α=0.05.

Comparison	**78 ha**	**314 ha**	**1256 ha**
	$F_{3,278} = 35.90$ $P < 0.001$	$F_{3,278} = 37.67$ $P < 0.001$	$F_{3,278} = 38.41$ $P < 0.001$
Swainson's vs. Red-tailed	-0.8904 -0.5350*	-0.8652 -0.5275*	-0.8134 -0.4977*
Swainson's vs. Ferruginous	-0.49667 -0.0059*	-0.4472 0.0191	-0.4465 -0.0104*
Red-tailed vs. Ferruginous	0.1782 0.7446*	0.2133 0.7514*	0.1754 0.6787*
Swainson's vs. Random	-0.2739 0.0356	-0.2744 0.0196	-0.2701 0.0048
Red-tailed vs. Random	0.3840 0.8032*	0.3699 0.7681*	0.3367 0.7091*
Ferruginous vs. Random	-0.1372 0.4016	-0.1693 0.3426	-0.1435 0.3352

TABLE 2. Number (and percent) of tree species used by three *Buteo* hawks in Cimarron County, Oklahoma, 2004–2005.

Tree species/nest substrate	Swainson's (n = 134)	Red-tailed (n = 31)	Ferruginous (n = 14)
Siberian elm (*Ulmus pumilla*)	95 (71)	1 (3)	5 (36)
Cottonwood (*Populus deltoides*)	28 (21)	26 (84)	4 (29)
Red mulberry (*Morus rubra*)	4 (3)	0	0
White mulberry (*M. alba*)	1 (0.7)	0	0
Hackberry (*Celtis occidentalis*)	3 (2)	0	0
Osage orange (*Maclura pomifera*)	1 (0.7)	0	1 (7)
Black walnut (*Juglans nigra*)	0	1 (3)	0
Honey locust (*Gleditsia triacanthos*)	0	1 (3)	1 (7)
Black locust (*Robinia pseudoacacia*)	1 (0.7)	0	0
Oneseed juniper (*Juniperus monosperma*)	1 (0.7)	0	2 (14)
Platform	0	0	1 (7)
Cliff	0	2 (7)	0

FIGURE 1. Land cover map of Cimarron County, Oklahoma, compiled from NLCD and CRP data layers and illustrating nest locations in 2004-2005 for Swainson's (red markers), Ferruginous (yellow), and Red-tailed hawks (blue). Gray stippling represents agricultural areas; prairie is shown in topaz; CRP is shaded light blue; green areas are wooded.

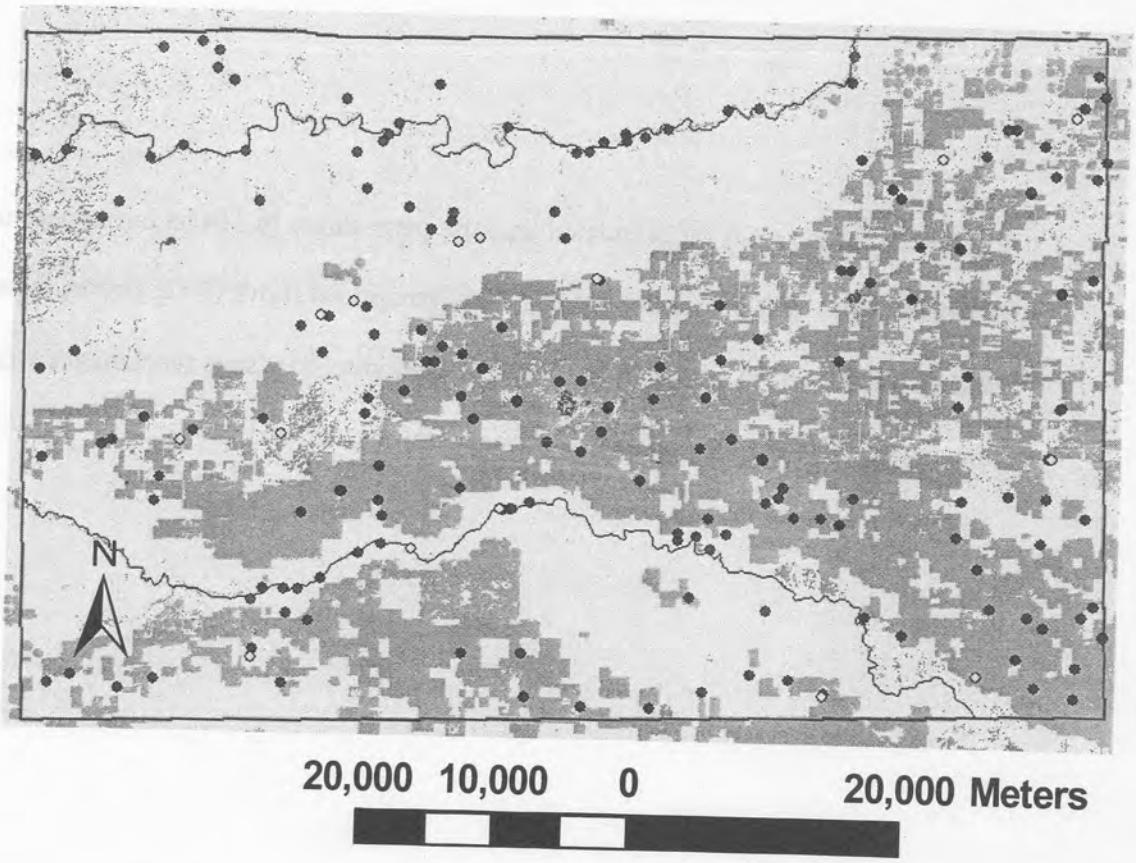
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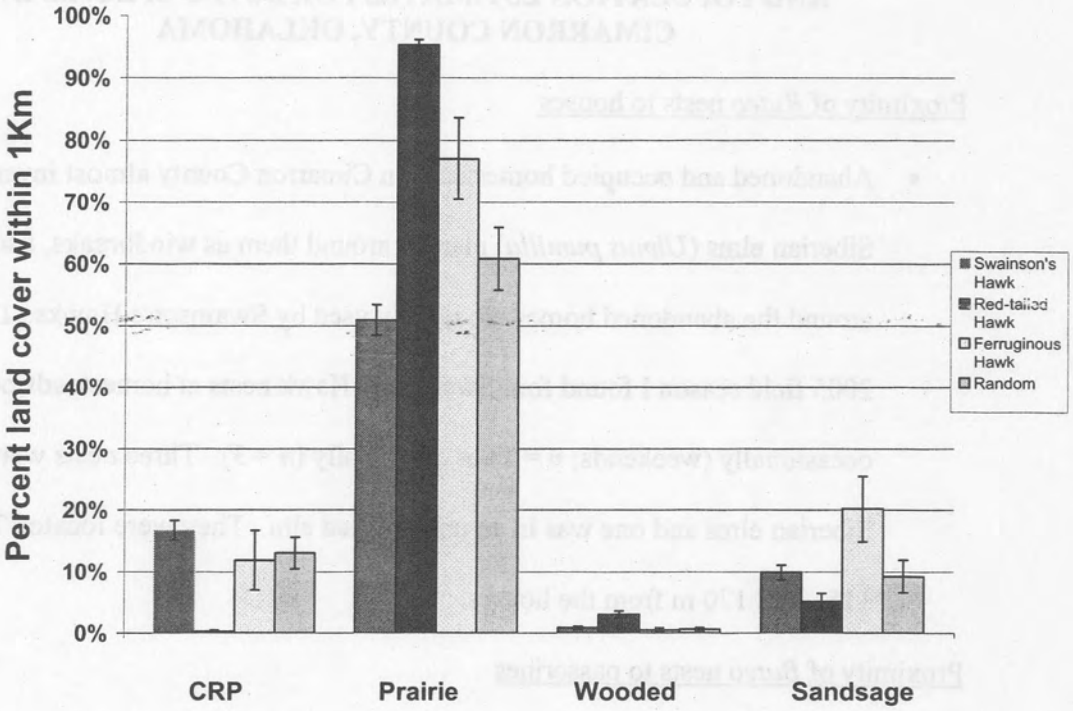
FIGURE 2. Mean ± SE for calculated land use percentages in 314 ha buffers around Swainson's (n=168), Red-tailed (n=38), and Ferruginous Hawk (n=18) nests, as well as random points (n=54) in Cimarron County, Oklahoma. Sandsage percentages were calculated from a different GIS layer, hence totals can exceed 100%.


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent land cover within 1Km
CRP
Prairie
Wooded
Sandsage
Swainson's Hawk
Red-tailed Hawk
Ferruginous Hawk
Random

CHAPTER 3: INTERSPECIFIC RELATIONSHIPS, DENSITY AND POPULATION ESTIMATES FOR *BUTEO* SPECIES IN CIMARRON COUNTY, OKLAHOMA

Proximity of *Buteo* nests to houses

- Abandoned and occupied homesteads in Cimarron County almost invariably have Siberian elms (*Ulmus pumilla*) planted around them as windbreaks, and the trees around the abandoned homes are readily used by Swainson's Hawks. During the 2005 field season I found four Swainson's Hawk nests at homesteads occupied occasionally (weekends; $n = 1$) or continually ($n = 3$). Three nests were in Siberian elms and one was in an unidentified elm. They were located 70-, 85-, 115-, and 170 m from the houses.

Proximity of *Buteo* nests to passerines

- During the 2005 field season I found 10 House Sparrow (*Passer domesticus*) nests built into or immediately below an active Swainson's Hawk nest and two similarly placed in active Red-tailed Hawk nests.
- Additionally, I often found Western Kingbirds (*Tyrannus verticalis*) and sometimes Cassin's Kingbirds (*T. vociferans*) nesting in the vicinity of a *Buteo* (same or adjacent tree). Presumably the raptors, generally secretive in the nest area, do not attempt to prey on the passerines- to do so would create unwanted commotion at the hawk's nest.

- On 2 June 2004, I located a Ferruginous Hawk nest near the top of a 3-m oneseed juniper (*Juniperus monosperma*) with four juveniles approximately three weeks old. Returning 22 June 2004, I found the nest empty and the remains of two juvenile Ferruginous Hawks on the ground beneath the nest, likely blown out during a storm the evening of 2 June. A Loggerhead Shrike (*Lanius ludovicianus*) was sitting on a nest with four eggs ~1 m below the deserted hawk nest. On 5 June 2005, I visited this tree again, and found a shrike nest with three juveniles that had been built directly beneath the empty hawk nest. On 22 May 2005, I found a Ferruginous Hawk nest containing two juveniles ~5 m up in a cottonwood tree along the dry Beaver River bed. A shrike nest was ~2 m up in the same tree. Another pair of presumably breeding (scolding, etc.) shrikes was found on three dates in 2005 along an Osage orange (*Maclura pomifera*) row with many old nests that was <30 m from a Siberian elm with an incubating Swainson's Hawk.
- Konrad and Gilmer (1982) cited several instances, from their own and other studies, of raptors nesting in proximity to passerines, and they believed it was mutually beneficial for the birds involved by providing increased insect supply at prey remains and increased protection from other predators for the passerines, and pest insect removal and added nest predator vigilance for the raptors.

<u>Proximity of *Buteo* nests to other raptorial species</u>

- On 22 May 2005, an adult Great Horned Owl (*Bubo virginianis*) and an adult Swainson's Hawk flushed simultaneously from a lone hackberry tree (*Celtis occidentalis*) in the dry Beaver River bed and flew off side by side at my approach. The hawk had a nest near the top of the tree, which was also used by a

Swainson's pair in 2004. Also in the tree were two unfledged owls, <5 m from a large, bulky, disheveled nest, presumably the owls'. The two nests were ~7 m apart.

- On 24 June 2005, I found two locations where a Swainson's Hawk was incubating in proximity to a Chihuahuan Raven nest. One raven nest had one juvenile and was 150 m from the hawk nest; the other, with four juveniles, was 135 m from the hawk nest. The setting for each occurrence was an abandoned homestead site, and all four nests were in Siberian elms.
- An interesting case of raptors nesting in proximity occurred at the same location both years of the study. Along a two-track lined intermittently with trees, a Ferruginous Hawk nest was located 150 m east of a Great Horned Owl nest, which was 115 m east of a Swainson's Hawk nest. The latter nest had 1–3 broken and abandoned eggs in both years and a Swainson's Hawk pair in the immediate vicinity; the former two species had juveniles present in both years.

Swainson's Hawk nest density

In 2005, I found 102 Swainsons' Hawk nests in Cimarron County. Using this figure as a minimum estimate, the calculated density for breeding Swainson's Hawks in the county is 2.13 nests/100 km^2. For the two years of the study, I found a combined 147 different Swainson's Hawk nest sites in the county. I deliberately tried not to search the same areas in both years, but Swainson's Hawks show high breeding site fidelity (83%; Woodbridge 1991), so it is reasonable to assume that most of these territories were occupied in both years of the study. Using 150 nests as a reasonable estimate of breeding pairs, the density calculation equals 3.14 nests/100 km^2. Considering that I did not cover

the entire county, and did not exhaustively or systematically search areas that received coverage, it would not be a stretch to estimate 200 pairs for the county; the density estimate in this case is 4.20 nests/100 km^2. These densities are at the low end of the range of studies cited by England et al. (1997), and are considerably lower than the 20–30 pairs/100 km^2 in studies from California (England et al. 1995; Woodbridge et al. 1995).

Buteo Population Estimates for Cimarron County and Oklahoma

Due to the conservation status of Swainson's and Ferruginous hawks in Oklahoma, I will compare previous Oklahoma population estimates with numbers from this study. Bednarz (1988) estimated the Oklahoma breeding population of Swainson's Hawks at <300 pairs. I estimated 150–200 breeding pairs in Cimarron County, and I found 15 breeding pairs in western Texas County in 2004 with minimal effort. Considering that Oklahoma Breeding Bird Atlas (OBBA) efforts in the three counties of the Panhandle found SWHA in 38 blocks (out of 48 blocks surveyed; 79%), with breeding confirmed in 19 blocks, and found the species present as far east as Muskogee County (Reinking 2004), 300 pairs is likely an underestimation.

Hall et al. (1988) conservatively estimated the Oklahoma population of Ferruginous Hawks at 25 pairs; Wheeler (2003) gave an estimate of 20–33 pairs. Researchers from the George M. Sutton Avian Research Center located 15 nests in Cimarron County in 1995 (Trent 1995). I found nine pairs in Cimarron and Texas counties in 2004, and 14 pairs in 2005 (12 in Cimarron County). Boal (pers. comm.) found eight additional pairs nesting on the Rita Blanca National Grassland in 2005, giving a minimum of 22 pairs for the state in 2005, with 20 pairs in Cimarron County. My search efforts in Texas County were minimal, but the OBBA found Ferruginous

Hawks more common in Texas County than elsewhere (Reinking 2004). Given that there were at least 22 pairs nesting in the Oklahoma Panhandle in 2005, and that my search efforts were minimal in Texas County, I conclude that there are >33 pairs nesting in Oklahoma.

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CHAPTER 4: A HABITAT MODEL AND POPULATION ESTIMATE FOR MOUNTAIN PLOVERS IN OKLAHOMA

Numbers of grassland birds have declined steeply in North America (Knopf 1994; Vickery et al. 1999). The principle agents driving the decline of native grassland birds are habitat loss and the introduction of cereal grains and exotic grasses, fragmentation, encroachment of woody vegetation, wetland drainage, and changes in the historic grazing community (Vickery et al. 1999, Knopf 1994; Grant et al. 2004; Coppedge et al. 2004; Brennan and Kuvlesky 2005). Analysis of North American Breeding Bird Survey (BBS) data indicates that 13 species of grassland birds declined significantly between 1966 and 1996 (Peterjohn and Sauer 1999).

Several declining grassland bird species breed in Oklahoma. One of them, the Mountain Plover (*Charadrius montanus*), approaches the eastern limits of its breeding range in the western part of the Oklahoma Panhandle. Mountain Plovers are sparsely distributed throughout their range, making population estimation difficult. Breeding Bird Survey (BBS) routes are not evenly distributed across their breeding range (Knopf 1996); in Oklahoma, Mountain Plovers regularly occur on only one BBS route (Sauer et al. 2004). Rangewide BBS data for 1966–2003 indicate a nonsignificant annual population decline of 1.9% (Sauer et al. 2004); however, trend data are not available for Oklahoma due to the small sample.

Previous studies in Oklahoma (e.g. Shackford 1986; Shackford and Leslie 2000) investigated Mountain Plover breeding biology but did not provide a population estimate

for Oklahoma. A large proportion of the population is presumed to winter in southern California (Dinsmore 2003; U.S. Fish and Wildlife Service 2003), and based on winter counts in 1998–2002, the U.S. Fish and Wildlife Service estimated the continental population at 5,000–11,000 birds (U.S. Fish and Wildlife Service 2003).

The breeding range of the Mountain Plover formerly extended a few hundred kilometers farther east of its current range (Bent 1929; Knopf 1996), but in Oklahoma it had been known to breed only in Cimarron County (Tate 1923; Sutton 1967; Baumgartner and Baumgartner 1992; Reinking 2004) until I found birds breeding in northwestern Texas County (McConnell et al. 2005). Although Mountain Plovers have historically been associated with shortgrass prairie, heavily grazed sites, and prairie dog (*Cynomys* spp.) towns (Graul and Webster 1976; Knowles et al. 1982; Dinsmore et al. 2003; Kotliar et al. 1999), they also breed in cultivated fields in Oklahoma and other parts of their breeding range north to Wyoming (Shackford 1986; Shackford et al. 1999; Knopf and Rupert 1999).

My objectives were to define the breeding range of the Mountain Plover in Oklahoma, develop a habitat model based on land use, soil, and topographic features of plover locations, and estimate the number of Mountain Plovers currently breeding in Oklahoma.

METHODS

Study area.— I conducted this study primarily in Cimarron County, Oklahoma, which was wholly contained within the Shortgrass Prairie Bird Conservation Region (Rich et al. 2004) and the Western Short Grasslands Ecoregion (Ricketts et al. 1999). Cimarron County occupies 4,769 km^2 and ranges from 1,090 to 1,518 m in elevation, increasing

from east to west. Most of the land area is flat, but the northwestern part of the county is dominated by mesas. In 1971–2000, average annual precipitation in Boise City (36° 43' 47", 102° 30' 47") was 47 cm (National Oceanic and Atmospheric Administration 2002).

In 2002, 96% of Cimarron County was farmland: cropland 40% and grazing land (almost entirely for cattle) 56%. Crops and area harvested in 2002 were: sorghum, 236 km^2; winter wheat, 228 km^2; corn, 88 km^2; and forage (hay, etc.), 65 km^2 (U.S. Dept. of Agriculture 2004). Many of the agricultural sections have pivot irrigation systems drawing on the Ogalala Aquifer. In 2004, Cimarron County had 641 km^2 enrolled in the Conservation Reserve Program (CRP; P. Toon, U.S. Dept. of Agriculture, in litt.).

Historically, the Western Short Grasslands were characterized by buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*) prairie; pastures dominated by these grasses persist in Cimarron County (Ricketts et al. 1999). On well-drained soils, sand sagebrush (*Artemisia filifolia*) and plains yucca (*Yucca glauca*) are common (Tyrl et al. 2002).

Surveys.—Two observers (John Shackford and I) conducted surveys during May and June, 2004–2005, in 10 townships in Cimarron County where Mountain Plovers were documented previously (Shackford 1986; Shackford et al. 1999; Shackford and Leslie 2000). Mountain Plovers return to their breeding grounds in Cimarron County from late March to early April, and dates chosen for surveys ensured that only breeders, not transients, were counted. I examined each township on an Oklahoma Department of Transportation highway map to determine those sections that had roads on all four sides. Of those, I chose 60 sections for point counts using a random number generator. Before the second field season, I randomly selected 78 sections from the original set of road-

enclosed sections. In each selected section, we conducted a 10-minute point count at the midway point on all four sides. We counted at each selected section twice each field season (i.e., 480 10-minute point counts total in 2004; 624 in 2005).

We recorded all adult individuals of all bird species detected during each count, and recorded estimated distances to each Mountain Plover detected. We also created a habitat map for each survey section by filling in a blank paper map with land-cover features. Additionally, we broadcast a 1-minute recording of Mountain Plover calls at the 7-minute mark of each point count to increase our chance of detecting plovers. We conducted point counts within four hours of sunrise and sunset on days without excessive wind or precipitation, thus avoiding the midday hours when Mountain Plovers may retreat to shaded areas making detection more difficult (Graul 1975, Shackford 1996).

After we completed counts in the selected townships, we extensively searched townships in the remainder of Cimarron County and in Texas County as far east as Guymon (36° 24' 36", 101° 17' 24") to look for additional Mountain Plovers outside the survey townships and to determine the eastern limits of their breeding range in Oklahoma.

Studies that do not make allowances for probability of detection (P_d) differences between observers and among species have faced increasing criticism in recent years (Thompson 2002; Rosenstock et. al 2002). I used a removal model (Farnsworth et al. 2002) to calculate P_d for each observer. I divided each 10-minute count into three time bands of 3-, 2-, and 5-minute duration and assigned plovers to the corresponding time band in which they were first detected. I analyzed those data in SURVIV software (Farnsworth et al. 2002 online supplement) and calculated P_d for each observer. I used

observer-specific P_d to adjust raw count numbers and used both adjusted and unadjusted counts in my analyses to illustrate a range of population estimates.

GIS analysis.—I imported all Mountain Plover locations into a geographic information system (GIS; ArcMap 9 [ESRI, Redlands, California, USA]) and digitized bare areas in the survey sections. I imported the U.S. Department of Agriculture's Soil Survey Geographic data (SSURGO; U.S. Dept. of Agriculture 2005), and the U. S. Geological Survey's (USGS) Digital Elevation Model (DEM; U.S. Geological Survey 2004) into the GIS to estimate the amount of plover habitat available, and I extrapolated counts to available habitat to derive a population estimate. I analyzed the SSURGO maps for the study area to see if the plovers were concentrated in a particular soil type(s), and analyzed the DEM to derive slope percentages for 30- x 30-m blocks in the study area. I placed 63-ha buffers around Mountain Plover location points based on estimates of plover home ranges in eastern Colorado (Knopf and Rupert 1996; Dreitz et al. 2005).

To determine whether Mountain Plovers occurred disproportionately close to CRP fields, I performed a *t*-test comparison (Minitab 2000) between the mean distance to CRP land of our plover locations (n = 100) and a GIS-generated random sample of survey township points where J. Shackford and I did not find plovers (n = 65).

RESULTS

The first round count for the 2004 point counts was lower than the other three rounds (Table 1), possibly due to the observers acclimating to protocol procedures, and I used only the last three rounds for population and density estimates. We detected an average of 22.67 (±1.53 S.D.) Mountain Plovers in each of the last three rounds. One observer had a higher P_d for the two years of the study (0.94 vs. 0.65), which may have

been due to differences in search methodology between the two observers. Any potential differences in ability to detect plovers were accounted for with the removal model (Farnsworth et al. 2002) I used.

Over the two years of the study, 89% of the locations where we found Mountain Plovers, whether during surveys or additional exploring, were flat (<2% slope), completely or mostly bare, and contained Sherm or Gruver clay loam within a 63-ha buffer around the plover location. In Cimarron County, 95% of our plover locations, and all 11 breeding confirmations (nest or young), occurred within the 10 townships chosen for surveys (including three locations in contiguous sections; Fig. 1). Therefore, for each round of surveys, I only extrapolated to survey townships, and only used sections within those townships that contained Sherm clay loam soil and had <2% slope (284 sections out of the 360 available in the 10 townships). All survey townships contained agricultural fields with bare areas. Also, for each round, I extrapolated the counts on a township-by-township basis, using only townships where we detected Mountain Plovers, and added up the extrapolated counts for each township to produce a total extrapolated count for the round (Table 1). That was done instead of simply extrapolating the total count for each round to the entire 284 sections, and it allowed for variability among townships: during the two years of surveys we found 63% of our plovers in only 22% of the townships.

We found few plovers outside of the 10 survey townships, mostly in adjoining sections (Fig. 1), and those probably contributed a small number to the Cimarron County population. However, I also discovered a small pocket of breeding plovers in northwestern Texas County (McConnell et al. 2005) that was ≤25 km from where Mountain Plovers have been found breeding in Morton County, Kansas (Busby and

Zimmerman 2001). The area in Texas County was similar to the areas where we found plovers in Cimarron County: in Texas County, all plovers were in fields with <2% slope, and on Gruver clay loam, which is structurally similar to Sherm clay loam (U.S. Dept. of Agriculture 2005; Brian Carter in litt.). I found five breeding pairs in Texas County on 24–25 June 2004 and estimated ≥14 birds in the area on 8–9 June 2005.

The average unadjusted, extrapolated count for the last three rounds was 115 Mountain Plovers (a density-derived estimate using unadjusted counts yielded a similar average of 124 Mountain Plovers); the average for the adjusted, extrapolated counts was 134 plovers. I estimated an additional 10–20 plovers outside the survey townships in Cimarron County and 15–30 plovers in Texas County, and arrived at an unadjusted state population estimate of 140–165 plovers, and an adjusted estimate of 160−185 plovers.

I used unadjusted counts of birds detected <400 m from the observers to calculate densities for Mountain Plovers in the 10-township survey area in Cimarron County (Table 2).

In the distance-to-CRP comparison between random points and Mountain Plover locations, the random points were closer to CRP (mean = 538 m cf. mean = 683 m for plover locations), although the difference was not significant (t = -1.91; df = 153; P = 0.058).

DISCUSSION

Almost 90% of our Mountain Plover locations were in bare, flat (<2% slope) agricultural areas on Sherm or Gruver clay loam soil. The flat areas of Cimarron County are where the majority of agricultural activity is found, so it is difficult to determine if the plovers are choosing for one feature and the other is simply conjoined. Nevertheless, the

Mountain Plover's preference for flat areas has been noted in several other studies (Graul 1975; Parrish 1988; Beauvais and Smith 2003). Bare agricultural fields likely mimic the short, heavily grazed prairie sites that Mountain Plovers prefer (Graul and Webster 1976; Knowles et al. 1982; Knopf and Miller 1994; U.S. Fish and Wildlife Service 2003), and even in "natural" settings (e.g., prairie dog towns) plovers seem to select less vegetated nest sites compared with what is randomly available (Knowles et al. 1982; Knopf and Miller 1994).

We found fewer plovers as we moved west from the extreme western part of our survey townships (Fig. 1). Bare, flat agricultural fields existed there, but the soil was sandier (Dalhart fine sandy loam; U.S. Dept. of Agriculture 2005) compared with plover-occupied areas farther east. There may be differences between the two habitats (e.g., food availability) that account for their apparent difference in suitability; alternatively, Mountain Plovers may avoid the sandy soils due to the possibility that blowing sand may cover the nest scrape or eggs. In one bare field in this sandy area, so much fine, sandy soil had blown across a section road in May 2005 that a snow plow was used to reopen the road, which was covered to a depth of 1−2 m. This sort of wind drift is presumably less likely with the more tightly packed clay loam. Analysis with SSURGO data could be an additional useful tool for managers and researchers to define appropriate habitat for Mountain Plovers.

Although 89% of Mountain Plover locations were characterized as flat and bare with a clay loam soil, I do not mean to imply that all areas in the western Oklahoma Panhandle containing these features will harbor Mountain Plovers. Dividing the survey sections into ¼-section plots (= 65 ha, approximately the estimated Mountain Plover

home range size), I calculated the percentage of ¼-sections that had <2% slope and a bare area in Sherm clay loam soil and in which we found Mountain Plovers. During the 2004 surveys, we found plovers in only 26% of the ¼-sections meeting those criteria; in 2005, we found plovers in 48% of the ¼-sections with the requisite bare, flat, clay loam conditions. In fact, agricultural land existed in eastern Cimarron and western Texas counties that appeared suitable for Mountain Plovers (flat, Sherm clay loam), but we found only three plovers there.

The southeastern quarter of Cimarron County (one plover found) appeared to have suitable habitat but contained less CRP land than areas where we found plovers. CRP fields can serve as a source of arthropod prey (McIntyre and Thompson 2003), but our Mountain Plover locations were not closer to CRP fields than were random locations. Our search effort was greater in the survey townships and it was possible that there were more plovers present outside of that area than were represented on the map; however, J Shackford (unpubl. data) found no Mountain Plovers in the apparently suitable habitat during 14 years of previous research (1986–1999). Habitat factors important to the plovers but unrecognized by us may be preventing their expansion into this area. Given that these areas contain habitat similar to the populated areas, they should be considered for future Mountain Plover monitoring efforts. My habitat model may be suitable for analysis of potential plover habitat in adjoining areas of southeastern Colorado, southwestern Kansas, and the northern Texas Panhandle.

Plover populations at the edge of the species' range may not be vigorous enough to expand further east, even into potentially suitable habitat. The estimated density of birds in Cimarron County (0.17/km^2) is much lower than densities reported elsewhere

e.g., 2.0–4.7 birds/km^2 at Pawnee National Grassland, Colorado (Knopf 1996); 5.83–6.80 birds/km^2 at the Charles M. Russell National Wildlife Refuge in Montana (Knopf 1996), and 4.47 birds/km^2 in Wyoming (Plumb et al. 2005). All studies with higher densities were conducted on prairie dog towns, and perhaps agricultural areas of the Oklahoma Panhandle, whether occupied by plovers or not, provide marginal habitat.

In most of their range, Mountain Plovers are associated with prairie dog towns. Numerous small to medium-sized (~60–250 ha) prairie dog towns exist in Cimarron County, but only 5% of the Mountain Plovers we found were in this habitat (none in 2004), despite special efforts to locate them in such areas in 2005. This may be due to local control efforts; most prairie dog towns may not become established long enough for the prairie dogs to maintain the grass at a height short enough for the plovers. The only prairie dog town in which we found breeding Mountain Plovers (seven adults, six juveniles on 17 June 2005) was in an area that has been continuously occupied by prairie dogs for at least 20 years. Additionally, in 2005, Cimarron County experienced a wet late winter–early spring, and even in most occupied prairie dog towns, herbaceous vegetation was high.

Mountain Plovers breeding in the Oklahoma Panhandle seem to have a fairly rigid suite of habitat requirements, unlike the congeneric Killdeer (*Charadrius vociferus*), which we noted in a wide variety of habitat types throughout Cimarron County. We found Mountain Plovers almost entirely in bare agricultural areas that had <2% slope, with Sherm or Gruver clay loam soils. I speculate that 1) these areas are more suitable for Mountain Plovers than local prairie dog towns because the bare areas more closely mimic the plovers' preferred overgrazed habitats, 2) the clay loam soil is more compact

and less susceptible to wind erosion, and less likely to cover a nest scrape or eggs, than bare, flat, but sandy agricultural soil in close proximity, and 3) bare areas in agricultural fields provide close access to plots with growing crops such as wheat or corn-milo that provide shade from the midday heat (Graul 1975, Shackford 1996), and perhaps even shelter from predators for fledglings.

Without a previous population estimate, it is difficult to speculate about trends in the Oklahoma Mountain Plover population, or whether bare agricultural fields in Cimarron County serve as a population sink, but there has evidently been a small, presumably persistent, breeding population in Cimarron County for many decades (Tate 1923; Flowers 1985; Shackford and Leslie 2000). The population appears to be maintaining itself by nesting primarily in the bare sections of agricultural fields roughly between Boise City and Keyes (36° 48' 27", 102° 15' 6"). I hope that this study will provide a solid baseline of information which state and federal agencies can use to more actively manage and protect the Mountain Plover population in Oklahoma, because these birds represent a unique and charming feature of the birdlife of Oklahoma.

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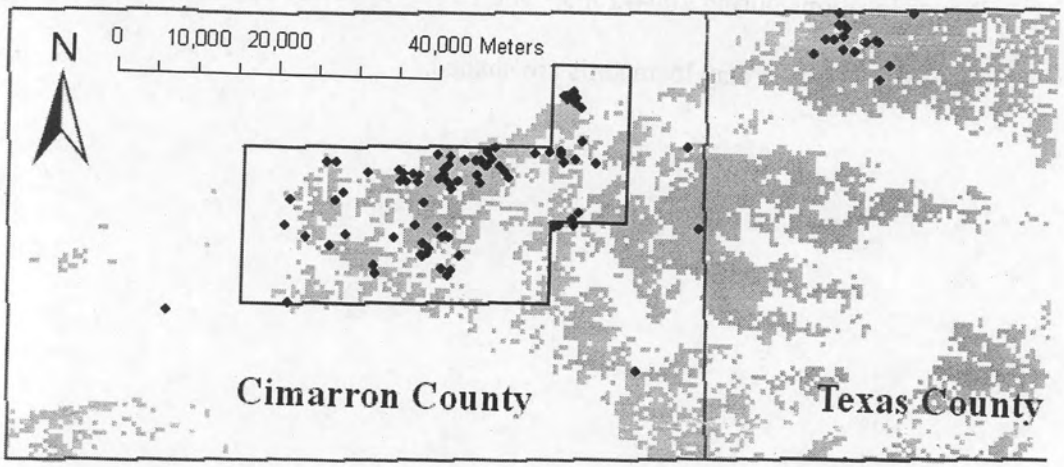
Table 1. Raw and extrapolated Mountain Plover counts for the 10 survey townships in Cimarron County, Oklahoma, over four rounds of surveys in 2004–2005. Differences in the unadjusted:raw and adusted:unadjusted ratios vary each round, which is due to differences in observer P_d and the roster of townships used for extrapolation.

Survey	Raw	Unadjusted	Adjusted
2004-1	13	66	91
2004-2	24	125	140
2005-1	23	112	141
2005-2	21	108	121

Table 2. Density estimates for Mountain Plovers in Cimarron County, Oklahoma.

Survey (Year-Round)	Density (Birds/km^2)
2004-2	0.215
2005-1	0.191
2005-2	0.102
Mean (± SD):	0.169 (±.060)

Figure 1. Map of Cimarron and western Texas counties, Oklahoma, showing Mountain Plover locations during 2004-2005. The 10 survey townships are outlined. Areas of Sherm and Gruver clay loam soils are shaded.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Cimarron County
Texas County

CHAPTER 5: LONG-BILLED CURLEW BREEDING RANGE AND HABITAT ASSOCIATIONS IN CIMARRON COUNTY, OKLAHOMA

Long-billed Curlews (*Numenius americanus*) are endemic to the North American prairies and breed on "the Great Plains, Great Basin, and intermontane valleys of western U. S. and southwestern Canada" (Dugger and Dugger 2002). They are at the eastern edge of their breeding range in Oklahoma. Curlews winter in interior Central America and along both coasts in the U. S. and Central America. There are two subspecies recognized; Oklahoma is within the breeding range of *N .a. americanus*; *N. a. parvus* breeds further north and west in North America (Sutton 1967; Dugger and Dugger 2002).

Tate (1923) regarded Long-billed Curlews as "summer residents on the prairies of the entire Oklahoma Panhandle" and reported four nests near Boise City in 1913. Although Nice (1931) reported them breeding in several counties east of the Panhandle, they were later categorized as rare breeders in Cimarron (Sutton 1967) and Texas (Baumgartner and Baumgartner 1992) counties. The Oklahoma Breeding Bird Atlas (OBBA) data indicate that the curlews' range in the state is restricted to Cimarron and west Texas counties (Reinking 2004). The North American Breeding Bird Survey data indicate a significant decline of 16% year^{-1} (1966–2003) in Oklahoma, but that was derived from just two routes on which the birds were found. Survey-wide, a nonsignificant decline of 1.8% year^{-1} is indicated z(Sauer et al. 2004). Hunting pressure in the 19th century and continued loss of habitat are believed to be the main factors in the curlew's decline (Dugger and Dugger 2002).

Our findings for Long-billed Curlew distribution were similar to that found by the OBBA (Reinking 2004; Figs. 1 & 2). Figure 1 shows their distribution on a SSURGO soil map. They appear to cluster in the Sherm and Gruver clay loams, although not as exclusively as the Mountain Plovers. They are ground nesters, like the plovers, and may avoid the sandy soil for the same reasons I suspect for the plovers (wind-blown sand covering eggs/nest scrape). Curlews do not seem to require the same low vegetation or bare soil that plovers do and can perhaps nest in sandy soil areas that are vegetated and not bare, where wind-blown sand is less of a problem. I found three curlew nests in 2005: one in a small prairie dog (*Cynomys ludovicianus*) town (on 7 May), one in a plowed agricultural field with low weeds (on 2 June), and one in a mostly bare field with 10-cm wheat stubble (on 14 May;2 eggs).

Curlews were not as restricted as the plovers in their habitat preferences. I found them in bare or mostly bare situations ~40% of the time (Table 1), compared to the plovers' ~90%. Additionally, I found curlews feeding in a variety of agricultural situations (pasture, wheat, stubble/harvested fields, etc.).

I often saw Long-billed Curlews mobbing Chihuahuan Ravens (*Corvus cryptoleucus*) and Swainson's Hawks (*Buteo swainsoni*) in defense of nest or young. I often found them along or in section roads, and I found a dead juvenile in a Cimarron County road on 10 June 2004. Protesting adults sometimes flew at moving vehicles, and a pair that I found dead <10 m apart in a section road 23 May 2005 were presumably struck by a vehicle while protesting from a road.

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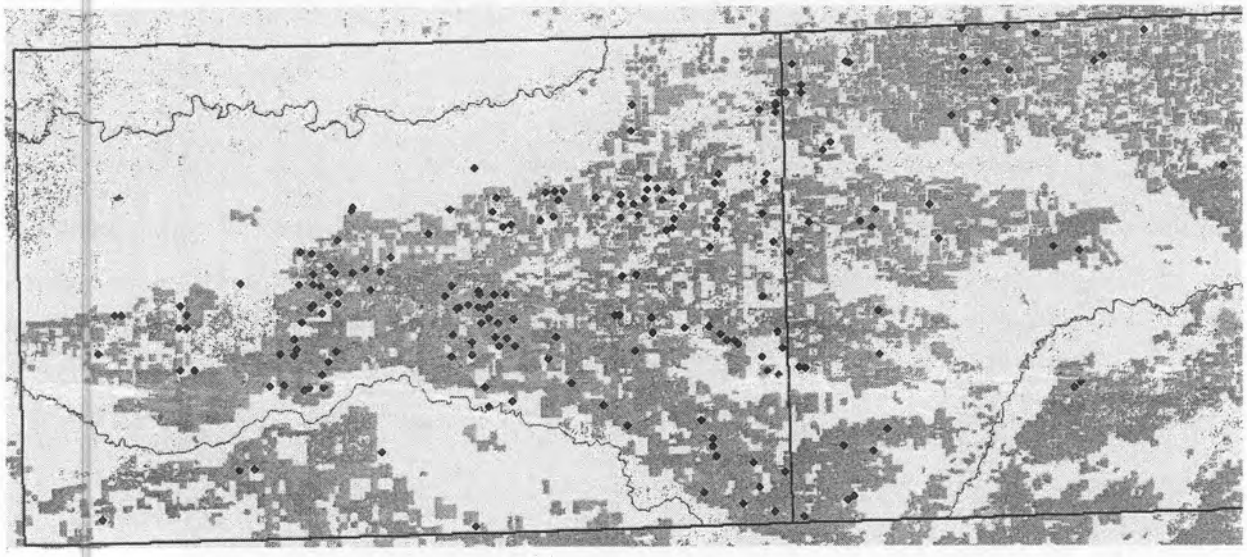
Table 1. Habitat types in which Long-billed Curlews were found in 2004–2005, Cimarron and Texas counties, Oklahoma.

Habitat	#	Pct.
Pond/playa/windmill pond/puddle	6	1.7
Wheat	22	6.4
Wheat/weed stubble	34	9.9
Weeds/forbs	8	2.3
Native prairie	21	6.1
Native prairie grazed	1	0.3
Pasture/grazed native prairie or CRP	27	7.8
Corn stubble	16	4.7
CRP	19	5.5
Prairie dog town	13	3.8
Bare/2–6" milo or corn	12	3.5
Bare/turned under vegetation	53	15.4
Milo stubble	12	3.5
Bare	62	18.0
Bare/forbs	5	1.5
Grazed 6" wheat	8	2.3
Roadside ditch	1	0.3
Short grass	6	1.7
Cattle pen	1	0.3
Sandsage	2	0.6
NP	8	2.3
8" dead wheat	5	1.5
Mown roadside by CRP	2	0.6
Total	**344**	**100**

Figure 1. Distribution of Long-billed Curlews, 2004–2005, Cimarron and Texas counties, Oklahoma. Sherm clay loam is shown in yellow, Gruver clay loam in orange. Blue diamonds represent birds present; red diamonds indicate confirmed breeding.

Figure 2. Distribution of Long-billed Curlews, 2004–2005, Cimarron and Texas counties, Oklahoma. CRP fields are shown in light blue, agricultural areas are grey, and prairie is shown in topaz. Blue diamonds represent birds present; red diamonds indicate confirmed breeding.



APPENDIX A: RANGES OF SELECTED SPECIES OF BIRDS IN THE OKLAHOMA PANHANDLE

In addition to conducting 1,104 10-minute surveys in 10 contiguous townships in Cimarron County in 2004–2005, John Shackford and I made special efforts to cover as much of the county as possible, noting the locations of species of interest. Several species of birds were common enough in appropriate habitats in Cimarron County that we generally did not record locations for them outside of the 10-minute surveys. They include: Turkey Vulture (*Cathartes aura*; nest with two juveniles on mesa cliff 17 May 2005), Mallard (*Anas platyrhynchos*), Ring-necked Pheasant (*Phasianus colchicus*), Wild Turkey (*Meleagris gallopavo*; in river timber), Northern Bobwhite (*Colinus virginianus*), Scaled Quail (*Callipepla squamata*), Killdeer (*Charadrius vociferus*), Mourning Dove (*Zenaida macroura*), Rock Pigeon (*Columba livia*), Common Nighthawk (*Chordeiles minor*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Northern Flicker (*Colaptes auratus*), Say's Phoebe (*Sayornis saya*; common at abandoned houses/barns), Western Kingbird (*Tyrannus verticalis*), Horned Lark (*Eremophila alpestris*), Cliff Swallow (*Petrochelidon pyrrhonota*), Barn Swallow (*Hirundo rustica*), American Robin (*Turdus migratorius*; mostly in Boise City, also at a few locations in river timber), Northern Mockingbird (*Mimus polyglottos*), European Starling (*Sturnus vulgaris*), Lark Bunting (*Calamospiza melanocorys*), Blue Grosbeak (*Guiraca caerulea*), Dickcissel (*Spiza americana*), Red-winged Blackbird (*Agelaius phoeniceus*), Western Meadowlark

(*Sturnella neglecta*), Common Grackle (*Quiscalus quiscula*), Great-tailed Grackle (*Quiscalus mexicanus*), Brown-headed Cowbird (*Molothrus ater*), Bullock's Oriole (*Icterus bullockii*), Orchard Oriole (*Icterus spurius*; river timber), House Finch (*Carpodacus mexicanus*), and House Sparrow (*Passer domesticus*).

