RAPTOR SURVEY AND 2008 BIRD CENSUS

RESOLUTION COPPER MINE STUDY AREA

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TABLE OF CONTENTS

LIST OF TABLES
(tables follow text)

LIST OF FIGURES
(figures follow text)

LIST OF APPENDICES

EXECUTIVE SUMMARY

WestLand Resources, Inc. (WestLand) was retained by Resolution Copper Mining, LLC (RCM) to conduct bird surveys in the vicinity of RCM's holdings (collectively referred to as Resolution) near Superior, Arizona (the Study Area). The purpose of the census was to establish baseline information about bird populations at Resolution. This report provides an inventory of the birds observed as well as a discussion of results from the data collection efforts. These data are used to identify bird densities and biotic community associations and provide information about avian usage of the Study Area. Also included are the results of several years of raptor surveys that WestLand has conducted as part of the multi-year baseline study effort.

The Study Area for the bird census and raptor survey is located on private land, lands administered by the Arizona State Land Department, and on lands administered by the US Forest Service (the Tonto National Forest [TNF]). The bird census Study Area consists of locations and selected sites of biological interest in the immediate vicinity of Resolution. Fifty locations were surveyed throughout the areas of biological interest in the Study Area. Sites of biological interest included in this study are Devils Canyon (a spatially intermittent drainage defining the east extent of the Study Area, respectively), Queen Creek and Rancho Rio Creek (ephemeral drainages defining the north and south extent of the Study Area), several ponds scattered about the Study Area, and the talus slopes of Apache Leap (defining the west extent of the Study Area). The raptor survey Study Area includes selected locations in Devils Canyon, along Queen Creek, at Oak Flat Campground, and on the cliff face of Apache Leap.

RAPTOR SURVEYS

Pursuant to conducting ongoing baseline resource investigations in the vicinity of Resolution, WestLand conducted surveys for nesting raptors in 2003, 2004, and 2008. The purposes of these surveys were to locate raptor nesting territories and to monitor existing locations of raptors in the Study Area.

The Study Area supports several species of breeding raptors. The initial baseline inventory (2003) and ongoing monitoring of the Study Area have documented occupied breeding territories of zone-tailed hawks, Cooper's hawks, and peregrine falcons. Great horned owls were observed on site in 2003 and western screech-owls were observed in 2008. Many turkey vultures were also observed within the Study Area. During the 2008 survey, two active raptor-breeding territories were observed in the Study Area: a peregrine falcon eyrie and a zone-tailed hawk nest. Ideal nesting habitat for raptors is found along the face of Apache Leap and along Queen Creek. Recreation pressures may limit the use of two oak groves near Oak Flat Campground and Dry Reservoir by nesting raptors.

BIRD CENSUS

The avian species reportedly expected in each biotic community are based on Brown (1994), the *Arizona Breeding Bird Atlas* (ABBA) published by the Arizona Game and Fish Department (Corman and Wise-Gervais 2005), the Three Bar Game Management Area survey effort (Szaro 1981), and the

Maricopa Audubon Society Devils Canyon survey effort (Jacobs and Flesch 2007). WestLand observed more avian species within each biotic community than were expected by Brown or recorded by the ABBA (2005), Szaro (1981), or Jacobs and Flesch (2007). The increased number of species documented by WestLand is attributed to the increased survey effort. No species were expected but not found by WestLand.

The 2008 winter and breeding bird surveys covered 50 points grouped into nine different biotic community types. The diversity of birds encountered during winter survey was relatively high. Fifty-four bird species were recorded during the winter survey point counts, and two additional species were observed opportunistically within the Study Area during winter survey efforts. The winter densities of birds across the site were relatively low in all biotic communities, with densities ranging from 1.2 birds per hectare in the Interior Chaparral-scrub oak series to 11.3 birds per hectare in the Interior Chaparral-manzanita series. The weighted average density across all biotic community types is only 6.8 birds per hectare during the winter survey.

The density and diversity of birds observed during the breeding survey were much higher than in the winter survey in all biotic communities. Ninety-two (92) species were observed in the Study Area during breeding surveys. Species diversity ranged from lows of 28 species in the Arizona Uplands subdivision of the Sonoran Desertscrub biotic community and Interior Chaparral-scrub oak series to a high of 44 species in the Madrean Evergreen Woodlands. Bird densities ranged from a low of 9.7 birds per hectare in the Interior Chaparral-scrub oak series to a high of 44.1 birds per hectare in the Interior Riparian Deciduous Forest alder grove in Devils Canyon. The weighted average density across all biotic community types in during breeding survey was 23.3 birds per hectare.

Observations within 3-minute, 2-minute, and 5-minute segments of the total time at each survey point showed the expected pattern of numerous species and individuals observed during the first segment, and relatively few species and individuals added during the final 5 minutes. Similar patterns were obtained in the winter and breeding surveys. From these results, we conclude that 10 minutes is an appropriate time period for the surveys. A shorter time is likely to miss species and individuals, and a longer time is not likely to provide a return in observations proportional to the additional effort.

An analysis of the winter survey data for the possible effect of time of day on the surveys shows that time of day does not appear to be significant for surveying birds in the winter, although there may be somewhat more activity as the day becomes slightly warmer. During the breeding survey, our data indicate significant positive correlations with time of day for both numbers of species and numbers of individuals. This result is contrary to our expectation of decreasing activity during the day, but it also provides justification for surveying during the full 4-hour period after sunrise.

In conjunction with our bird surveys, we collected vegetation data at each of the 50 survey points, and the data were summarized for each biotic community type. We evaluated possible correlations between bird species diversity and total bird density and the vegetation characteristics of total tree density, total tree

canopy cover, and shrub cover. While there were some indications of positive and negative relationships, none of these correlations were statistically significant.

KEY FINDINGS

RAPTOR SURVEYS

- Three breeding raptor species were identified on site during the 2003, 2004, and 2008 surveys. Two additional species were observed in 2008 as compared to previous years, but breeding was unconfirmed.
- The initial baseline inventory (2003) and ongoing monitoring of the Study Area have documented occupied breeding territories of zone-tailed hawks, Cooper's hawks, and peregrine falcons. Great horned owls were observed on site in 2003 and western screech-owls were observed in 2008. The area also supports large concentrations of turkey vultures. (A known turkey vulture communal roosting area is located west of the study area at the Boyce Thompson Arboretum.)
- During the 2008 survey, two active raptor-breeding territories were observed in the Study Area: a peregrine falcon eyrie and a zone-tailed hawk nest.
- Ideal nesting habitat for raptors is found along the face of Apache Leap and along Devils Canyon and Queen Creek. Recreation pressures may limit the use of two oak groves near Oak Flat Campground and Dry Reservoir by nesting raptors.
- The Cooper's hawk nest identified in 2003 was unoccupied in 2008. The great horned owls noted in 2003 were not observed during the 2008 inventory. A western screech-owl was heard vocalizing at Oak Flat Campground on the night of May 8, 2008. Numerous turkey vultures were observed in flight along Apache Leap and throughout the Study Area.
- During the course of conducting biological studies in Devils Canyon, WestLand observed several species of raptors. Four of the species—peregrine falcon, common black-hawk, zone-tailed hawk, and Cooper's hawk—have also been observed in the Study Area outside of Devils Canyon. One additional species, the prairie falcon, was also observed in Devils Canyon.

BIRD CENSUS

Species Diversity

- Fifty-six bird species were observed on or adjacent to the Study Area during the winter surveys. During the breeding survey, 92 species were observed on or near the Study Area.
- Seven species were observed in the winter survey in the Interior Chaparral-scrub oak series, and eight species were observed in the Interior Riparian Deciduous Forest of Rancho Rio Creek. Twenty-six species were observed in the Interior Chaparral-manzanita series and 28 species at the Interior Riparian Deciduous Forest at the ponds. The average number of species per biotic community in the winter survey was 16.7.
- The number of species observed in each biotic community tended to increase with each winter survey as migratory birds arrived when temperatures rose. The number of new species observed tended to decrease with later winter survey sets.

- The numbers of breeding survey species observed in the different biotic communities ranged from a low of 28 species in the Interior Chaparral-scrub oak series and Arizona Upland Subdivision of Sonoran Desertscrub to highs of 42 species in the Interior Riparian Deciduous Forest of Devils Canyon and 44 species in the Interior Chaparral-manzanita series. The average number of species per biotic community in the breeding survey was 36.0.
- The number of species observed in a biotic community in the breeding survey tended to increase with each survey event. The number of new species decreased with later survey sets, with the exception of the last survey in the Interior Riparian Deciduous Forest alder grove of Devils Canyon.
- Many more species were observed in each biotic community during the breeding survey than in the winter survey.

Bird Species Densities

- Winter densities range from a low of about 1.2 birds per hectare in the Interior Chaparral-scrub oak series to a high of 11.3 birds per hectare in the Interior Chaparral-manzanita series. A weighted average of all biotic community types gives a density of 6.8 birds per hectare for the winter survey.
- Winter survey bird density values are all very low, indicating that wintering birds are sparsely distributed in the Study Area and surrounding land. There were several points during each survey set at which no birds were observed, and at many points only a few individuals or species were recorded.
- Total breeding survey densities range from a low of about 9.7 birds per hectare in the Interior Chaparral-scrub oak series to a high of 44.1 birds per hectare in the Interior Riparian Deciduous Forest alder grove in Devils Canyon. The Interior Chaparral-manzanita series had a relatively high density at about 34.6 birds per hectare. A weighted average of all biotic communities gives a density of 23.3 birds per hectare during the breeding survey.
- These breeding survey bird densities are all higher than the winter survey densities and the difference between maximum and minimum bird densities among biotic communities was lower in the breeding survey than in the winter survey.

Survey Set Time Segments

- Observations within 3-minute, 2-minute, and 5-minute segments of the total time at each survey point showed the expected pattern of numerous species and individuals observed during the first segment, and relatively few species and individuals added during the final 5 minutes. Similar patterns were obtained in the winter and breeding surveys.

- Between 70 and 75 percent of species and individuals were observed during the first 5 minutes of a count, and the last 5 minutes added only 25 to 30 percent of species and individuals. Most biotic community types also showed this pattern.
- Surveyors concluded that 10 minutes is an appropriate time period for the surveys. A shorter time is likely to miss species and individuals, and a longer time is not likely to provide a return in observations proportional to the additional effort.

Vegetation Data at Bird Survey Points

- The average tree density in the biotic communities range from lows of 70.7 trees per hectare in the Interior Riparian Deciduous Forest and 94.5 trees per hectare in the Interior Chaparral-scrub oak series, to a high of 403.4 trees per hectare in the Interior Riparian Deciduous Forest in Devils Canyon. The maximum-to-minimum ratio for tree density is 5.7, indicating a wide range in densities.
- The average tree canopy cover ranged from lows of 436 square meters per hectare in the Interior Chaparral-scrub oak series and 880 square meters per hectare in the Interior Chaparral-manzanita series to a high of 16,240 square meters per hectare in the Interior Riparian Deciduous Forest in Devils Canyon.
- Twenty-three species of trees were recorded at least once as the closest tree in a quarter. Many of these tree species were only recorded in a single biotic community, and no tree species were recorded in all biotic communities.
- The average cover of shrub species ranged from a low of 15 percent at the pond sites to a high of 42 percent in the Interior Chaparral-scrub oak series.
- Average herbaceous ground cover was generally very low in almost all biotic community types, ranging from a low of 1 percent in the Interior Chaparral-manzanita series to a high of 24 percent in the Interior Riparian Deciduous Forest pond sites community.

Bird-Vegetation Correlations

- Possible correlations were evaluated between bird species diversity and total bird density and vegetation characteristics. No statistically significant correlations were noted.
- However, based on limited data, the area of highest tree density and cover (Interior Riparian Deciduous Forest biotic community in the alder grove of Devils Canyon) and the area with the highest shrub cover (Interior Chaparral - scrub oak series) exhibited the greatest bird densities.

1.0 INTRODUCTION

WestLand Resources, Inc. (WestLand) was retained by Resolution Copper Mining, LLC (RCM) to conduct bird surveys in the vicinity of RCM's holdings (collectively referred to as Resolution in this report) near Superior, Arizona (the Study Area; Figure 1). The purpose of the census was to establish baseline information about bird populations at Resolution. This report provides an inventory of the birds observed and various statistical evaluations. These data are used to identify bird densities and biotic community associations and provide information about avian usage of the Study Area. Also included are the results of several years of raptor surveys that WestLand has conducted as part of the multi-year baseline study effort.

A description of the Study Area and a summary of previous bird surveys conducted in or near the Study Area are provided in the following paragraphs. A brief comparison of WestLand's results with expected species lists is also provided. Subsequent sections describe the raptor surveys and the bird census survey method, discuss the survey results, and offer a summary and conclusions about the census.

1.1 STUDY AREA DESCRIPTION

The Study Area for the raptor survey and bird census is located on private land, on lands administered by the Arizona State Land Department, and on lands administered by the US Forest Service (the Tonto National Forest [TNF]). The bird census was conducted at locations and selected sites of biological interest in the immediate vicinity of Resolution. Sites of biological interest included in this study include Devils Canyon (a spatially intermittent drainage defining the east extent of the Study Area), Queen Creek and Rancho Rio Creek (ephemeral drainages defining the north and south extent of the Study Area, respectively), several ponds scattered about the Study Area, and the talus slopes of Apache Leap (defining the west extent of the Study Area). The raptor survey was conducted at selected locations in Devils Canyon, along Queen Creek, at Oak Flat Campground, and on the cliff face of Apache Leap.

The Study Area is situated in the Pinal Mountains immediately east of Superior. The lowest elevation in the area is 3,100 feet (950 meters) near Queen Creek. The highest elevation is 4,820 feet (1,470 meters) at a high point on Apache Leap, overlooking the town of Superior. The western edge of the Study Area is generally very steep, with the cliffs of the Apache Leap formation rising abruptly above Superior. East of Apache Leap, there are parallel ridges trending toward the northeast. The northeastern portion of the Study Area is known as Oak Flat and is relatively level when compared with other parts of the Study Area.

The Study Area topography also defines surface water drainage patterns. Apache Leap forms a drainage divide near the western edge of the Study Area. West of this divide, very steep headwaters of ephemeral channels drain west toward Superior and Queen Creek. East of the divide, ephemeral channels with shallower gradients drain to the northeast. The divide east of Apache Leap separates the channels draining north through Oak Flat to Queen Creek from those draining east through Rancho Rio Creek to Devils Canyon and is much less visually obvious.

The major biotic communities in the Study Area include Interior Chaparral, Madrean Evergreen Woodland, the Arizona Uplands Subdivision of Sonoran Desertscrub, and Interior Riparian Deciduous Forest, as described by Brown (1994). The following paragraphs summarize vegetation characteristics of these biotic communities; Figure 2 depicts the extent of these communities within the Study Area as mapped by Brown and Lowe (1980) and refined by WestLand based on field studies and aerial image analysis. The study area is inclusive of Oak Flat Campground. Recreational activities in the area include camping, off-roading, climbing, etc.

Interior Chaparral

Interior Chaparral is a vegetation community found in relatively arid regions, with low, often dense scrub consisting primarily of evergreen shrubs (Corman and Wise-Gervais 2005). Most chaparral shrubs have dense, compact crowns and small, evergreen sclerophyllous leaves. They tend to be deeply rooted and some species, such as the scrub oak (*Quercus turbinella*), have extensive superficial and tap root systems. Most of these plant species sprout readily from root crowns and will regenerate quickly after fire events. Notable exceptions to this phenomenon include desert ceanothus (*Ceanothus greggii*) and pointleaf manzanita (*Arctostaphylos pungens*). These fire-adapted species produce prolific seed crops that may remain dormant in the soil for decades, only germinating after fire (Brown 1994).

Interior Chaparral exists largely in Arizona and within small areas in New Mexico, Texas, and northern Mexico. In Arizona, this biotic community occurs discontinuously in a diagonal band from the extreme northwest corner of the state to central Arizona below the Mogollon Rim. This vegetation is present across mid-elevation (approximately 3,500 to 6,500 feet [1,050 to 2,000 meters]) foothills, mountain slopes, and canyons. Interior Chaparral is prevalent in the region which includes the Study Area. To the southeast, disjunct and isolated chaparral communities extend into the drier mountains of southeastern Arizona, as well as portions of southern New Mexico, west Texas, and northern Mexico (Brown 1994).

Scrub oak is the most widespread species within Arizona Interior Chaparral communities and is commonly the dominant species. Although it sometimes occurs in nearly pure stands, it usually is found in association with shrubs such as mountain mahogany (*Cercocarpus* spp.), skunkbush (*Rhus trilobata*), silktassel (*Garrya wrightii*), and desert ceanothus. At higher elevations with increased moisture, this biotic community may be dominated by pointleaf manzanita, or a mixture of sclerophyllous shrubs with no single species attaining dominance. In the rugged mountains below the Mogollon Rim, Interior Chaparral generally transitions upslope to Madrean Evergreen Woodlands and downslope to Sonoran Desertscrub and/or Semi-Desert Grasslands.