In the accounts that follow, I present breeding distributions of breeding birds in Cimarron County (and sometimes Texas County, which received much lighter coverage) based on our study. The base maps, with scale and legend, are presented below. In the species accounts, blue circles on the map indicate bird(s) present; red circles indicate confirmed breeding. In some cases, for species confined to the mesa region, I have substituted a slope percentage map for the vegetation maps. Note that we did not cover Cimarron County in its entirety (Fig. 1), so that a gap in a bird's range on our maps does not necessarily imply absence. Also note that although I have indicated instances where we confirmed breeding, this was not a priority; instead, the emphasis was on covering the greatest area of the county possible. Because our study was conducted during breeding season, most of these birds could be assumed to be at least attempting to breed, whether confirmed or not.

Comparisons are made to the Oklahoma Breeding Bird Atlas (OBBA; Reinking 2004). Our efforts served mostly to "fill in the spaces" between Atlas blocks, although we sometimes found species present that were not found by Atlas efforts. For the most part, I was continually impressed with how similar our distribution maps for Cimarron County were to the OBBA maps, considering their blocks only covered ~12% of the county.

Below is a map on which I have plotted all GPS locations of species of interest in Cimarron County during the 2 years of the study (Fig. 1; blue=bird(s) present; red=breeding confirmed). This gives a fair idea of the area covered in the county during our fieldwork. There are some areas of the map that are blank, not because they were not covered, but simply because we did not note a species of interest in that area. Overall, however, the map gives a good indication of coverage.

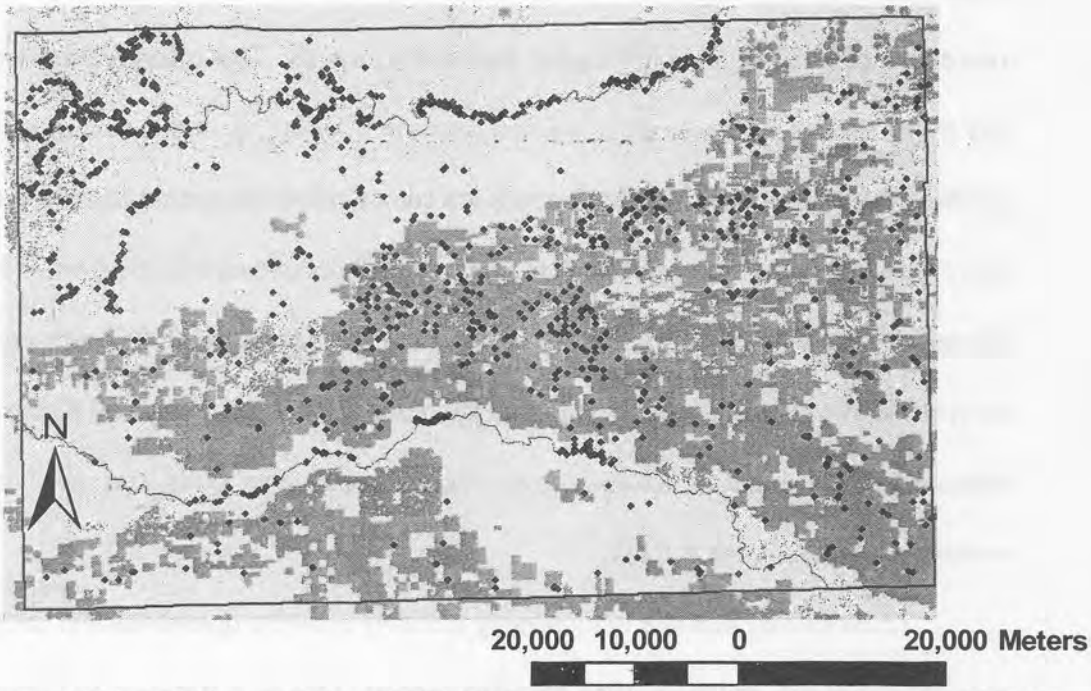


Fig. 1. Map of Cimarron County, Oklahoma, giving approximation of areas receiving coverage during 2004–2005 field seasons.

PANHANDLE WETLANDS

(Much of the information presented here can be found in the species accounts that follow; Latin names are presented here only for species not mentioned in the accounts)

Cimarron County is arid: from 1971–2000, average annual precipitation in the Boise City area was 47 cm (NOAA 2002). However, wetlands (natural and artificial)

exist in the western one-half of the Panhandle and provide habitat for wetland-obligate species. The Cimarron and, in particular, Beaver rivers contain long, dry stretches; according to the locals, they are much drier than they were a few decades ago, and small dams, now waterless, in the ranch areas testify to a wetter past. In stretches of river with flowing water, however, cattail stands are common and form long, narrow wetland areas; I found Virginia Rails breeding in such a location along the Beaver River in 2005. The Cimarron River in particular has many such areas, and I walked one 2.5–3 km stretch on two evenings in 2005, playing Virginia Rail and Sora calls. This effort did not turn up any target species, but these areas warrant future monitoring, as do the occasional beaver ponds in the ranch areas. Windmill ponds are common in southcentral Cimarron County, and I found breeding American Avocets at these, and occasional Black-crowned Night Herons. Playas formed during the wet spring and early summer of 2005 and were frequented by avocets, ducks, and migrant shorebirds. The Boise City and Keyes sewage treatment ponds attract numerous migrant ducks, herons, terns, gulls, and shorebirds; avocets and ducks breed at them.

Texas County is home to increasing numbers of swine operations and their associated lagoons, and these often attracted avocets. One such wetland, on the west side of R13-T6-S19/30, contained breeding avocets (≥6 adults, two juveniles) and 11 Black-crowned Night Herons (mix of adults and immatures) on 12 July 2005. Easily the best wetland area we found during our research was a catchment basin in Texas County. It is owned (leased?) by (Seaboard Farms?), and Scott Anderson, the manager, said this area filled up in one day (15 May 2005) after a rain. It covered ~¼-section (R13-T6-S26, southwest ¼) when JS (4 July) and I (12 July) visited it. JS counted 350 avocets here; I

counted 260. I also noted seven adult Black-necked Stilts. Both species were doing much protesting, but we found neither eggs nor young. On 12 July, this playa also held a Franklin's Gull (*Larus pipixcan*), Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*), two White-faced Ibises (10 on 4 July), two male Cinnamon Teal (also here 4 July), 12 Great Blue Herons, and numerous shorebirds, including dowitchers (*Limnodromus* sp.), Stilt Sandpipers (*Calidris himantopus*), Lesser & Greater Yellowlegs (*Tringa flavipes & T. melanoleuca*) , Least Sandpipers (*Calidris minutilla*), and Wilson's Phalaropes (~150 both dates).

SPECIES ACCOUNTS

Cattle Egret (*Bubulcus ibis*)

Single bird in a pasture in extreme southwestern Texas County 14 June 2004.

Green Heron (*Butorides virescens*)

Single bird flyover on 1 June 2005 along creek just east of Black Mesa.

White-faced Ibis (*Plegadis chihi*)

Six records, mostly from the sewage ponds at Boise City (13 on 15 May 2005) and Keyes (one bird here 16 June 2004) in mid-May and a large playa in Texas County in early July (including 10 on 4 July 2005). Also encountered a flock of seven birds at a pond in northwestern Cimarron County on 11 May 2005.

Cinnamon Teal (*Anas cyanoptera*)

On 15 May 2004 there was a pair of Cinnamon Teal (♀ Cinnamon or Blue-winged Teal?) at a catchment pond just east of the Boise City sewage ponds; a male was there 22 May. That pond had dried up when checked again in early July. A pair was at

the same location 10 May 2005. We had two locations in Texas County with Cinnamon Teal, including ≥2 males at a 65-ha playa.

Northern Shoveler (*Anas clypeata*)

Single male seen at Keyes sewage ponds 1 June 2004.

Ruddy Duck (*Oxyura jamaicensis*)

Bred at Keyes sewage ponds in 2004; two females with one and five hatchlings here 16 June. Two pairs here 22 May 2005; pair present 2 June.

Wilson's Phalarope (*Phalaropus tricolor*)

Most birds, presumably migrants, were seen at the Boise City (dozens 15 May 2005) and Keyes sewage ponds in mid-May, and in early July at a large Texas County playa (~150 on two dates). Two June records: two at the Boise City sewage ponds 4 June 2004, and one at a small playa 11 km southwest of Boise City on 15 June 2005.

Bald Eagle (*Haliaeaetus leucocephalus*)

I found a Bald Eagle nest on 30 June 2005 with one juvenile bird which was flying well (McConnell et al. 2006). Beneath the nest I found eight black-tailed prairie dog (*Cynomys lucovicianus*) skulls, and there was a prairie dog town <2 km away. The nearest large body of water was Clayton Lake, >50 km to the west. Lake Carl Etling was <5 km to the north, but was drained on 21 April 2005. Clint Boal (in press) found an active Bald Eagle nest in an area similarly removed from a large body of water in 2004 in Dallam County, TX, ~48 km south/southwest of this location; he also found numerous prairie dog bones under the nest. I found another large stick nest ~9.5 km east of Kenton in 2005 that is certainly an eagle nest of some sort and appears to have been used fairly

recently. Bill Voelker examined photos of this nest and believed it was a Bald Eagle nest.

Prairie Falcon *(Falco mexicanus)*

I found two nests in 2005 on cliffs in the mesa area. In 1995, researchers from the G. M. Sutton Avian Research Center found seven active breeding pairs in Cimarron County (GMSARC 1995), all at cliffs in the mesa area.

Virginia Rail *(Rallus limicola)*

I located a pair of Virginia Rails breeding in a narrow, cattail-lined strip of wetlands in the Beaver River in southcentral Cimarron County on 16 June 2005 (McConnell et al. in press). Following is a summary of repeated visits to the site:

6/16- bird giving "kiddick" call, 10:35 A.M.

6/17- pair; one bird giving descending grunts, the other giving alarm calls (a loud, sharp *heep!*, or *peep!*). No nest found. Mockingbird here imitating "kiddick" call.

6/19- pair; no nest found. Bird giving alarm calls.

6/22- no nest found.

6/25- no nest found.

6/27- juveniles heard for first time, giving a plaintive, wheezy, whistled *heee-ip*, or *seee-ip*. One adult gave alarm calls, to which the young responded with *seee-ip* calls; the adult then moved quickly to the juveniles' location.

6/28- saw one juvenile briefly, following an adult through the cattails.

6/29- heard two or three juveniles.

7/2- ≥4 juveniles calling. Photographed an adult.

7/5- adult gave descending grunts once.

7/8- juveniles calling *seee-eet*, sometimes with a downwards slur at the end. One adult twice gave a harsh, grating bawl, to which the juveniles responded with *see-ip* calls. It appears that one adult has two juveniles with it, and the other adult has one or two juveniles ~15 m away. The adults are generally in the same two spots each time I visit, and juvenile calls are heard in the same locations. Photographed an adult.

This was evidently the first confirmed breeding of this species in Oklahoma since 1961 and the fourth since 1930, but I would imagine there are undetected breeding Virginia Rails in Oklahoma every year. I walked westward along the Cimarron River from Route 287 ~2.5–3 km the evenings of 2&3 July 2005, broadcasting Virginia Rail and Sora (*Poranza carolina*) calls, and did not hear any responses. This promising-looking area had much standing water and wide swaths of cattails and would be a good place to monitor in the future.

American Golden Plover (*Pluvialis dominica*)

Found a bird in northwestern Texas County 8 June 2005 in partial breeding plumage (much black on belly; less around face), hopping around on one leg in a bare field with some wheat stubble and forbs. Interestingly, also had a Killdeer and a pair of Mountain Plovers in the same field, so had three plover species in a ¼-section.

White-winged Dove (*Zenaida asiatica*)

Breeding confirmed in Boise City in 2004 (McConnell and Shackford 2005). Pair seen in 2005 in Boise City.

Western Screech Owl (*Otus kennicottii*)

Found at two locations, at Black Mesa State Park by John Shackford, Berlin Heck, Warren Harden and Jack Tyler 22 June 2005, and one being mobbed by passerines at another location ~5 km south of the park on 30 June 2005.

Chimney Swift (*Chaetura pelagica*)

Pair flying over Boise City High School evening of 5/15/05; pair over Boise City sewage ponds 31 May 2005.

Vermilion Flycatcher (*Pyrocephalus rubinus*)

Nested at Black Mesa State Park both years of the study. Pair nest-building 20 May 2004; birds feeding young 18&23 June 2005.

Juniper Titmouse (*Baeolophus ridgwayi*)

Just two sightings, both in 2005: two birds near Kenton 19 May, and one or two birds ~11 km south of Kenton 6 July.

Gray Catbird (*Dumetella carolinensis*)

I saw a Gray Catbird in a riparian area in the mesa country, ~23 km east/northeast of Kenton, on 3 July 2005; no evidence of breeding and no vocalizations.

Cedar Waxwing (*Bombycilla cedrorum*)

JS found a pair in a riparian area in the mesa country on 22 June 2005 and confirmed nest-building 3 July. This is evidently the sixth nesting record for the state (McConnell et al. 2006). I had a flock of 12 near Black Mesa on 1 June 2005.

Cassin's Sparrow (*Aimophila cassinii*)

We made efforts during our surveys in (mostly) 2005 to record habitat for Cassin's Sparrows (n=79; all birds recorded were singing males). We found 45 (57%) in

CRP and 20 (25%) in native prairie (the former habitat was much more common in our survey areas than the latter). The rest were in various habitats at ≤5% (milo stubble, wheat, weeds, etc.), so ~75% were in CRP or other non-shortgrass prairie habitats. I also found them during additional searches in the ranch (shortgrass prairie) areas, and they were abundant in the sandsage areas between Wheeless and Boise City; we had no sandsage in our survey fields. I only recorded one nest, with one Brown-headed Cowbird egg and three Cassin's Sparrow eggs in native prairie, on 5 June 2004, but we made no efforts to find nests for this species. During surveys conducted in 2004 in Bird Conservation Region 18 (PIF 2006), Rocky Mountain Bird Observatory found them at higher densities in native prairie (42/km^2) in Oklahoma than in CRP region-wide (10.2/km^2; Sparks et al. 2005; CRP density estimate for Oklahoma not available due to low sample size). Further studies could determine if this species is nesting successfully in CRP in Cimarron County, and compare productivity in CRP to the sandsage and native prairie areas.

Brewer's Sparrow (*Spizella breweri*)

I found a Brewer's Sparrow 18 May 2005 giving alarm notes in a grassy area with oneseed juniper and skunkbush, ~11 km east/northeast of Kenton. I did not find a nest and the bird was not seen again 19 May, 28 May or 23 June. The only Oklahoma breeding record is from Sutton (1967), who found a colony 16–19 km W of Boise City in sandsage. I searched this area on foot on 19&20 June 2005 and did not find any Brewer's Sparrows.

Grasshopper Sparrow (*Ammodramus savannarum*)

Mostly in CRP; a few in sandsage in southcentral part of Cimarron County.

Lark Sparrow *(Chondestes grammacus)*

Common breeder throughout Cimarron County. I found a nest in Texas County 25 June 2004 which contained three Lark Sparrow eggs and one Brown-headed Cowbird egg. On 23 May 2005, I found three nests, each with four eggs, within grass tufts in the streets of the old residential area of the former helium plant northeast of Keyes.

Black-throated Sparrow *(Amphispiza bilineata)*

Birds present (one singing male each time) in 2005 at a location ~3 km east of Kenton 20 May and 23 June. Found an abandoned nest with one egg in cholla cactus 23 June.

Scott's Oriole *(Icterus parisorum)*

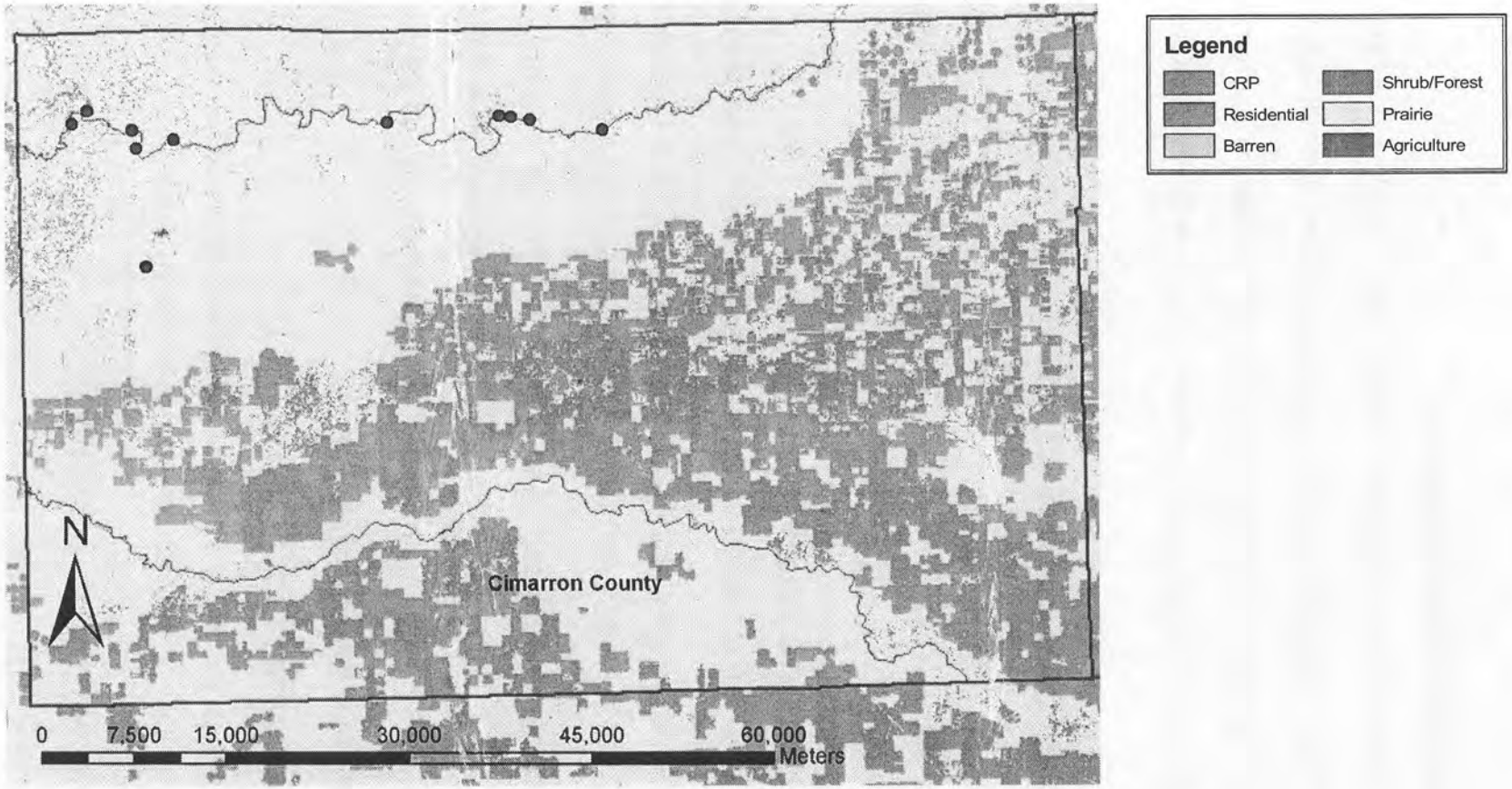
I saw a male Scott's Oriole on 21 June 2004 which flew into a cottonwood, perched ~15 seconds, then flew off to the south. This area, 25 km due east of Kenton, was visited several times in 2005 but no Scott's Orioles were found again.

Pine Siskin *(Carduelis pinus)*

Noted during 2005 at various locations around Cimarron County until 6/10. Seen many times in and around Boise City in May, including a singing bird(s?) on several dates in the trees outside our rented house.

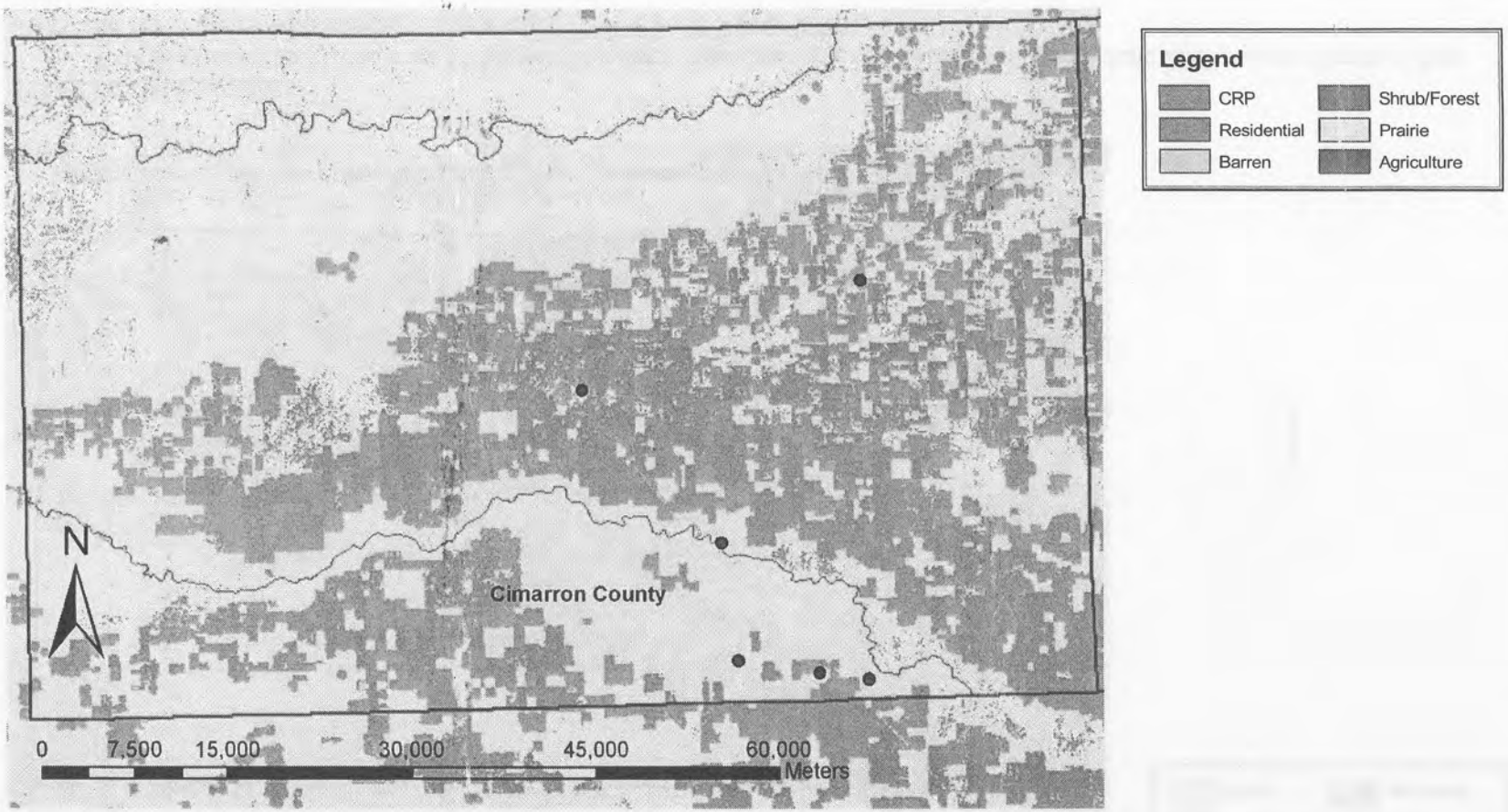
American Goldfinch *(Carduelis tristis)*

I found this species at a few locations on 9 July 2005 in an area along the Cimarron River in the northeastern quarter of Cimarron County. I also had a flyover ~11 km east/northeast of Kenton on 19 May 2005.



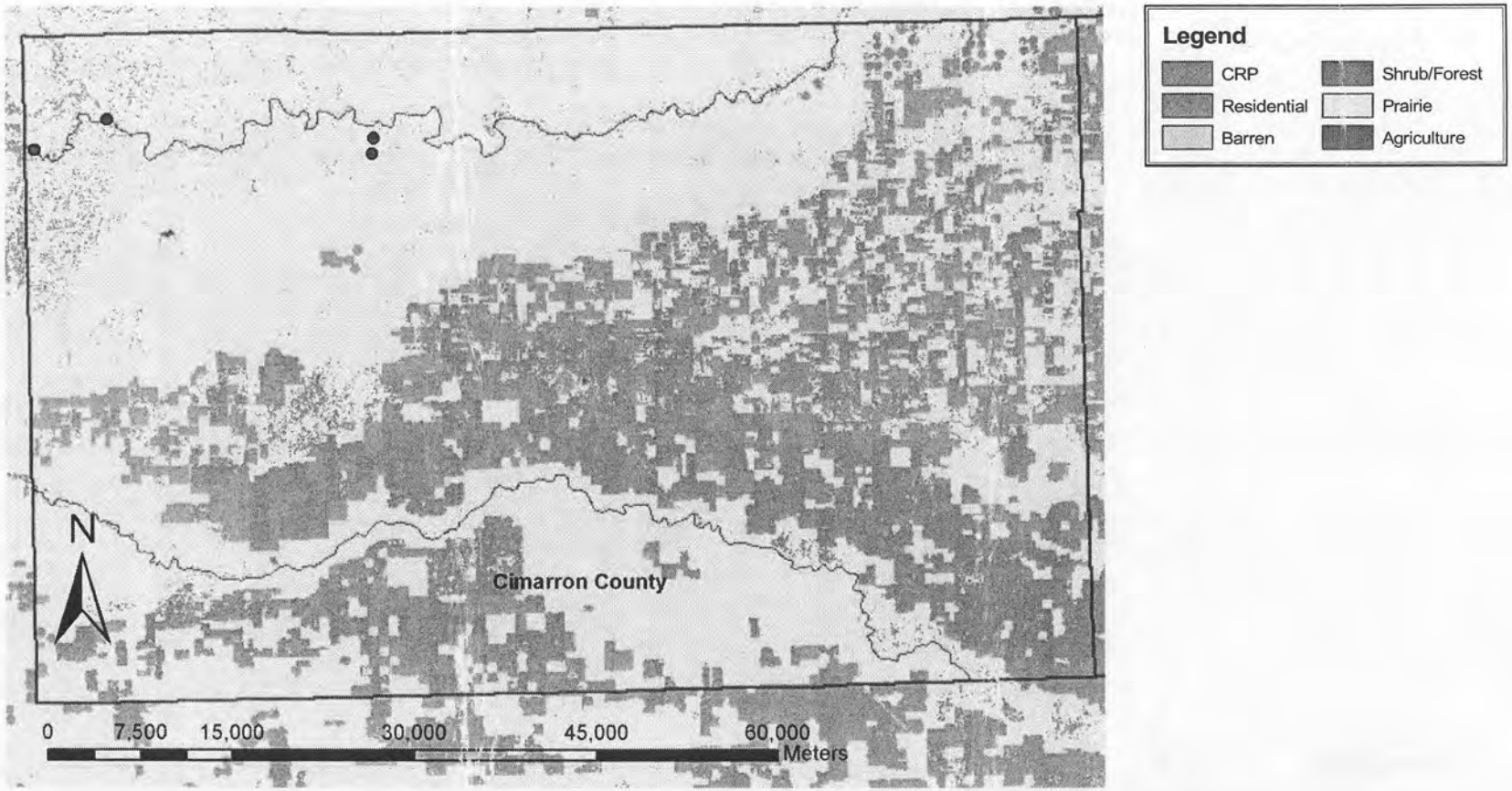
Great Blue Heron (*Ardea herodias*)

Found mostly along the Cimarron River, including one at a nest 18 May 2005. Had several overhead in the course of one day (1 June 205), including 3 at once, northwest of Kenton. Also had two records in Texas County, including ≥12 at a 65-ha playa 12 July 2005.



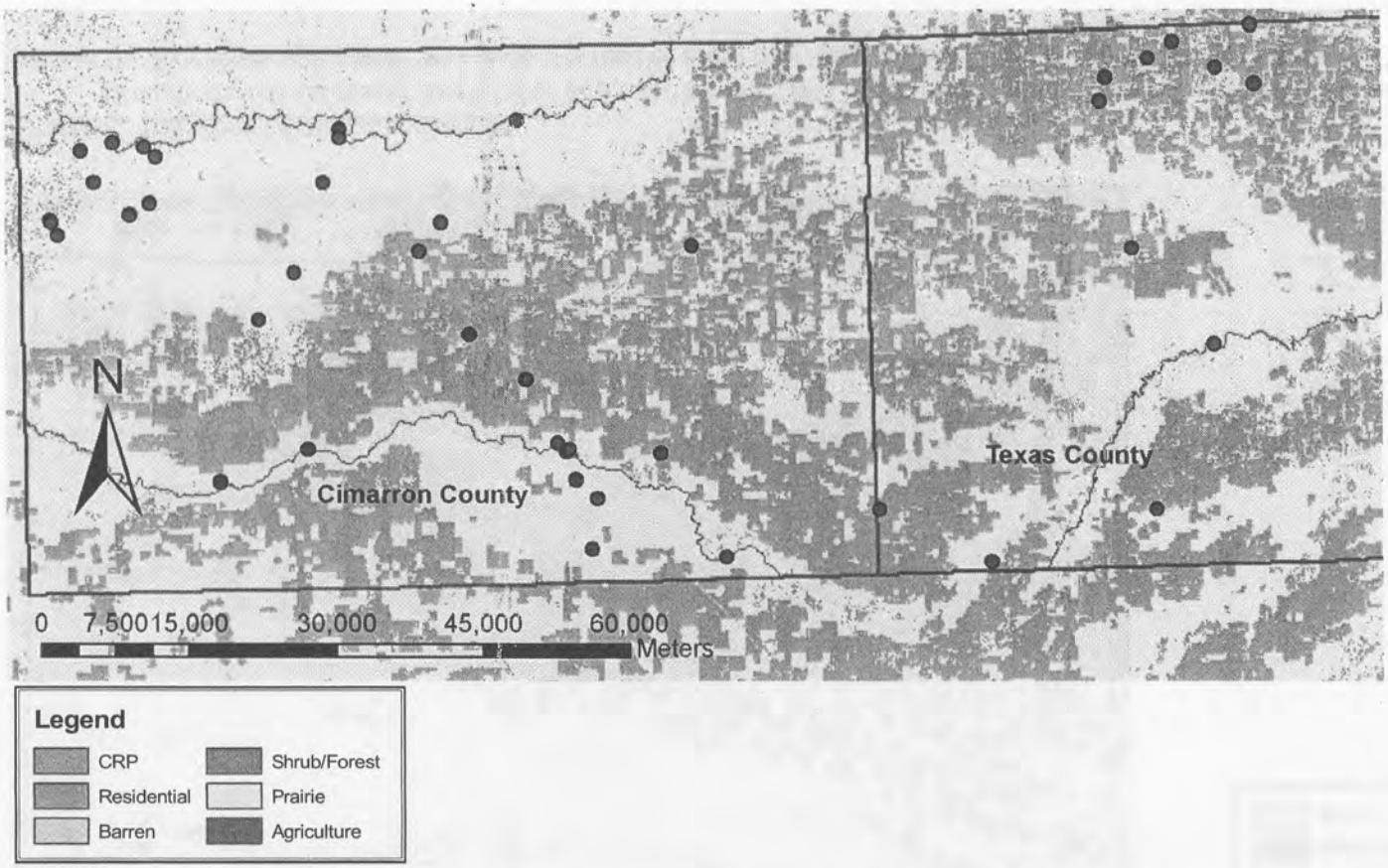
Black-crowned Night Heron (*Nycticorax nycticorax*)

Often at the Keyes and Boise City sewer ponds; also several at windmill ponds in southeastern Cimarron County. Had ≥11 birds, a mix of adults and immatures, at a swine operations wetland in Texas County on 12 July 2005.



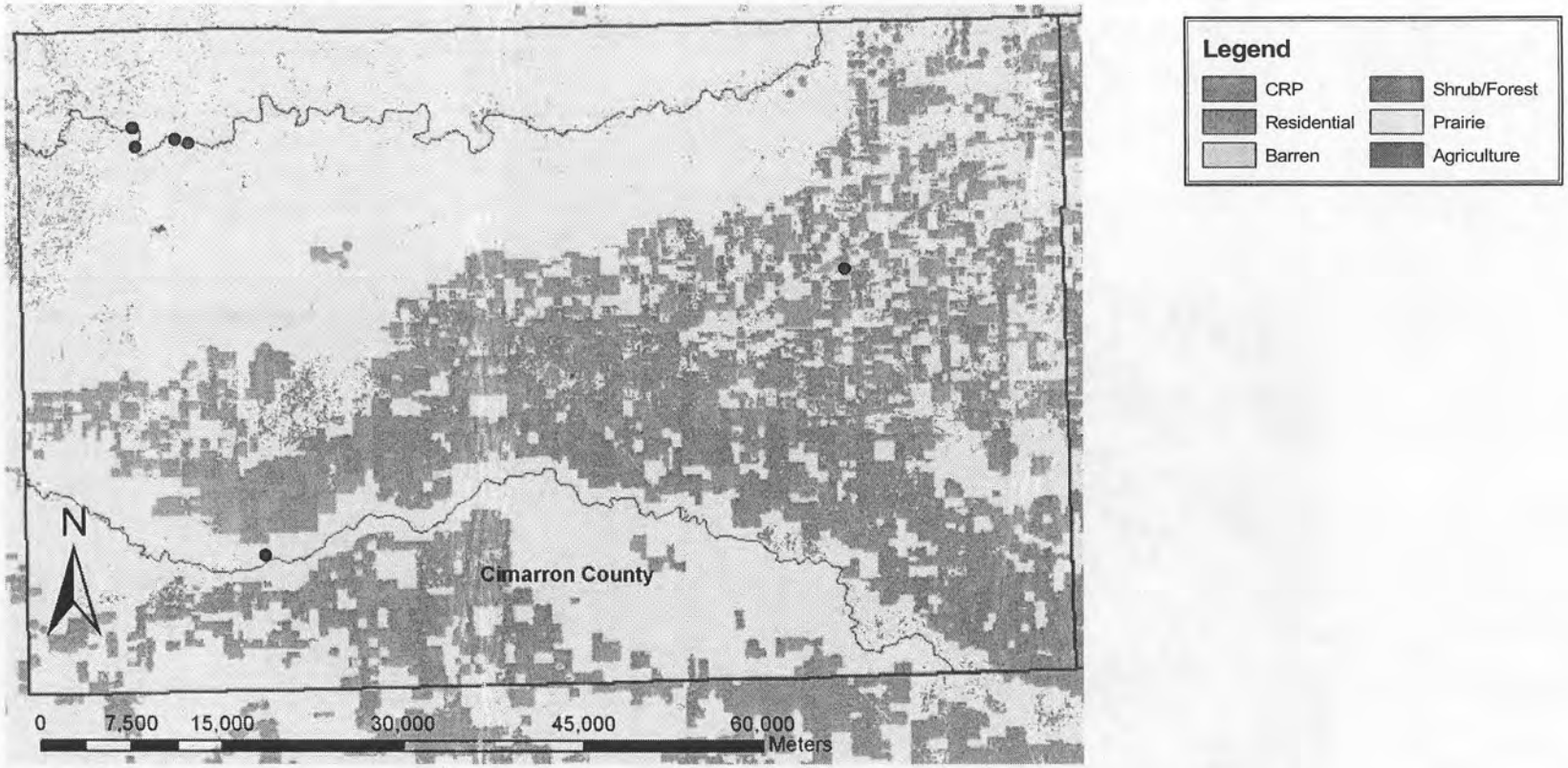
Wood Duck (*Aix sponsa*)

One May date (single male on 11 May 2005); three June dates (pair on Cimarron River 1 June 2005, single female 4 June 2005, and three males with one female at a small beaver pond 9 June 2005).



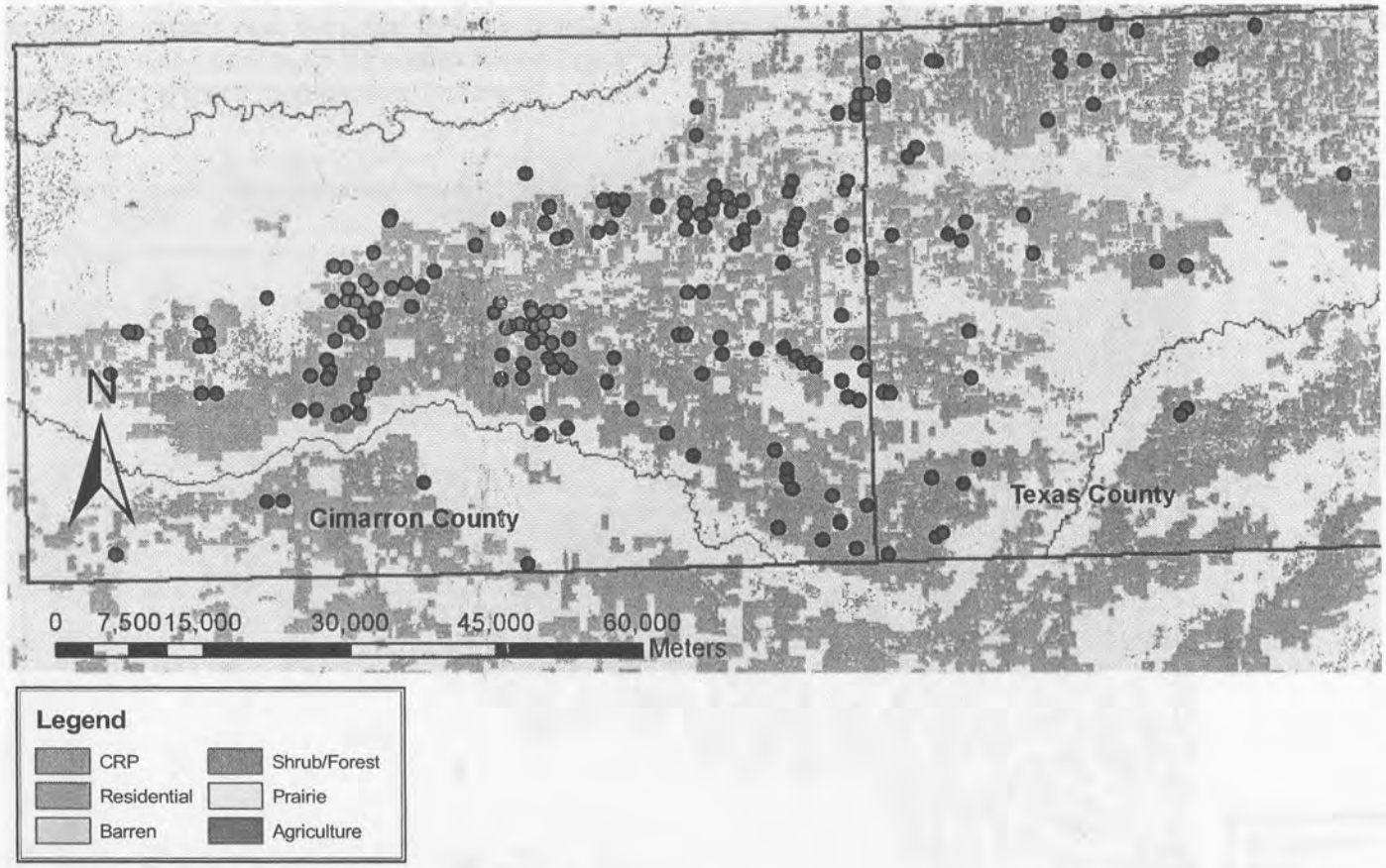
American Avocet (*Recurvirostra americana*)

Confirmed breeding twice in 2004 and seven times in 2005. Found at the Boise City and Keyes sewage ponds, piggery lagoons, cattle ponds, and at a 65-ha playa (~350 avocets here 4 July 205) in Texas County. At the latter locality, as at some of the smaller wetlands, breeding was not confirmed although adults were behaving (protesting, etc.) as though nests or juveniles were in the vicinity.



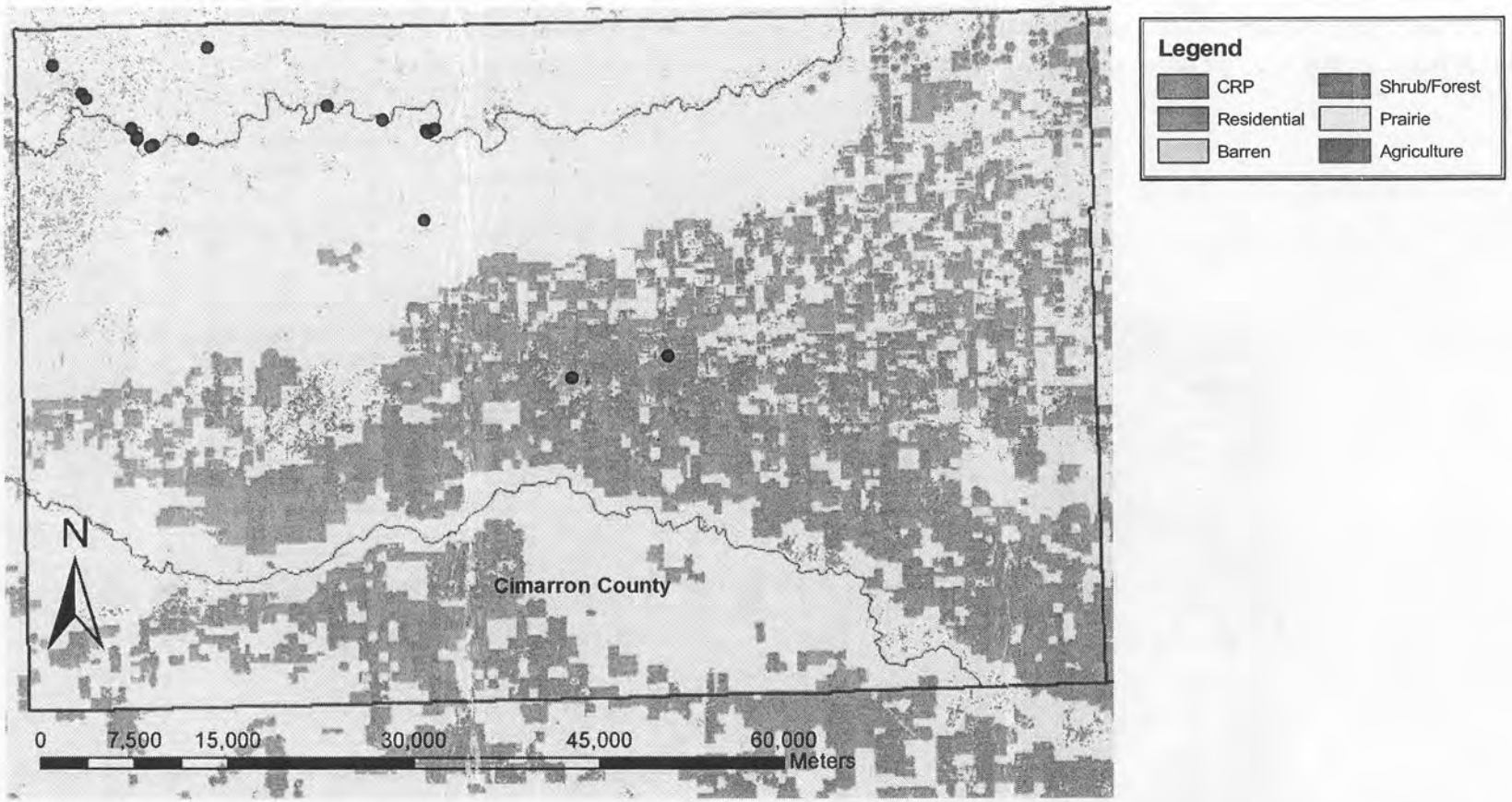
Spotted Sandpiper (*Actitis macularia*)

Blue diamonds represent single birds and red diamonds two birds; all dates 2005. Found along the Cimarron River four times, once at the Keyes sewage ponds, and once at a feedlot pond (the latter the only June date- all others 17 May to 22 May).



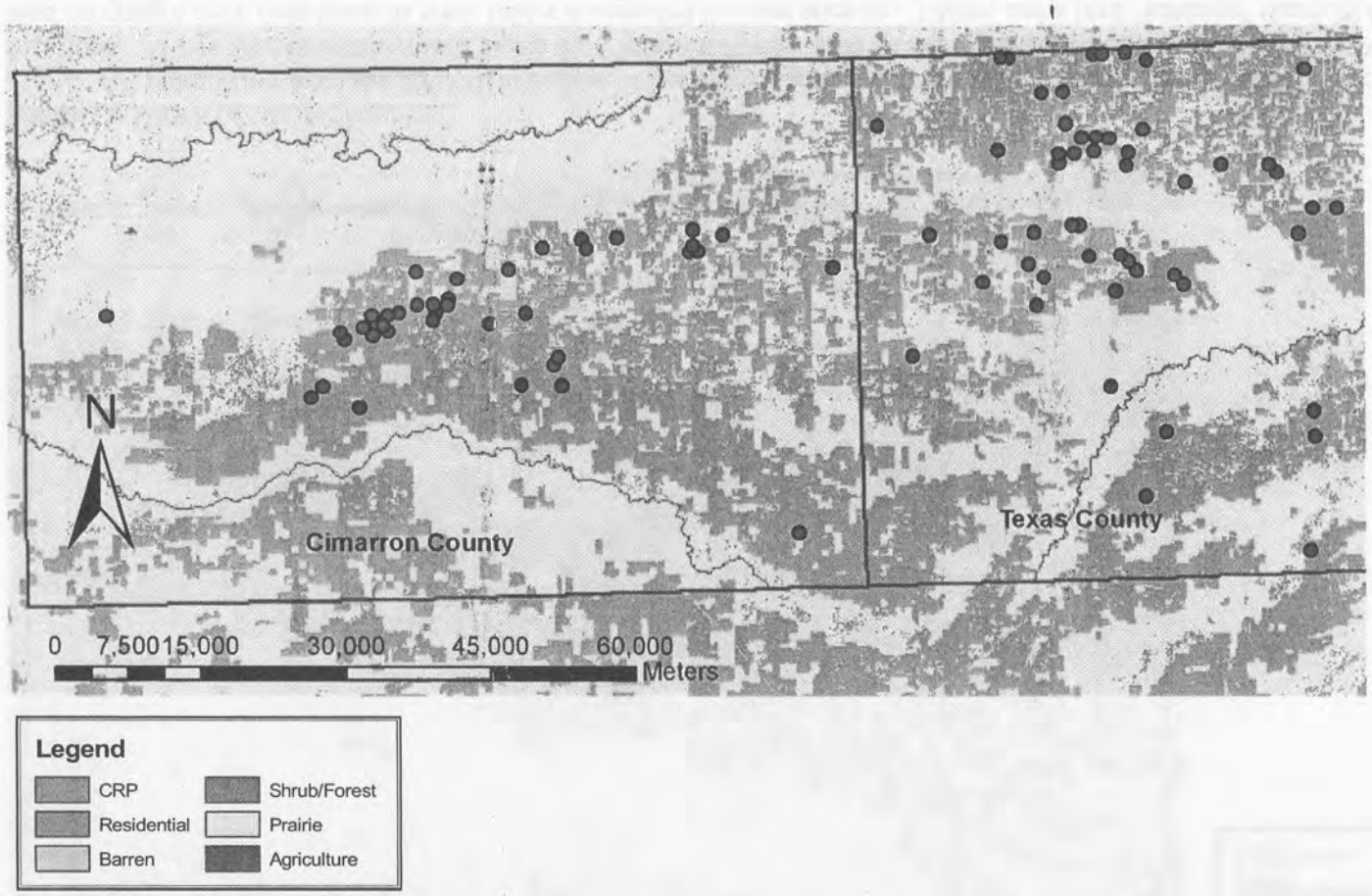
Long-billed Curlew (*Numenius americanus*)

We found Long-billed Curlews in a variety of habitats in the western half of the Panhandle, but they were concentrated in the agricultural areas. We found three curlew nests in 2005: one in a small prairie dog (*Cynomys ludovicianus*) town (7 May), one in a plowed agricultural field with low weeds (2 June), and one in a mostly bare field with 10 cm wheat stubble (14 May; two eggs).



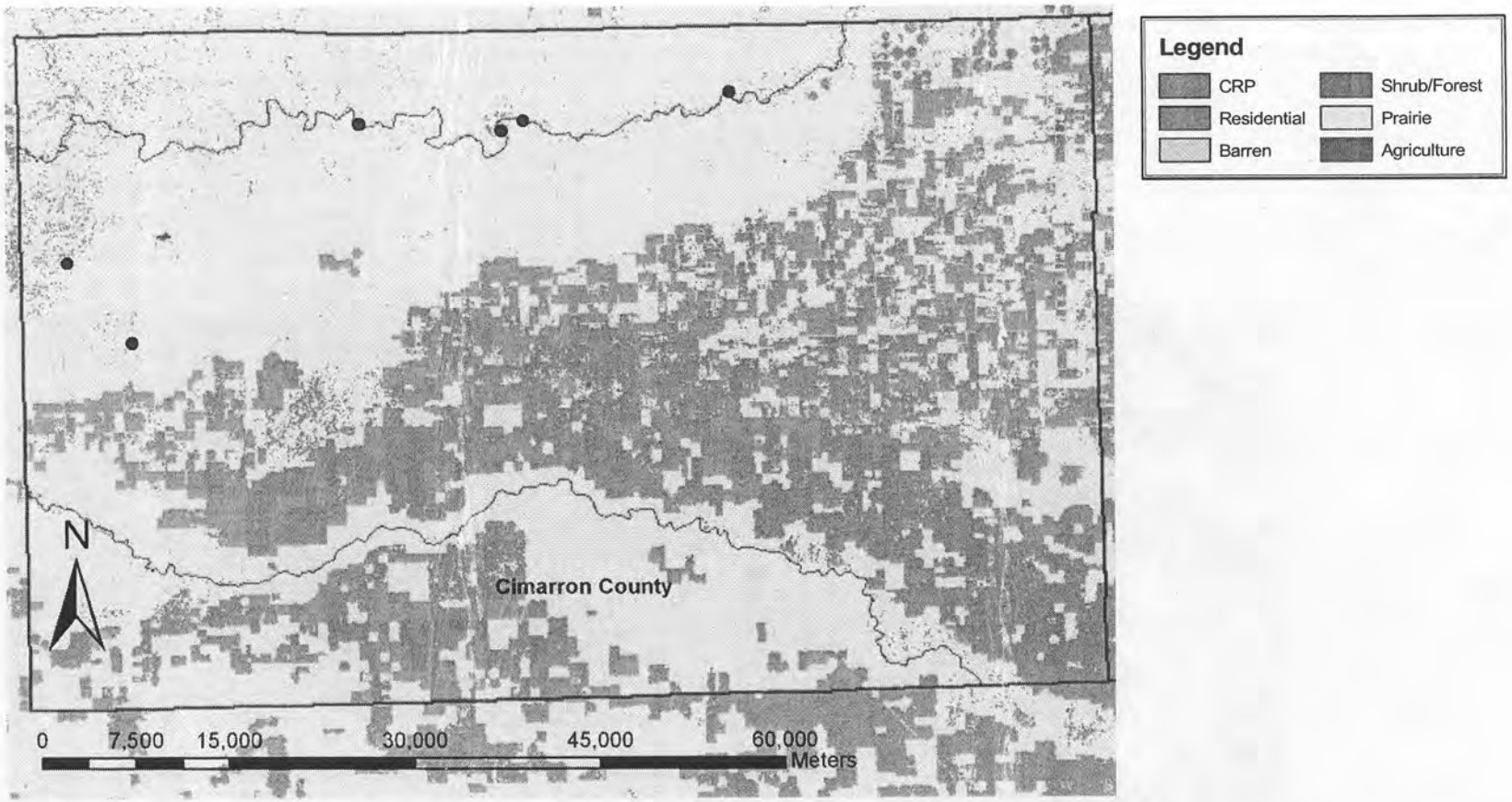
Mississippi Kite (*Ictinia mississippiensis*)

Mississippi Kites were common along the Cimarron River in the mesa country, often in small colonies. I counted 23 in the air at once, including year-old birds, near Black Mesa on 20 June 2004. On 20 June 2005, I found an adult Mississippi Kite impaled on a yucca plant (*Yucca glauca*) in a wooded riparian area 2 km south of the Colorado line. It had presumably impaled itself while chasing a prey item. Had several birds over Texhoma, Texas County, on 1 July 2004.



Northern Harrier (*Circus cyaneus*)

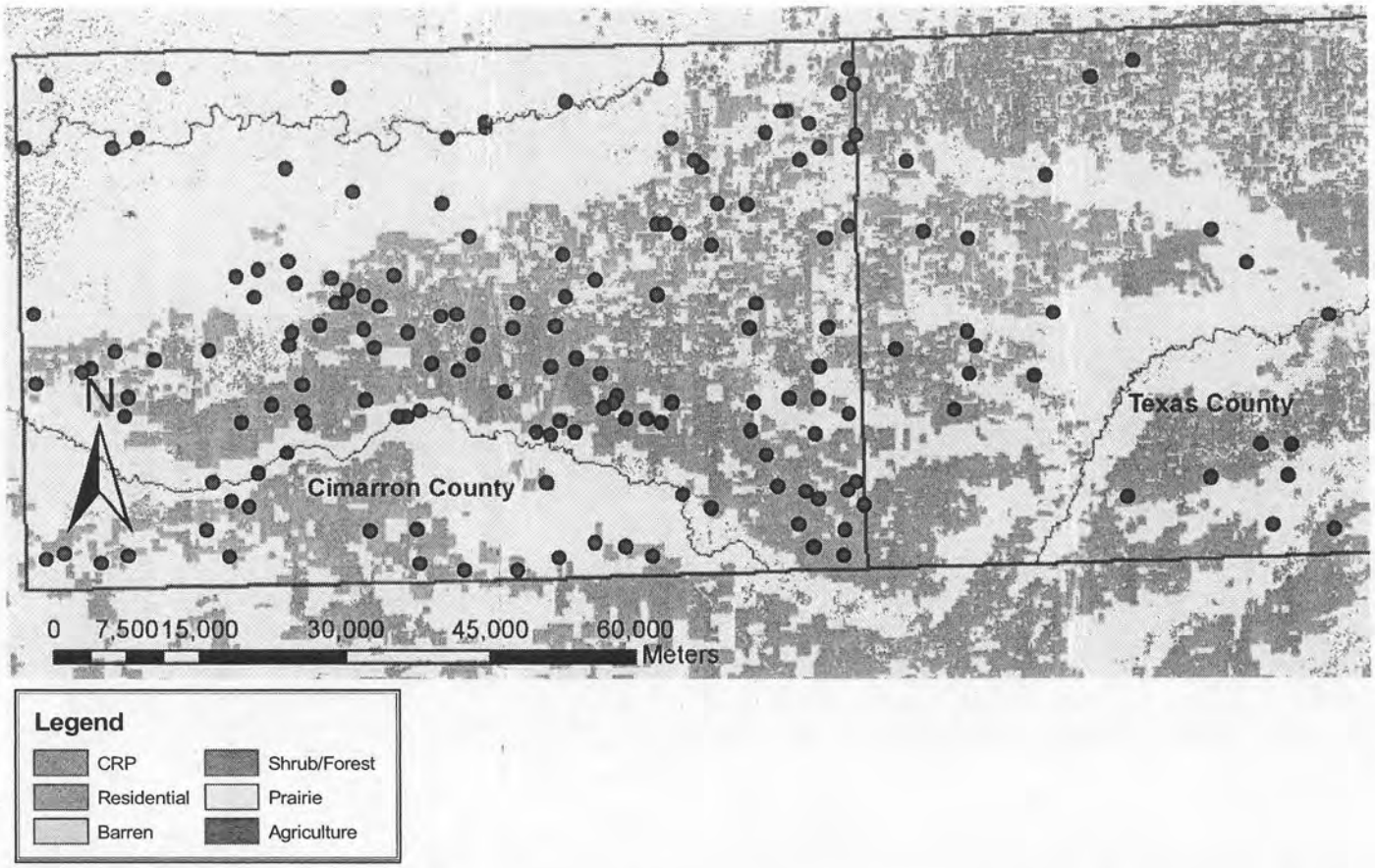
We found harriers at numerous locations, mostly in the vicinity of CRP areas. In Texas County we confirmed breeding at three locations in 2004 and at one location in 2005; we also had a breeding pair in 2005 in Cimarron County. Greater effort would undoubtedly result in more confirmations for this species.



Cooper's Hawk (*Accipiter cooperii*)

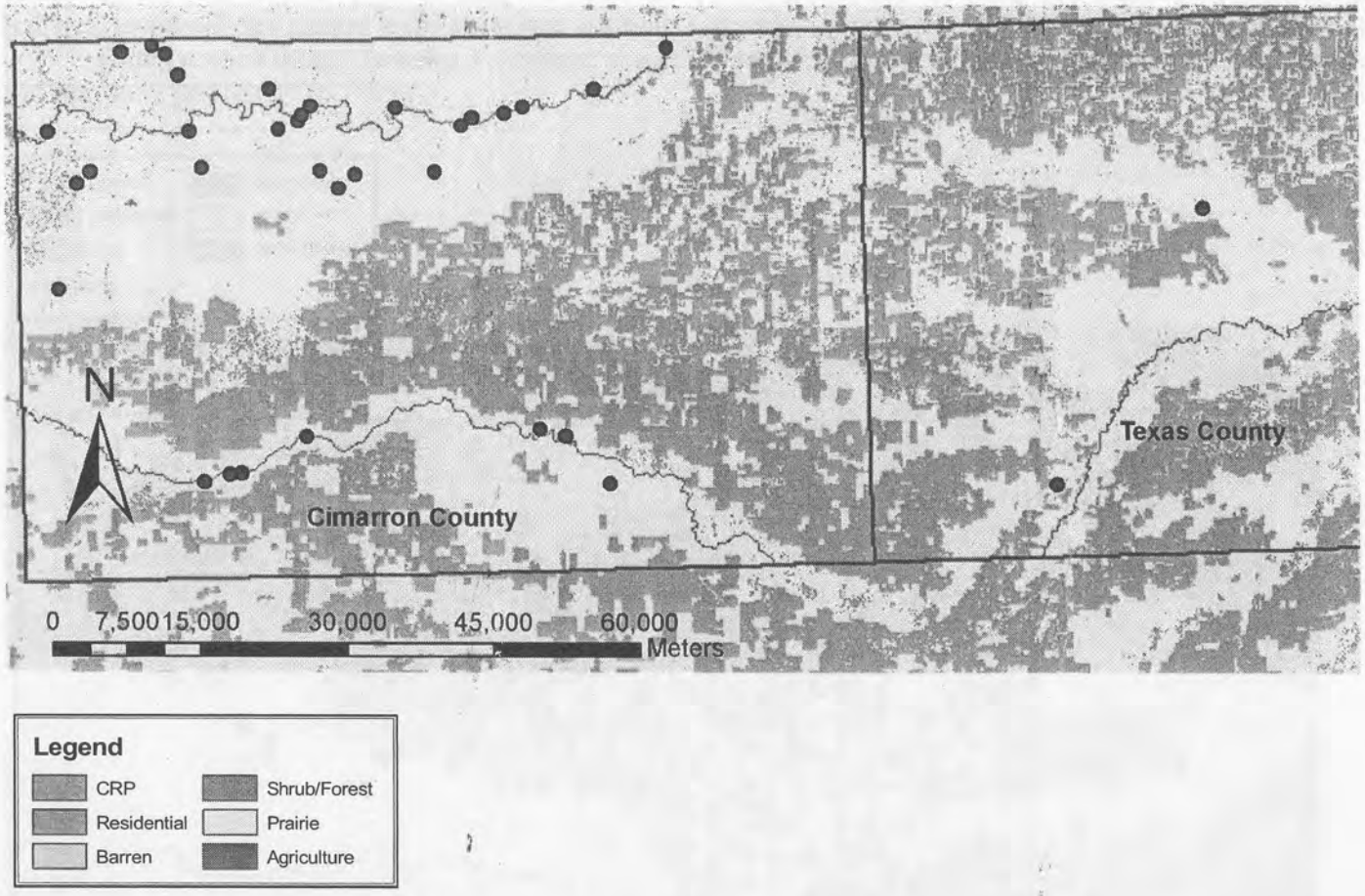
All records are from the 2005 field season. I have taken some slight liberties with the "breeding confirmed" designation at two locations. At one site, in cottonwoods along the Cimarron River, I had an adult present three dates (13 May to 29 May), including a bird carrying a prey item towards what I later designated the nest area on 13 May, and a bird "kekking" there 29 May. I failed to find the birds on several later dates. At another site in a cottonwood-lined draw, I had an adult "kek" twice and later harass a Great Horned Owl (*Bubo virginianus*). There were two old nests there in the cottonwoods and it appeared to be a regular Cooper's Hawk breeding

site. JS found a nest 20 May in an elm (*Ulmus* sp.) by a homestead which is occasionally occupied. On 9 July a fledgling and another unaged Cooper's Hawk were in cottonwoods along the Cimarron River. In the mid-1990s, researchers from the G. M. Sutton Avian Research Center found as many as seven breeding pairs in Cimarron County (GMSARC 1995), mostly in the extreme northwestern area of the county.



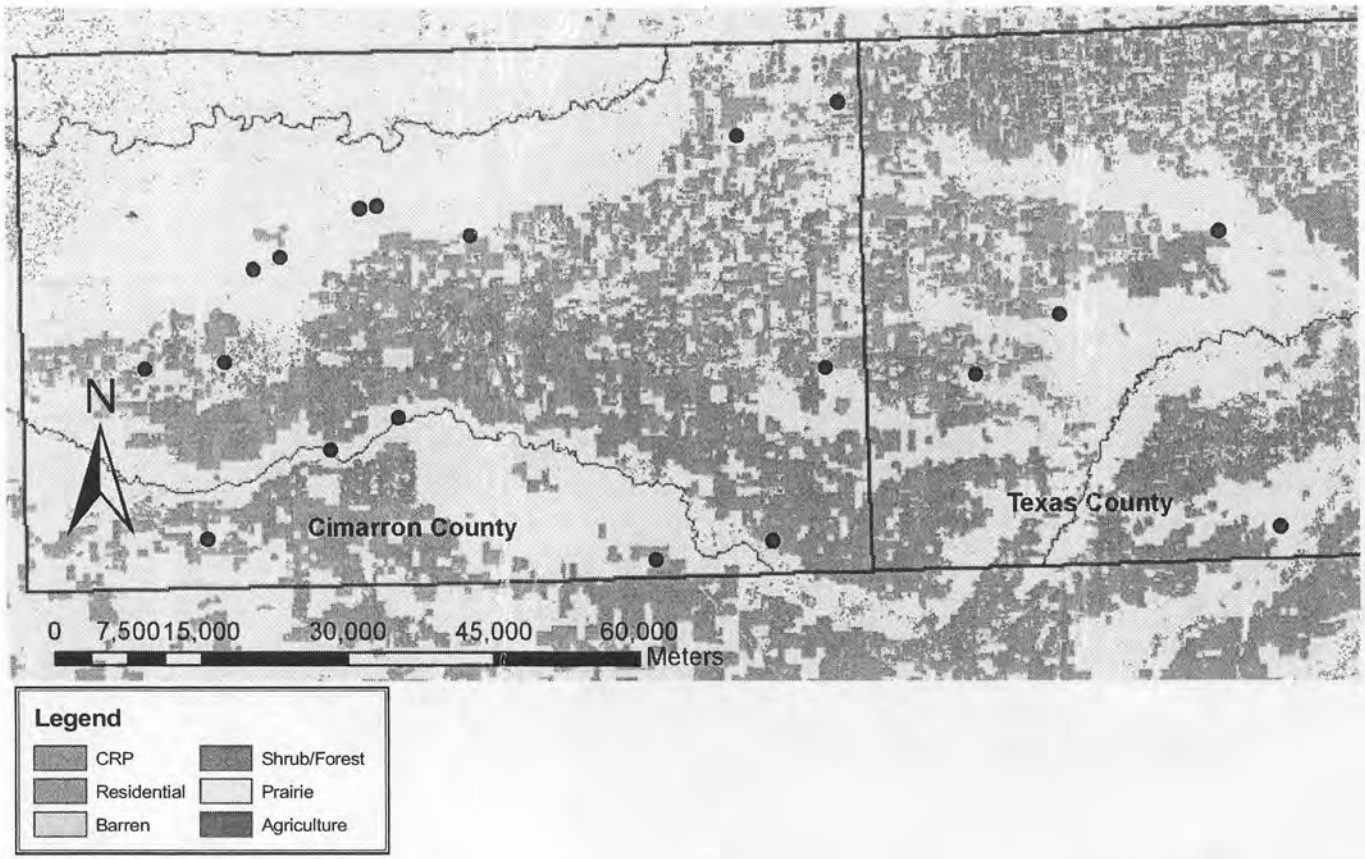
Swainson's Hawk (*Buteo swainsoni*)

Easily the most common breeding *Buteo* in the area studied, and virtually the only one breeding in the agricultural areas.



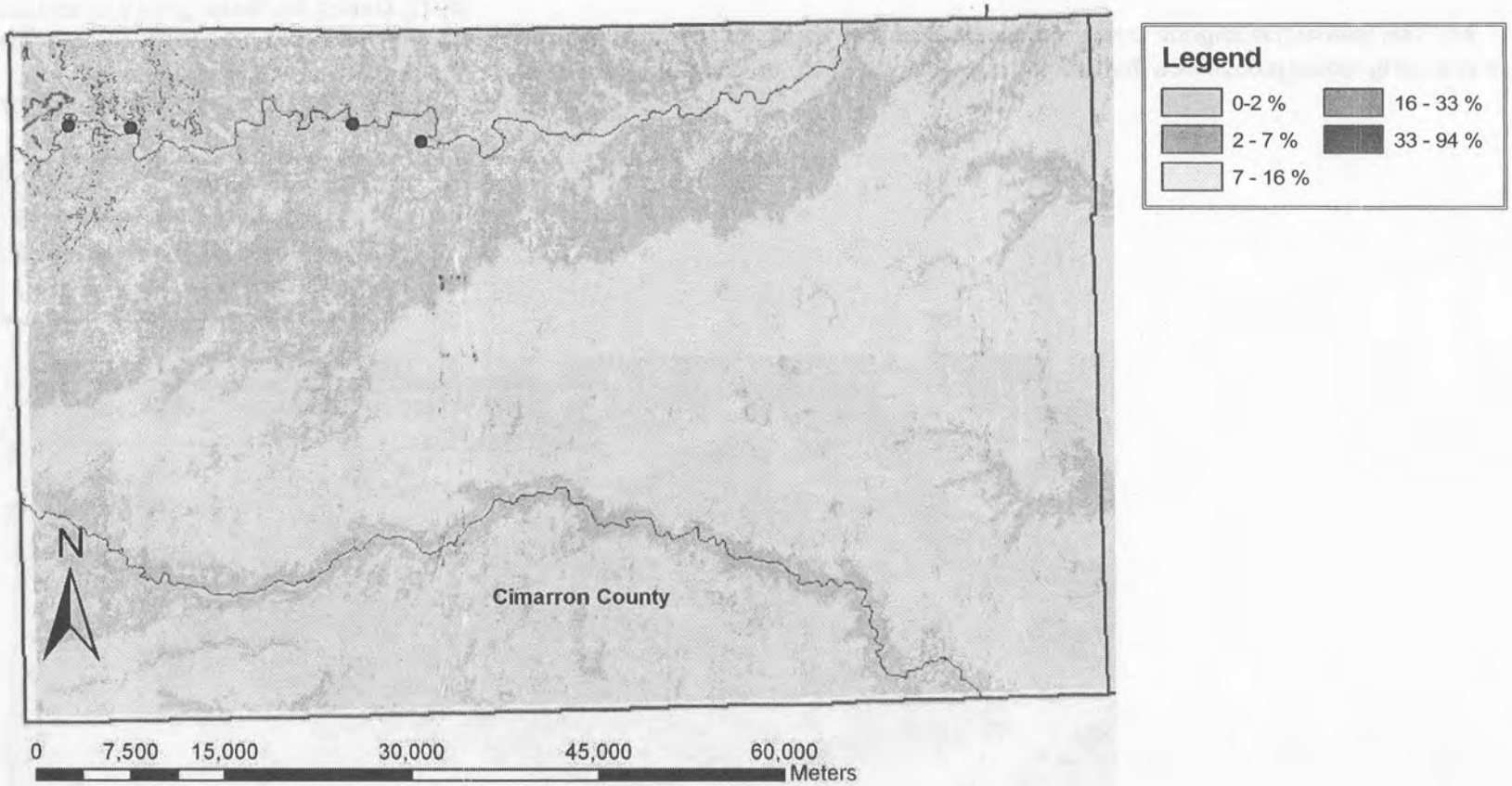
Red-tailed Hawk (*Buteo jamaicensis*)

Found nesting almost entirely in timber along river/creek beds. Was a rare nester 35 years ago (Bill Voelker, pers. comm.). Only one bird, a (presumably non-breeding) 1-year old, seen in the agricultural areas of Cimarron County during our two field seasons.



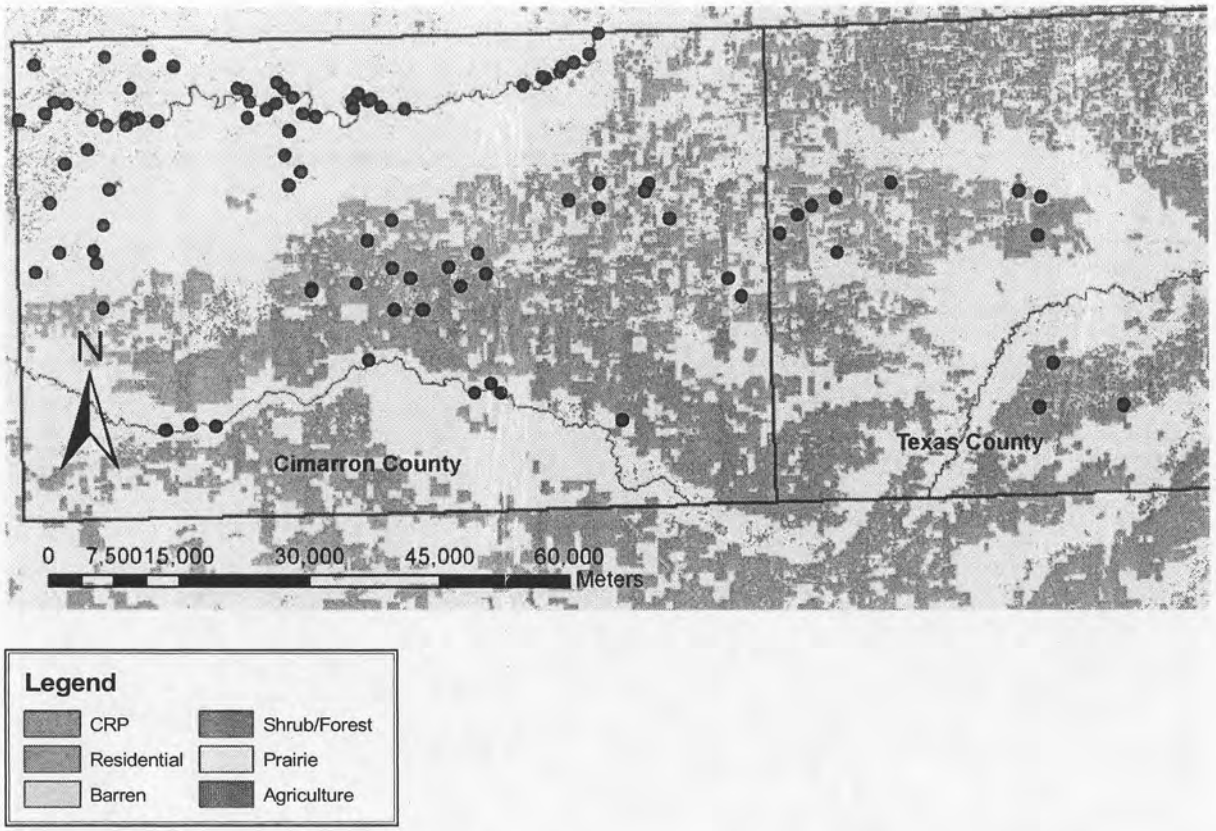
Ferruginous Hawk (*Buteo regalis*)

Found nesting mostly in prairie locations; nested in sandsage areas more often than other *Buteos*. Had two nesting rufous females, including one female at the same nest site both years of the study (light phase male present in all three instances). The other female, found nesting in sandsage in 2005, may have been present both years as well, as a rufous bird was seen in 2004 at some roadkill (along with Turkey Vultures) at a location ~5 km from the rufous female nest discovered in 2005. This nest fledged two rufous juveniles.



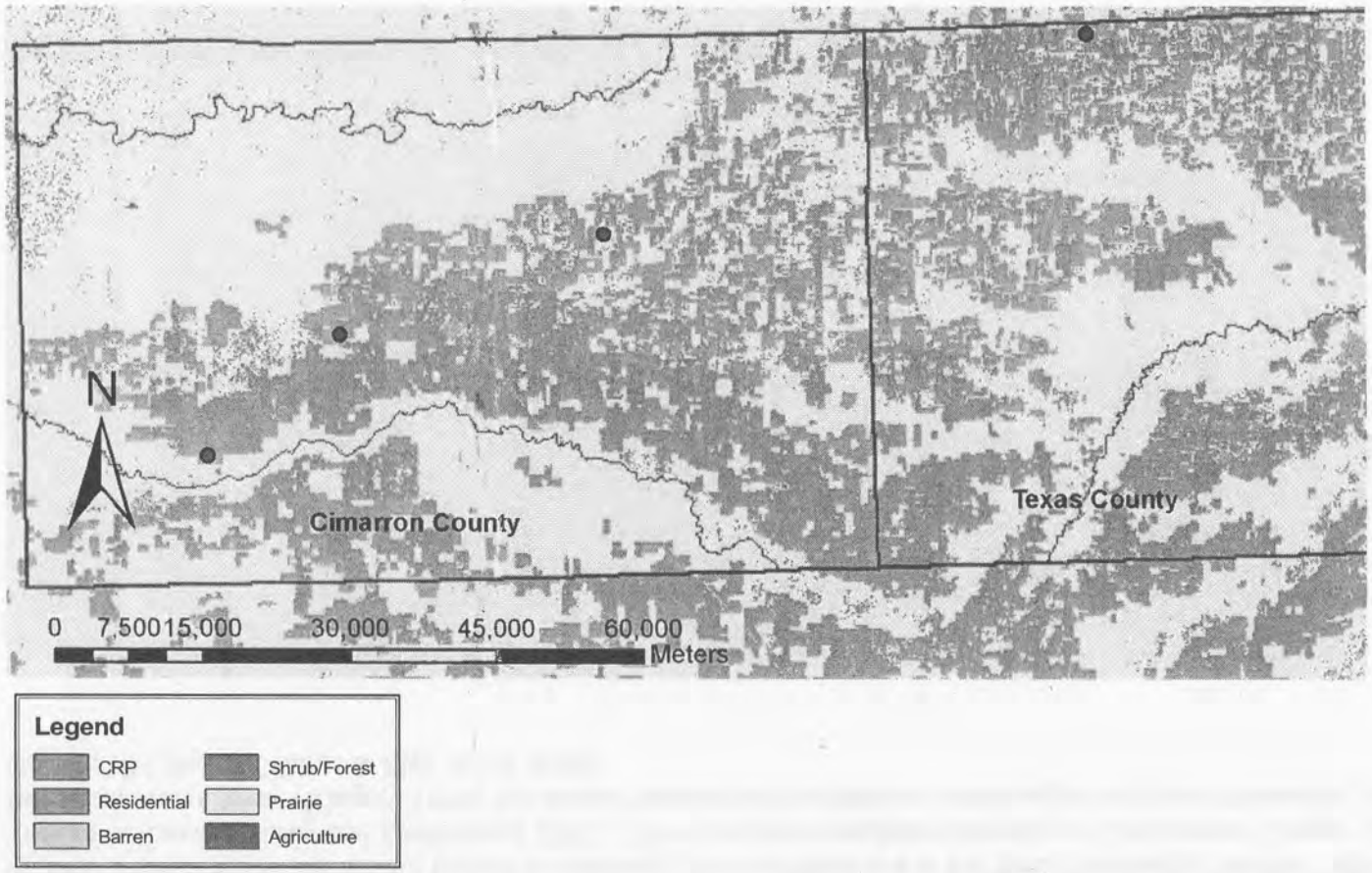
Golden Eagle (*Aquila chrysaetos*)

Found three nests in 2005, all on cliffs. One fledged one juvenile, another had a bird close to fledging 1 June, and a third had a downy white juvenile 8 May. At a fourth location, had a pair present, including a very vocal, protesting bird in late May. On 2 June a young bird flew over this spot; whether a 1-year old bird or a recently fledged juvenile I could not determine.



American Kestrel (*Falco sparverius*)

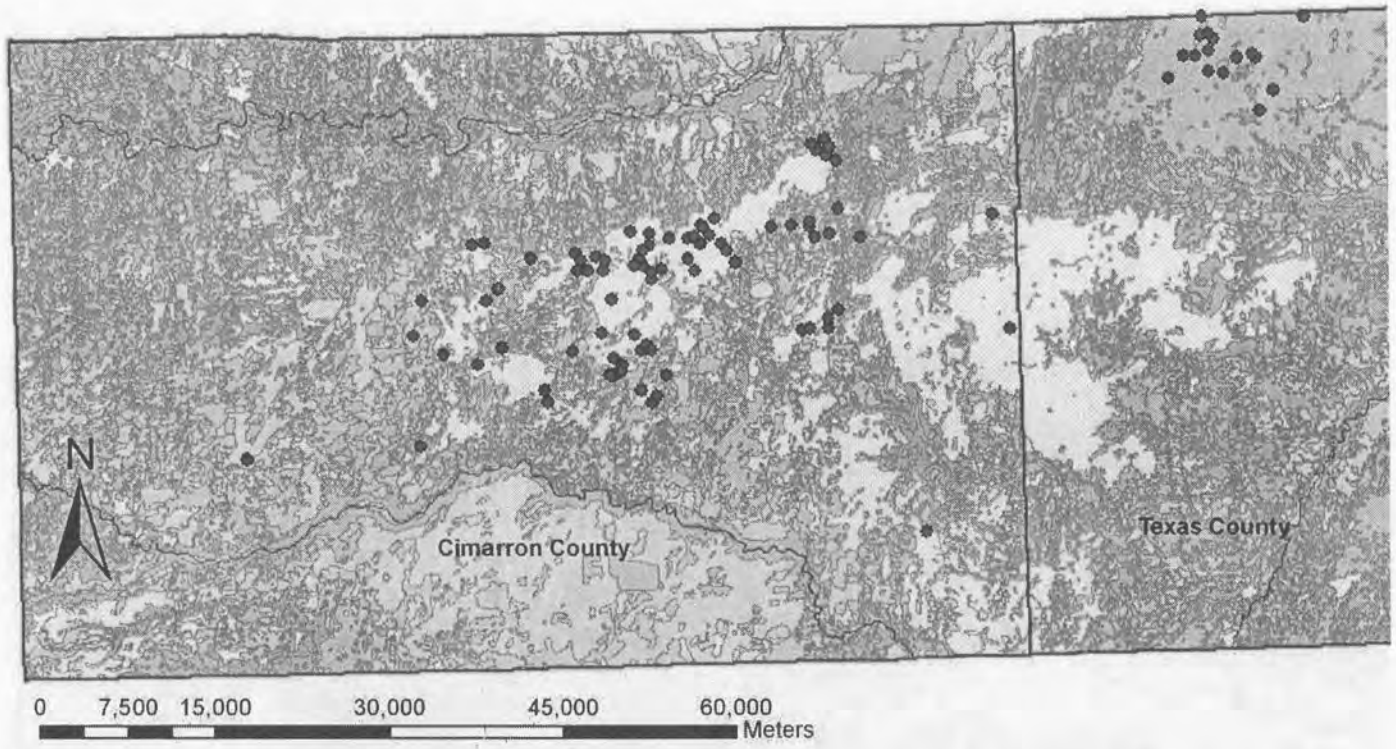
Found in agricultural areas and in creek/riverbed timbers. In many instances where breeding was unconfirmed, there was a (presumably breeding) pair present. Found one nest, with four juveniles, in a crevice in a mesa face; another active nest was in a crevice in a bluff along the Beaver River.



Peregrine Falcon (*Falco peregrinus*)

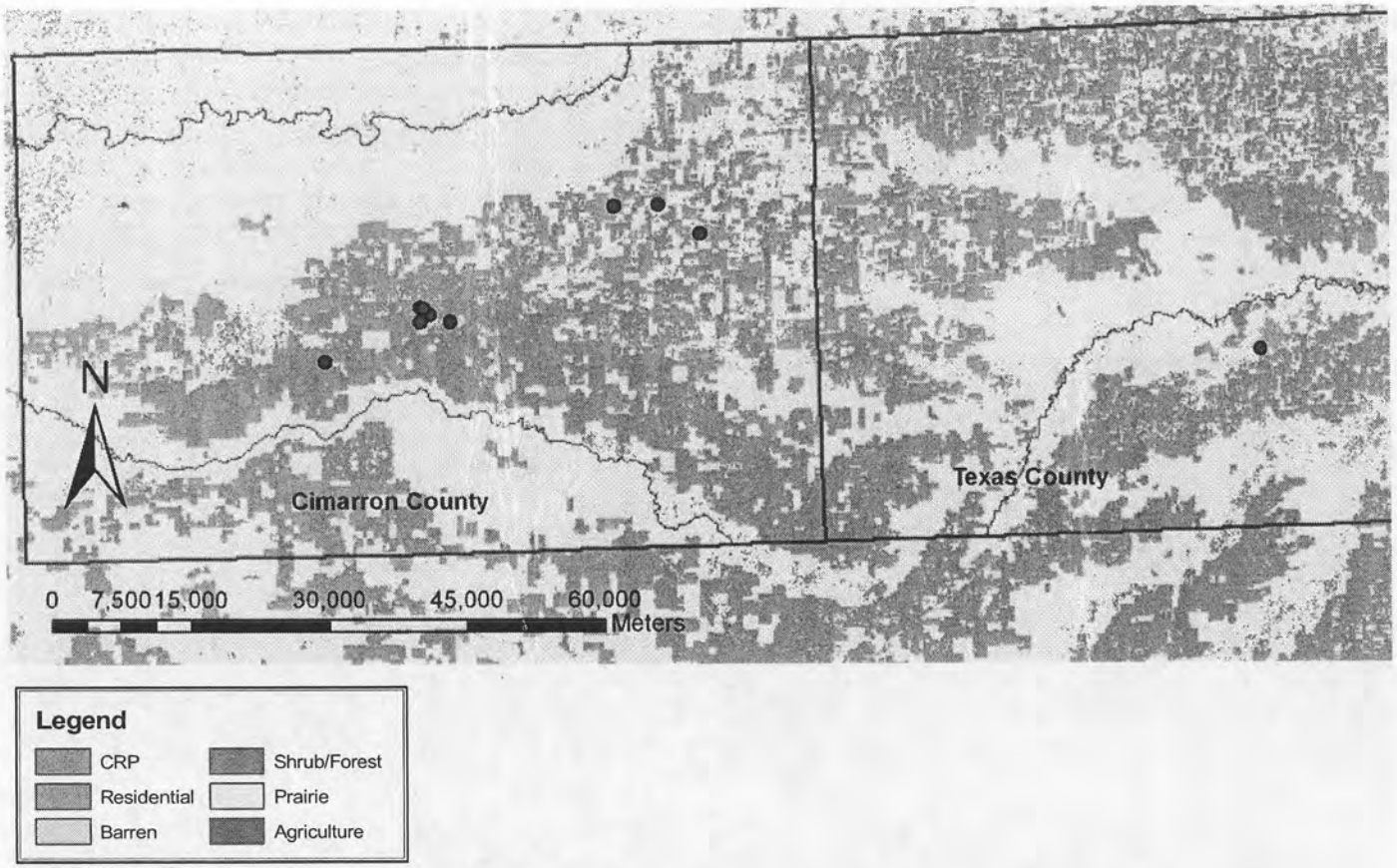
Found on five dates (6 May to 11 July) in 2005, including one bird w/location unrecorded. Two unidentified falcons in 2004 could have been Peregrines; I also had a bird just north of Keyes on 22 May 2005 that looked like a Peregrine species. Additionally, on 24 June 2005, I found the wing of an immature Peregrine Falcon while picking up Great Horned Owl pellets at an abandoned homestead ~5 km south/southeast of Wheeless. Owls were present and had presumably killed the falcon. With this many birds

present, I think it is possible that Peregrine Falcons are nesting somewhere in Cimarron County, maybe in the mesa country or on one of the concrete feed towers that occur throughout the agricultural areas. I looked at a few towers in Cimarron County and did not note any peregrines on them, but they house Rock Pigeons (*Columba livia*) and House Sparrows (*Passer domesticus*), and possibly rodents as well. Peregrine Falcons are not known to breed anywhere in Oklahoma or the Texas Panhandle (Seyffert 2001), and only in Topeka in Kansas (Busby and Zimmerman 2001). They have been confirmed breeding in Las Animas County, Colorado, ~100 km from Cimarron County (Kingery 1998); the nearest location in New Mexico is the Sangre de Cristo Mountains, ~250 km away (Chad Nelson, NM Dept. of Game & Fish, in litt. 2005).