Interior Chaparral is the dominant vegetation community in the upland portions of Study Area above Apache Leap (Figure 2). Due to high shrub cover, thin to absent soil, and low annual precipitation, this biotic community has a characteristically low density of herbaceous cover. As is typical of the Interior Chaparral biotic community in central Arizona, vegetation in the central portion of the Study Area is dominated by scrub oak and/or pointleaf manzanita. Catclaw mimosa (*Mimosa acerosa*) is also very common. Scrub oak-dominated chaparral predominates in the boulder outcrops just east of Apache Leap,

while manzanita-dominated chaparral is more common along the eastern margins of the Study Area just west of Devils Canyon. We have subdivided the Interior Chaparral biotic community into scrub oak series and manzanita series for the purposes of this study.

Madrean Evergreen Woodland

Madrean Evergreen Woodlands occur in areas characterized by relatively mild winters and wet summers. As its name suggests, this biotic community is centered within the Sierra Madre mountain range in Mexico, reaching its northern-most distribution in Arizona, New Mexico, and Trans-Pecos Texas. At its lower elevations, the woodlands are typically open with widely dispersed trees. The trees in these lower elevations typically consist of evergreen oaks or combinations of oaks, alligator-bark and one-seed junipers (*Juniperus deppeana* and *J. monosperma*), and pinyon pines (*Pinus edulis*) in various proportions. This association has been commonly described as encinal.[1] Higher up the mountain gradient, encinal woodlands transition into a Mexican oak-pine association with oak species typical of higher elevations as well as one or more Madrean pine species such as Apache pine (*P. englemannii*), Chihuahuan pine (*P. leiophylla*), Arizona pine (*P. ponderosa* var. *arizonica*), and others (Brown 1994).

In the mountainous regions below the Mogollon Rim in central Arizona, such as the Chiricahua, Santa Rita, Baboquivari, Tumacacori, Huachuca, Catalina, and Pinal Mountains, the dominant oaks within the encinal zone include emory oaks (*Quercus emoryi),* Arizona white oak, *(Q. arizonica*), and, south of the Gila River, Mexican blue oak (*Q. oblongifolia*). At the northern limits of this biotic community, Madrean Evergreen Woodlands occur within and/or above drier Interior Chaparral biotic community, as well as below and along drainages within Great Basin conifer woodlands.

This study focuses on the oak (or encinal) woodland series of the Madrean Evergreen Woodland biotic community. Within the Study Area, Madrean Evergreen Woodland encinal woodlands are present in narrow bands along drainages, but are distinguished from riparian vegetation, as described below (Figure 2). Two oak species, Arizona white oak and Emory oak, dominate the canopy layer. Although large alligator-bark junipers are likely to have been here in the past (B. Schmalzel [WestLand], pers. obs.), a history of fire suppression and active clearing in the area has favored fire-intolerant tree species such as one-seed juniper, which are now common. Understory layers in this region generally include chaparral-associated species, such as pointleaf manzanita, catclaw mimosa, scrub oak, and skunkbush.

Arizona Upland Subdivision of Sonoran Desertscrub

The Sonoran Desertscrub biotic community is in a large, arid region centered at the head of the Gulf of California and encompasses the western half of the Mexican state of Sonora, Mexico's Baja Peninsula, southeastern California, and central and southwestern Arizona. Brown (1994) recognizes five subdivisions within this biotic community, including the Arizona Upland subdivision. This subdivision extends from the vicinity of Topock, Arizona, southeast to central Arizona near Phoenix, then south to

[1] The term "encinal" is a Spanish term derived from *encino* (meaning oaks) and *al* (place of) and is used to describe evergreen woodlands composed wholly or partially of oaks (Brown 1994).

north-central Sonora, Mexico. The majority of this subdivision occurs on slopes, broken ground, and multi-dissected sloping plains (e.g., uplands). This landscape receives the most precipitation and is the most verdant of all the North American desert communities. There are three recognized "series" within this subdivision: the jojoba-mixed scrub, creosote bush-mixed scrub, and paloverde-cacti-mixed scrub series. The latter series is the most extensive within the subdivision, and the vegetation within the western portion of the Study Area is consistent with this series.

Columnar cacti such as saguaros (*Carnegiea gigantea*) and shrubby trees such as foothill palo verde (*Parkinsonia microphylla*) are prime indicator species within this biotic community (Phillips and Comus 2000). This vegetation most often takes on the appearance of a scrubland or low woodland of leguminous trees with intervening spaces containing one to several layers of scrubs and perennial succulents. Typical trees include blue palo verde (*Parkinsonia florida*), foothill palo verde, mesquites (*Prosopis* spp.), and acacias (*Acacia* spp.). As stated above, foothill palo verde trees are the characteristic leguminous tree in the Arizona Upland subdivision. However, at the northern, upper, and eastern limits of this community it may be accompanied or replaced by crucifixion thorn (*Canotia holacantha*). In addition to saguaros, the following cacti are representative of this subdivision: buckhorn cholla (*Opuntia acanthocarpa*), cane cholla (*O. spinosior*), staghorn cholla (*O. versicolor*), chain fruit cholla (*O. fulgida*), teddy bear cholla (*O. bigelovi*), Christmas cactus (*O. leptocaulis*), fish-hook barrel cactus (*Ferocactus wislizenii*), and prickly pear (*O. phaeacantha*). Additional representative plants include ocotillo (*Fouquieria splendens*), creosote bush (*Larrea tridentata*), and triangle-leaf bursage (*Ambrosia deltoidea*).

The portions of the Study Area west and south of the Apache Leap escarpment are classified as the Arizona Upland subdivision of Sonoran Desertscrub (Figure 2).

Interior Riparian Deciduous Forest

Interior Riparian Deciduous Forests represent an unusual situation where high altitude species penetrate downslope among tropical and subtropical forms (Brown 1994). This community exists along perennial or seasonally intermittent streams and may be divided into two major vegetation series: cottonwood-willow and mixed broadleaf. These riparian series, in particular the mixed broadleaf, represent relict communities of formerly widespread, early Tertiary mixed mesophytic (moist) forest. This riparian community is adapted to this ancient climate and has retreated to pockets where this climatic condition persists. The riparian community within the Study Area is consistent with the mixed broadleaf series.

The mixed broadleaf series occurs in association with rubble bottomed, perennial or near-perennial streams. In Arizona below the Mogollon Rim, arboreal constituents are frequently an admixture of stands of riparian species forming gallery forests of the interior riparian "big six" species: Arizona sycamore (*Platanus wrightii*), Arizona alder (*Alnus oblongifolia*), Goodding and Bonpland willows (*Salix gooddingii, S. bonplandiana*), Arizona black walnut (*Juglans major*), velvet ash (*Fraxinus veluntina*), and Fremont cottonwood (*Populus fremontii*). Other noted species include western soapberry (*Sapindus saponaria* var. *drummondii*), Texas mulberry (*Morus microphylla*), netleaf hackberry (*Celtis laevigata*),

and Mexican elder (*Sambucus mexicana*). Arizona cyprus (*Cupressus arizonica*) and various oaks (*Quercus* spp.) are sometimes present. Understory species include bracken fern (*Pteridium aquilinum*), smooth sumac (*Rhus glabra*), poison ivy (*Toxicodendron rydbergii*), and canyon grape (*Vitis arizonica*).

Riparian vegetation within the study area is restricted to a few pockets, as described above, and is often found in contact with Madrean Evergreen Woodland vegetation. The most significant area of Interior Riparian Deciduous Forest within the Study Area is located within the depths of Devils Canyon. Riparian vegetation here is dominated by stands of Arizona alder, scattered sycamore, and velvet ash. Some of these stands form gallery forests that attain heights of 60 feet (18 meters) or more. The understory is dominated by button willow (*Cephalanthus occidentalis*). Other trees include Goodding willow and Arizona white oak. In the lower reaches of Devils Canyon, alders give way to stands of Goodding willow and a few scattered cottonwoods. Additional patches of riparian vegetation are located along Queen Creek and Rancho Rio Creek, as well as at the margins of several ponds and stock tanks scattered throughout the Study Area within locations otherwise characterized as Interior Chaparral.