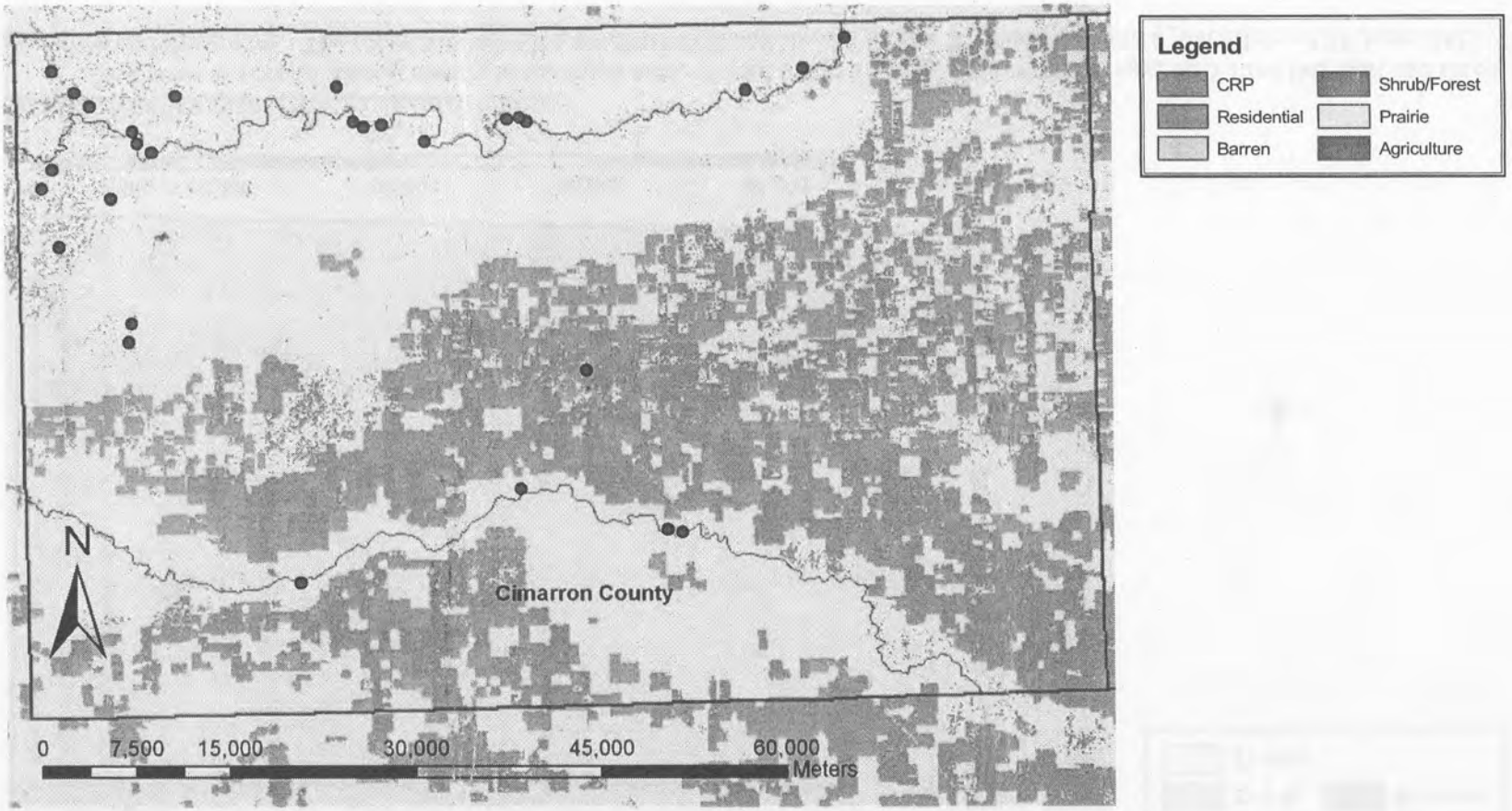
Mountain Plover (*Charadrius montanus*)

Found in small numbers in bare agricultural fields roughly between Boise City and Keyes. I also discovered a pocket of breeding birds in northwestern Texas County (McConnell et al. 2006). Their locations are shown here on a U.S. Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) map. The birds are obviously concentrated in areas with Sherm clay loam (yellow) and the structurally similar Gruver clay loam (orange). We also found some breeding on a long-standing prairie dog town northwest of Boise City (westernmost confirmed breeding locations on map), and, in a grazed pasture just north of there, Marc Criffield found and photographed a flock of ≥20 (premigratory or migrating?) Mountain Plovers on 6 October 2004.



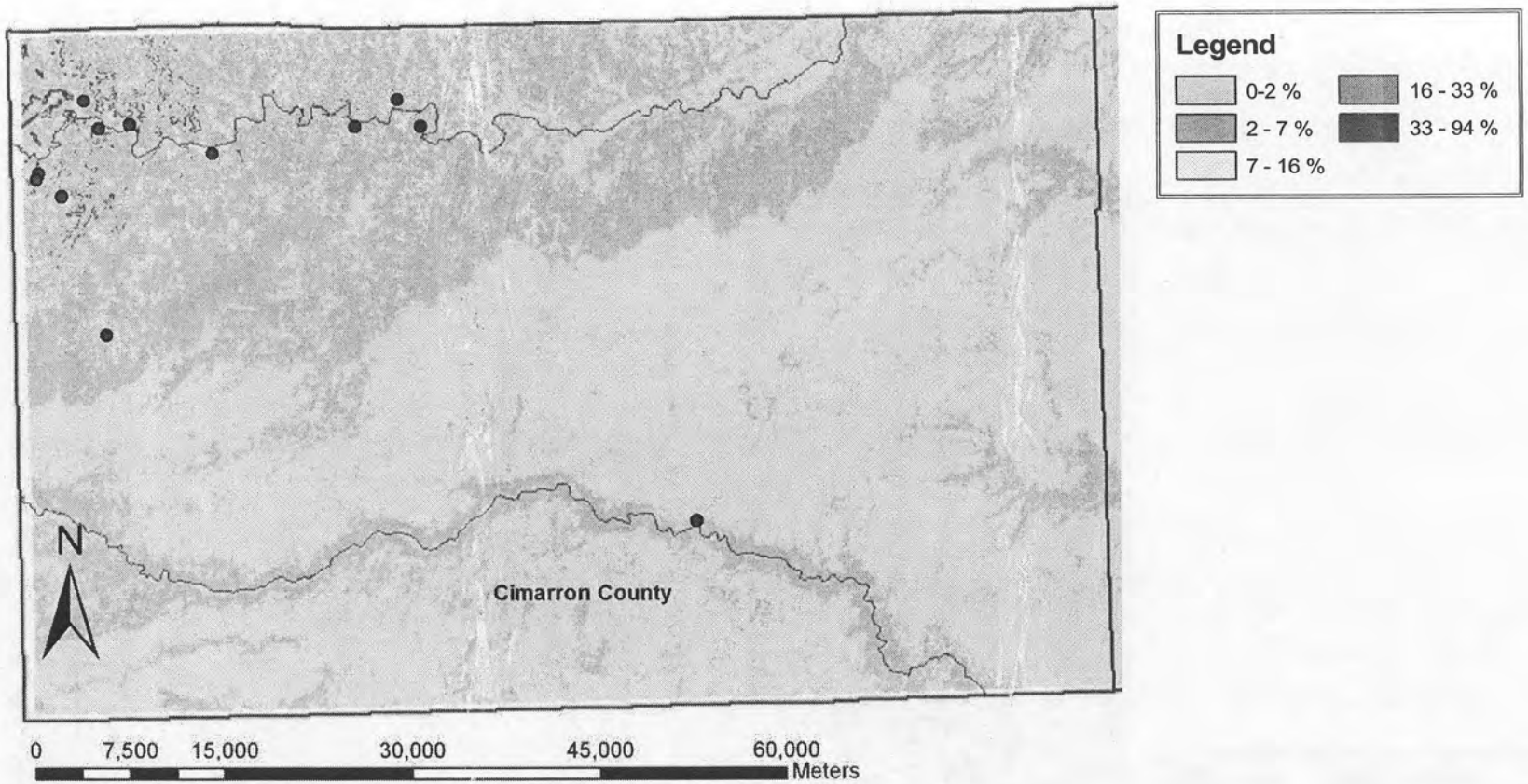
Eurasian Collared Dove (*Streptopelia decaocto*)

Breeding confirmed in Boise City in 2004. Found mostly near Boise City, Keyes, and Guymon.



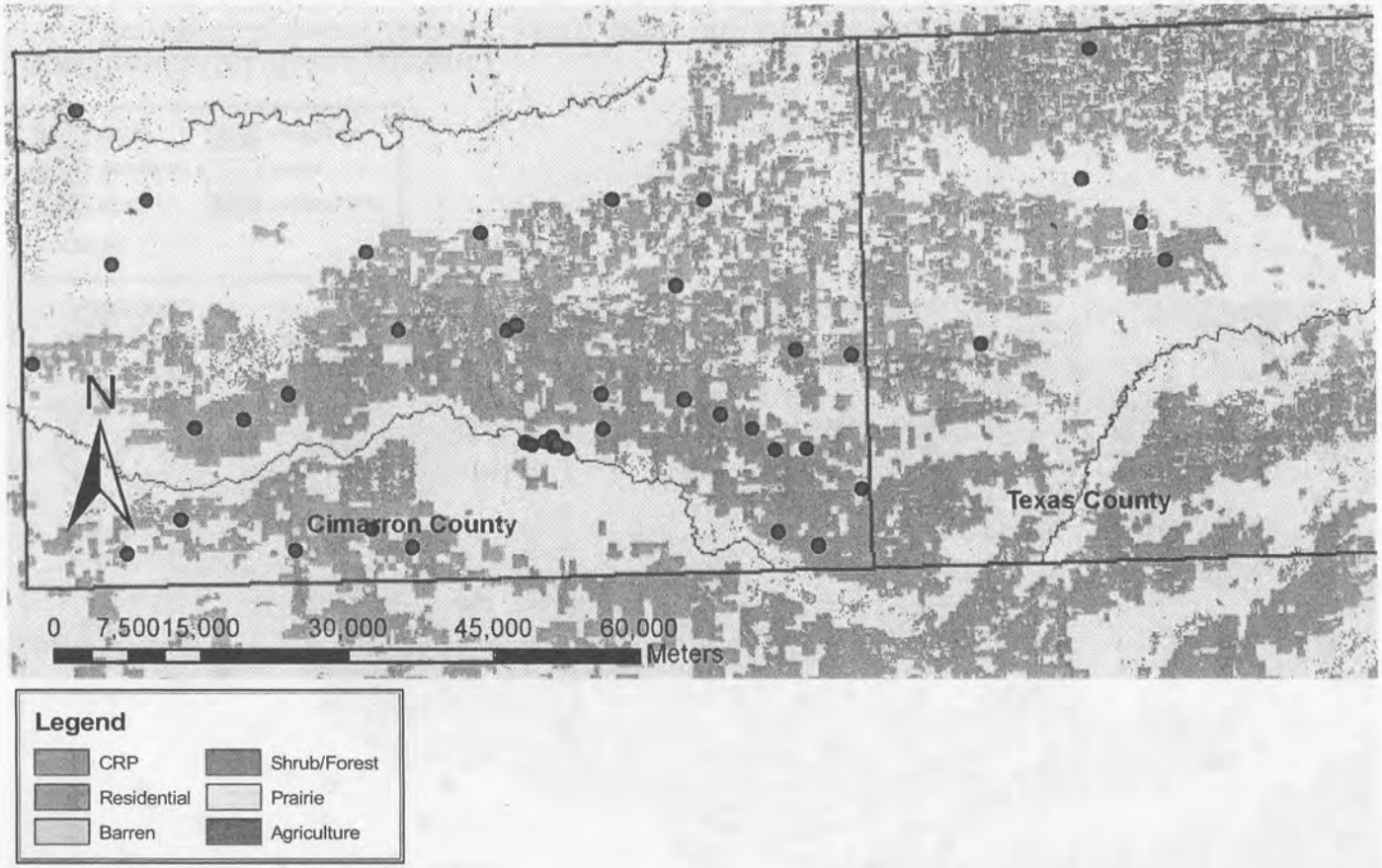
Yellow-billed Cuckoo (*Coccyzus americanus*)

Usually in salt cedar (*Tamarix ramosissima*) along rivers and creeks. Confirmed breeding twice.



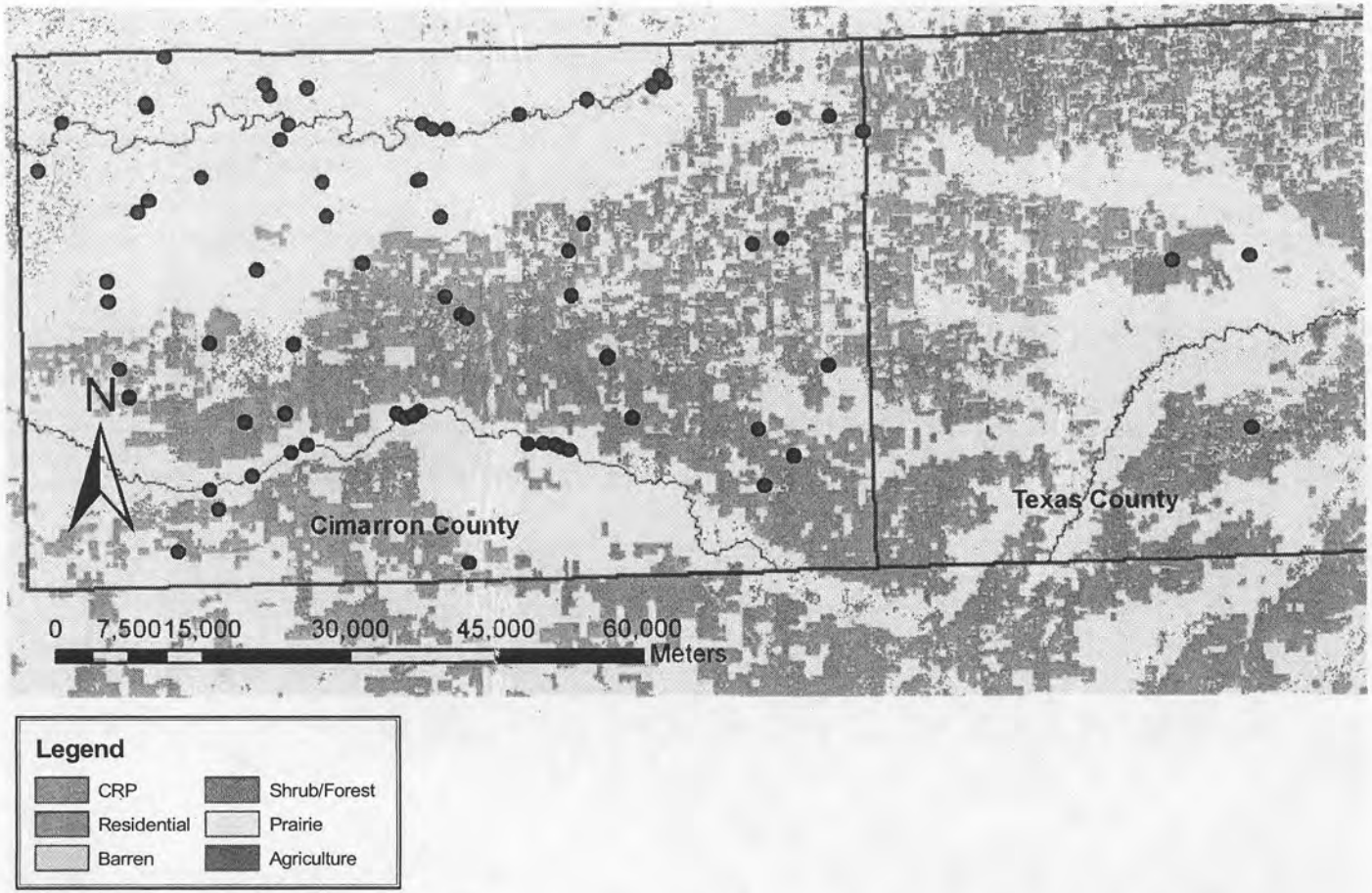
Greater Roadrunner (*Geococcyx californianus*)

Had birds at several places, mostly in the mesa area. Found a nest 16 May 2005 with one egg; on 5 June this nest had three juveniles and three eggs. The other two breeding confirmations involved a family 28 June 2004 and a juvenile bird 28 June 2005.



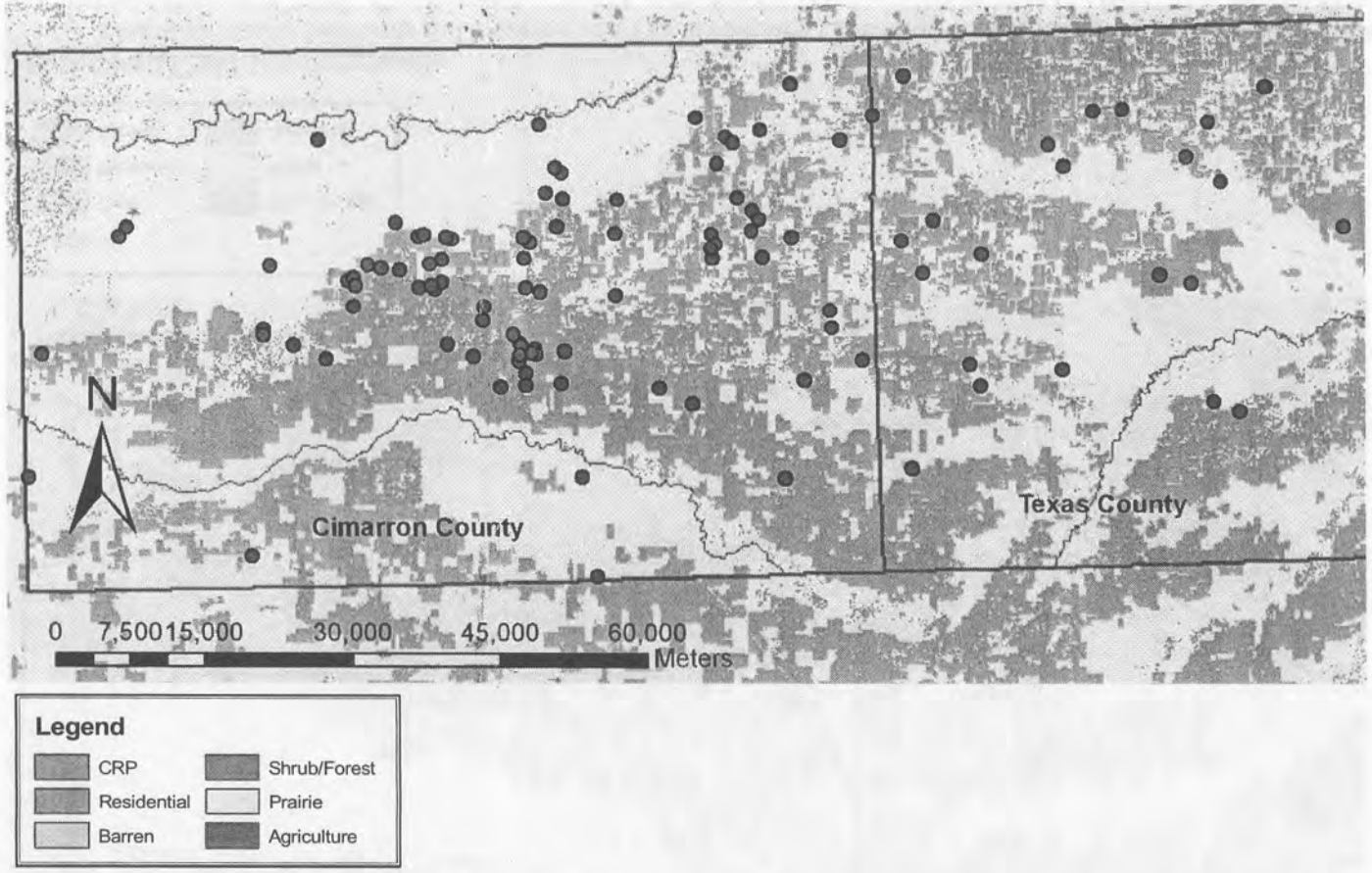
Barn Owl (*Tyto alba*)

Birds found roosting and nesting in abandoned barns, homes, silos (sometimes unused silos on active farms), and in holes along river/creek bluffs. Sometimes found roosting in trees by abandoned homes or along a river. A pair found 7 May 2005 in a mesa crevice was presumably nesting, although juveniles not seen. Area of high concentration along Beaver River in southcentral Cimarron County.



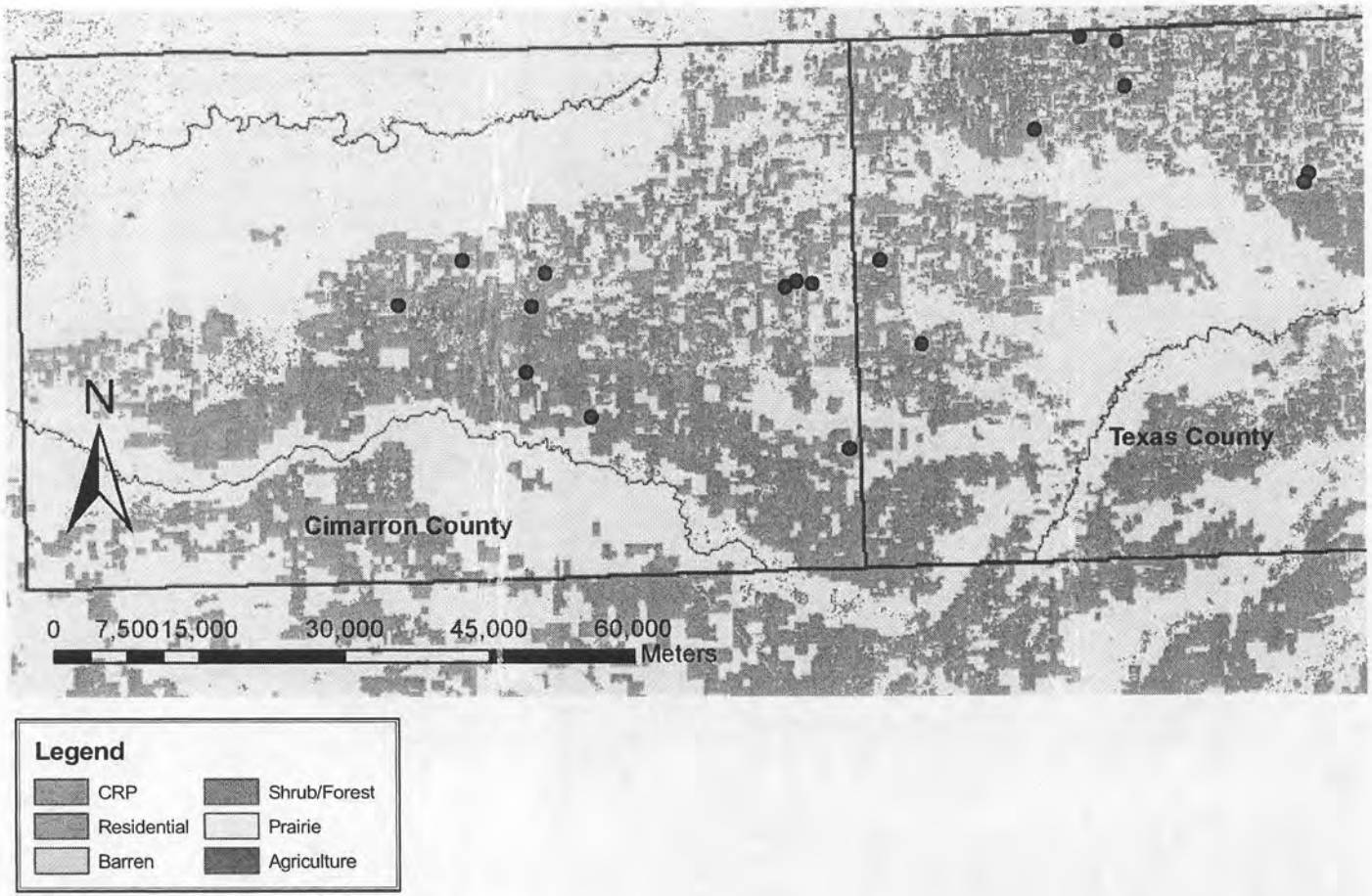
Great Horned Owl (*Bubo virginianus*)

Very common around Cimarron County, particularly in river timber and around abandoned homesteads. Note that many of the "bird(s) present" sightings are probably hatch-year birds, which are difficult to tell from the adults when flying away.



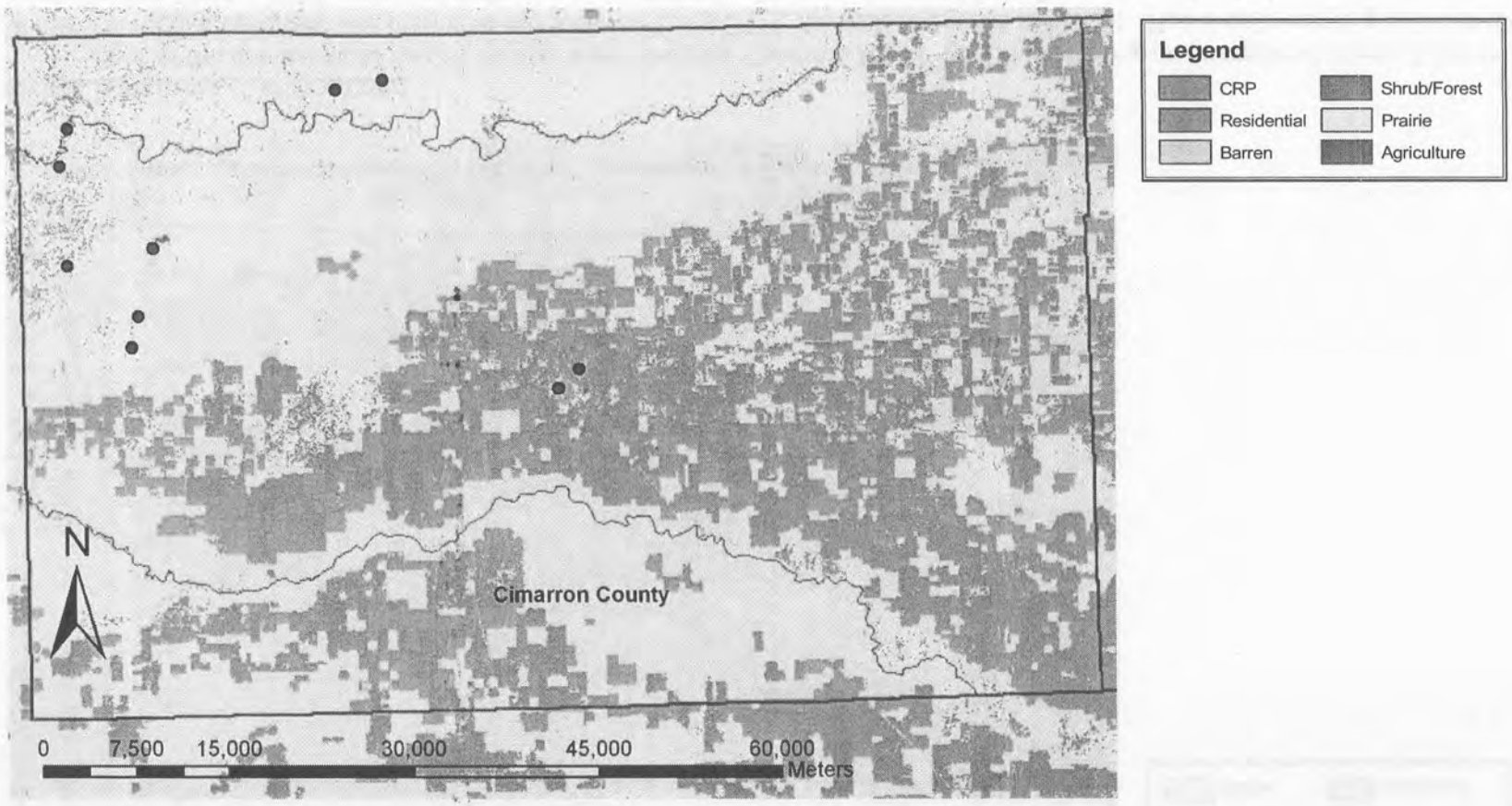
Burrowing Owl (*Athene cunicularia*)

Almost invariably found in prairie dog towns (active and inactive), and apparently no town is too small: there were two owls present on both survey rounds in 2004 on a prairie dog town roughly ½ ha in size. The largest concentration I found, 23 birds in one binocular sweep, was just across the Kansas line from R11-T6-S16 in a prairie dog town next to a house.



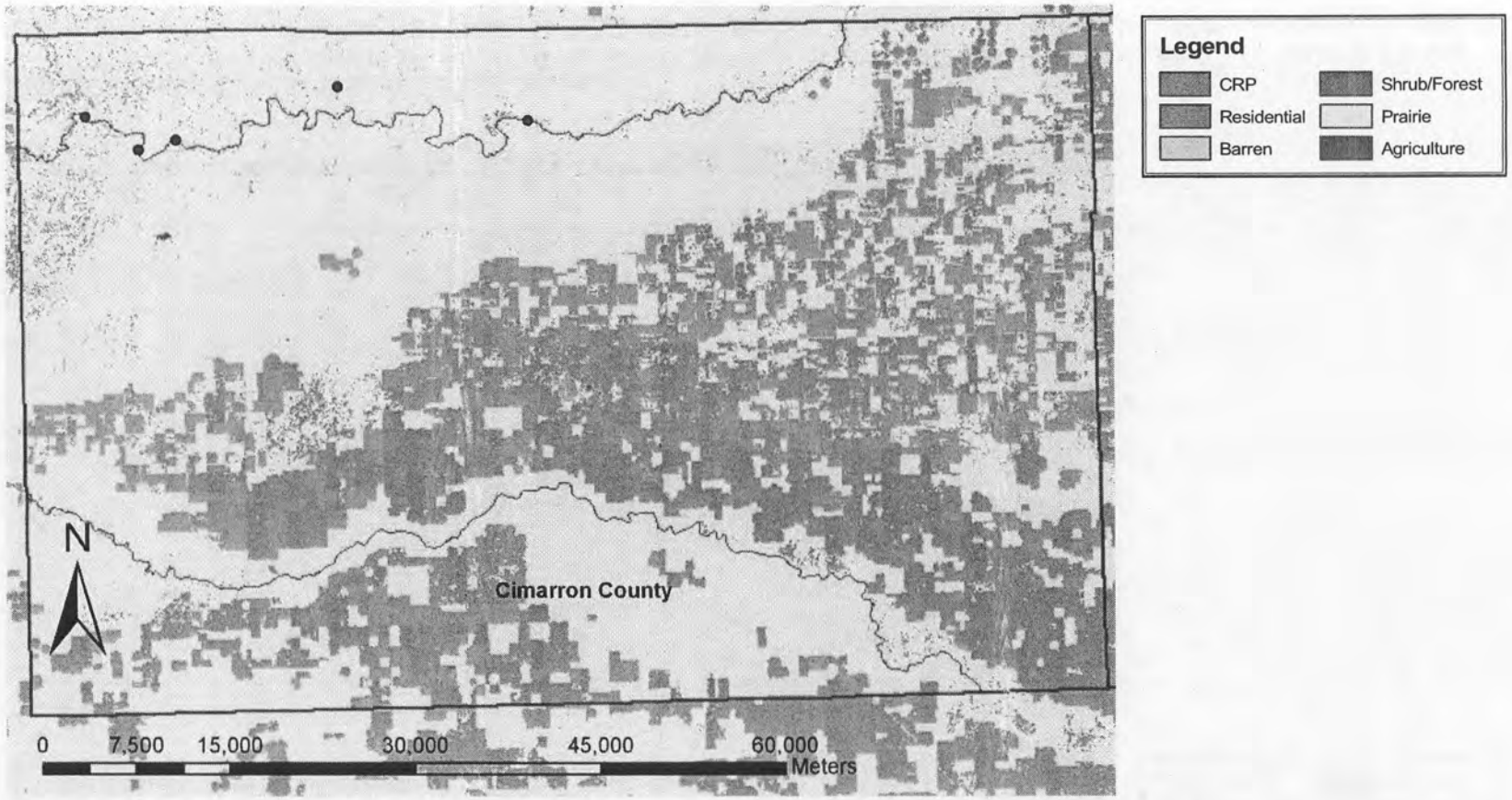
Short-eared Owl (*Asio flammeus*)

Found at several locations in Cimarron and Texas counties. Breeding confirmed in Texas County in 2004 and at two locations in Cimarron County in 2005. Confirmations would undoubtedly increase with increased effort. This species is undoubtedly benefiting from the CRP program here in the Oklahoma Panhandle.



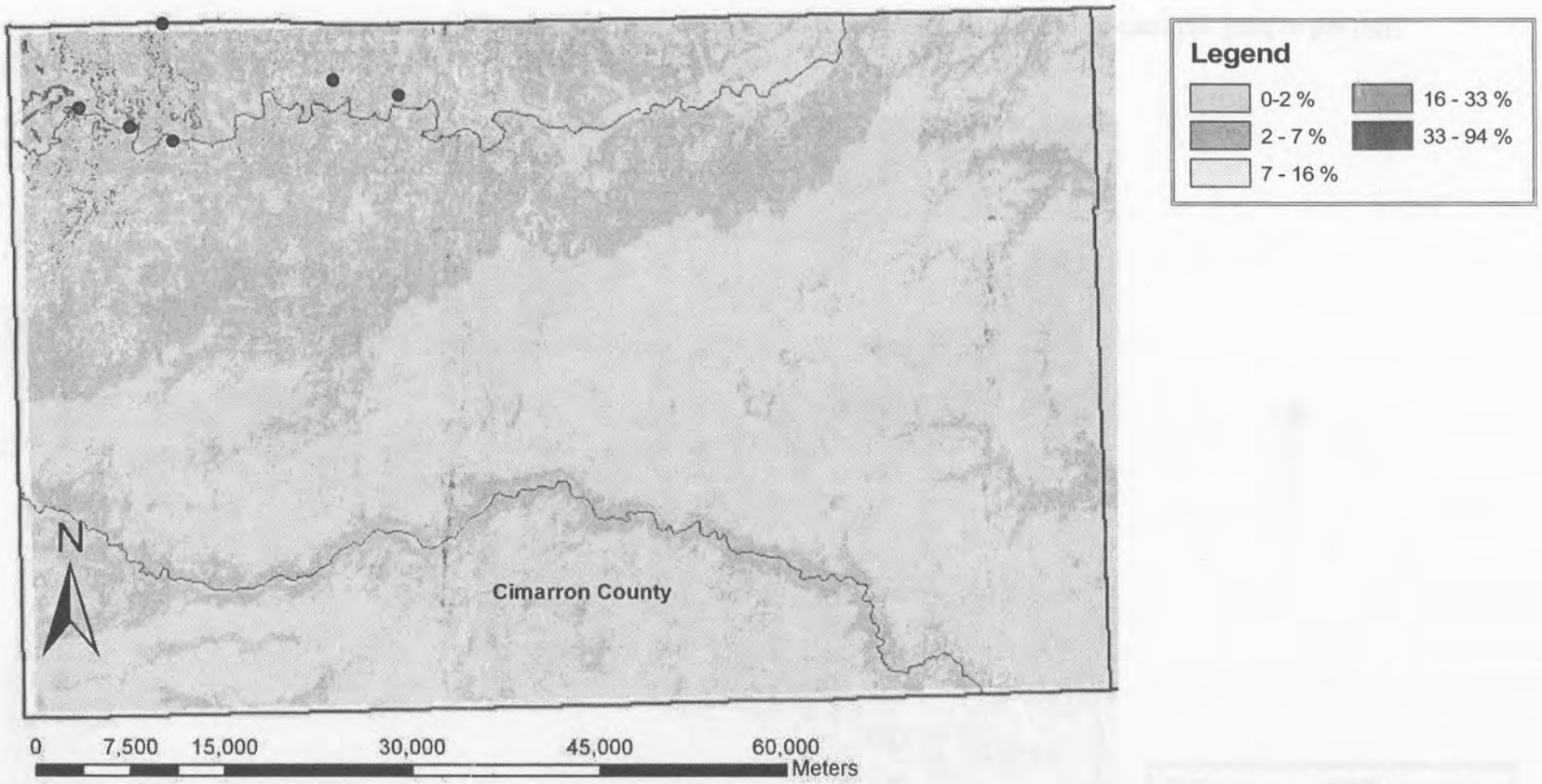
Black-chinned Hummingbird (*Archilochus alexandri*)

This account assumes that all hummingbirds seen were of this species. A few birds regularly came to a feeder in Kenton during our two field seasons. JS, Berlin Heck, Warren Harden and Jack Tyler found a nest on 24 June 2005; incubation ongoing 3 July. A pair was present just outside Boise City on 1 June 2004; female here 6 June, but I could not locate a nest. I saw a hummingbird in a yard in Boise City in late June/early July 2005. A male was performing courtship flights in Black Mesa State Park on 2 July 2005. I found several birds in R1T4, including several at various locations along a wash, on the morning of 1 July 2005.



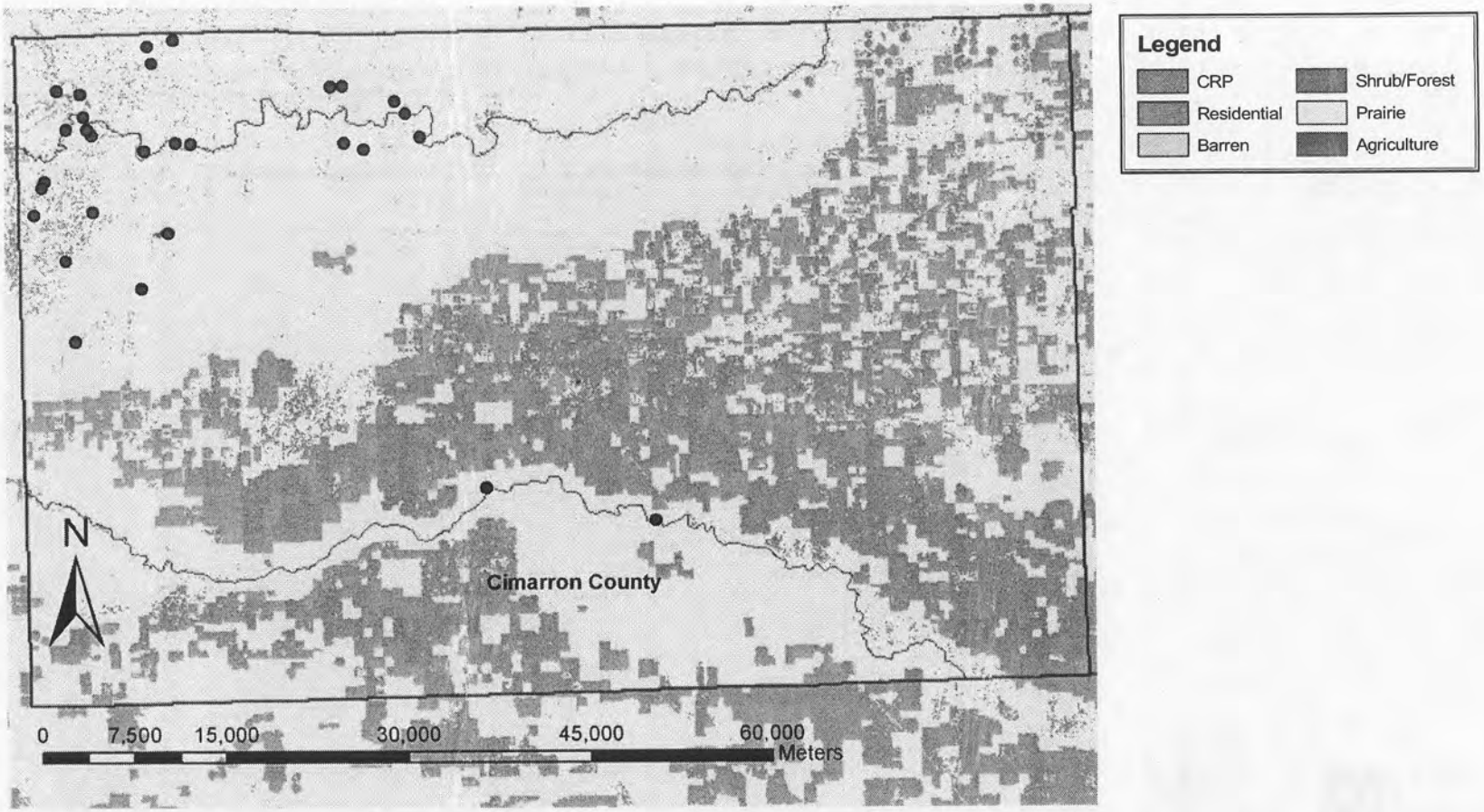
Belted Kingfisher (*Ceryle alcyon*)

Four of the five locations for this species were along the Cimarron River; the fifth was along an intermittent creek. I did not confirm breeding, but a pair was present at one location 2 July 2004; the male had a fish in his bill. Had a male carrying a fish at the same location 17 May 2005 and a bird at the same spot 20 May. There were several holes in a cutaway bank along the river at another location 18 May 2005.



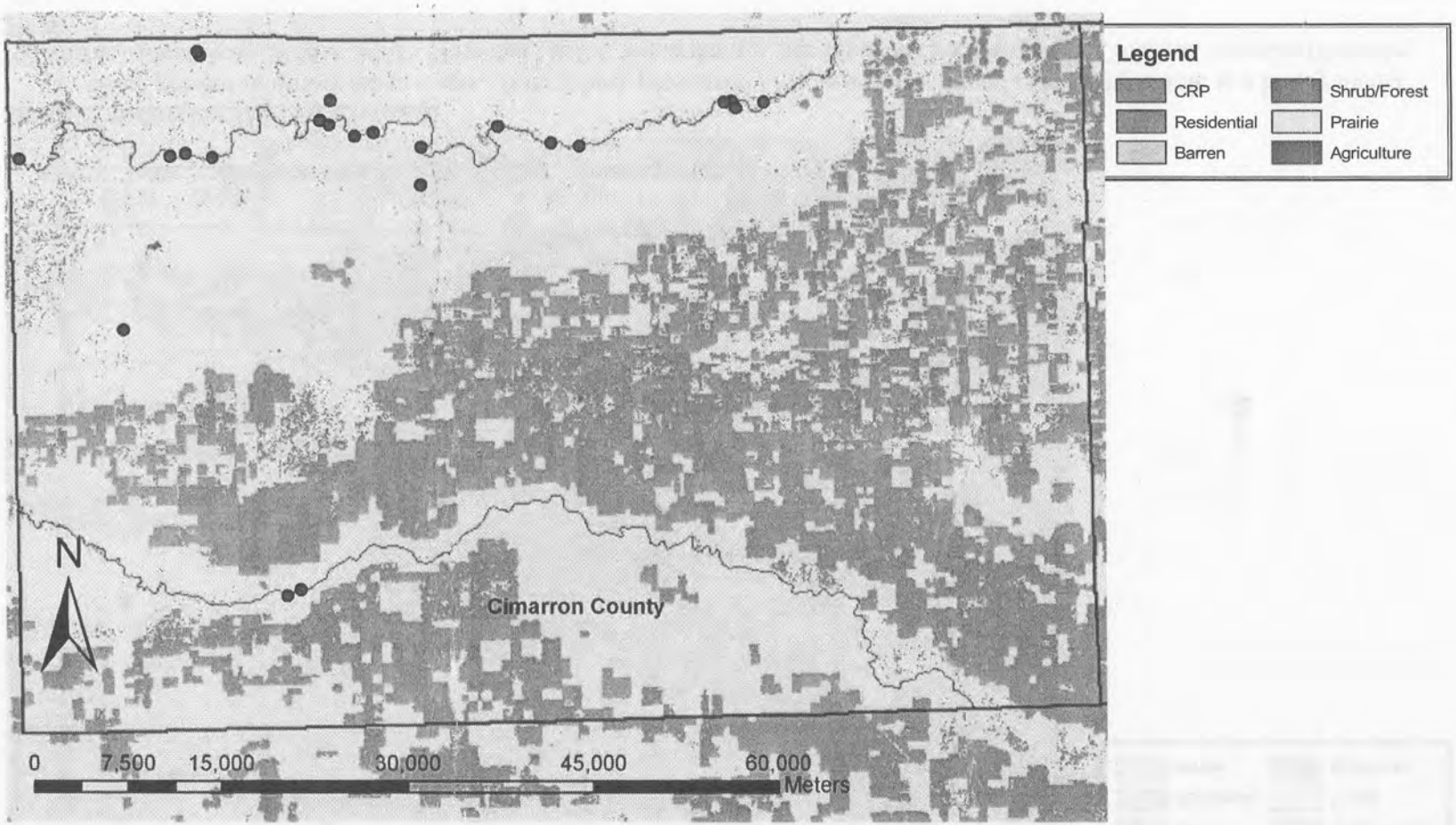
Lewis's Woodpecker (*Melanerpes lewis*)

Found at six locations; breeding confirmed at two2, including a nest <100 m south of the Colorado line found 7 July 2005. The other breeding location had juveniles calling from a hole in the same tree both years (5 July 2004 and 4 July 2005). At a third location, a pair was present and excavating a hole on 17 May 2005; the birds were not found there again, and on 4 July a pair of Red-headed Woodpeckers (*Melanerpes erythrocephalus*) had an active nest ~1 m from the hole the Lewis's Woodpeckers had been excavating. The easternmost location involved a bird seen 9 May 2005, but not found on several subsequent dates.



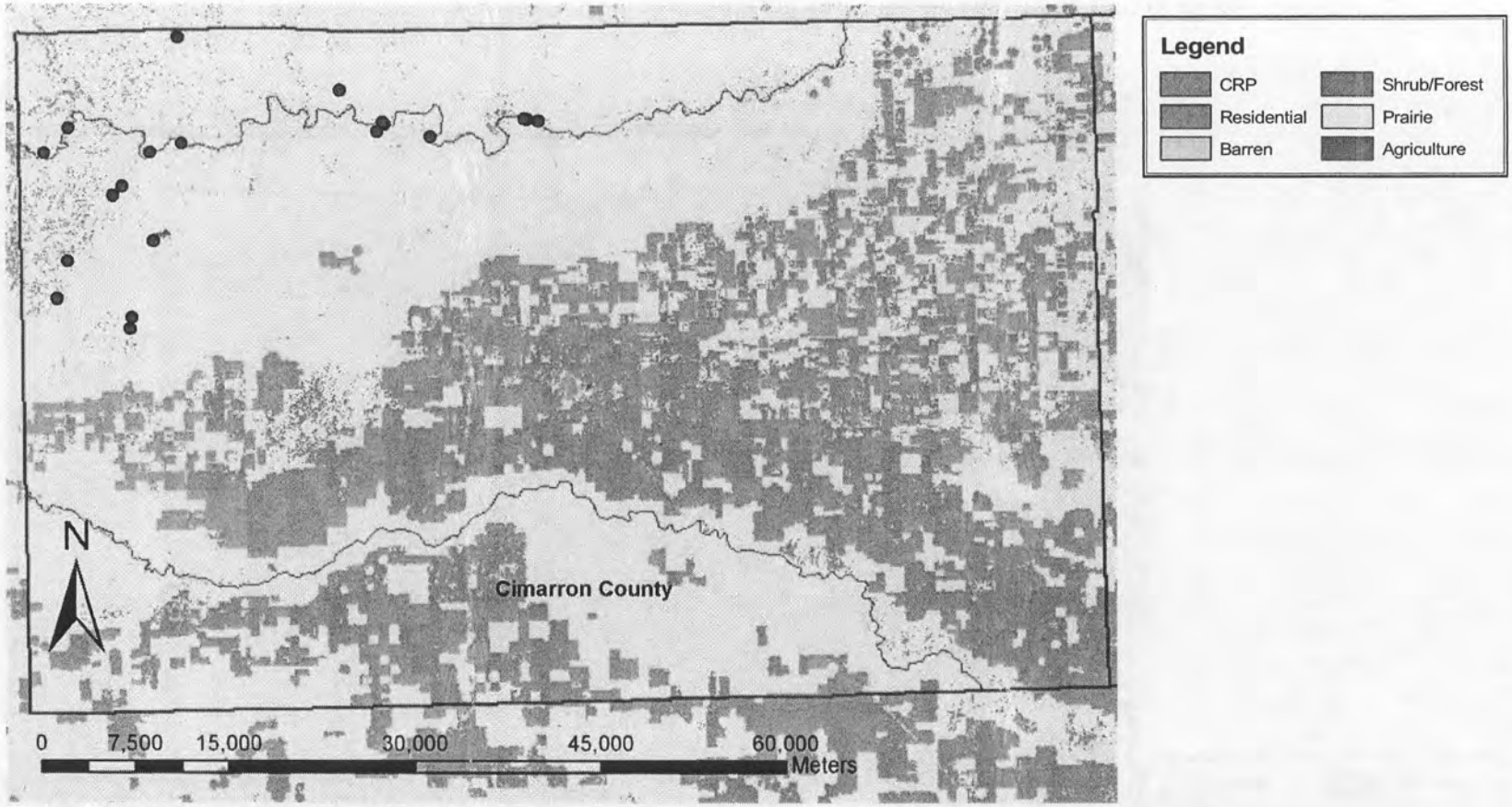
Ladder-backed Woodpecker (*Picoides scalaris*)

Confined mostly to the mesa area. The confirmed breeding involved a pair with the male carrying food in his bill.



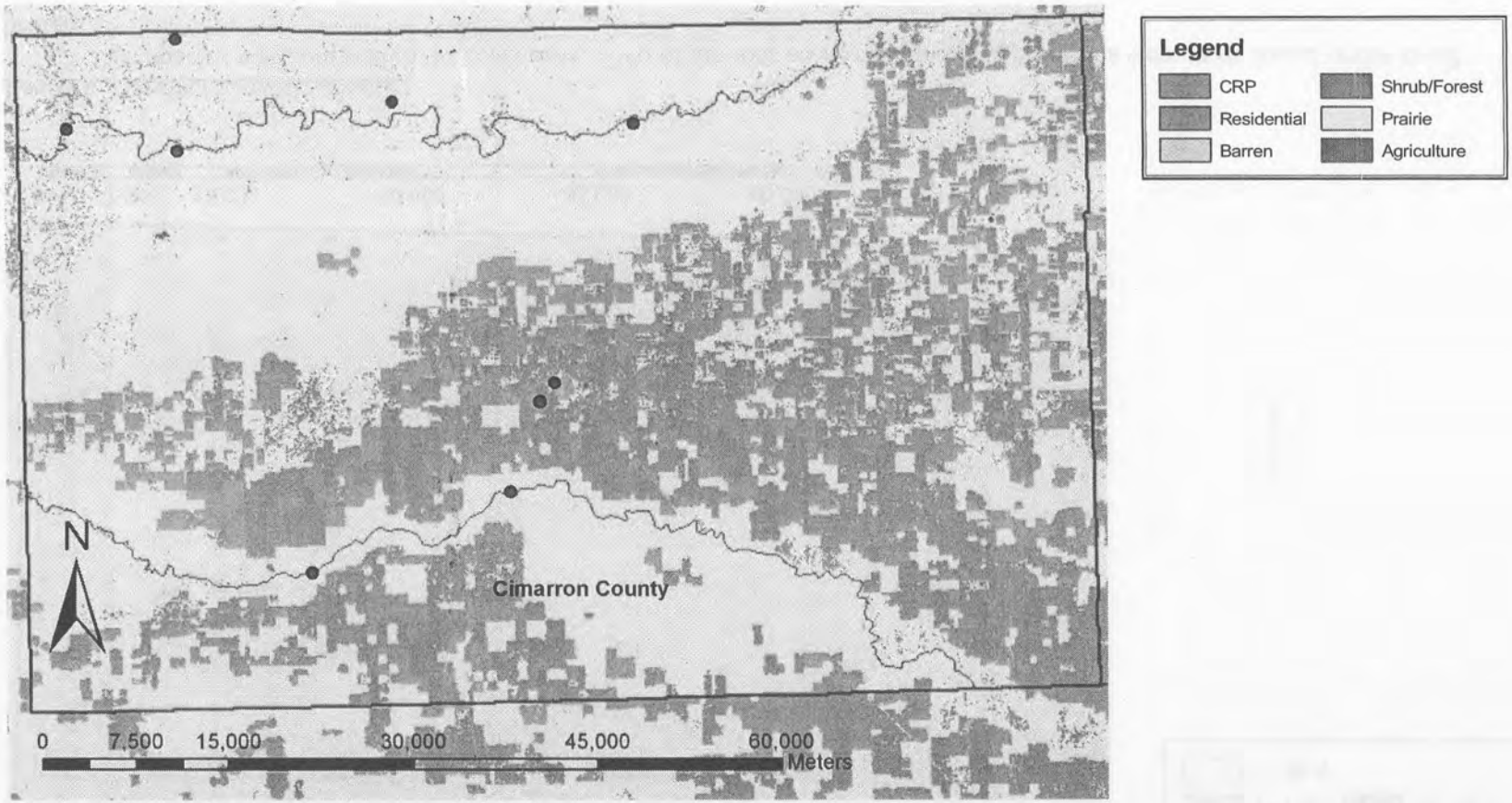
Downy Woodpecker (*Picoides pubescens*)

Found mostly in river timber. Note that OBBA (Reinking 2004) did not find any birds west of Beaver County.



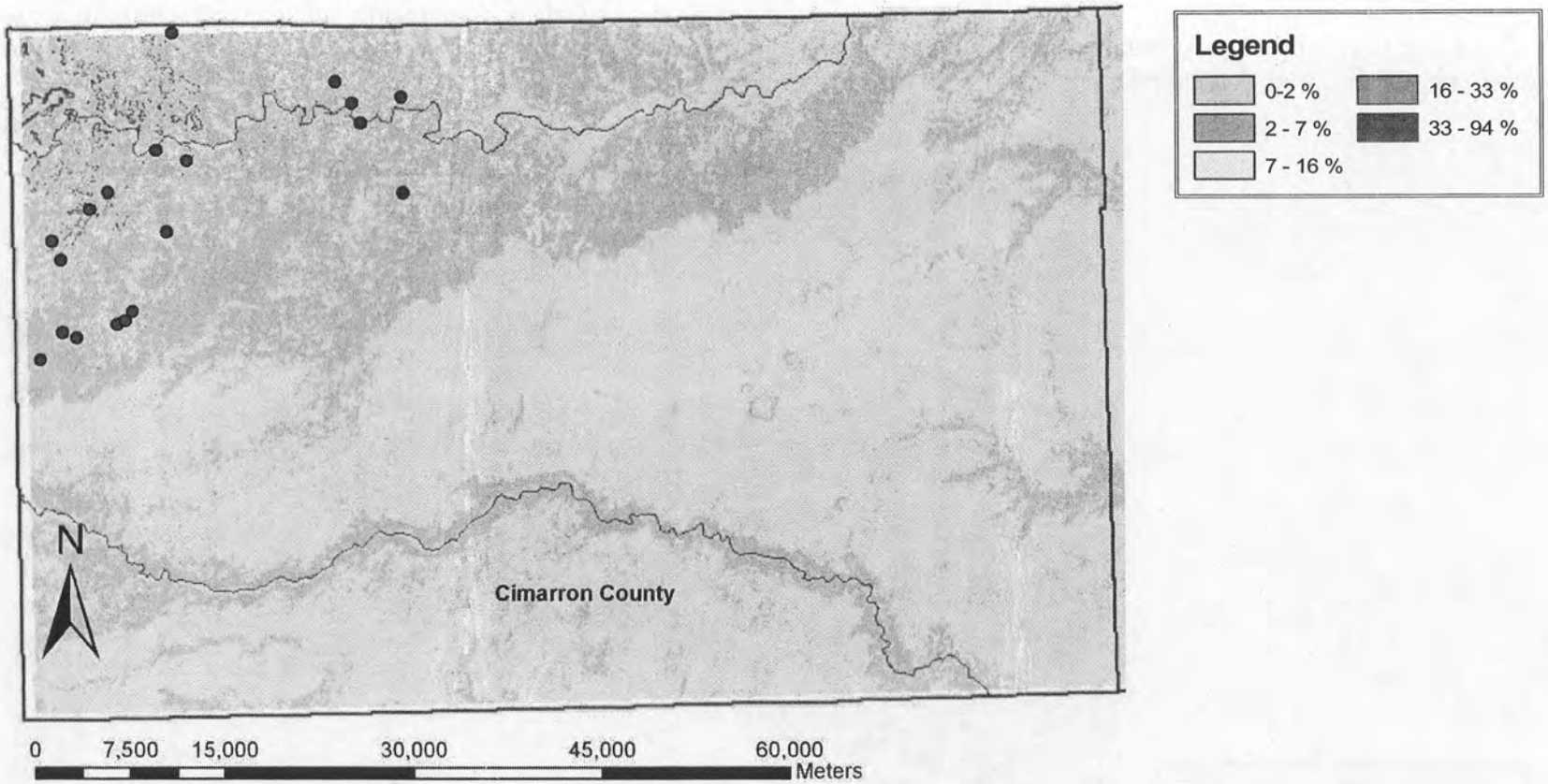
Hairy Woodpecker (*Picoides villosus*)

Often present in timber along rivers. A dark bird, presumably *P.c. monticola*, found excavating a hole in a honey locust (*Gleditsia triacanthos*) 20 May 2005. Note that OBBA found them in one block each in Texas and Cimarron counties (Reinking 2004).



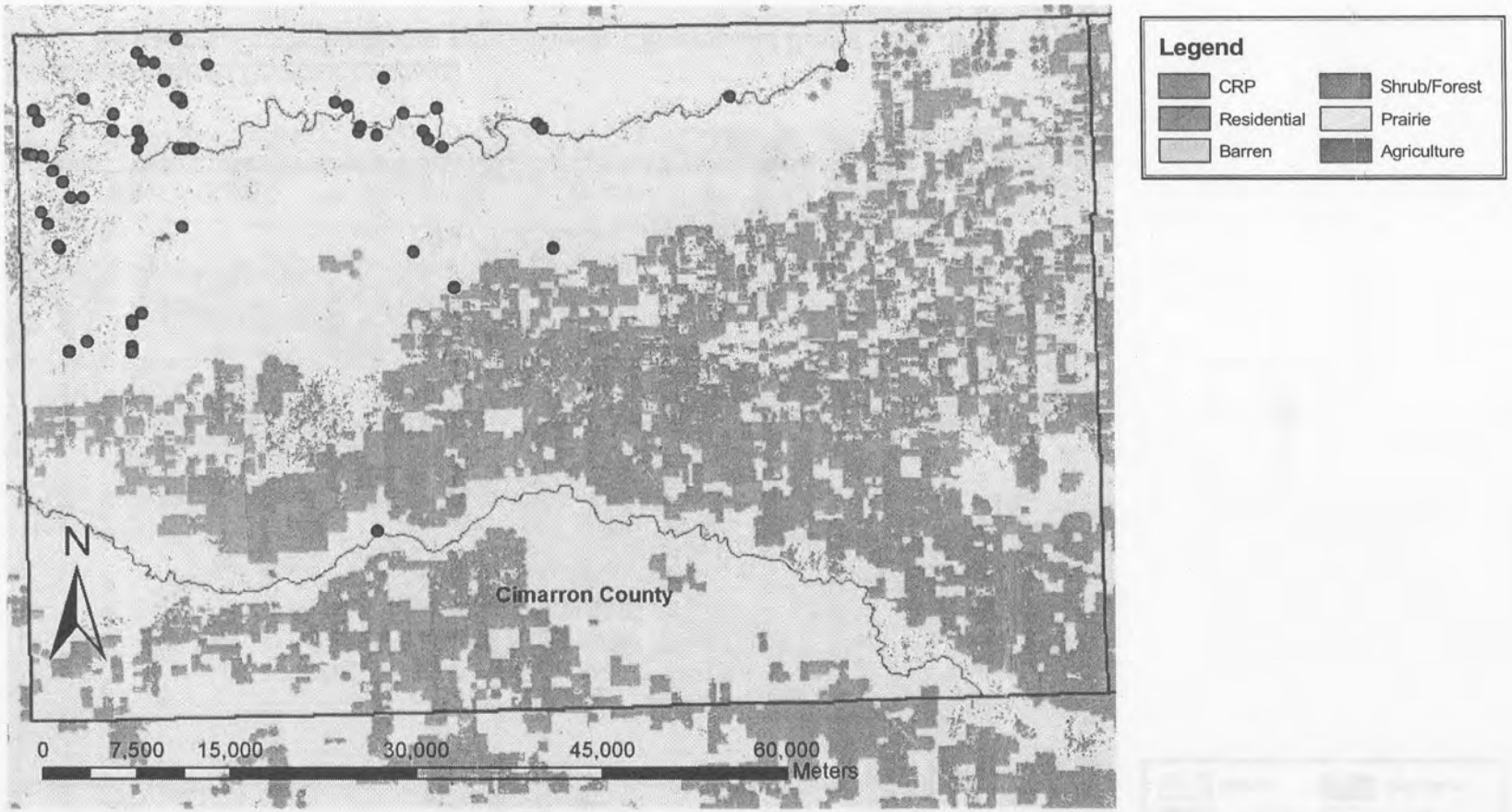
Western Wood-Pewee (*Contopus sordidulus*)

Presumably all pewees found were of this species. Some were confirmed by voice, and I did not hear an Eastern Wood-Pewee (*Contopus virens*) during two seasons of fieldwork. Only two of the locations here were earlier than 31 May. In 2004, I had a Western Wood- Pewee in the Boise City Cemetery 27 May and 2 June.



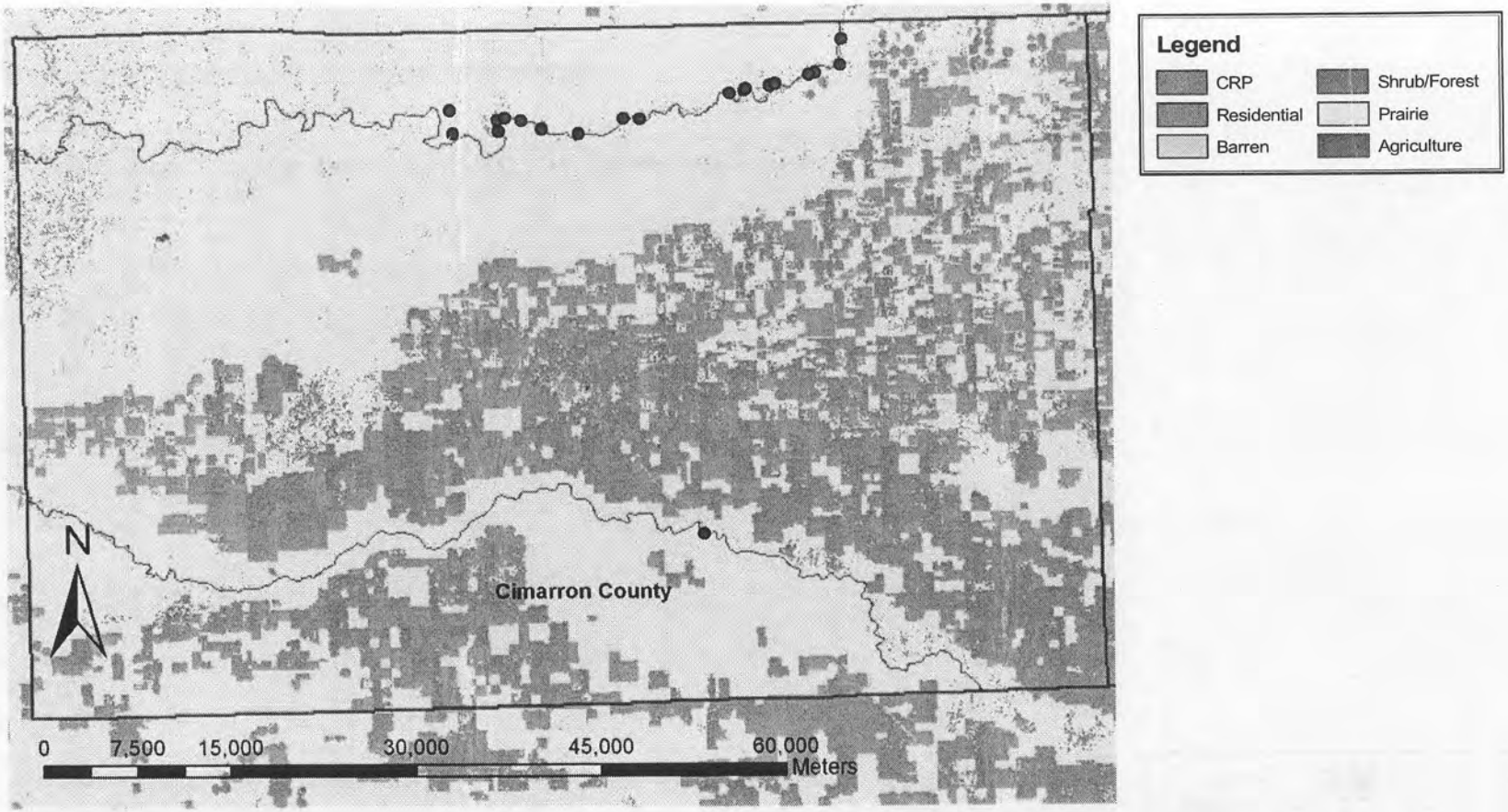
Eastern Phoebe (*Sayornis phoebe*)

This species was confined to the mesa area. Two of the four confirmed breeding locations were nests found under small bridges.



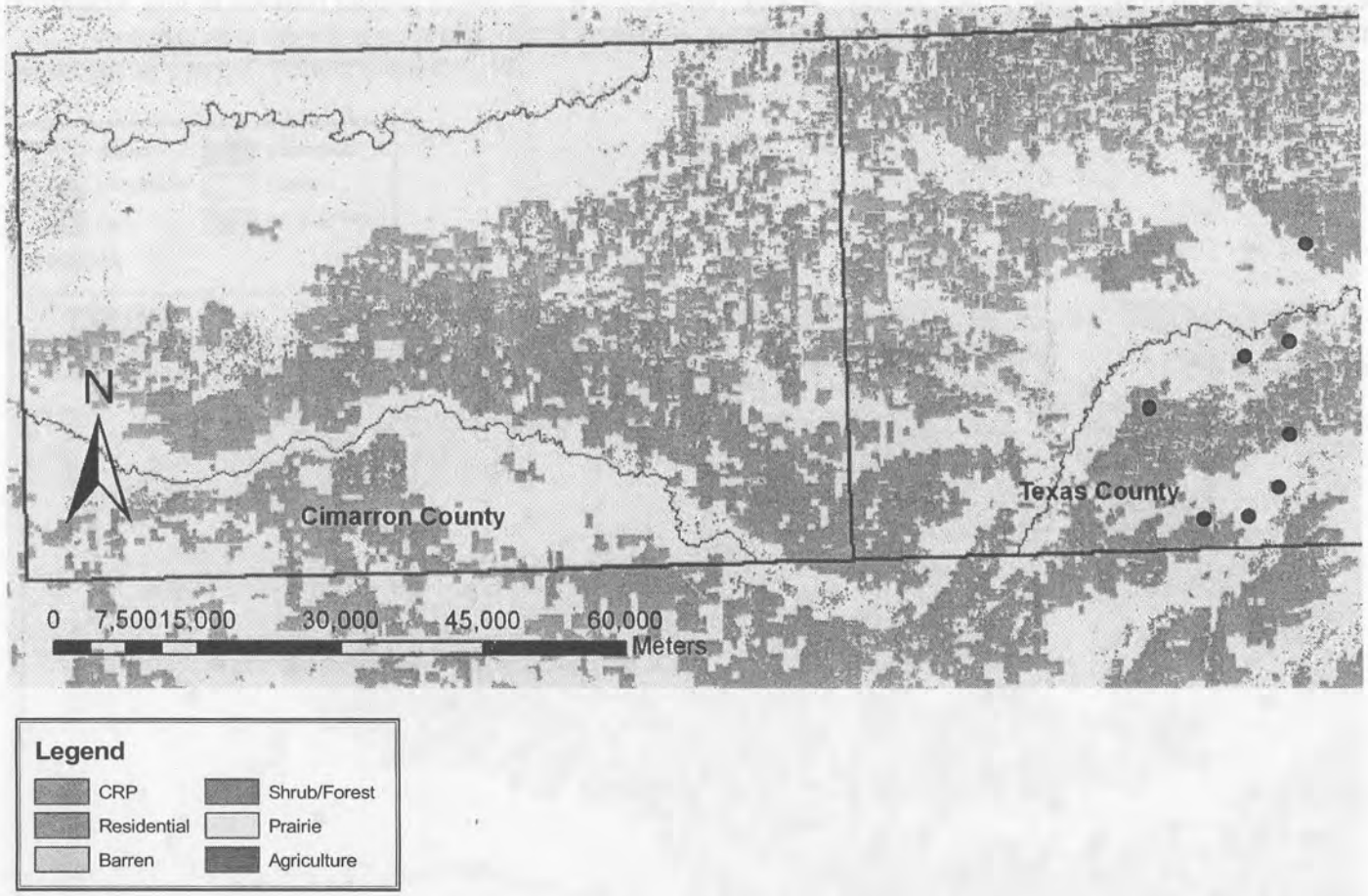
Ash-throated Flycatcher (*Myiarchus cinerascens*)

Found widely, mostly in the mesa country.



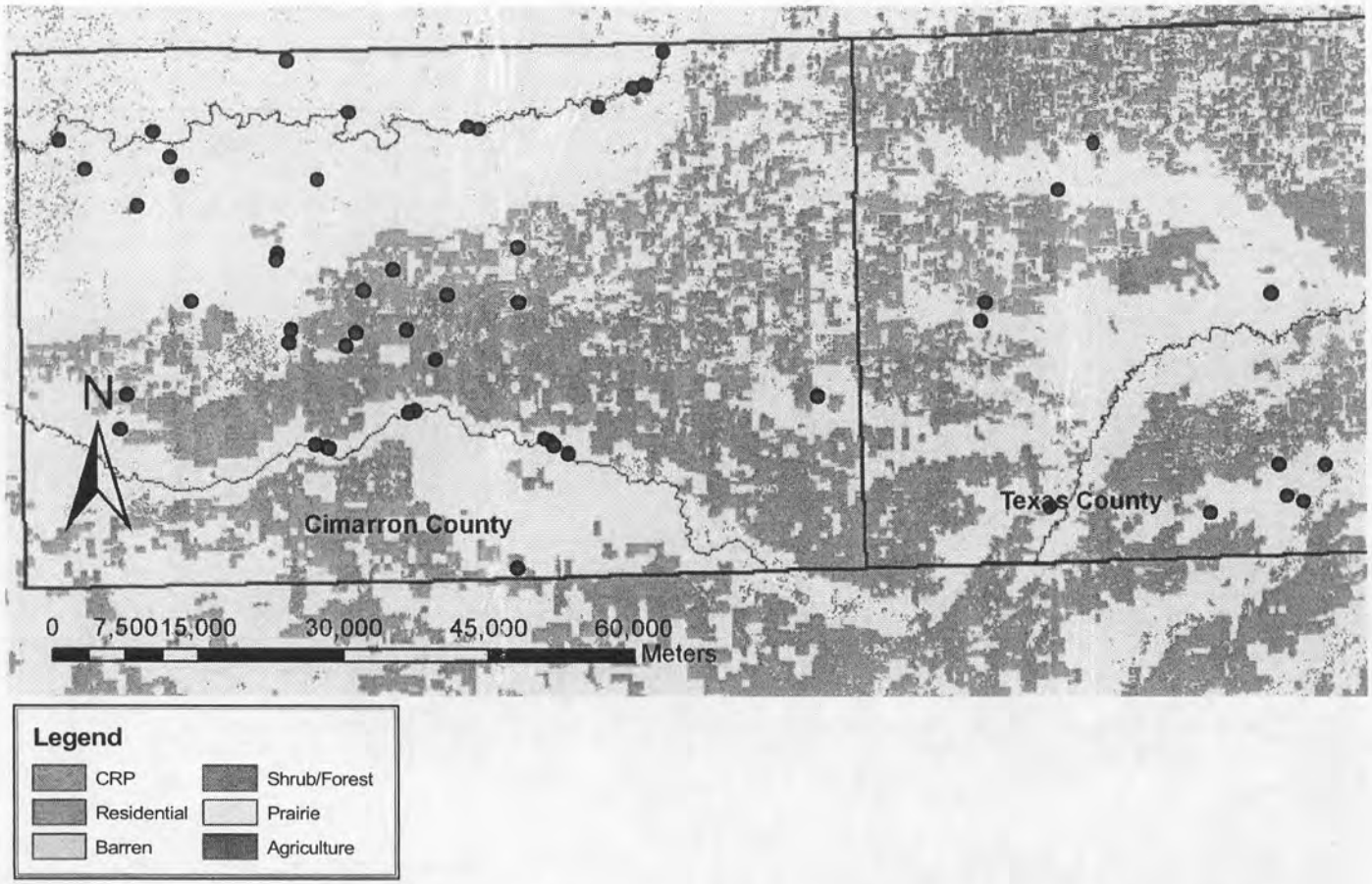
Eastern Kingbird (*Tyrannus tyrannus*)

All Eastern Kingbird locations were along the Cimarron and Beaver (one) rivers.



Scissor-tailed Flycatcher (*Tyrannus forficatus*)

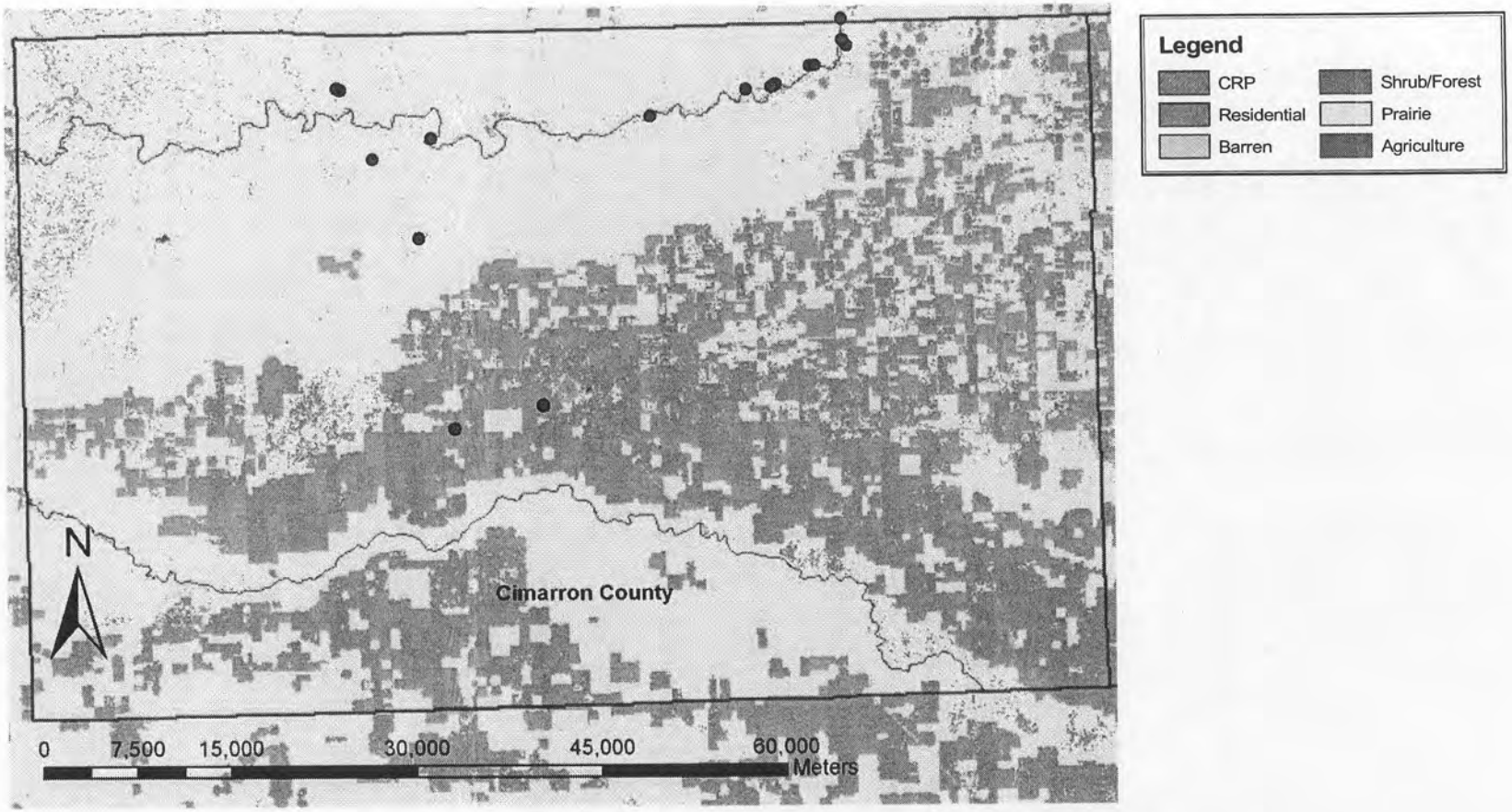
Found mostly in Texas County; one Cimarron County location unrecorded. Red diamonds represent (presumably breeding) pair ($n = 3$) and family ($n = 1$).



Loggerhead Shrike (*Lanius ludovicianus*)

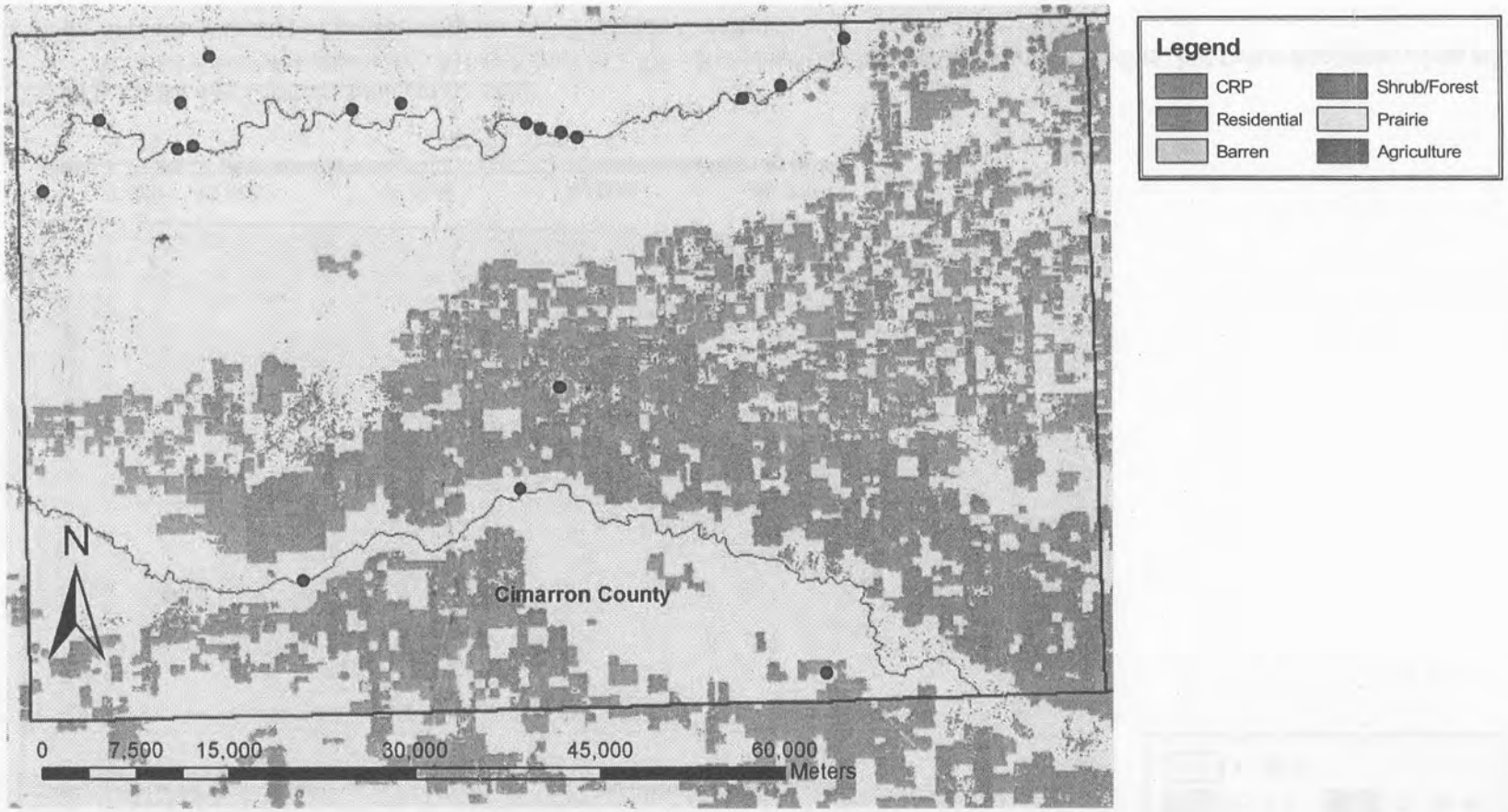
Confirmed breeding at 25 locations (21 in 2005). Where tree species was noted, found seven nests in cottonwood (*Populus deltoides*), four in oneseed juniper (*Juniperus monosperma*), four in Siberian elm (*Ulmus pumilla*), one in skunkbush (*Rhus trilobata*), and one in osage orange (*Maclura pomifera*). I found a shrike nest with four eggs on 22 June 2004 in a oneseed juniper ~1 m beneath a deserted Ferruginous Hawk nest that had been active 2 June. On 22 May 2005, I found a shrike nest ~3 m below an active

Ferruginous Hawk nest in a cottonwood along the Beaver River. I also found a presumably breeding pair on three dates in 2005 at an osage orange hedgerow that was <30 m from an occupied Swainson's Hawk nest.