For the purposes of this study, the Interior Riparian Deciduous Forest biotic community has been subdivided into the following categories:

- Alder Grove
- Devils Canyon
- Queen Creek
- Rancho Rio Creek
- Ponds

The Devils Canyon category includes the aforementioned sycamore, ash, willow, and cottonwood species, and is distinguished from the alder grove category, which is also present in Devils Canyon.

1.2 PREVIOUS SURVEYS WITHIN AND IN THE VICINITY OF THE STUDY AREA

Biotic Communities: Southwestern United States and Northwestern Mexico (Brown 1994) catalogs and defines by biological community the eco-region centered on Arizona, New Mexico, Sonora, Chihuahua, and Baja California Norte, plus portions of adjacent California, Nevada, Utah, Colorado, Texas, Coahuila, Sinaloa, and Baja California Sur. This book is arranged by climatic formations with chapters devoted to each biome as well as descriptions of zonal subdivisions. The biotic communities described above are based upon Brown's categorization. The climate, physiognomy, distribution, representative plant species, and characteristic vertebrates (including birds) are described for each biotic community. The information presented within this work is a compilation of both historical accounts of early explorers, hunter-naturalists, collectors, and early conservationists as well as works from numerous historical and modern biogeographers, biological surveyors, researchers, and scientists throughout the arid southwest. WestLand reviewed Brown's lists of avian species expected in the biotic communities within the Study Area, as described below.

In 2005, the Arizona Game and Fish Department (AGFD) published the *Arizona Breeding Bird Atlas* (ABBA; Corman and Wise-Gervais 2005). This publication was the culmination of 7 years of surveys completed statewide from 1993 to 2000. The primary goal of the ABBA was to provide a "snapshot" for each of Arizona's breeding bird species at the end of the 20th century. The ABBA survey coverage was based upon 7.5-minute topographic maps provided by the US Geologic Survey (USGS). Where possible, one survey was conducted within each quadrangle (quad) throughout Arizona. Because of the extensive area involved, each quad was divided into six sectors. One sector from each of these was randomly selected as a "priority block." These priority blocks were intensively surveyed for the presence of breeding birds. WestLand has reviewed the ABBA records from the Superior quad, which contains the Study Area, as well as the records of the Pinal Ranch quad, which is located adjacent to the east of the Study Area.

The following paragraphs summarize the avian species reportedly expected in each biotic community, based upon Brown (1994), the ABBA (2005), the Three Bar Game Management Area[2] survey effort (Szaro 1981), and the Maricopa Audubon Society Devils Canyon survey effort (Jacobs and Flesch 2007). Additional species identified by WestLand are also listed; detailed accounts of WestLand's observations of bird populations are provided in Section 3.2. WestLand observed more avian species within each biotic community than were expected by Brown or recorded by the ABBA (2005), Szaro (1981), or Jacobs and Flesch (2007). The increased number of species documented by WestLand is likely due to the increased survey effort. No species were expected but not found by WestLand.

Avian Species of the Interior Chaparral Biotic Community

According to Brown (1994), typical breeding birds of the Interior Chaparral biotic community consist of general scrub-adapted species such as the western scrub jay (*Aphelocoma californica*), bushtit (*Psaltriparus minimus*), canyon wren (*Catherpes mexicanus*), crissal thrasher (*Toxostoma crissale*), spotted towhee (*Pipilo maculatus*), canyon towhee (*Pipilo fuscus*), rufous-crowned sparrow (*Aimophila ruficeps*), and black-chinned sparrow (*Spizella atrogularis*). Researchers conducting bird inventories within chaparral communities at the Three Bar Game Management Area recorded most of the above-mentioned species as well as Gambel's quail (*Callipepla gambelii*), white-winged dove (*Zenaida asiatica*), common poorwill (*Phalaenoptilus nuttallii*), black-chinned hummingbird (*Archilochus alexandri*), Mexican jay (*Aphelocoma ultramarina*), bridled titmouse (*Baeolophus wollweberi*), Bewick's wren (*Thryomanes bewickii*), Scott's oriole (*Icterus parisorum),* hooded oriole (*Icterus cucullatus,)* and northern cardinal (*Cardinalis cardinalis*) (Szaro 1981).

The ABBA identified the following 26 avian species within Interior Chaparral in the areas mapped by the Superior and Pinal Ranch USGS 7.5 minute series quadrangles: ash-throated flycatcher (*Myiarchus cinerascens*), common poorwill, common nighthawk (*Chordeiles minor*), white-throated swift (*Aeronautes saxatalis*), western scrub-jay, Gambel's quail, juniper titmouse (*Baeolophus ridgwayi*),

[2] The Three Bar Game Management Area is located on the TNF west of Roosevelt Lake, approximately 35 miles northwest of the Study Area.

bushtit, cactus wren (*Campylorhynchus brunneicapillus*), rock wren (*Salpinctus osoletus*), canyon wren, blue-gray gnatcatcher (*Polioptila caerulea*), Townsend's solitaire (*Myadestes townsendi*), northern mockingbird (*Mimus polyglottos*), crissal thrasher, black-chinned sparrow, white-crowned sparrow (*Zonotrichia leucophrys*), rufous-crowned sparrow, northern cardinal, white-winged dove, mourning dove (*Zenaida macroura*), Scott's oriole, Virginia's warbler (*Vermivora virginiae*), spotted towhee, house finch (*Carpodacus mexicanus*), and canyon towhee.

WestLand observed the following 13 species in addition to those listed in the ABBA for the Superior and Pinal Ranch quads and by Szaro (1981) at the Three Bar Game Management Area: turkey vulture (*Cathartes aura*), greater roadrunner (*Geococcyx californianus*), black-chinned hummingbird, Anna's hummingbird (*Calypte anna*), unidentified hummingbird sp., ladder-backed woodpecker (*Picoides scalaris*), empidonax flycatcher (*Empidonax* sp.), black phoebe (*Sayornis nigricans*), lark sparrow (*Chondestes grammacus*), black-throated sparrow (*Amphispiza bilineata*), dark-eyed junco (*Junco hyemalis*), brown-headed cowbird (*Molothrus ater*), and lesser goldfinch (*Carduelis psaltria*).

Avian Species of the Madrean Evergreen Woodland Biotic Community

The Madrean Evergreen Woodland biotic community supports a rich assortment of bird species. According to Brown (1994), common species within this biotic community include Montezuma quail (*Cyrtonyx montezumae*), Arizona woodpecker (*Picoides arizonae*), acorn woodpecker (*Melanerpes formicivorus*), buff-breasted flycatcher (*Empidonax fulvifrons*), Mexican jay, bridled titmouse, western bluebird (*Sialia mexicana*), Hutton's vireo (*Vireo huttoni*), bushtit, and black-throated gray warbler (*Dendroica nigrescens*) (Brown 1994).

The ABBA recorded the following 18 avian species within the Madrean Evergreen Woodland biotic community near the Study Area: turkey vulture, western scrub-jay, acorn woodpecker, dusky-capped flycatcher (*Myiarchus tuberculifer*), Hutton's vireo, juniper titmouse, ruby-crowned kinglet (*Regulus calendula*), bushtit, Bewick's wren, Townsend's solitaire, phainopepla (*Phainopepla nitens*), yellow-rumped warbler (*Dendroica coronata*), black-throated gray warbler, black-headed grosbeak (*Pheucticus melanocephalus*), bridled titmouse, hepatic tanager (*Piranga flava*), and Scott's oriole.

WestLand recorded the following additional 16 species that were not included in the ABBA for this area: gray hawk (*Buteo nitidus*), Swainson's hawk (*Buteo swainsoni*), zone-tailed hawk (*Buteo albonotatus*), white-winged dove, mourning dove, greater roadrunner, northern pygmy-owl (*Glaucidium gnoma*), Anna's hummingbird, unidentified hummingbird sp., ladder-backed woodpecker, gray flycatcher (*Empidonax wrightii*), Say's phoebe (*Sayornis saya*), ash-throated flycatcher, white-crowned sparrow, brown-headed cowbird, house finch, and lesser goldfinch.

Avian Species of the Arizona Upland Subdivision of Sonoran Desertscrub Biotic Community

The paloverde-cacti-mixed scrub series of the Arizona Upland subdivision of the Sonoran Desertscrub biotic community is particularly noted for its aviafauna. Some of its best known birds are in fact tropical

thornscrub species that achieve their northernmost distribution in this analogous habitat. Characteristic birds include the Harris' hawk (*Parabuteo unicinctus*), white-winged dove, Inca dove (*Columbina inca*), elf owl (*Micrathene whitneyi*), and pyrrhuloxia (*Cardinalis sinuatus*). Even the ''cactus woodpeckers" such as the Gila woodpecker (*Melanerpes uropygialis*), gilded flicker (*Colaptes chrysoides*), and ladder-backed woodpecker are quite widespread and not nearly as dependant upon saguaros as is widely assumed. Other desert birds typical of this community include the curve-billed thrasher (*Toxostoma curvirostre*), cactus wren, Gambel's quail, greater roadrunner, Costa's hummingbird (*Calypte costae*), verdin (*Auriparus flaviceps*), black-tailed gnatcatcher (*Polioptila melanura*), and mourning dove.

The ABBA recorded the following 20 avian species within the Arizona Upland subdivision of Sonoran Desertscrub biotic community near the Study Area: golden eagle (*Aquila chrysaetos*), American kestrel (*Falco sparverius*), Gambel's quail, greater roadrunner, Costa's hummingbird, Gila woodpecker, ladder-backed woodpecker, verdin, northern cardinal, black-tailed gnatcatcher, brown-crested flycatcher (*Myiarchus tyrannulus*), American robin (*Turdus migratorius*), northern mockingbird, crissal thrasher, cactus wren, phainopepla, Lucy's warbler (*Vermivora luciae*), yellow warbler (*Dendroica petechia*), black-throated sparrow, and rufous-crowned sparrow.

WestLand recorded 11 additional species that were not included in the ABBA for this area: turkey vulture, peregrine falcon (*Falco peregrinus anatum*), white-winged dove, mourning dove, white-throated swift, unidentified hummingbird sp., Say's phoebe, ash-throated flycatcher, brown-headed cowbird, Scott's oriole, and house finch.

Avian Species of the Interior Riparian Deciduous Forest Biotic Community

A number of nesting birds are obligate to either the riparian deciduous trees, associated cliffs, or the streams themselves. One of the best known of these riparian obligates is the common black-hawk (*Buteogallus anthracinus*). According to Brown (1994), other examples of these riparian obligates include the summer tanager (*Piranga rubra*), zone-tailed hawk, white-tailed kite (*Elanus leucurus*), yellow warbler, yellow-billed cuckoo (*Coccyzus americanus*), Bullock's oriole (*Icterus bullocki*), violet-crowned hummingbird, Lucifer hummingbird (*Calothorax lucifer*), blue-throated hummingbird (*Lampornis clemenciae*), elegant trogon (*Trogon elegans*), and cliff swallow (*Petrochelidon pyrrhonota*).

The ABBA recorded the following 50 avian species within Interior Riparian Deciduous Forest near the Study Area: turkey vulture, Cooper's hawk (*Accipiter cooperi*), zone-tailed hawk, Gambel's quail, white winged dove, mourning dove, common poorwill, Anna's hummingbird, black-chinned hummingbird, acorn woodpecker, Gila woodpecker, ladder-backed woodpecker, hairy woodpecker (*Picoides villosus*), western wood-pewee (*Contopus sordidulus*), ash-throated flycatcher, Cassin's kingbird (*Tyrannus vociferans*), western kingbird (*Tyrannus verticalis*), gray vireo (*Vireo vicinior*), plumbeous vireo (*Vireo plumbeus*), Hutton's vireo, western scrub-jay, bushtit, violet-green swallow, bridled titmouse, Bewick's wren, canyon wren, house wren (*Troglodytes aedon*), American robin, ruby-crowned kinglet, blue-gray gnatcatcher, phainopepla, Virginia's warbler, yellow warbler, yellow-rumped warbler, painted redstart (*Myioborus pictus*), hepatic tanager, summer tanager, green-tailed towhee (*Piplio chlorurus*),

black-headed grosbeak, brown-headed cowbird, hooded oriole, Scott's oriole, house finch, lesser goldfinch, Hammond's flycatcher (*Epidomax hammondii*), Lincoln's sparrow (*Melospiza lincolnii*), white crowned sparrow, brown-crested flycatcher, Bell's vireo (*Vireo bellii*), Lucy's warbler, and northern cardinal.

During the summer of 2007, the Maricopa Audubon Society commissioned a vegetation and wildlife survey of Devils Canyon (Jacobs and Flesch 2007). The authors observed 43 bird species within the Interior Riparian Deciduous Forest along Devils Canyon. The study identified 15 birds that were not included in the ABBA census. These are mallard (*Anas platyrhynchos*), great blue heron (*Ardea herodias*), peregrine falcon, common black-hawk, red-tailed hawk (*Buteo jamaicensis*), gilded flicker, black phoebe, common raven, verdin, cactus wren, northern mockingbird, crissal trasher, spotted towhee, canyon towhee, and rufous-crowned sparrow.

In addition to the species recorded by the ABBA and Jacobs and Flesch (2007), WestLand observed the following 21 species within this biotic community: great horned owl (*Bubo virginianus*), Eurasian collared dove (*Streptopelia decaocto*), white-throated swift, northern rough-winged swallow (*Stelgidopterix serripennis*), rufous hummingbird (*Selasphorus rufus*), unidentified hummingbird sp., belted kingfisher (*Megaceryle alcyon*), crissal thrasher, greater pewee (*Contopus pertinax*), gray flycatcher, empidonax flycatcher, Say's phoebe, black-throated sparrow, Virginia's warbler, yellow-breasted chat (*Icteria virens*), dark-eyed junco, chipping sparrow (*Spizella passerina*), Bullock's oriole, Cassin's finch (*Carpodacus cassinii*), lark sparrow, and red-winged blackbird (*Agelaius phoeniceus*).

2.0 RAPTOR SURVEY

2.1 INTRODUCTION AND BACKGROUND

Pursuant to conducting ongoing baseline resource investigations in the vicinity of Resolution, WestLand conducted surveys for nesting raptors in 2003, 2004, and 2008. The purposes of these surveys were to locate raptor nesting territories and to monitor existing locations of raptors in accordance with established survey protocols and procedures.

The vegetation structure in the raptor survey area provides a diverse habitat that supports a sufficient prey base for raptors. Small mammals, birds, and an assortment of reptiles were observed living or foraging throughout the area, particularly in the boulder-strewn areas. The surface water features in the Study Area provide adequate water for both raptors and their prey. Riparian vegetation within Queen Creek Canyon provides suitable nesting substrates (e.g., large sycamore trees) as well. The vertical cliff faces of Apache Leap and Devils Canyon provide substantial nesting substrates as well. The west cliffs of Apache Leap extend for approximately 6 miles (10 kilometers) in a north-south direction and face west. This cliff attains a maximum height of approximately 600 feet (180 meters). Significant cliff faces also occur intermittently along both sides of Devils Canyon from its confluence with Rancho Rio Creek downstream for approximately 6 miles and attain a maximum height of approximately 400 feet (120 meters). Opportunities for nesting elsewhere in the Study Area appear limited. The large trees suitable for raptor nesting are limited to the canyon bottoms and two oak groves at Oak Flat Campground and Dry Reservoir. However, excessive human disturbance and activity levels, particularly at Oak Flat Campground, may limit the use of these two oak groves by raptors.

Elsewhere in the Study Area, few if any, suitable nesting substrates are available. Initially, the numerous rock outcrops, boulder fields, tall spires (or "hoodoos"), and stacked rock "totem" formations that dominate the landscape appeared to provide abundant nesting opportunities for raptors. However, WestLand field personnel who conducted intensive surveys for Arizona hedgehog cactus throughout the area reported that nearly all of these boulders and rock formations are potentially accessible to mammalian predators and, therefore, unsuitable as raptor nesting habitat.

2.2 SUMMARY OF RAPTOR SURVEY

WestLand prepared a *Baseline Biology and Land Use Report* (2003a) and a *Biological Assessment and Evaluation* (2003b) describing the Study Area's overall biological resources. Three active raptor nests were observed during the 2003 field survey. A Cooper's hawk nest was recorded within an Emory oak located immediately downgradient of Dry Reservoir, near Oak Flat Campground. An active peregrine falcon eyrie was detected on the face of Apache Leap. A single, active zone-tailed hawk nest was observed in Queen Creek Canyon. Although no nest sites were located, great horned owls were observed in the vicinity of Apache Leap Pond. In addition, two active zone-tailed hawk nests were observed in the vicinity in 2003: one on Queen Creek downgradient (to the northwest) and one within Devils Canyon (to the east).