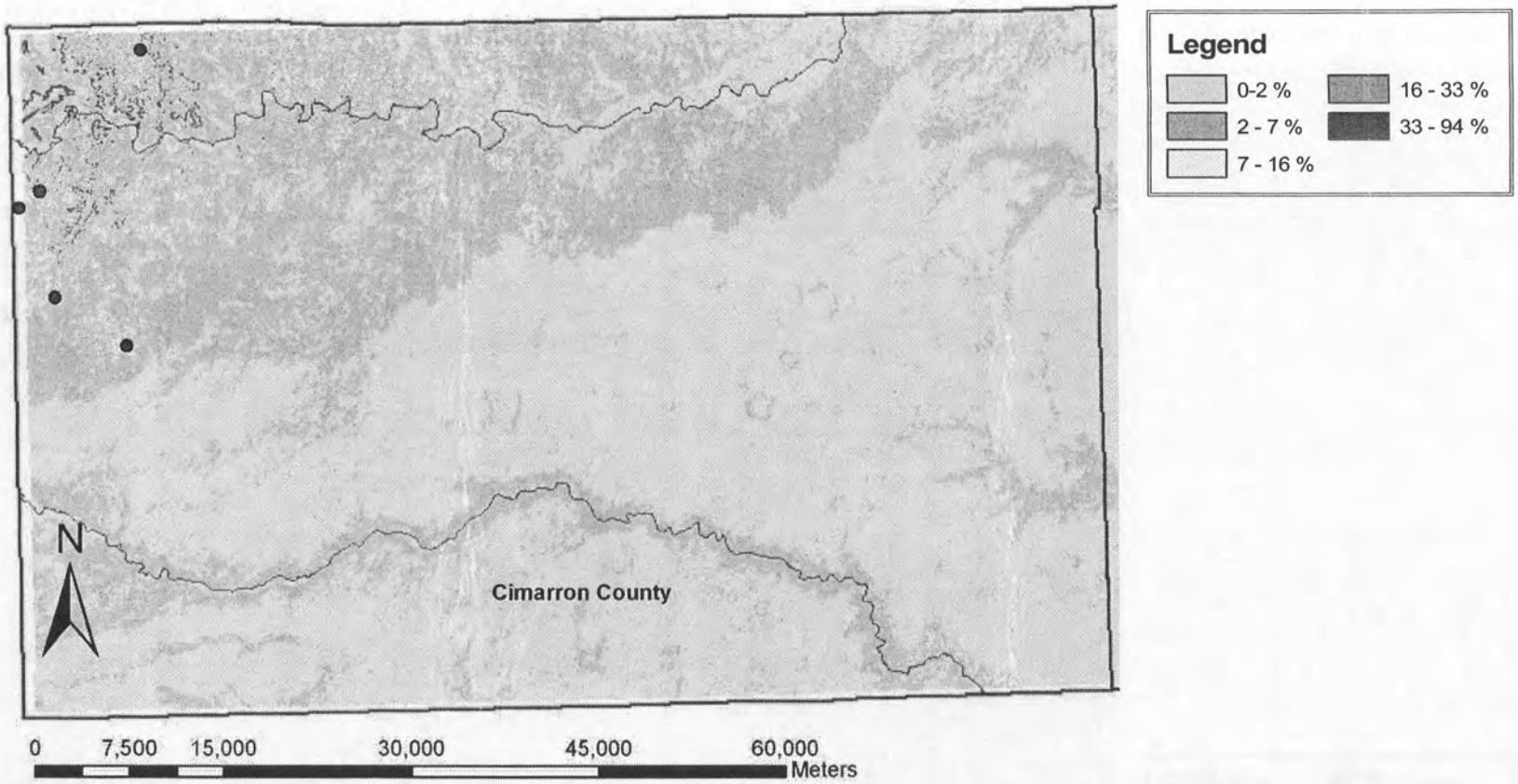
Warbling Vireo (*Vireo gilvus*)

Found mostly in river timber. Concentrated along Cimarron River near Colorado, where the timber is so thick it suggests eastern deciduous forest.



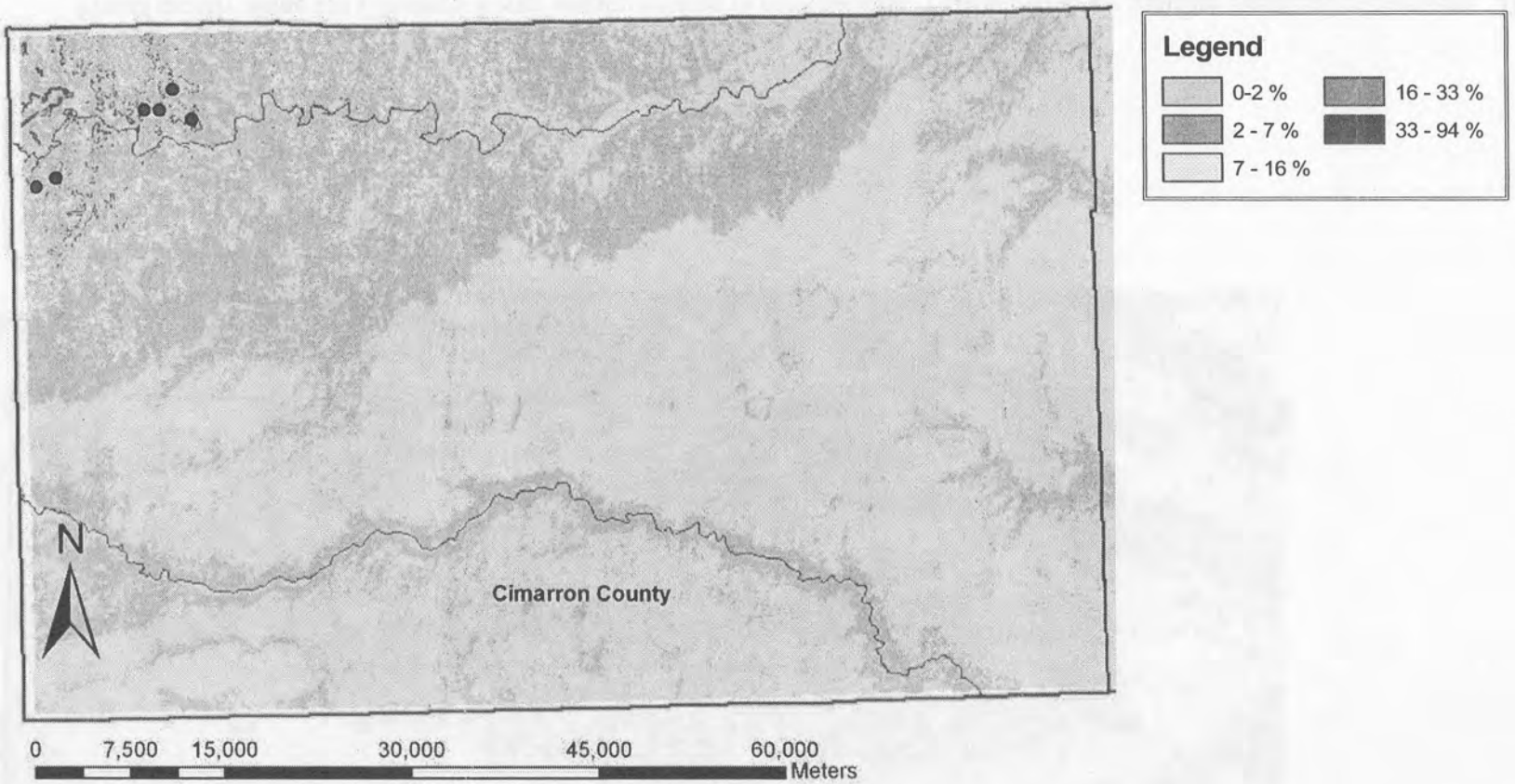
Blue Jay (*Cyanocitta cristata*)

All Blue Jay sightings were in 2005; most were in timber along the Cimarron River. I only had one breeding confirmation (three fledglings 27 June), but had two birds, presumably pairs, at seven other locations.



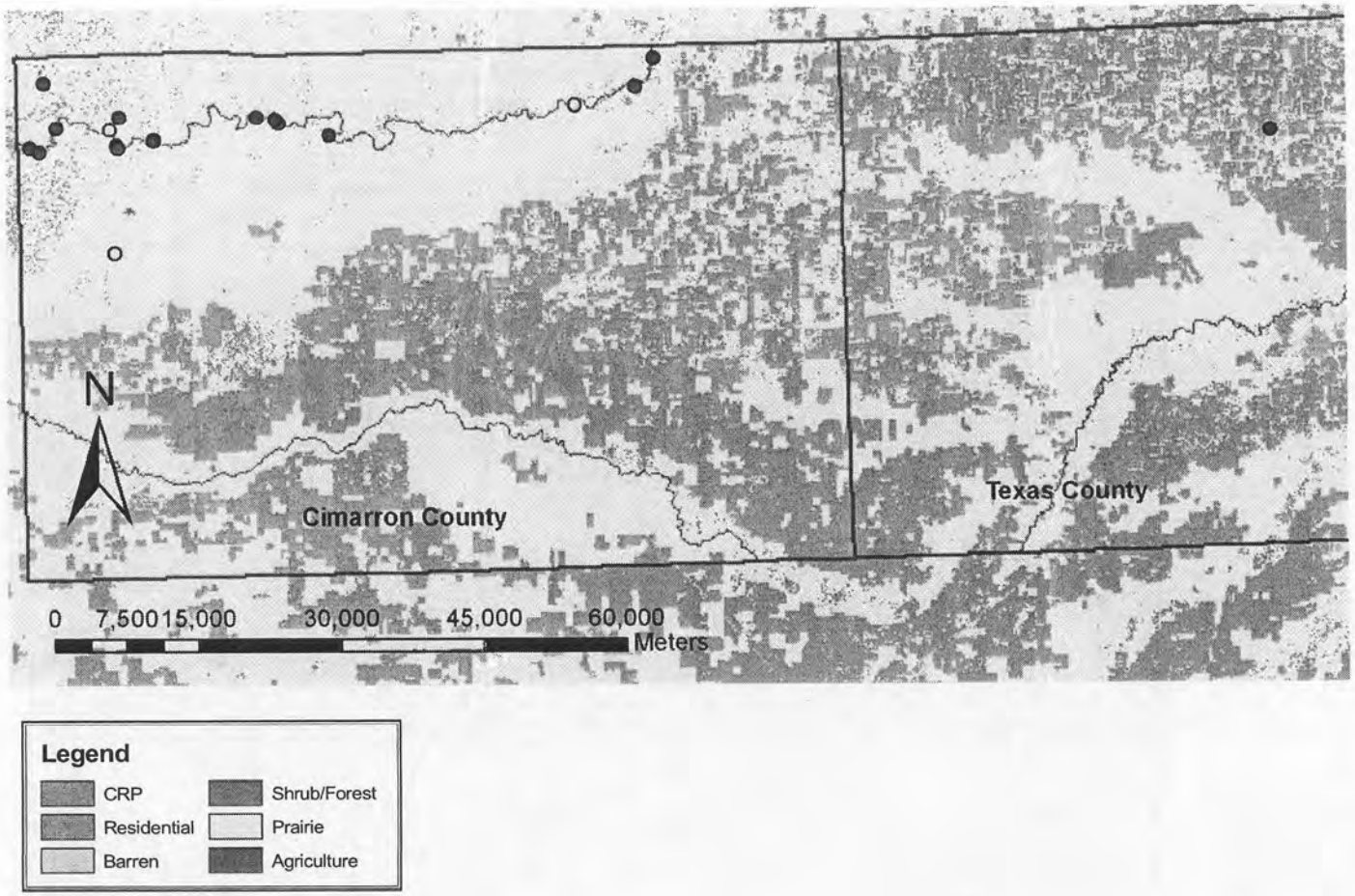
Western Scrub Jay (*Aphelocoma californica*)

Another mesa area specialty. All sightings in 2005. Not classified here as confirmed breeders, but twice encountered an adult with an immature; these had presumably bred in Cimarron County.



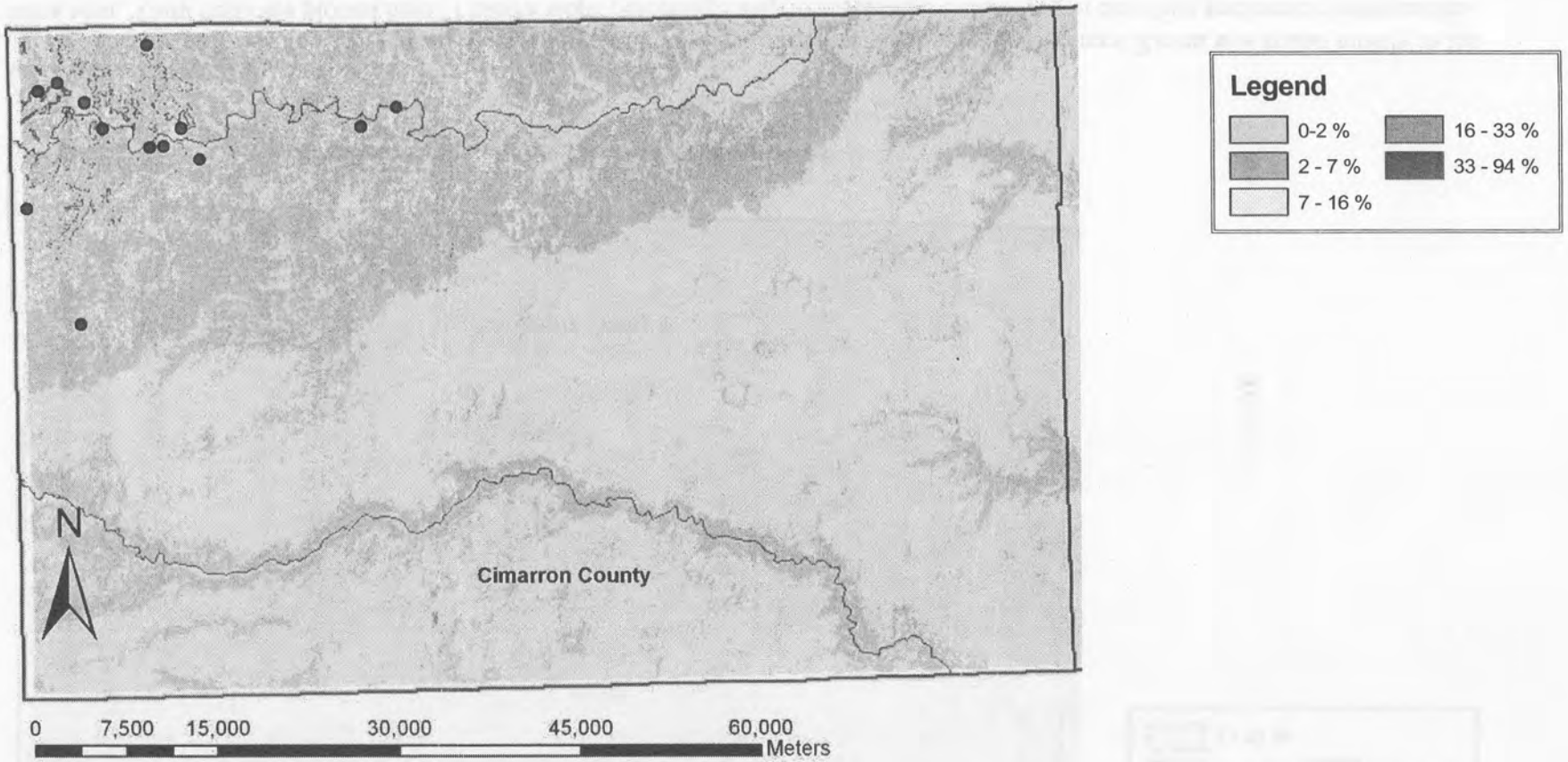
Pinyon Jay (*Gymnorhinus cyanocephalus*)

All sightings in 2005. I found a pair building a nest in a oneseed juniper on 28 May; there were four naked, blind nestlings there 23 June. Additionally, I encountered two flocks (28 May and 13 June) of 21 & 15 birds, respectively, which were comprised of ~⅔ hatch year birds, some still begging and being fed.



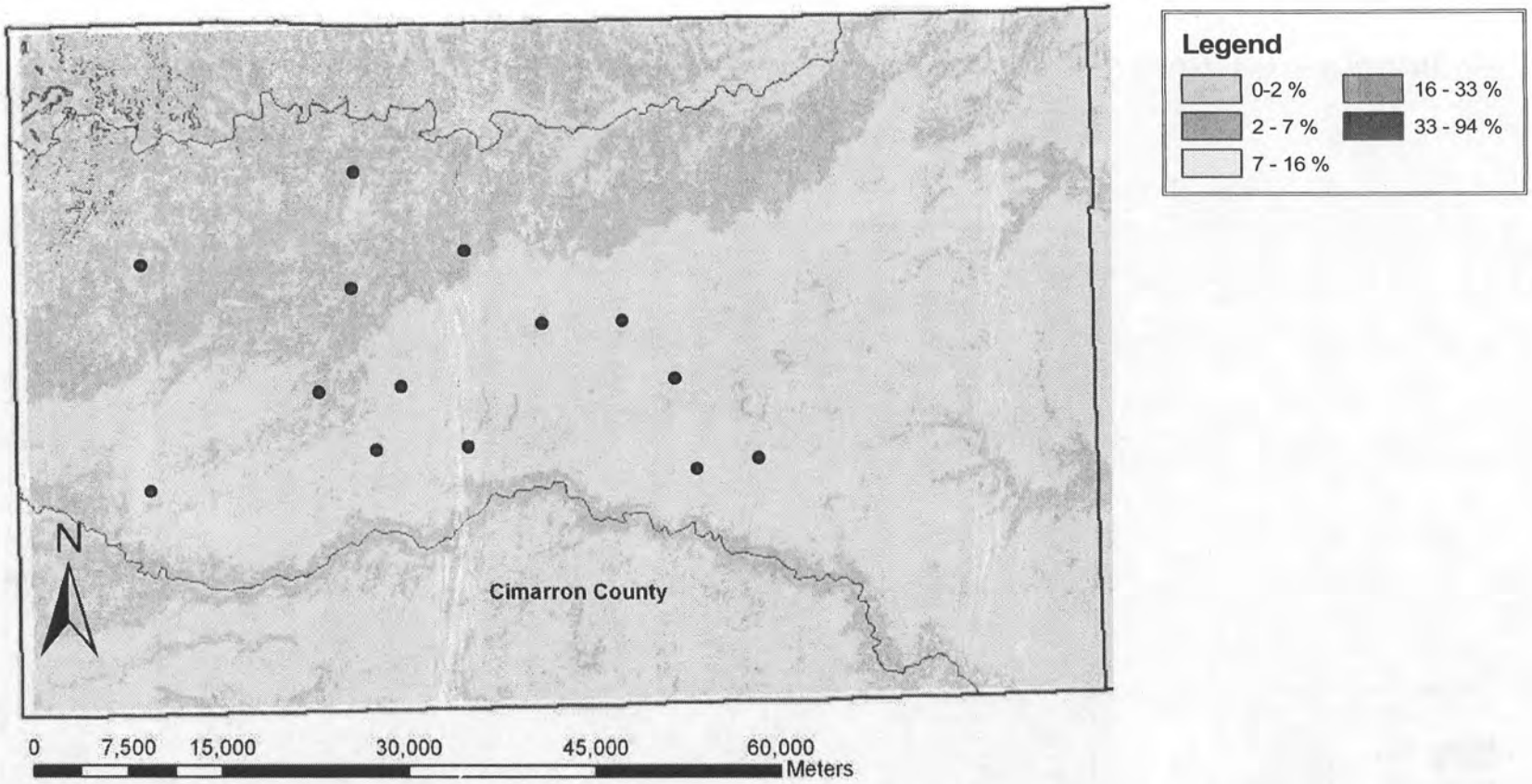
Black-billed Magpie (*Pica pica*)

Found mostly along the Cimarron River, usually nesting in cottonwoods. Yellow diamonds indicate locations of old nests. The Texas County location had ≥9 birds, including four fledglings, and many old nests.



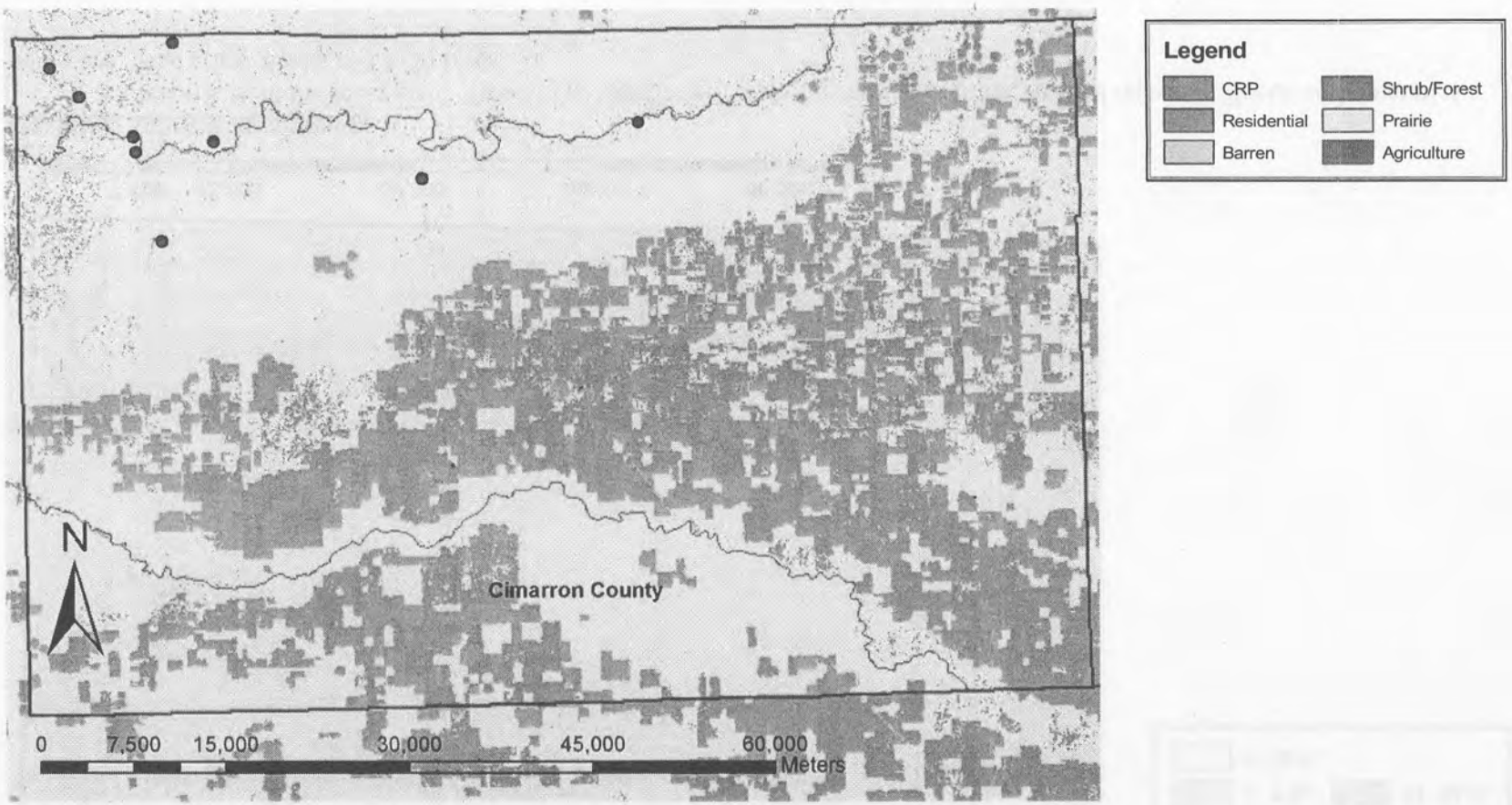
Common Raven (*Corvus corax*)

Found mostly in the mesa areas. Had one sighting each year just north of Boise City of presumably this bird- the calls were right. May be present in very small numbers in the agricultural areas.



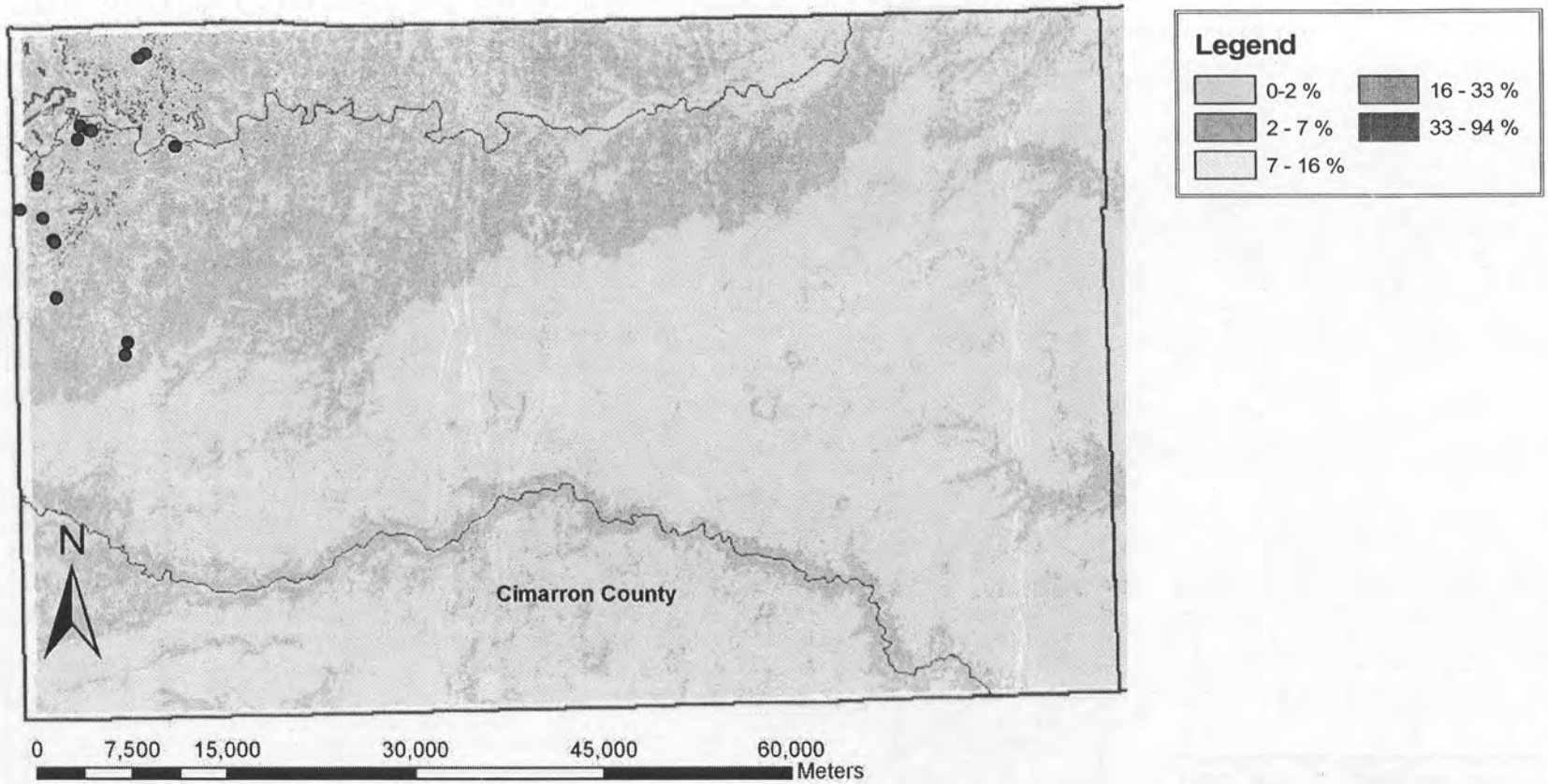
Chihuahuan Raven (*Corvus cryptoleucus*)

This species was confined primarily to the agricultural areas of the county, while the Common Raven was found mostly in the mesa area. Only nests are plotted here. I used a slope percentage map to accentuate differences in elevation preference between this species and the Common Raven.



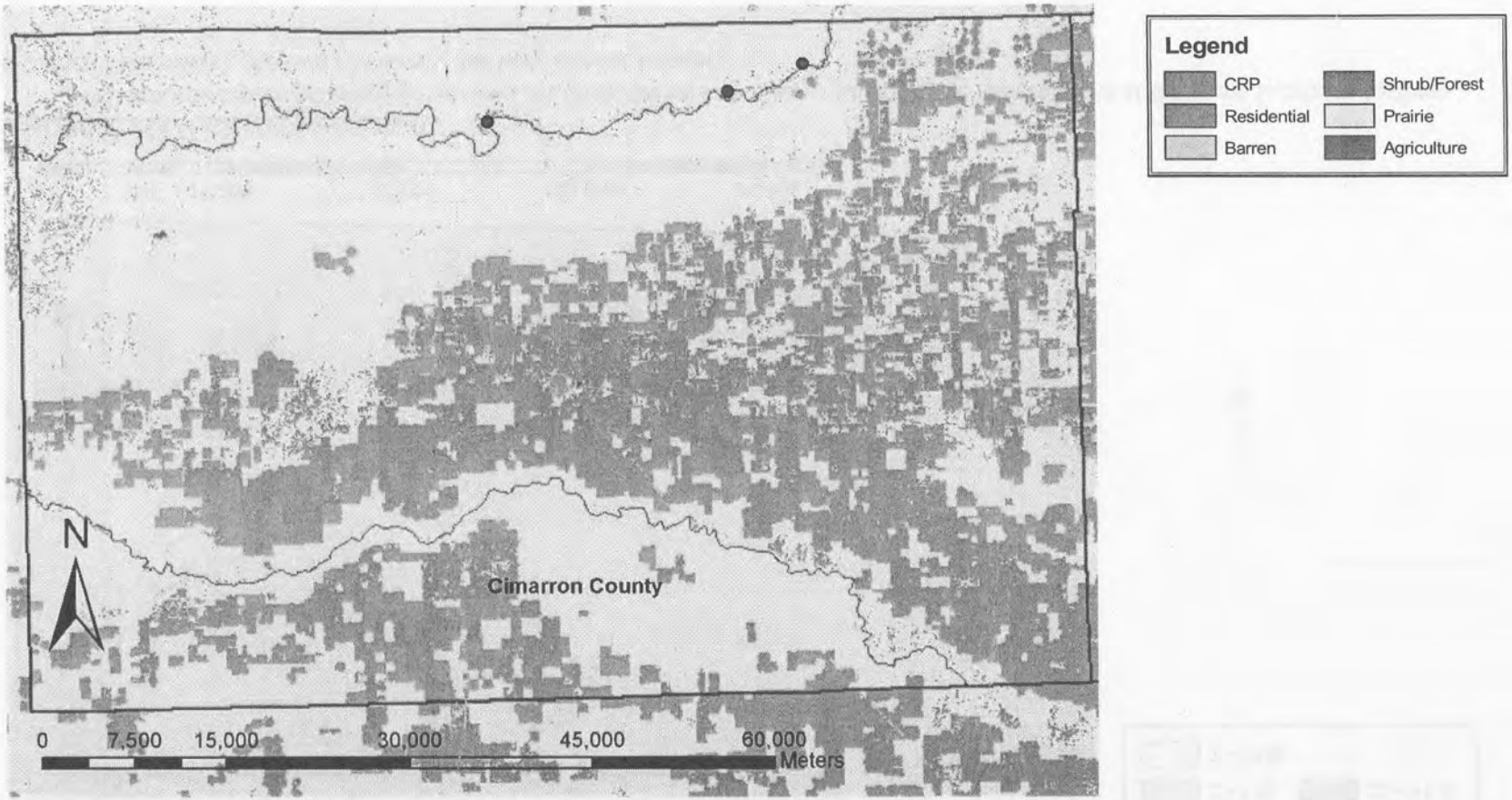
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)

Usually found along rivers and creeks. On 7 July 2005, I found three fledglings being fed near a creek bed ~700 m south of the Colorado line; bird with nest in sandy Cimarron River bank 31 May 2005.



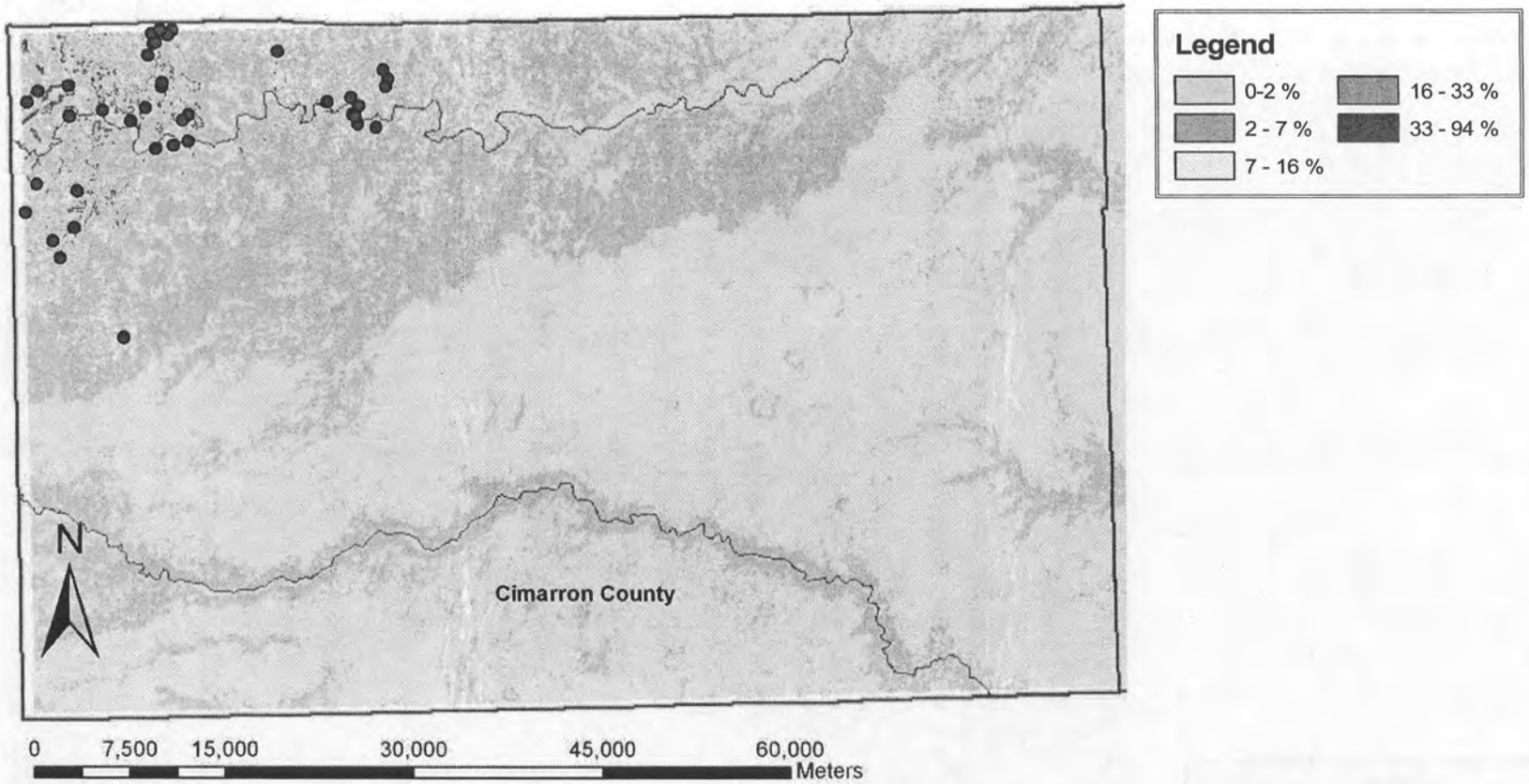
Bushtit (*Psaltriparus minimus*)

All records from the mesa area. Two of the "confirmed" sightings represent nests; the rest represent flocks with juveniles being fed. Had a few flocks of 15–20 birds.



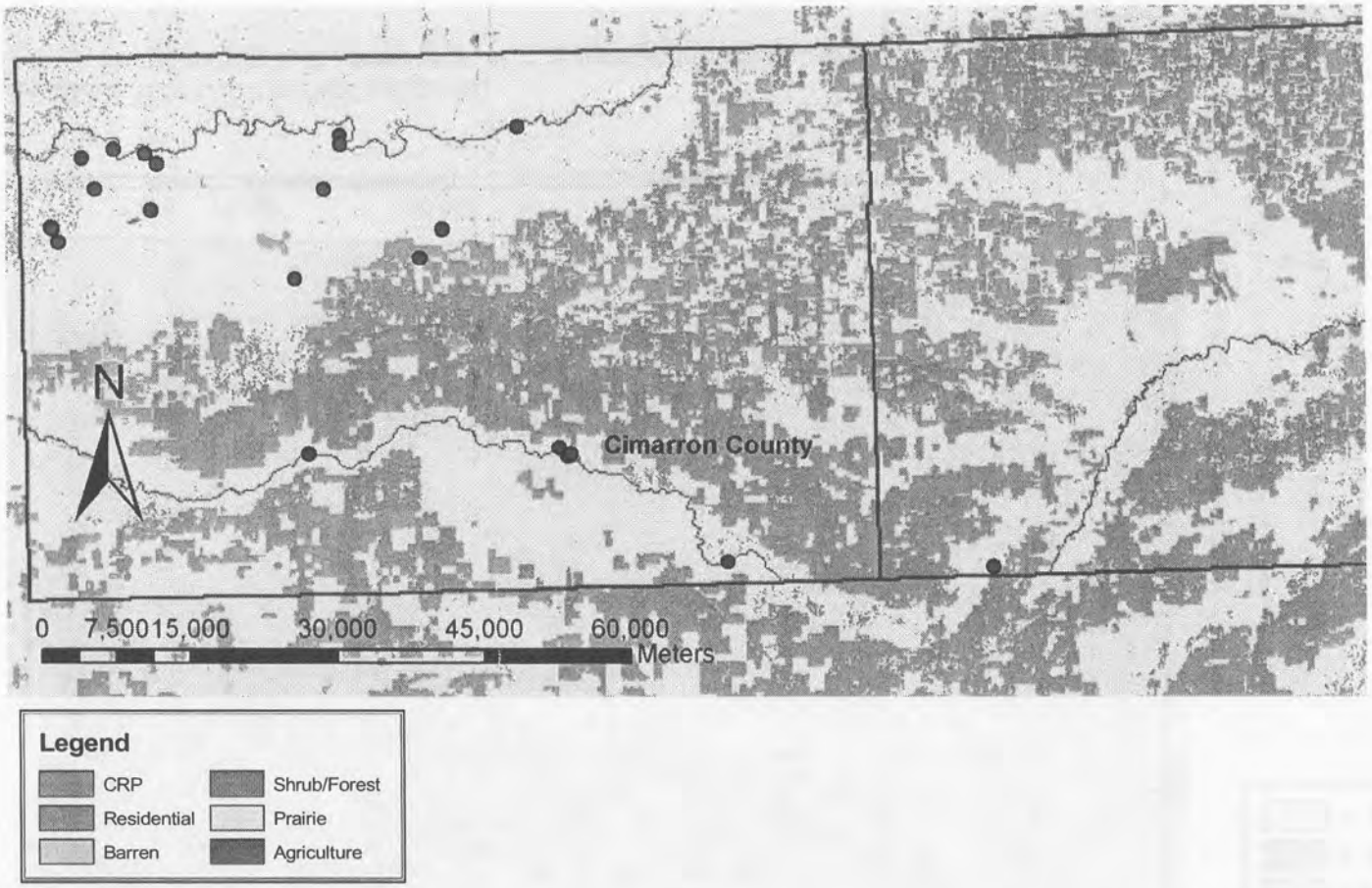
White-breasted Nuthatch (*Sitta carolinensis*)

Located three times in Cimarron River timber. The two easternmost sightings were in an area of timber so heavy it suggests eastern deciduous forest.



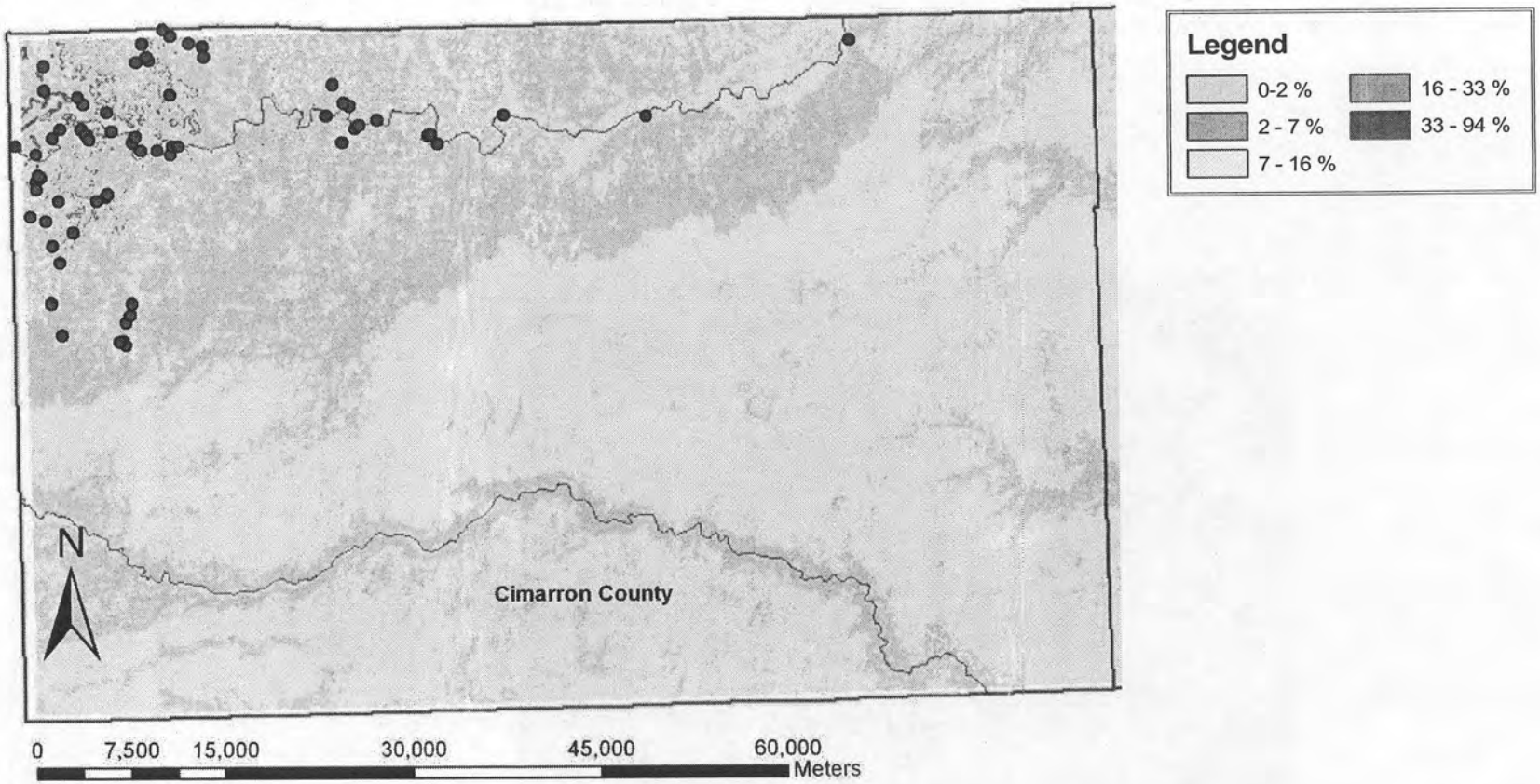
Canyon Wren (*Catherpes mexicanus*)

All records represent singing males on bluffs in the mesa country. On 14 occasions found it at the same locale as Rufous-crowned Sparrow(s); the two obviously use very similar habitats.