In 2004, WestLand repeated the raptor surveys in the Study Area (WestLand 2004). These surveys verified the continued occupancy of the peregrine falcon eyrie on Apache Leap as well as a single zone-tailed hawk nest at Queen Creek. The Cooper's hawk nest observed near Dry Reservoir in 2003 was vacant in 2004.

Raptor surveys were repeated in 2008. The 2008 survey documented the continued occupancy of the peregrine eyrie on Apache Leap as well as the zone-tailed hawk breeding area in Queen Creek. A western screech-owl (*Megascops kennicottii*) activity center was noted in the vicinity of Oak Flat Campground in 2008. Although no nest was observed, a pair of these small owls was repeatedly observed, both visually and aurally, during the course of the breeding survey. It is WestLand's opinion that this activity center represents an active breeding territory. The locations of the active raptor nests and the great horned owl and western screech-owl activity centers are depicted in Figure 3.

2.3 RAPTOR SPECIES DESCRIPTION, STATUS, RANGE, AND HABITAT

Three breeding raptor species were identified on site during the 2003, 2004, and 2008 surveys. Two additional species were observed but breeding was unconfirmed. Finally, two more species were observed opportunistically in 2008. The following paragraphs provide brief species accounts for these seven species. All raptor species are afforded protection under the Migratory Bird Treaty Act, which prohibits the "take" of migratory birds. The regulatory definition of "take," as provided in 50 CFR 10.12, means to "pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect."

American Peregrine Falcon

The adult peregrine falcon is a 14- to 18-inch (bird weighing approximately between 1 and 2 pounds, with pointed wings that have a span of approximately 39- to 46-inches (AGFD 2002). The peregrine falcon is sexually dimorphic with female birds being larger than males. The plumage of adult peregrines is variable in color and pattern. Most birds are dark blue-grey or brownish on the back with dark brown to black barring and streaking on a buffy breast (Glinski 1998).

In Arizona, peregrines occur statewide during the migration season and also as resident breeders and winter visitors in suitable habitat. This species may be found at elevations ranging from 400 to 9,000 feet (122 to 2,750 meters) (Glinski 1998). Peregrine falcons live mostly along mountain ranges and river valleys. Peregrine falcons require cliffs for nesting and perching and often utilize open expanses for foraging. Plant communities surrounding breeding cliffs in Arizona are extremely variable and range from Sonoran and Mohave Desertscrub through mixed conifer forest (Glinski 1998).

On August 25, 1999, the peregrine falcon, formerly an endangered species, was removed from the federal list of endangered species and designated as "Delisted Taxon, Recovered, being monitored in the entire range." The peregrine falcon is considered a sensitive species by the US Forest Service.

Zone-Tailed Hawk

The zone-tailed hawk has long, slender wings. The body is almost entirely black above and below. The cere is yellow and there is a nearly naked patch of pale skin between the bill and the eyes. The tail has bands of dusky white that alternate with gray (Glinski 1998).

Zone-tailed hawks in Arizona breed mostly over the southern two thirds of the state and rarely winter in the state. Those that do winter in Arizona are found in lower-elevation desert areas. This hawk is found in habitats from low deserts to high conifer forests. The species is commonly seen foraging over fairly open rocky and brushy slopes of mountains and foothills. Nests can be found in a variety of trees, from palo verde trees to Douglas-firs (*Pseudotsuga menziesii*) (Glinski 1998).

This hawk has never been federally listed as threatened or endangered, nor is it a species of special concern in the state of Arizona.

Cooper's Hawk

The Cooper's hawk is a medium-sized woodland raptor with a very long tail and relatively short, rounded wings. Mature males are a uniform blue-gray in the crown and upper parts and have rich rufous transverse barring underneath. Adult females are basically brown above with barring similar to that of males underneath (Glinski 1998).

Cooper's hawks may be present year round throughout the entire state of Arizona. Cooper's hawks usually breed in woodland and forest habitats ranging from well-developed mesquite bosques and cottonwood-willow riparian forest to spruce-fir forests at the highest available peaks. The species is also known to commonly breed in urban areas (Glinski, 1998).

The Cooper's hawk has never been federally listed as threatened or endangered, nor is it a species of special concern in the state of Arizona.

Western Screech-Owl

The western screech-owl is a small, stocky, cryptically colored bird with a large head, a short body, and long wings. Like many small owls, the western screech-owl has conspicuous "ear tufts," feathers that sprout vertically from behind the eyes. These tufts are typically erect only during the day; at night, the bird's head appears round (Glinski 1998).

This species ranges from south-central Mexico northward across the western half of North America to southeastern Alaska. In Arizona, western screech-owls are common over most of the lower elevation deserts in the southern half of the state. They are uncommon in northwestern Arizona and rare in the northeastern part of the state.

The diet of the western screech-owl includes rodents, small birds, lizards, scorpions, grasshoppers, and crickets. Nests are located within cavities found in trees, large cacti, hollow stumps, and crevasses in rocks or buildings. Where available, saguaros appear to be the favorite nest substrate.

This owl has never been federally listed as threatened or endangered, nor is it a species of special concern in the state of Arizona.

Great Horned Owl

The great horned owl is Arizona's largest owl, with a wingspan of 52 to 56 inches (1.3 to 1.4 meters). This owl has a large, heavy body, large eyes and conspicuous ear tufts. Adults are generally grayish with undertones of buff on the wings and tail. The breast is uniformly covered with horizontal dark barring and a bib, or throat patch ranging from white to orange. The legs and feet of this owl are large and fully feathered (Glinski 1998).

The great horned owl is common in most of Arizona, including high-elevation forests, cool riparian canyon streams, and dry creosote bush flats of the desert lowlands (Glinski 1998).

This owl has never been federally listed as threatened or endangered, nor is it a species of special concern in the state of Arizona.

Common Black-hawk

This medium- to large-sized hawk has broad, rounded wings in flight. Adults are uniformly black in color except for a white band on the short, broad tail (Glinski 1998).

The common black-hawk is widespread in Mexico and reaches the northern limit of its range in Arizona. It is widely, but sparsely, distributed in the canyons below the Mogollon Rim (Glinski 1998).

These large raptors are obligate nesters in relatively undisturbed, mature riparian gallery forests comprised of Arizona sycamore, Fremont cottonwood, Arizona alder, Arizona cypress, and Arizona black walnut (Corman and Wise-Gervais 2005).

Black-hawks are migratory in Arizona, arriving in their breeding areas in March or April and returning south in October. They exhibit high site fidelity, returning to the same small breeding territories year after year (AGFD 2005). Hunting is primarily from low perches near the ground, such as low branches, downed trees, roots, and emergent boulders (AGFD 2005). They will also walk on sandbars, mudflats, and shallow riffles in search of crustaceans or stranded fish. They feed primarily on crabs (outside of Arizona), amphibians, fish, reptiles, and crayfish (AGFD 2005). The riparian zone present in portions of Devils Canyon provides suitable habitat for this hawk.

The common black-hawk is a Wildlife Species of Special Concern in Arizona, as well as a US Forest Service sensitive species.

Prairie Falcon

The prairie falcon is a large, powerful falcon with pointed wings. The coloration is brownish above and whitish below. They have a conspicuous dark "mustache" accented by white behind the eye. A true desert falcon, this bird differs from the similar peregrine falcon in that it nests on lower cliffs and in areas that are more open and arid than those preferred by peregrines (Glinski 1998). However, habitat partitioning between these two related species is not absolute, and they often occur together in the same canyons or, in some cases, the same cliff face (Glinski 1998).

The breeding range of this species is limited to western North America, from southern British Columbia, Alberta, and Saskatchewan south to central Mexico (Glinski 1998). The range is bounded on the west by the Pacific Ocean and extends eastward to eastern New Mexico and Colorado. In Arizona, breeding sites are found throughout the state in appropriate habitats (Glinski 1998).

Unlike peregrine falcons, which prey primarily on birds, prairie falcons prey mainly on ground-dwelling rodents (Glinski 1998). However, in the Arizona desert, they also take large numbers of birds as well as reptilian prey (Glinski 1998). The numerous cliff faces and arid habitats associated with Devils Canyon provide suitable habitat for this falcon.

This species is not listed as threatened or endangered under the Endangered Species Act and is not a US Forest Service sensitive species.

2.4 RAPTOR SURVEY METHODS

Raptor survey methodology included linear transects, variable transects, and cliff surveys, all of which are described briefly below.

In general, linear transects are utilized in order to sample large areas in a relatively short period of time (Cooperrider et al. 1986). Linear transects were conducted along Queen Creek and two tributary drainages near the western portion of Oak Flat (Figure 3). These narrow canyon bottoms contain groves of sycamore, velvet ash, and Emory oaks that provide potential nest trees for raptors. Surveyors proceeded slowly on foot along transects, scanning the treetops with binoculars for evidence of raptors or their nests.

Variable transects were conducted in larger areas containing groves of cottonwoods, oaks, and other trees as well as in areas where steep topography and rock outcrops provided potential nest sites (Figure 3). Observers conducting variable transects moved through the survey areas in a meandering fashion, scanning all appropriate nest substrates with binoculars.

Cliff surveys were conducted on the face of Apache Leap from four fixed points located at intervals along the length of the cliff (Figure 3). Surveyors scanned the cliff face with the aid of binoculars and spotting scopes for a period of 2 hours. Observations took place during the early morning hours from one-half hour before sunrise until 4 hours after sunrise for three of the survey points. Surveys at the southernmost fixed point were conducted in the late afternoon. Evidence of raptor habitation (including stick nests,

whitewash, and visual observations of raptors) was recorded on data forms. If raptors were present, behavioral observations were made to determine breeding status. Specific indicators of breeding activities include (Postupalsky 1974):

- Presence of a nest or eyrie[4]
- Young in nest
- Adult in nest in incubation posture
- Mating behavior
- Prey deliveries
- Nest maintenance
- Adult near nest

The Study Area was first surveyed for the presence of raptors on May 22 and 23, 2003, during the known raptor nesting/breeding season, with particular focus on areas containing appropriate nesting substrates such as cliff faces, rock outcrops, utility poles, and large trees. WestLand conducted the 2004 surveys on May 19 and 20, 2004. The 2008 raptor surveys were conducted on May 8, 9, and 20, 2008. The raptor surveys conducted in 2004 and 2008 included both a general survey and ongoing monitoring of previously identified raptor nests. Opportunistic observations of raptors were also recorded by WestLand field personnel during the course of other field activities. These observations were not conducted by survey protocol and are, therefore, separately described in Section 2.6.

2.5 RAPTOR SURVEY RESULTS AND DISCUSSION

The 2008 raptor surveys identified two active raptor breeding territories in the area: a peregrine falcon eyrie on the face of Apache Leap and an active zone-tailed hawk nest in a sycamore tree in Queen Creek Canyon (Figure 3). Both of these territories were also active in 2003 and 2004. The Cooper's hawk nest identified in 2003 was unoccupied in 2008. The great horned owls noted in 2003 were not observed during the 2008 inventory. However, no focused effort was made to find these nocturnal birds. A western screech-owl was heard vocalizing at Oak Flat Campground on the night of May 8, 2008. Numerous turkey vultures were observed soaring along Apache Leap and throughout the area.[5]

The peregrine falcon eyrie on the face of Apache Leap was monitored on May 8, 2008. The cliff face was observed in the afternoon from approximately 3:30 p.m. through 7:30 p.m. No activity was recorded until 7:05 p.m. when the female was heard vocalizing. At 7:06 p.m., a male peregrine falcon came into view and flew back and forth in front of the cliff face carrying a small bird. He was subsequently joined in flight by the female, and an aerial prey exchange was observed when the female approached the male from beneath, inverted, and took the prey from his talons. The female then proceeded to a cliffside perch to feed while the male presumably entered the eyrie. The nest likely contained eggs that had not yet

[4] The eyries of cliff nesting raptors can consist of a stick nest, scrape, ledge, or cavity.
[5] A well-known turkey vulture communal roost is located at the nearby Boyce Thompson Arboretum, where up to 100 individuals congregate nightly (Glinski, 1998).

hatched, as no prey was delivered to the nest. At approximately 7:20 p.m., the female joined the male at the nest and observations were terminated.

The 2003 Cooper's hawk nest site near Dry Reservoir was visited on May 9, 2008. The nest site and its vicinity near the Oak Flat Campground were examined for signs of current occupancy. Although the nest was still present, there was no evidence of recent activity. No Cooper's hawks were observed, no signs of recent nest maintenance were observed, and no Cooper's hawk feathers, prey remains, or whitewash was noted beneath the nest. The nest vicinity was searched for the possible presence of an alternate nest. This search did not detect any signs of Cooper's hawks or their nests. The reasons for the absence of Cooper's hawks in this territory in 2008 are unknown. However, as was the case in 2004, WestLand field personnel noted a high degree of human disturbance throughout the canyon bottom that forms the core of this breeding territory. In addition, there is a well-used campsite with a large fire ring directly below the nest tree. It appears that repeated fires have scorched large branches of the nest tree, which are dying and falling down. The canyon bottom is covered with human and dog footprints and moderate amounts of trash were also noted. Surveyors surmised that the human activity may have disturbed the Cooper's hawks enough for them to abandon the nest site.

On May 20, 2008, WestLand field personnel located an active zone-tailed hawk nest in a sycamore tree within Queen Creek Canyon, immediately adjacent to US Highway 60. An incubating female zone-tailed hawk occupied the nest. When the nest was approached to determine its activity status, the female became agitated and vocalized at the observer. To prevent possible disruption of breeding behavior, the observer quickly left the area. This nest was located in the same area where zone-tailed hawks were detected in 2003 and 2004.

2.6 OPPORTUNISTIC RAPTOR OBSERVATIONS IN DEVILS CANYON

During the course of conducting numerous ongoing biological studies in Devils Canyon, WestLand observed several species of raptors. These raptor observations are summarized below. The locations of these observations are depicted in Figure 4. Four of the species—peregrine falcon, common black-hawk, zone-tailed hawk, and Cooper's hawk—have also been observed in the Study Area outside of Devils Canyon. One additional species, the prairie falcon, was observed in Devils Canyon.

WestLand located a probable peregrine falcon breeding area near the confluence of Devils Canyon and Hackberry Creek. The first observation occurred on March 25, 2008, at 1:14 p.m., when a peregrine falcon was seen overhead. On April 3, 2008, at 11:35 a.m., a single peregrine falcon was observed vocalizing and landing twice upon a deep ledge on the cliffs across from the confluence of Hackberry Creek and Devils Canyon. At 12:24 p.m., a pair of peregrines was observed together at the same area of the cliff. The male then returned to the same ledge used at 11:35 a.m., vocalized, and flew off to join the female on a nearby ledge. After copulation, the male left the area for a few minutes while the female remained at the ledge. At 12:40 p.m., the male returned to the original ledge, vocalized, and flew away. The female left the area at this point and the male visited the original ledge and vocalized before both

birds left the area at 12:45 p.m. This behavior is strongly indicative of an active breeding territory/nest site and it is likely that this cliff face contains an active peregrine eyrie.[6]

An active zone-tailed hawk breeding area was detected in Devils Canyon just upstream of the mouth of Hackberry Canyon. On March 28, 2008, at 9:30 a.m., a zone-tailed hawk was observed vocalizing from an alder tree with a large stick nest. Later that day, at 12:24 p.m., a pair of zone-tailed hawks was observed copulating in a nearby sycamore tree. During the course of WestLand's studies, these birds were frequently observed throughout the stretch of Devils Canyon near the mouths of Rancho Rio, Hackberry, and Oak Creek Canyons. A second zone-tailed hawk activity center was observed at Pipe Springs on May 8 and 9, 2008, where an adult and sub-adult were observed in the vegetated area associated with the springs. There is possibly another breeding area at this location.

On April 24 and 25, 2008, a black-hawk was observed calling softly from a nest in an ash tree while another soared overhead. This bird was observed repeatedly returning to the nest for short periods of time, possibly feeding an incubating female. On June 12, 2008, a second black-hawk breeding area was located in a Fremont cottonwood that contained a large raptor nest in its top. A black-hawk was observed periodically circling the tree and vocalizing during the day.

Cooper's hawks were observed on two occasions in Devils Canyon. One was observed near the mouth of Rancho Rio Creek in November 2007. On April 25, 2008, at 9:55 a.m., a Cooper's hawk was observed flying away from the creek just 65 feet (20 meters) from the black-hawk nest in the ash tree described above. WestLand did not observe any signs of breeding activity.

In November 2007, a prairie falcon was observed upstream from Grapevine Spring. On May 9, 2008, a female falcon was heard vocalizing repeatedly from a cliff face in a manner consistent with an incubating or brooding female "hunger screaming" in order to elicit prey delivery from the attendant male. Although no prairie falcons were visually observed, this is strongly indicative of an occupied breeding area.