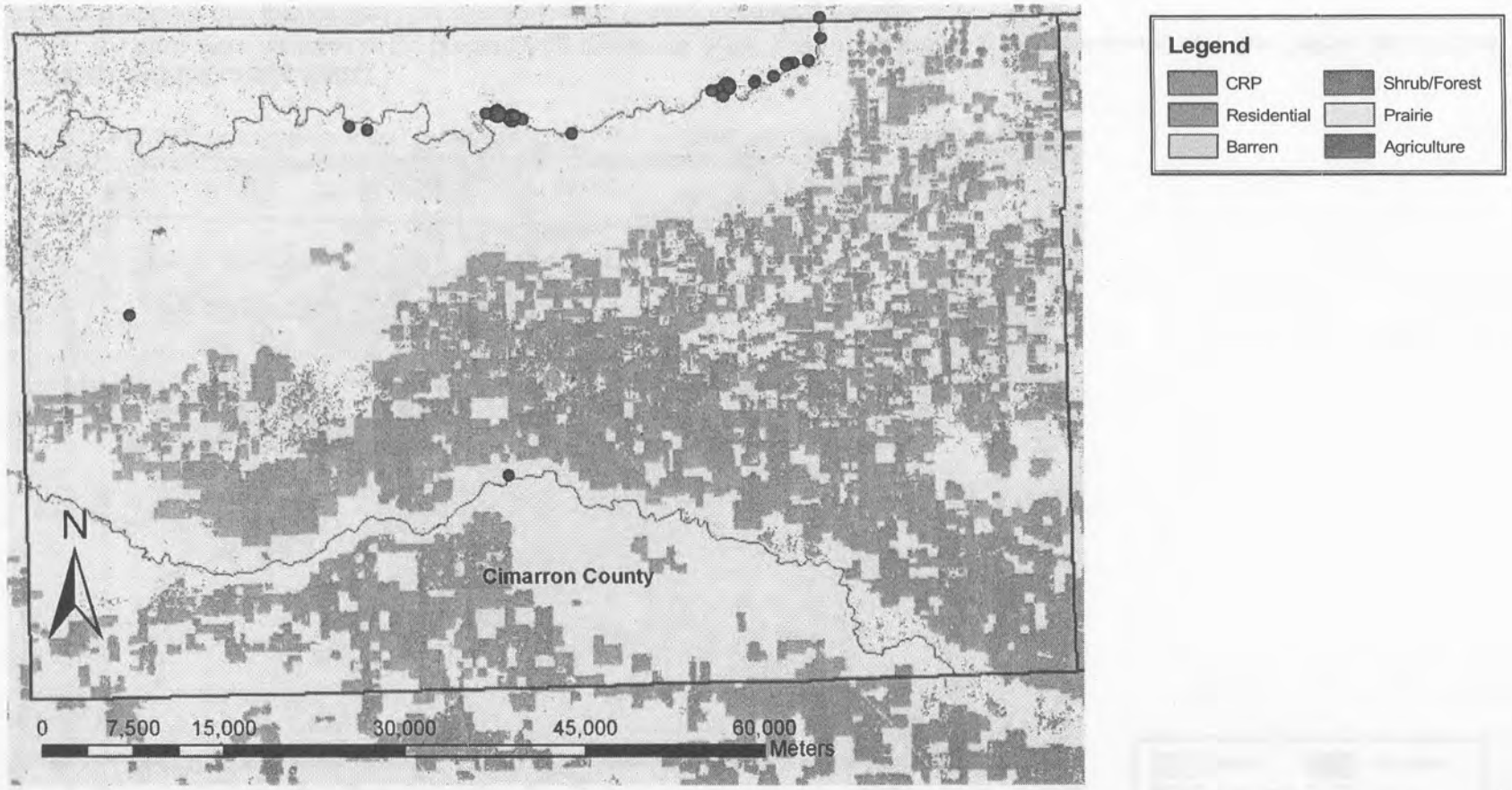
Rock Wren (*Salpinctes obsoletus*)

More commonly found than depicted here; I usually only noted breeding confirmations or unusual locations. Usually in areas with some topography, but on 22 June 2004 I had two groups of three in prairie with occasional small eroded areas, and on 9 May 2005 had a bird in an area of mostly CRP.



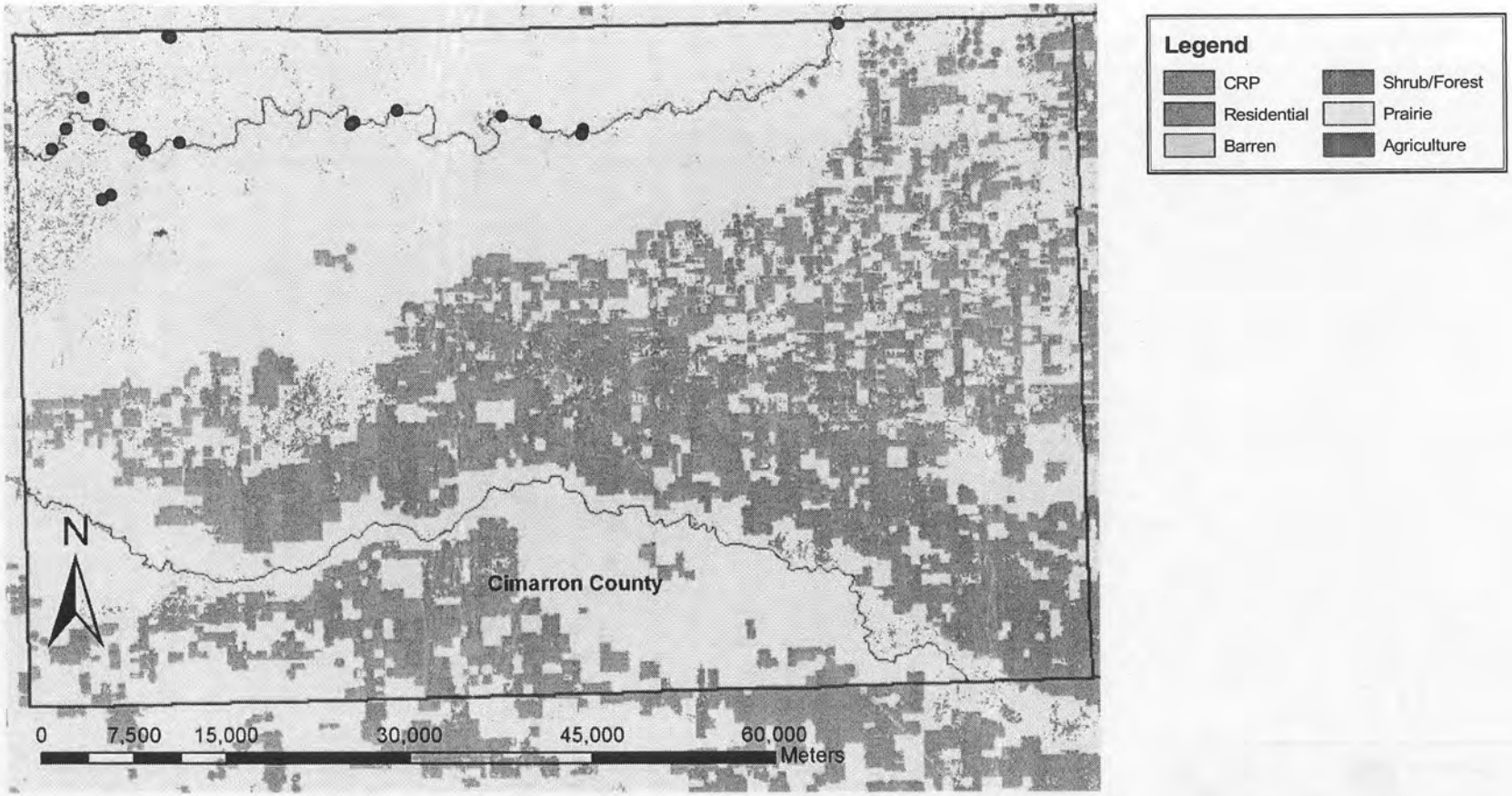
Bewick's Wren (*Thryomanes bewickii*)

Found mostly in the mesa area; also in riparian timber.



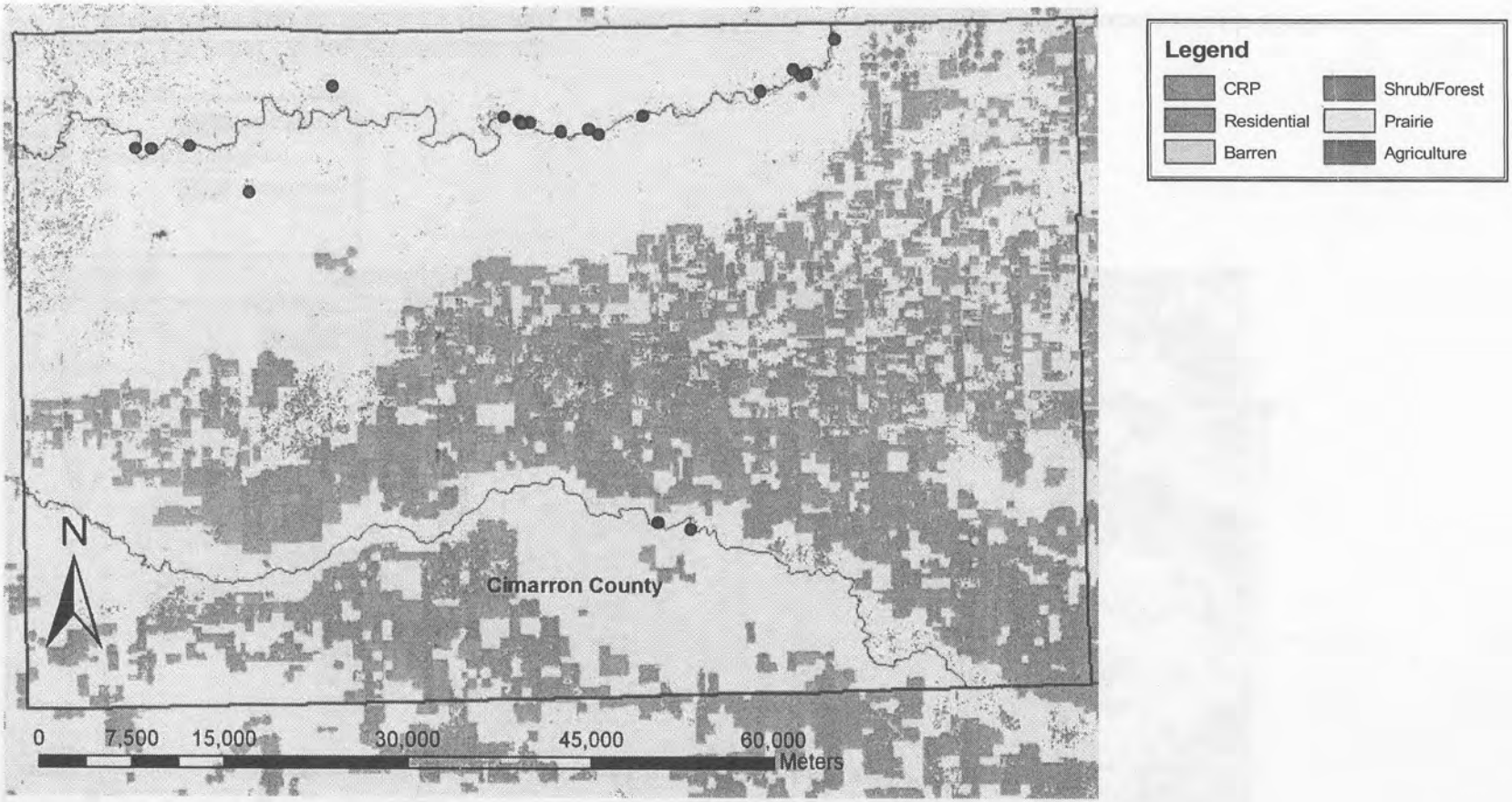
House Wren (*Troglodytes aedon*)

Found mostly in timber along the Cimarron River. Particularly common along a stretch in the northeast part of the county where the timber is so thick it resembles eastern deciduous forest.



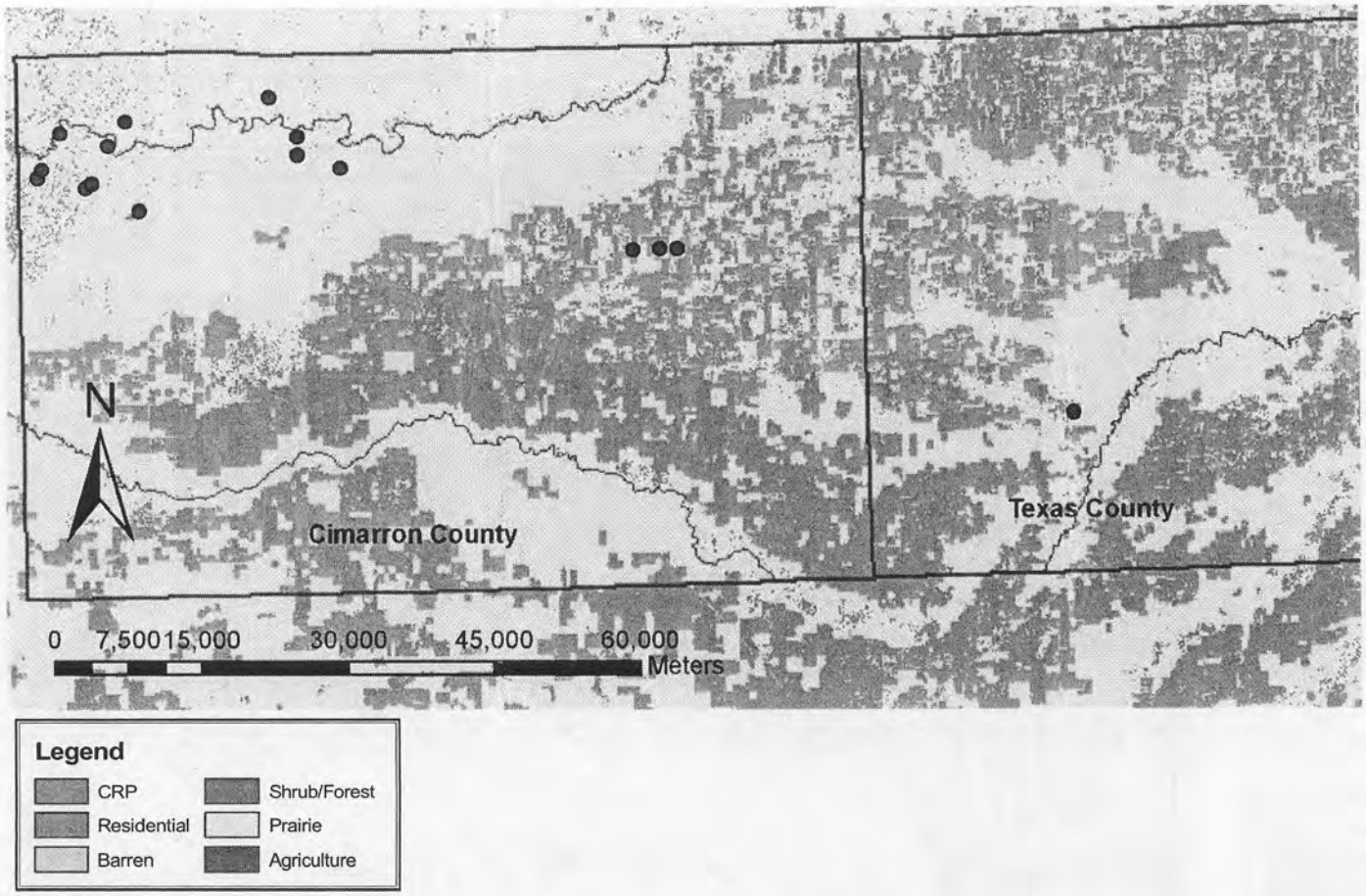
Eastern Bluebird (*Sialia sialis*)

All birds were recorded in the timber along river/creek beds. Confirmed breeding at 14 locations; note that OBBA did not find Eastern Bluebirds any farther west than eastern Beaver County (Reinking 2004).



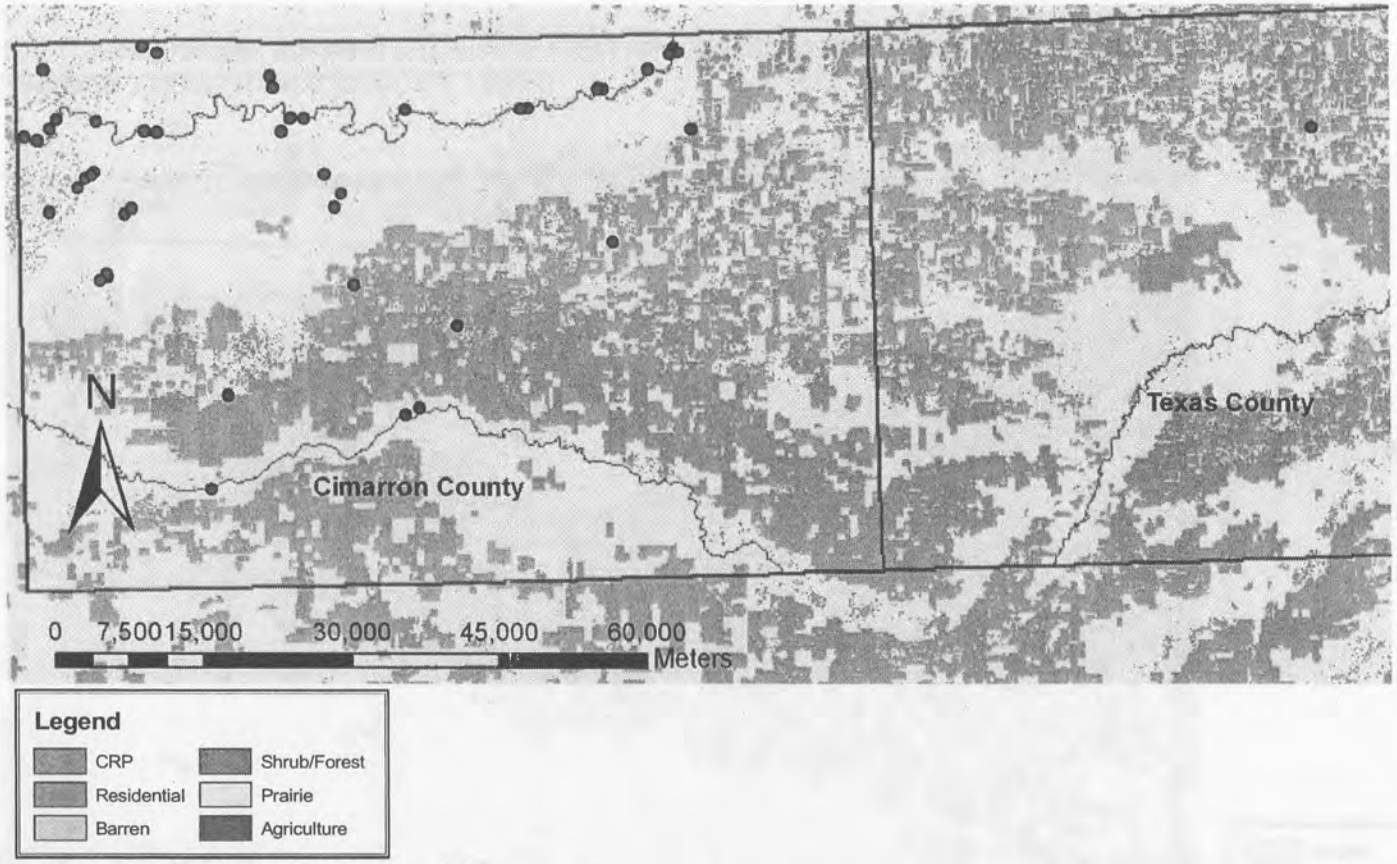
Brown Thrasher (*Toxostoma rufum*)

Found mostly in Cimarron River timber, particularly in areas with salt cedar.



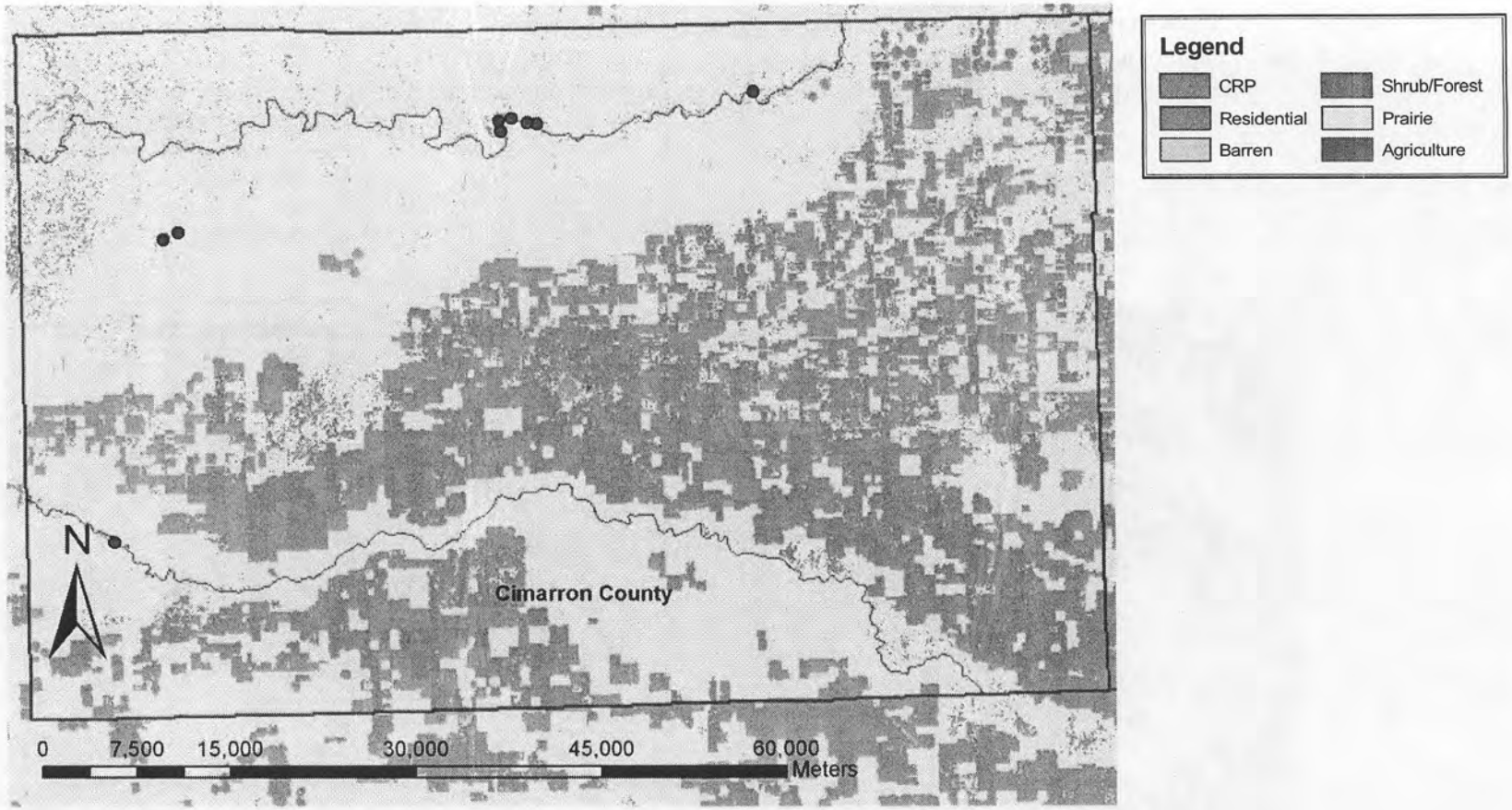
Curve-billed Thrasher (*Toxostoma curvirostre*)

Usually found near cholla cactus (*Opuntia imbricata*); all breeding confirmations were in locations with cholla.



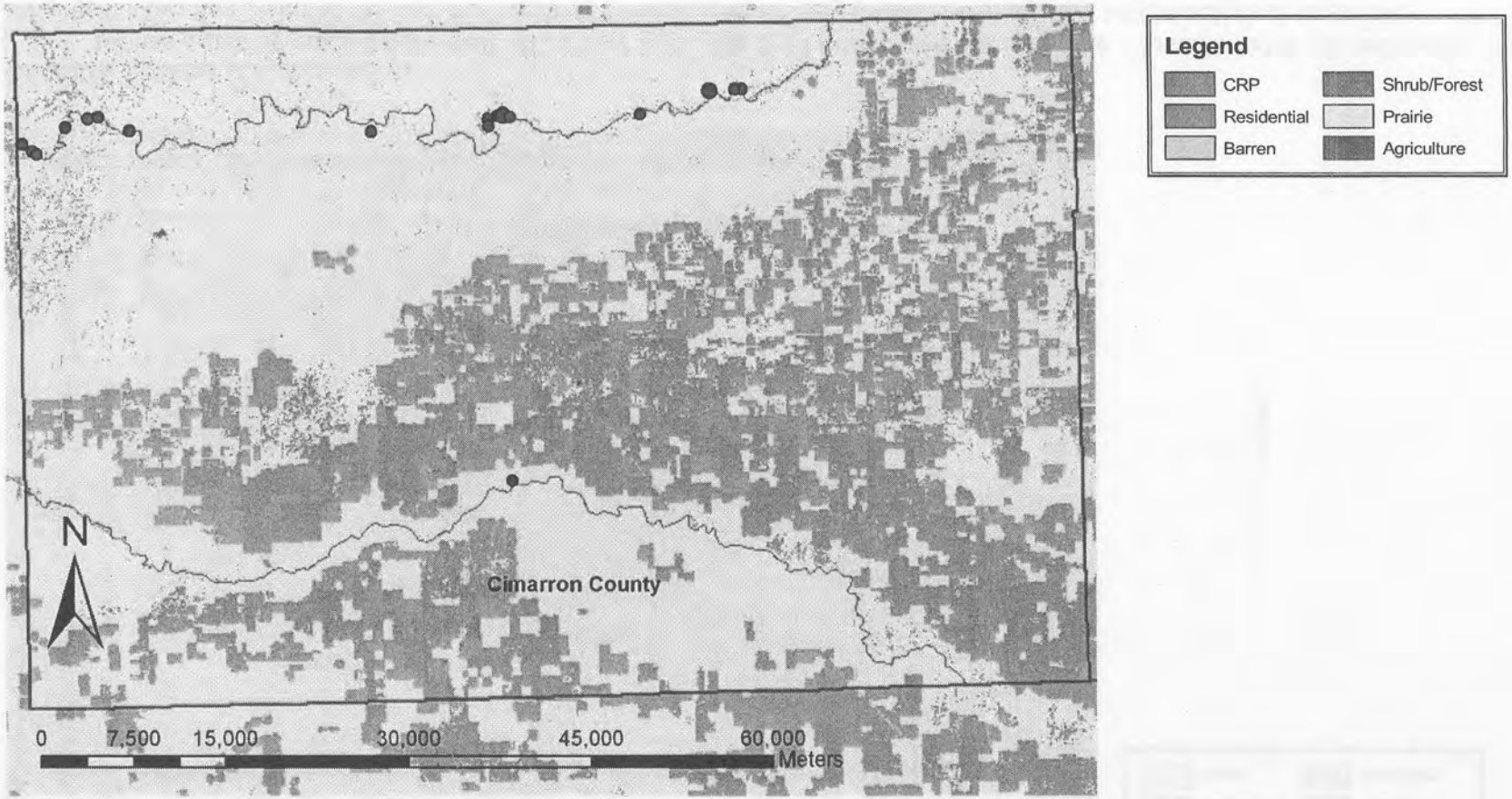
Yellow Warbler (*Dendroica petechia*)

Usually detected as singing males; some locations shown had up to three singing males. Both breeding confirmations involved adults feeding Brown-headed Cowbird (*Molothrus ater*) fledglings; also had a protesting female at another location. Had 19 detections for both May and June, and six for July. Usually found in cottonwoods along watercourses.



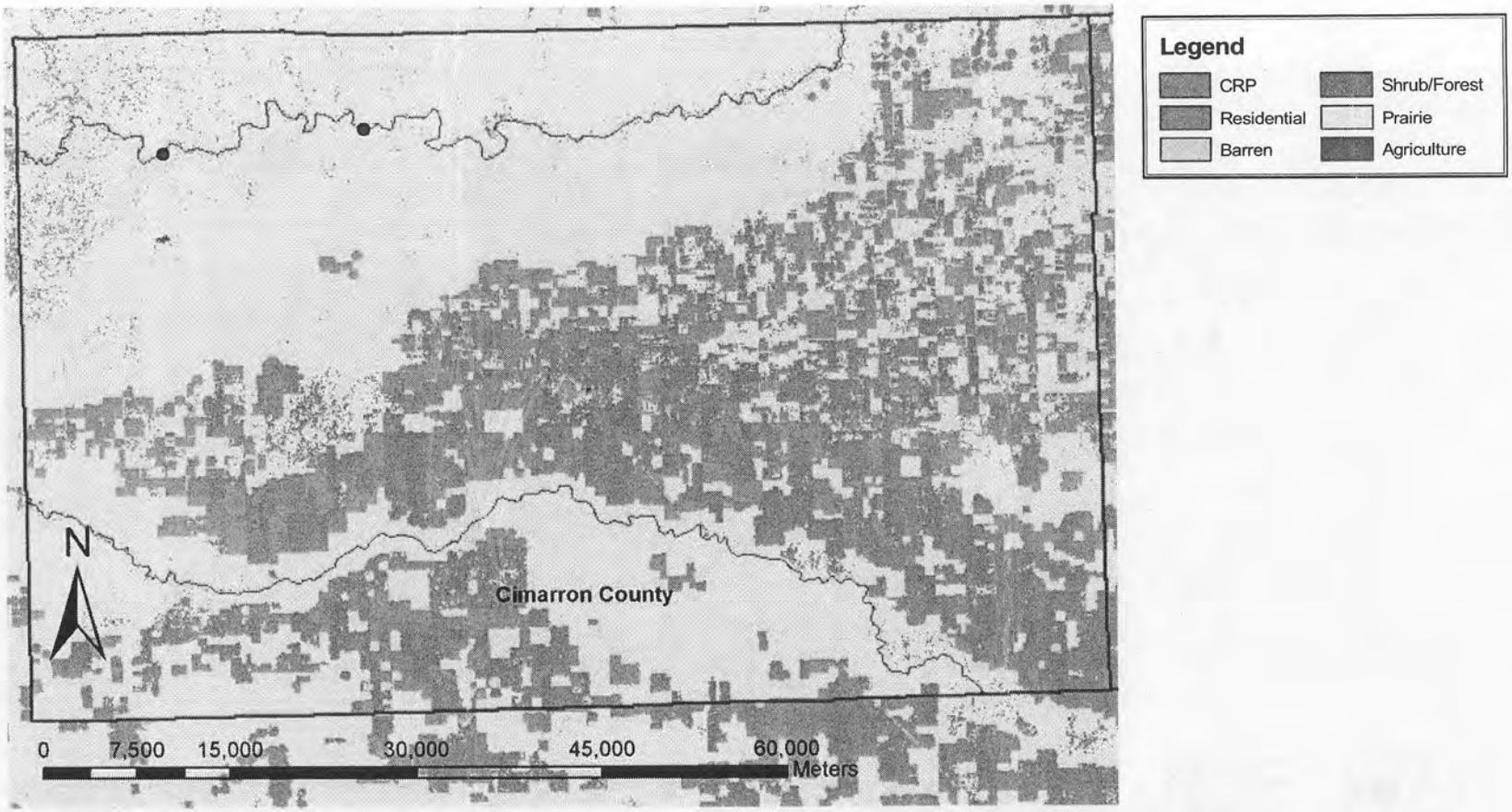
Common Yellowthroat (*Geothlypis trichas*)

Map locations represent 1–2 singing males per location. Usually found in cattails along river.



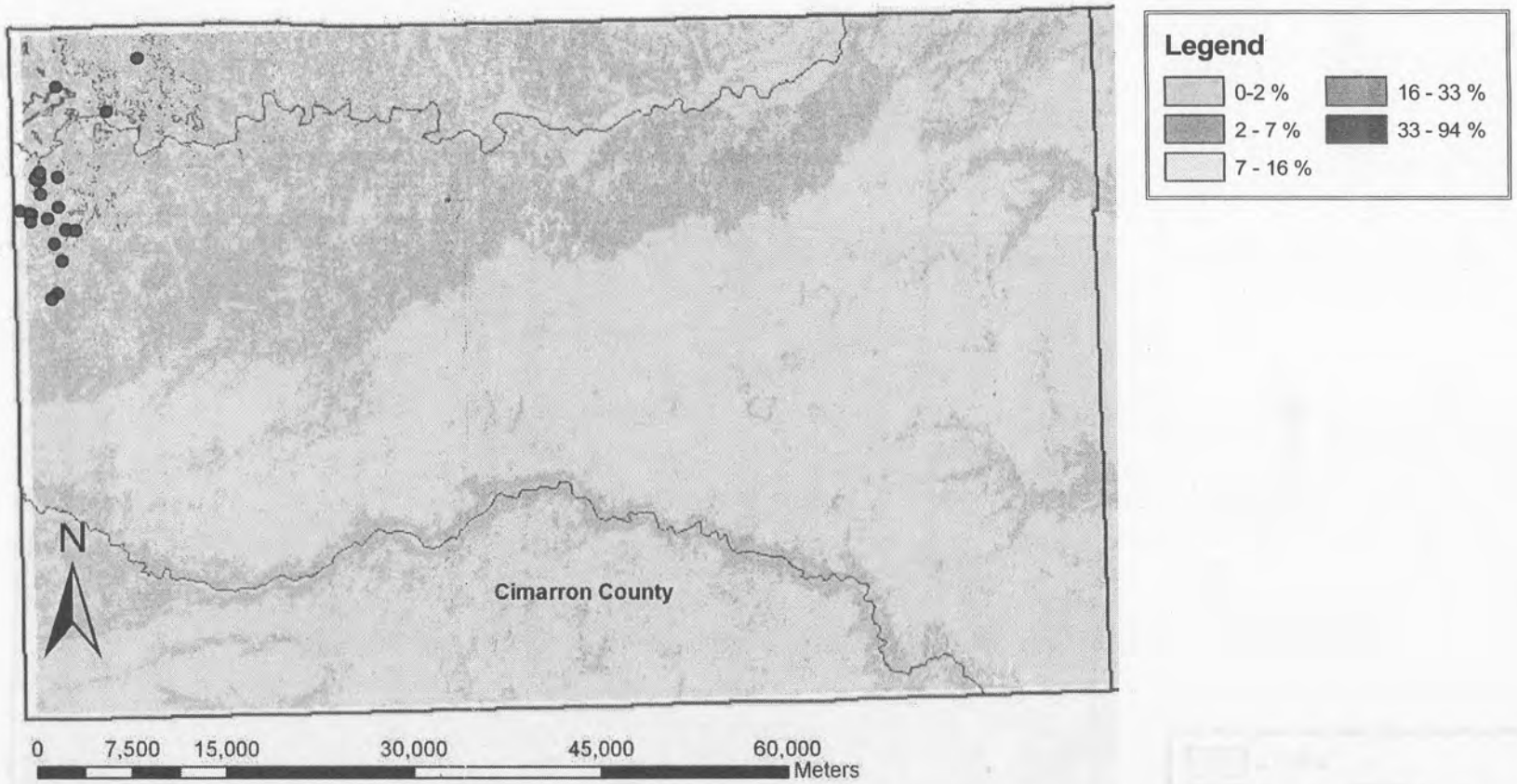
Yellow-breasted Chat (*Icteria virens*)

Invariably associated with salt cedar along rivers; this species appears to benefit from it.



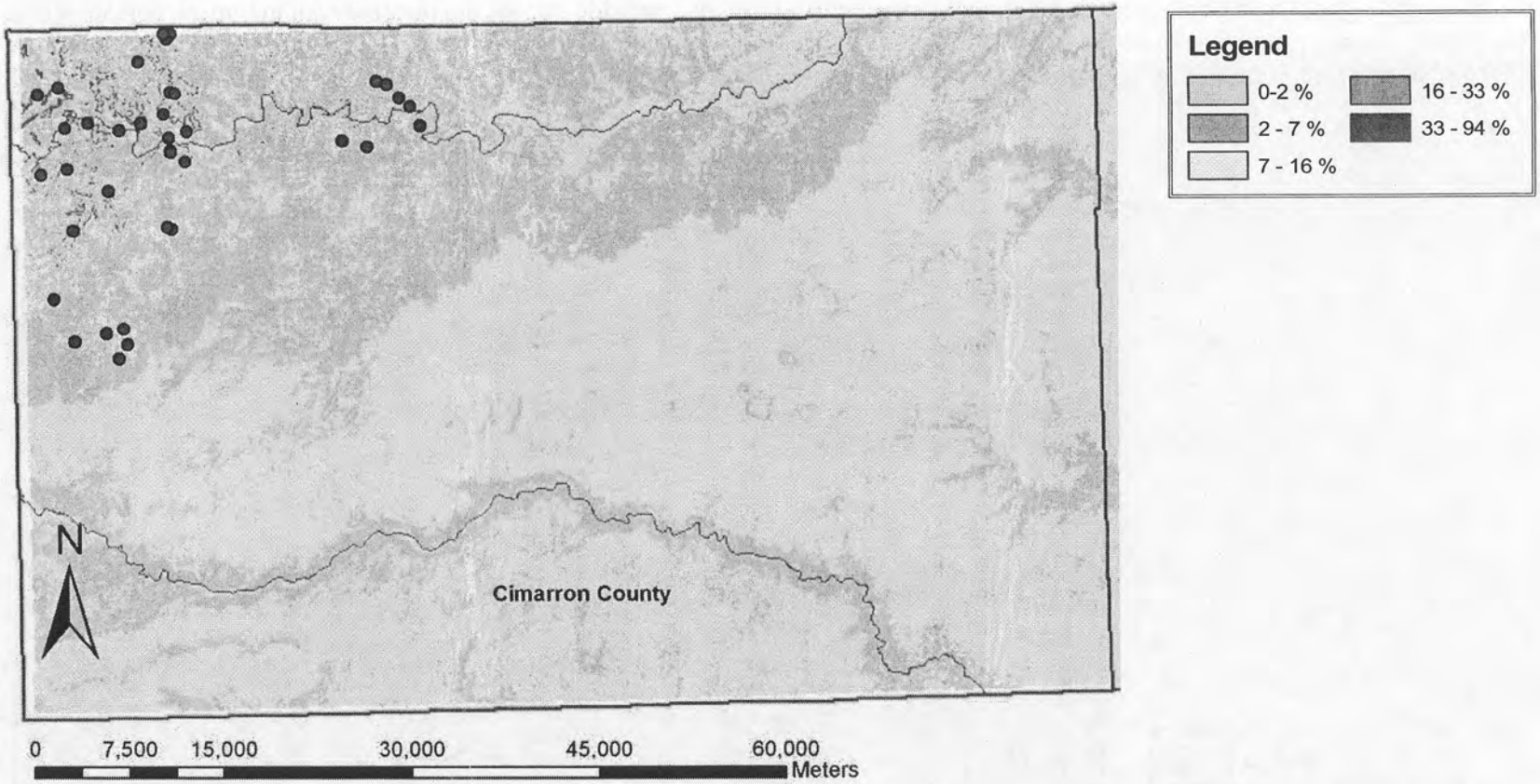
Summer Tanager (*Piranga rubra*)

I found a singing green-bellied male on 20 May 2005. On 29 May 2005 and again 19 June, I found an adult (all red) male singing at a location 16 km to the east, and confirmed breeding here 5 July (female building nest; McConnell et al. in press).



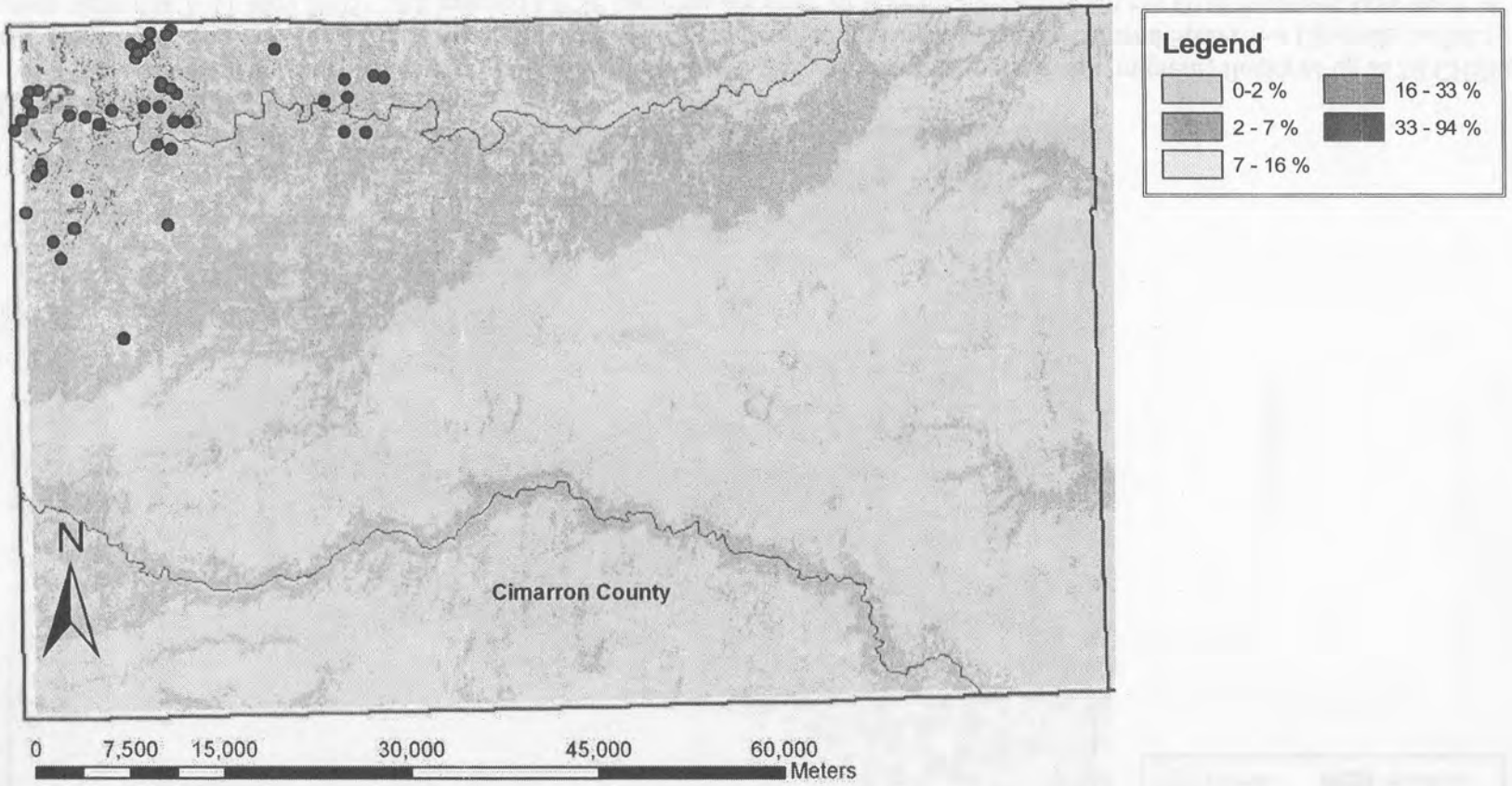
Spotted Towhee *(Pipilo maculatus)*

Found at 21 locations in the mesa country; breeding confirmed (two fledglings being fed) at one location on 11 June 2005. Invariably associated with Gambel's oak (*Quercus gambelii*), on slopes and in ravines. At five locations, adults' behavior (protesting, etc.) indicated nesting in the area, and the species appears to be well-established as a breeder in the Kenton area (McConnell et al. 2006).



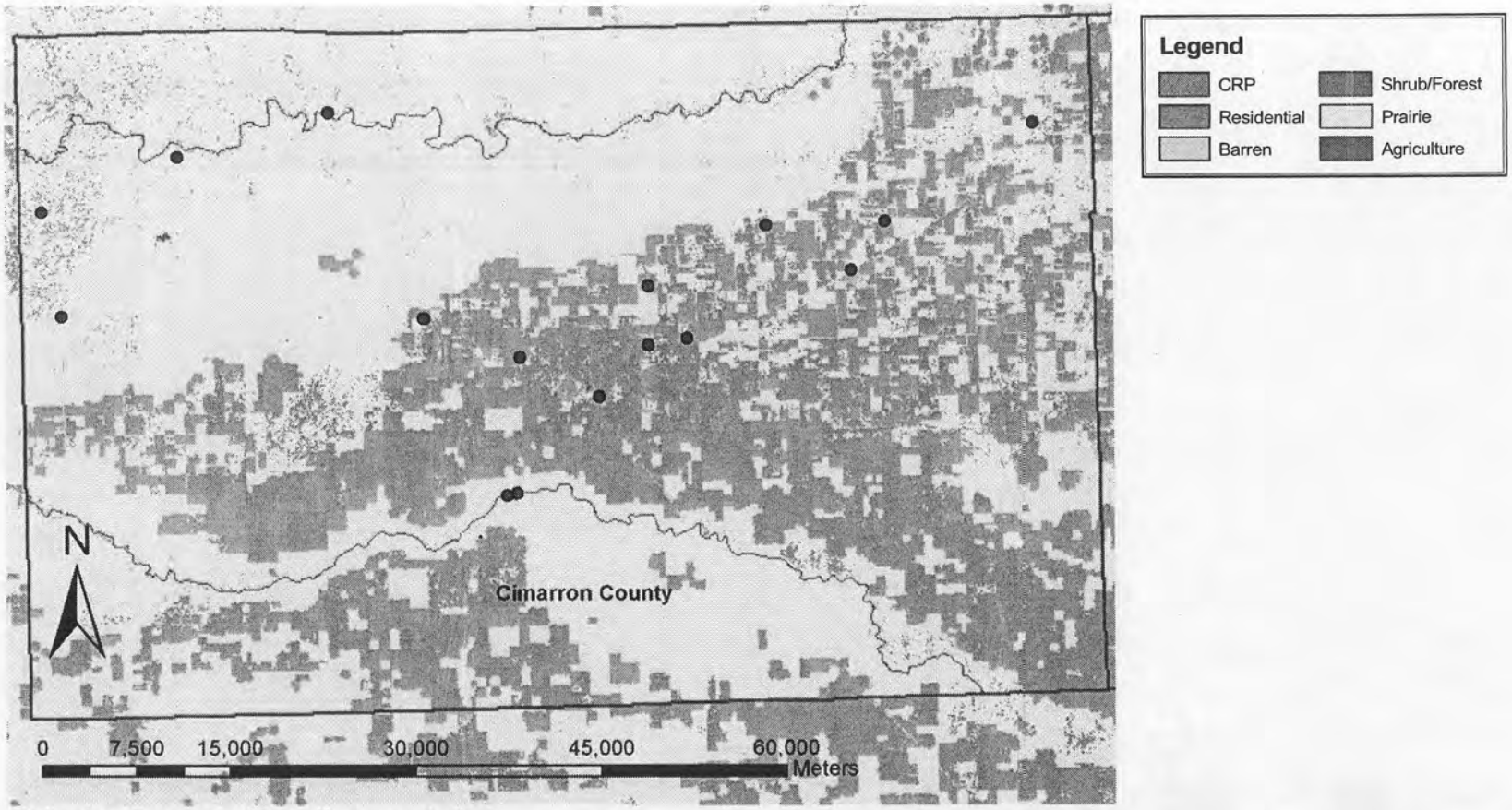
Canyon Towhee (*Pipilo fuscus*)

A mesa area specialist.



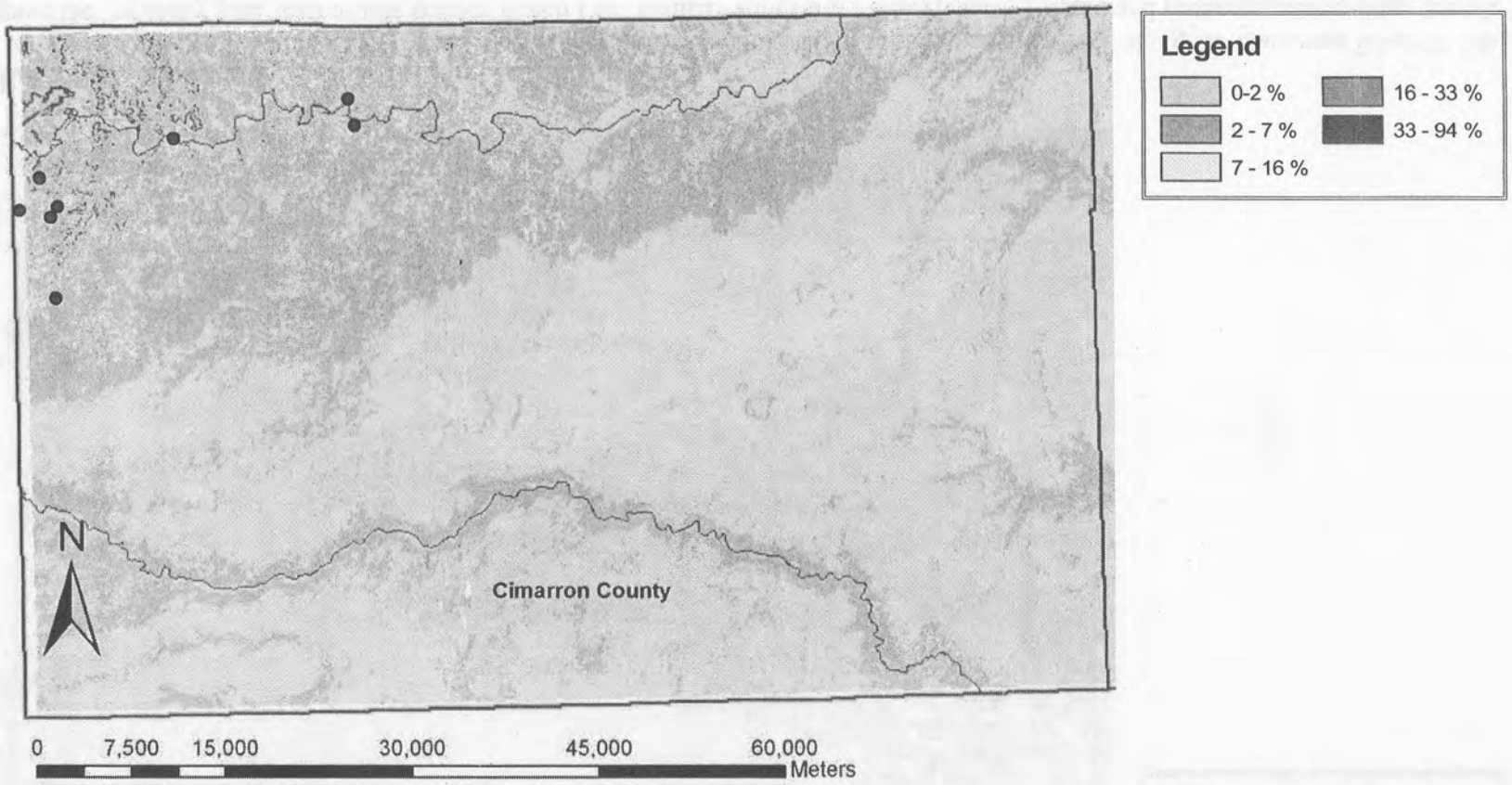
Rufous-crowned Sparrow (*Aimophila ruficeps*)

Found in the mesa area. Located simultaneously with the Canyon Wren at 14 locations. Found a nest with three eggs on 1 July 2005. Had several unconfirmed breeding situations where pairs were acting agitated (alarm calls, crest raised, etc.), likely in vicinity of nest.



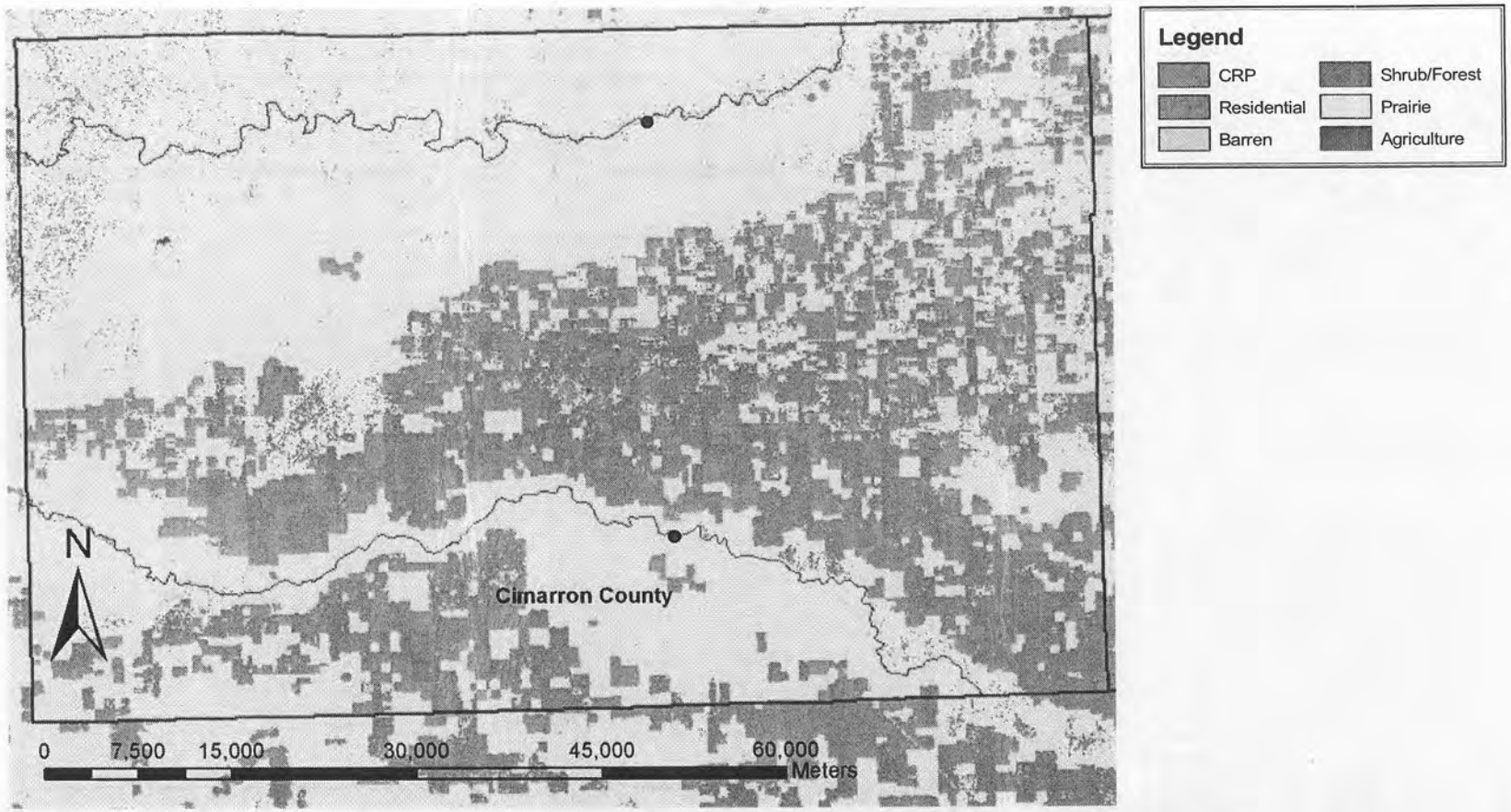
Chipping Sparrow (*Spizella passerina*)

One of the interesting phenomena of the 2005 field season was encountering (presumably migrant) flocks of up to 30 CHSPs bouncing along over the agricultural areas, 7&8 May. Flocks sometimes contained 1–2 **Clay-colored Sparrows** (*Spizella pallida*; seven sightings 7–11 May 2005). All mapped CHSP locations are after 10 May for both years; all but three represent May dates (6 July 2005 latest date). Some locations include up to three singing birds.



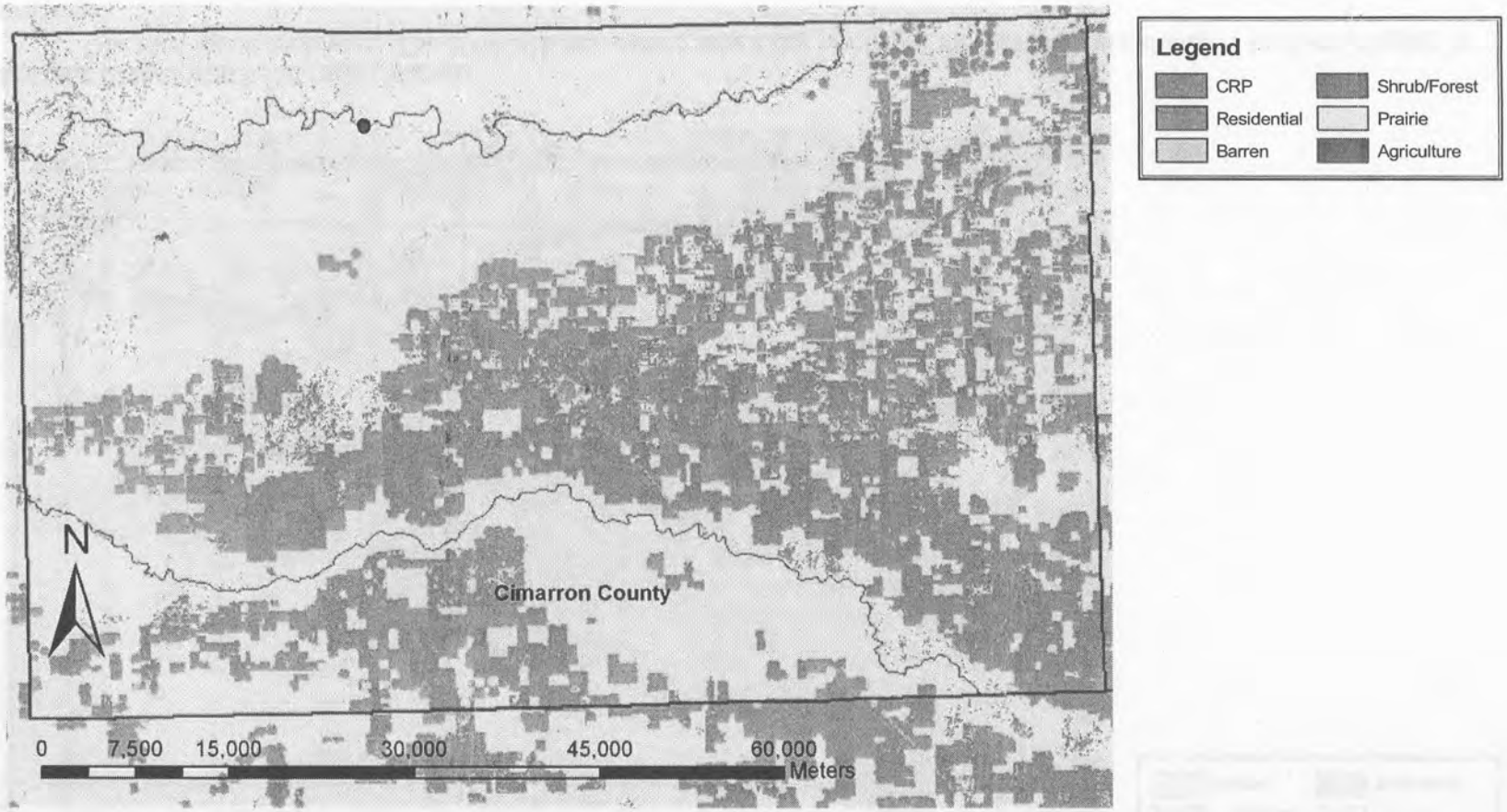
Black-headed Grosbeak (*Pheucticus melanocephalus*)

Had several singing males on a walk south of Kenton 11 June 2005. The three easternmost locations were all in mid-May and may have been migrants.



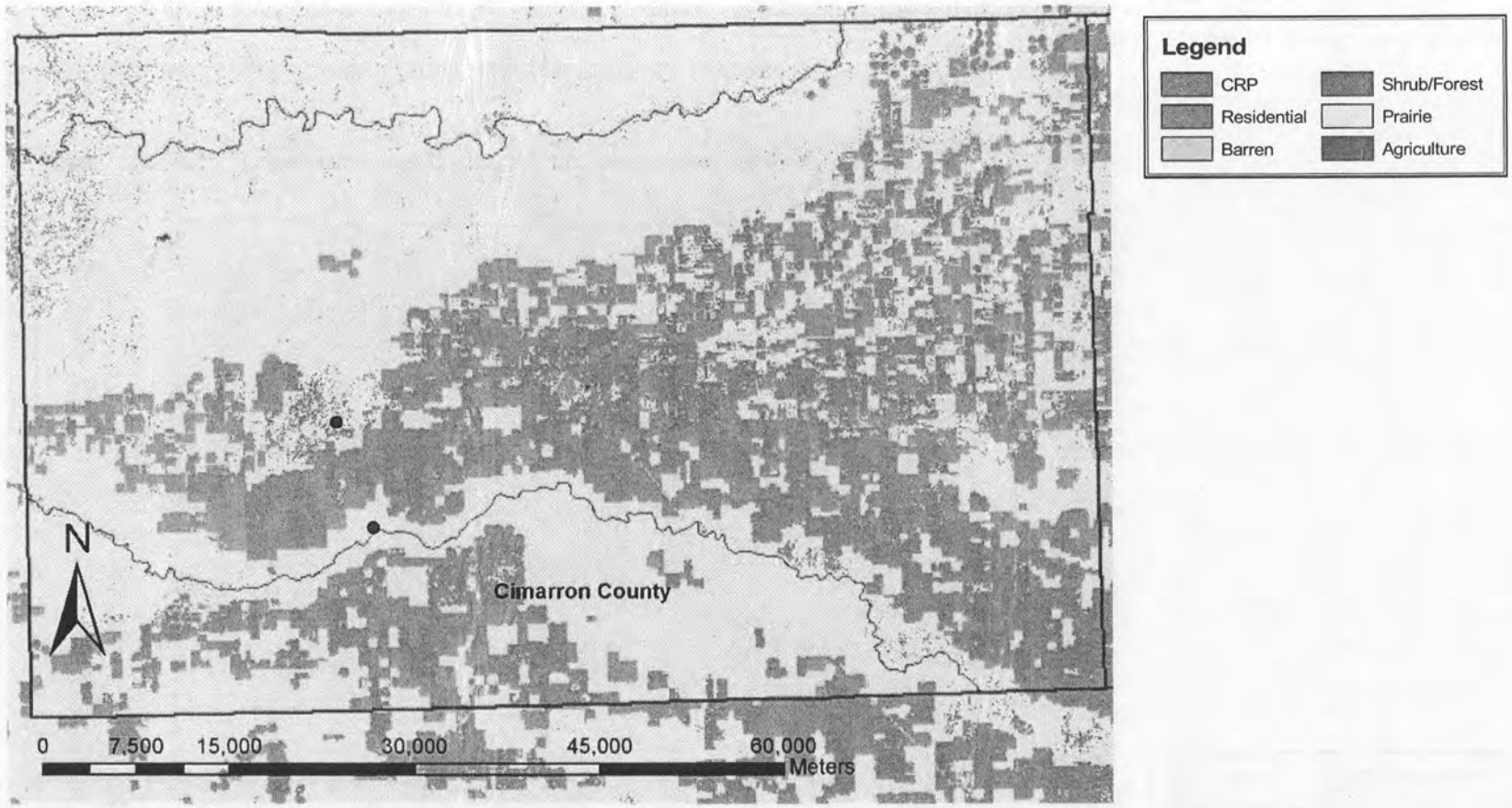
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)

I found two females which I identified as this species in 2005. One calling in cottonwoods along the Cimarron River 31 May gave the "squeaky gate" call of this species which I am familiar with from Pennsylvania. I found and photographed another female 2 July along the Beaver River.



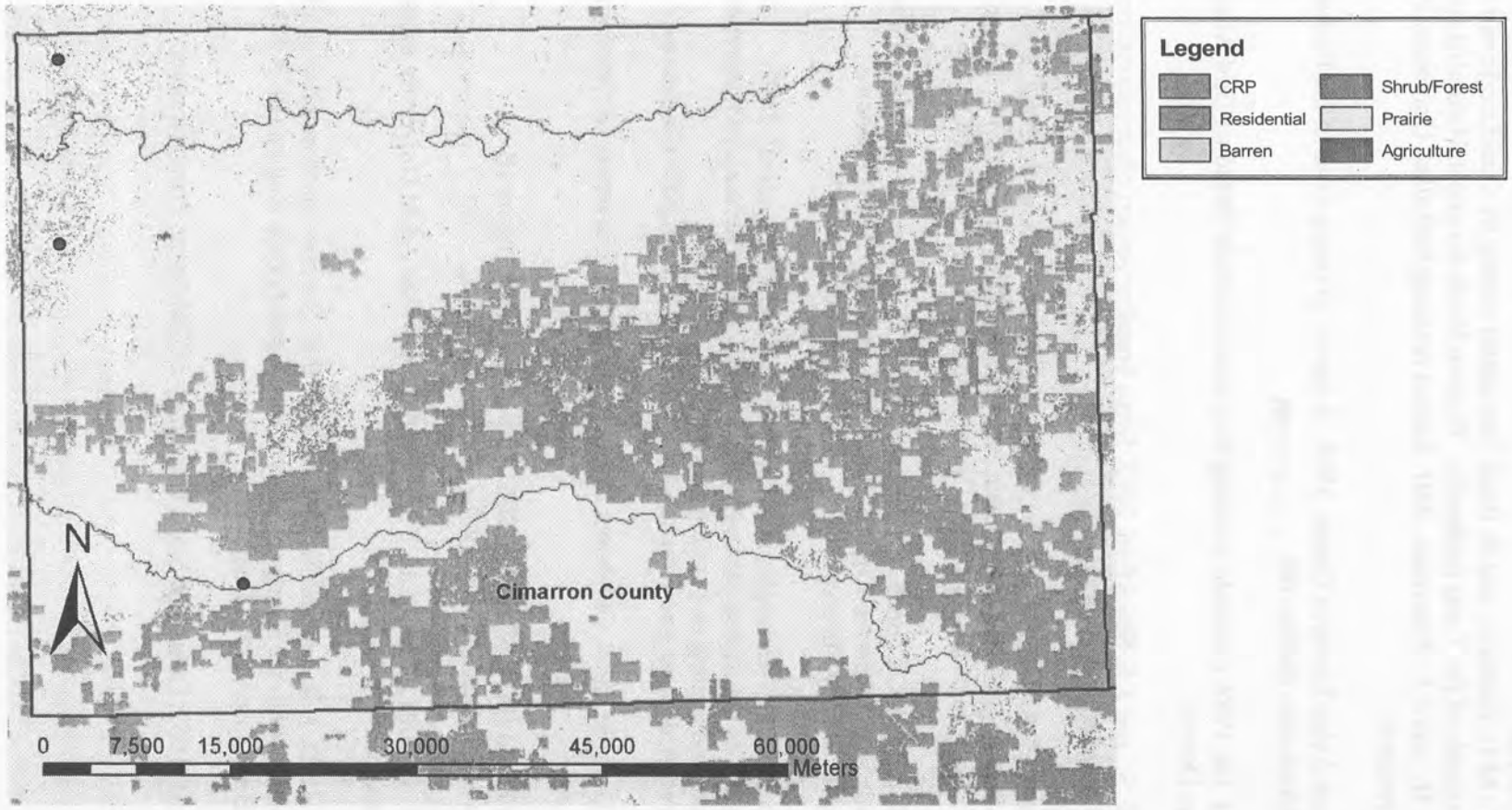
Lazuli Bunting (*Passerina amoena*) and **Indigo Bunting** (*P. cyanea*)

Male Lazuli Bunting singing on 14 May and 5 July 2005 at mapped location. I found a mostly brown year-old male Indigo Bunting singing at the same location on 29 May 2005, and on 19 June 2005 I found an adult pair ~170 m south of this location. Singing males of both species, presumably migrants, singing in a yard in Keyes 10 May 2004.



Eastern Meadowlark (*Sturnella magna*)

One bird found each year. The 2004 bird was calling near a dry portion of the Beaver River; the 2005 bird was singing in sandsage.



Lesser Goldfinch (*Carduelis psaltria*)

Found in two places in the Kenton area (two males, one female 30 June 2004; single male 23 June 2005); also a flythrough male along the Beaver River 26 May 2005. Possibly a female Lesser Goldfinch along Cimarron River in northeast quarter of county 27 June 2005.

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APPENDIX B: NON-TARGET SPECIES DETECTED DURING 10-MINUTE SURVEYS

John Shackford and I conducted 1,104 10-minute surveys in 10 townships in Cimarron County in May, 2004–2005, in an effort to assess the size of the Mountain Plover breeding population. I recorded all birds detected during surveys, and found a total of 68 species (Table 1).

Horned Larks were the most common species, comprising 20% of all individuals. Western Meadowlarks (15.9%), Lark Buntings (17.1%), Mourning Doves (14%), and Red-winged Blackbirds (8.5%) were quite common as well, and these five species made up >75% of our total number of individuals. The ubiquitous Western Meadowlarks were found on 94% of our surveys, followed by Horned Larks (86.7%), Mourning Doves (74.4%), and Lark Buntings (49%); these were the only species found on ~½ or more of our surveys.

Table 1. Species detected during 10-minute point counts, Cimarron County, Oklahoma, 2004–2005. "Bird/depc" = birds per point count only for point counts on which the species was detected.

Species	Total	Pct. Total Inds.	Birds/point count	Point counts found	Pct. point counts found	Birds/depc
Horned Lark	4831	0.20078	4.376	957	0.867	5.05
Lark Bunting	4124	0.17140	3.736	541	0.490	7.62
Western Meadowlark	3810	0.15835	3.451	1038	0.940	3.67
Mourning Dove	3369	0.14002	3.052	822	0.744	4.1
Red-winged Blackbird	2036	0.08462	1.844	421	0.381	4.84
Grasshopper Sparrow	1142	0.04746	1.034	512	0.464	2.23
Ring-necked Pheasant	616	0.02560	0.558	443	0.401	1.39
Western Kingbird	498	0.02070	0.451	252	0.228	1.98
Common Grackle	483	0.02007	0.438	123	0.111	3.93
Burrowing Owl	233	0.00968	0.211	132	0.120	1.77
Barn Swallow	225	0.00935	0.204	96	0.087	2.34
Yellow-headed Blackbird	219	0.00910	0.198	6	0.005	36.5
House Sparrow	199	0.00827	0.180	69	0.063	2.88
Cassin's Sparrow	183	0.00761	0.166	114	0.103	1.61
Cliff Swallow	170	0.00707	0.154	58	0.053	2.93
Swainson's Hawk	155	0.00644	0.140	127	0.115	1.22
Killdeer	149	0.00619	0.135	102	0.092	1.46
Long-billed Curlew	145	0.00603	0.131	100	0.091	1.45
Scaled Quail	129	0.00536	0.117	100	0.091	1.29
Mallard	123	0.00511	0.111	52	0.047	2.37
Chipping Sparrow	120	0.00499	0.109	19	0.017	6.32
Great-tailed Grackle	119	0.00495	0.108	42	0.038	2.83
Common Nighthawk	109	0.00453	0.099	65	0.059	1.68
Rock Pigeon	93	0.00387	0.084	32	0.029	2.91
Raven sp.	88	0.00366	0.080	58	0.052	1.52

Mountain Plover	81	0.00349	0.076	68	0.061	1.24
Lark Sparrow	77	0.00320	0.070	53	0.048	1.45
Turkey Vulture	70	0.00291	0.063	32	0.029	2.19
Chihuahuan Raven	69	0.00287	0.063	41	0.037	1.68
Eurasian Starling	64	0.00266	0.058	31	0.028	2.06
Brown-headed Cowbird	43	0.00179	0.039	8	0.007	5.38
Northern Harrier	40	0.00166	0.036	36	0.033	1.11
Bullock's Oriole	20	0.00083	0.018	16	0.014	1.25
House Finch	18	0.00075	0.016	7	0.006	2.57
American Kestrel	16	0.00066	0.014	16	0.014	1
Eurasian Collared-Dove	14	0.00058	0.013	10	0.009	1.4
American Avocet	13	0.00054	0.012	2	0.002	6.5
Blue Grosbeak	12	0.00050	0.011	12	0.011	1
American Crow	11	0.00046	0.010	10	0.009	1.1
Double-crested Cormorant	11	0.00046	0.010	1	0.001	11
Northern Mockingbird	22	0.00091	0.020	20	0.018	1.1
Clay-colored Sparrow	9	0.00037	0.008	7	0.006	1.29
Lesser Yellowlegs	9	0.00037	0.008	2	0.002	4.5
Say's Phoebe	9	0.00037	0.008	9	0.008	1
Dickcissel	8	0.00033	0.007	7	0.006	1.14
Short-eared Owl	8	0.00033	0.007	7	0.006	1.14
American Robin	7	0.00029	0.006	6	0.005	1.67
Loggerhead Shrike	7	0.00029	0.006	6	0.005	1.17
Upland Sandpiper	6	0.00025	0.005	5	0.005	1.2
Northern Bobwhite	5	0.00021	0.005	4	0.004	1.25
White-faced Ibis	5	0.00021	0.005	1	0.001	5
Yellow Warbler	4	0.00017	0.004	3	0.003	1.33
Common Raven	3	0.00012	0.003	2	0.002	1.5
Corvus sp.	3	0.00012	0.003	3	0.003	1
Ferruginous Hawk	3	0.00012	0.003	3	0.003	1
Bank Swallow	2	0.00008	0.002	2	0.002	1
Chimney Swift	2	0.00008	0.002	1	0.001	2
Eastern Kingbird	2	0.00008	0.002	2	0.002	1

Great Horned Owl	2	0.00008	0.002	1	0.001	2
Mississippi Kite	2	0.00008	0.002	2	0.002	1
Orchard Oriole	2	0.00008	0.002	1	0.001	2
Peregrine Falcon	2	0.00008	0.002	2	0.002	1
Savannah Sparrow	2	0.00008	0.002	2	0.002	1
Vesper Sparrow	2	0.00008	0.002	2	0.002	1
Bobolink	1	0.00004	0.001	1	0.001	1
Red-headed Woodpecker	1	0.00004	0.001	1	0.001	1
Red-tailed Hawk	1	0.00004	0.001	1	0.001	1
White-winged Dove	1	0.00004	0.001	1	0.001	1
Yellow-rumped Warbler	1	0.00004	0.001	1	0.001	1
	24058	1.00000	21.794			

Table 2. Scientific names of bird species detected during 10-minute point counts, Cimarron County, Oklahoma, 2004–2005.

English name	Genus	Species
Ring-necked Pheasant	*Phasianus*	*colchicus*
Scaled Quail	*Callipepla*	*squamata*
Northern Bobwhite	*Colinus*	*virginianus*
Double-crested Cormorant	*Phalacrocorax*	*auritus*
Great Blue Heron	*Ardea*	*herodias*
White-faced Ibis	*Plegadis*	*chihi*
Turkey Vulture	*Cathartes*	*aura*
Mallard	*Anas*	*platyrhynchos*
Mississippi Kite	*Ictinia*	*mississippiensis*
Northern Harrier	*Circus*	*cyaneus*
Swainson's Hawk	*Buteo*	*swainsoni*
Red-tailed Hawk	*Buteo*	*jamaicensis*
Ferruginous Hawk	*Buteo*	*regalis*
American Kestrel	*Falco*	*sparverius*
Peregrine Falcon	*Falco*	*peregrinus*
Killdeer	*Charadrius*	*vociferus*
Mountain Plover	*Charadrius*	*montanus*
American Avocet	*Recurvirostra*	*americana*
Lesser Yellowlegs	*Tringa*	*flavipes*
Upland Sandpiper	*Bartramia*	*longicauda*
Long-billed Curlew	*Numenius*	*americanus*
Rock Pigeon	*Columba*	*livia*
Eurasian Collared-Dove	*Streptopelia*	*decaocto*
White-winged Dove	*Zenaida*	*asiatica*
Mourning Dove	*Zenaida*	*macroura*
Great Horned Owl	*Bubo*	*virginianus*
Short-eared Owl	*Asio*	*flammeus*
Burrowing Owl	*Athene*	*cunicularia*
Common Nighthawk	*Chordeiles*	*minor*
Chimney Swift	*Chaetura*	*pelagica*
Red-headed Woodpecker	*Melanerpes*	*erythrocephalus*
Western Kingbird	*Tyrannus*	*verticalis*
Eastern Kingbird	*Tyrannus*	*tyrannus*
Say's Phoebe	*Sayornis*	*saya*
Loggerhead Shrike	*Lanius*	*ludovicianus*
American Crow	*Corvus*	*brachyrhynchos*
Chihuahuan Raven	*Corvus*	*cryptoleucus*
Common Raven	*Corvus*	*corax*
Horned Lark	*Eremophila*	*alpestris*
Bank Swallow	*Riparia*	*riparia*
Cliff Swallow	*Petrochelidon*	*pyrrhonota*
Barn Swallow	*Hirundo*	*rustica*
American Robin	*Turdus*	*migratorius*

Northern Mockingbird	*Mimus*	*polyglottos*
European Starling	*Sturnus*	*vulgaris*
Yellow Warbler	*Dendroica*	*petechia*
Yellow-rumped Warbler	*Dendroica*	*coronata*
Cassin's Sparrow	*Aimophila*	*cassinii*
Chipping Sparrow	*Spizella*	*passerina*
Clay-colored Sparrow	*Spizella*	*pallida*
Vesper Sparrow	*Pooecetes*	*gramineus*
Lark Sparrow	*Chondestes*	*grammacus*
Lark Bunting	*Calamospiza*	*melanocorys*
Savannah Sparrow	*Passerculus*	*sandwichensis*
Grasshopper Sparrow	*Ammodramus*	*savannarum*
Blue Grosbeak	*Passerina*	*caerulea*
Dickcissel	*Spiza*	*americana*
Bobolink	*Dolichonyx*	*oryzivorus*
Red-winged Blackbird	*Agelaius*	*phoeniceus*
Western Meadowlark	*Sturnella*	*neglecta*
Yellow-headed Blackbird	*Xanthocephalus*	*xanthocephalus*
Common Grackle	*Quiscalus*	*quiscula*
Great-tailed Grackle	*Quiscalus*	*mexicanus*
Brown-headed Cowbird	*Molothrus*	*ater*
Orchard Oriole	*Icterus*	*spurius*
Bullock's Oriole	*Icterus*	*bullockii*
House Finch	*Carpodacus*	*mexicanus*
House Sparrow	*Passer*	*domesticus*

APPENDIX C: BUTTERFLIES OF CIMARRON COUNTY

I noted the following butterflies during fieldwork in Cimarron County. *= new county record (John Fisher in litt. 2005); photographs available for all except Red-spotted Purple.

*Giant Swallowtail *(Papilio cresphontes)*
Tiger Swallowtail *(Papilio glaucus)*
Black Swallowtail *(Papilio polyxenes)*
Pipevine Swallowtail *(Battus philenor)*
Checkered White *(Pontia protodice)*
Orange Sulphur *(Colias eurytheme)*
Dainty Sulphur *(Nathalis iole)*
Southern Dogface *(Zerene cesonia)*
Sleepy Orange *(Eurema nicippe)*
Juniper Hairstreak *(Callophrys gryneus)*
Gray Hairstreak *(Strymon melinus)*
*Red-banded Hairstreak *(Calycopis cecrops)*
*Soapberry Hairstreak *(Phaeostrymon alcestis)*
Reakirt's Blue *(Hemiargus isola)*
Marine Blue *(Leptotes marina)*
Acmon Blue (*Plebeius acmon*)
Variegated Fritillary *(Euptoieta claudia)*
*Texan Crescent *(Phyciodes texana)*
Painted Crescent *(Phyciodes picta)*
Pearl Crescent *(Phyciodes tharos)*
Painted Lady *(Vanessa cardui)*
American Lady *(Vanessa virginiensis)*
Mourning Cloak *(Nymphalis antiopa)*
Red Admiral *(Vanessa atalanta)*
Common Buckeye *(Junonia coenia)*
*Red-spotted Purple *(Limenitis arthemis)*
*California Sister *(Adelpha bredowii)*
Goatweed Leafwing *(Anaea andria)*
Hackberry Emperor *(Asterocampa celtis)*
Common Wood Nymph *(Cercyonis pegala)*
Monarch *(Danaus plexippus)*
Queen *(Danaus gilippus)*
Common Checkered-Skipper *(Pyrgus communis)*
Green Skipper *(Hesperia viridis)*
Sachem *(Atalopedes campestris)*
Delaware Skipper *(Anatrytone logan)*
Dotted Roadside Skipper *(Amblyscirtes eos)*
Strecker's Giant Skipper *(Megathymus streckeri)*

VITA

Scott McConnell

Candidate for the Degree of

Master of Science

Thesis: Habitat associations, ranges, and population estimates for selected bird species in Cimarron County, Oklahoma

Major Field: Wildlife and Fisheries Ecology

Biographical:

Education: Received a Bachelor of Science degree in Wildlife and Fisheries Ecology from Pennsylvania State University, University Park, Pennsylvania in May 2003. Completed the requirements for the Master of Science degree with a major in Wildlife Ecology at Oklahoma State University, Stillwater, Oklahoma in May, 2006.

Professional Memberships: The Wildlife Society, Oklahoma Academy of Science, Delaware Valley Ornithological Club, Oklahoma Ornithological Society, Middleton Ornithological Club.

Name: Scott McConnell Date of Degree: May, 2006

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: POPULATION ESTIMATE AND HABITAT AFFINITIES OF SELECTED BIRD SPECIES IN CIMARRON COUNTY, OKLAHOMA

Pages in Study: 150 Candidate for the Degree of Master of Science

Major Field: Wildlife and Fisheries Ecology

Scope and Method of Study: There were two main objectives with this study: 1) to quantify Mountain Plover breeding habitat variables in the Oklahoma Panhandle, and use this information to derive a state population estimate for this species and 2) quantify habitat characteristics around *Buteo* nest locations to determine if there are differences in the types of habitat being used by the three species breeding sympatrically in the Oklahoma Panhandle. I conducted point counts in randomly chosen sections within known plover breeding townships in Cimarron County, and examined areas outside of the survey townships, recording plover locations and noting habitat characteristics at all locations. I also conducted searches for raptor nests in Cimarron County and entered nest locations into a global positioning system (GPS) unit. I imported nest locations into a geographic information system (GIS) and performed ANOVA analyses on habitat variables calculated with maps indicating land cover and elevation.

Findings and Conclusions: I found that 90% of my Mountain Plover locations, in Cimarron and Texas counties, were in flat, bare, agricultural areas with a clay loam soil; 95% of the Cimarron County locations were in the surveyed townships. I used the habitat variables to extrapolate my sample counts to suitable habitat within the survey townships, and, after including estimated numbers of plovers outside of the survey townships, arrived at an estimated population of 140–185 Mountain Plovers breeding in Oklahoma. Cimarron County *Buteos* appeared to partition the habitat, with Swainson's Hawks nesting primarily in the agricultural areas and Red-tailed Hawks nesting entirely in riparian timber in prairie areas. Ferruginous Hawks nested mostly in prairie, but chose areas with a greater sandsage component than their congeners. I found no evidence of interspecific aggression being responsible for *Buteo* distribution in Cimarron County.

ADVISER'S APPROVAL: Timothy J. O'Connell

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