2.7 RAPTOR SURVEY CONCLUSIONS

The Study Area supports several species of breeding raptors. The initial baseline inventory (2003) and ongoing monitoring of the Study Area have documented occupied breeding territories of zone-tailed hawks, Cooper's hawks, and peregrine falcons. Great horned owls were observed on site in 2003 and western screech-owls were observed in 2008. The area also supports large concentrations of turkey vultures. During the 2008 survey, two active raptor-breeding territories were observed in the Study Area: a peregrine falcon eyrie and a zone-tailed hawk nest. Ideal nesting habitat for raptors is found along the face of Apache Leap and along Queen Creek. Recreation pressures may limit the use of two oak groves near Oak Flat Campground and Dry Reservoir by nesting raptors.

[6] Rich Glinski, Arizona Game & Fish Department (retired), personal communication to author, July 24, 2008.

3.0 BIRD CENSUS

3.1 BIRD CENSUS SURVEY METHOD

The variable circular-plot method (VCPM) for estimating bird populations was determined to be the survey protocol most appropriate to census birds in the Study Area. An explanation of sampling methods and justification for the technique are provided in Appendix A. The following paragraphs summarize the specific application of this method to the Study Area.

The first stage of this procedure was to identify the biotic communities available in the Study Area and to locate representative points within those communities that would be used for surveying. Upon analysis after-the-fact, it is believed that the upland survey points represent the best opportunity for observing birds, and do not reflect general conditions in the uplands. Initial site visits were made in November and December 2007 to identify points within the biotic community types described in Section 1.1. Fifty points were located (Figure 2) and marked with numbered aluminum tags.

Interior Chaparral biotic community survey locations include five points generally dominated by manzanita, sited on flatter terrain in the northeastern corner of the Study Area, and five points dominated by scrub oak, located on steeper slopes east of Apache Leap. Six survey points on the west side of Apache Leap are located within the Sonoran Desertscrub, Arizona Upland Subdivision biotic community, but these points also include elements of semidesert grassland.[7] The eight survey points in the Madrean Evergreen Woodland biotic community are primarily in the vicinity of the Oak Flat campground. Six Interior Riparian Deciduous Forest biotic community survey points are in the alder grove in Devils Canyon, and 15 other riparian points are located elsewhere along Devils Canyon, Queen Creek, and Rancho Rio Creek. Five riparian points are adjacent to ponds near Oak Flat. This array of points is thus divided into nine distinct biotic community groups. At each survey point location the exact center point was chosen to be the closest tree or shrub species (Table 1). A complete list of these points, with UTM coordinates, is provided in Table 1.

The array of points could be surveyed in 3 days by two teams of observers. Each point was counted 3 times during the winter survey, with survey sets about 3 weeks apart. Each point was surveyed another three times during the breeding survey, with survey sets about 4 weeks apart to cover more of the season. To ensure the greatest reliability in our surveys, we had highly experienced observers leading each team in the field, and we kept the same teams throughout the survey. Each survey group had two people for safety and efficiency.

[7] Brown (1994) describes semidesert grassland as a perennial grass-scrub dominated landscape positioned between lower elevation desert-scrub and higher elevation evergreen woodlands, chaparral, or plains grasslands. This community adjoins and largely surrounds the Chihuahuan desert, and is largely a *Chihuahuan semidesert grassland.* Extensive areas of this grassland are found in the Mexican States of Chihuahua, western Coahuila, and northeastern Sonora extending southwards on the Mexican Plateau to just northeast of Mexico City. In the United States this community occurs in Trans-Pecos Texas, southern New Mexico, and southeast Arizona.

In applying the VCPM to the Study Area, we used 5-meter increments of radius out to 30 meters from the central point, and 10-meter increments from 30 to 100 meters. Birds observed at distances greater than 100 meters from the survey point were recorded but were generally beyond calculated detection limits for density estimates. Survey points were at least 150 meters apart, and frequently more than 200 meters apart, to minimize the possibility of re-counting of individual birds. Because the activity level of birds may decrease during the middle part of the day, census times were restricted to the first 4 hours after sunrise. This restriction is more critical in summer than in winter. For each point we counted for a 10-minute period during each cycle of surveying. The 10-minute period is a commonly used bird survey duration and it facilitates comparison to other VCPM studies. Also, Dettmers et al. (1999) found that 10-minute point count durations provided adequate data for modeling bird-biotic community relations. In order to better understand the rates of detection of birds at each census point, we noted the number of individual birds detected during a first 3-minute period, a second 2-minute period, and a third 5-minute period. We analyzed the data in a manner similar to Dettmers et al. (1999).

The VCPM is particularly useful in estimating densities for a wide variety of bird species. Because different species are detectable at different distances from the observer and the ability of the observer to detect particular species differs among biotic communities, detection distances are determined for each species in each biotic community and the observations from all points and the species observed at those points within that biotic community are combined. The detection distance is normally the distance at which the incremental density of a species in the next greater radial range is less than half of the incremental density in the lower range. Incremental densities are calculated by dividing the number of observations within a concentric ring by the area of that ring. For example, the incremental area of the ring between 30 and 40 meters from the central point would be the area of a 40-meter radius circle minus the area of a 30-meter radius circle.

Because incremental areas increase geometrically with the distance from the central point, minor errors in distance estimates for birds close to the point can bias the density estimate (Verner 1985). Similar biases can result if birds are attracted to or repelled from the observer (Gibbons, et al. 1996). However, the accuracy of detection limits and densities will improve with a greater number of observations. Another potential bias in this method may occur if uncommon birds happen to be observed close to the point. With too few observations to determine a reliable detection limit, very high densities for uncommon species based on one or two close observations could be calculated. To reduce the effects of this potential bias, a minimum detection limit of 20 meters was assumed for uncommon species observed close to the census point.

Once a detection limit has been determined for a species in a biotic community, a density estimate may be calculated based on pooled data from all points within that biotic community. The total number of individuals observed is divided by the area of a circle with a radius of the detection limit. This result is then divided by the total number of counts within that biotic community during the survey. The total number of counts for a biotic community is equal to the number of census points within that biotic community multiplied by the number of survey sets for each point.

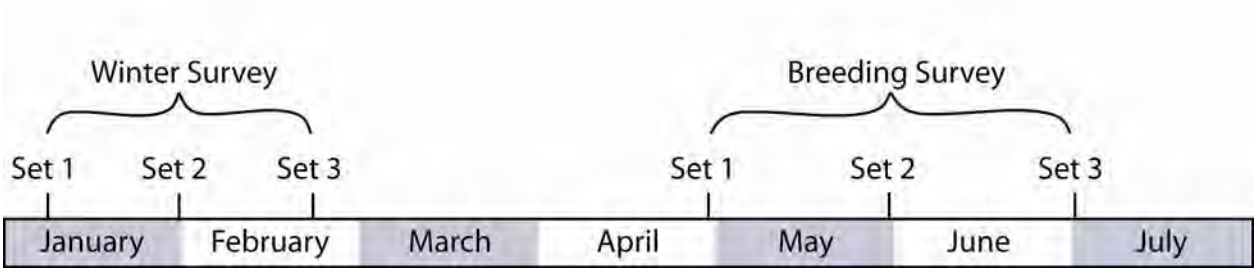
In addition to the bird species densities calculated at each census point, basic vegetation and physical data were collected at each point. These data include:

- Densities and sizes of each tree species
- Canopy cover of each tree species
- Estimated percent cover of the dominant shrub species
- Total herbaceous ground cover
- Underlying geology
- Proximity to surface water
- Other plant species observed on the site

The data collection procedure was a modification of the standard point-centered quarter sampling method. Instead of using points along a transect, we used all survey points within a biotic community to obtain average vegetation characteristics for the community. Tree densities and canopy cover are based on measurements of the closest tree in each quadrant. With bird density data and vegetation data at each survey point, the vegetative characteristics that are most important to the bird species richness and density could possibly be identified. In addition, when foraging behavior was seen, the events were recorded, including species of bird, type of foraging, and species of plant. Nesting observations were also recorded.

3.2 BIRD CENSUS RESULTS AND DISCUSSION

Two cycles of three sets of bird surveys were completed during the winter and the breeding surveys of 2008, as depicted graphically below.



The first winter survey set was January 8, 9, and 10; the second set was January 29, 30, and 31; the final winter survey set was February 19, 20, 21, and 22.[8] The first breeding survey set was April 28, 29, and 30; the second set was May 27, 28, and 29; the final breeding survey set was June 30, and July 1 and 2.

[8] By chance, each of these survey sets followed a significant storm event, producing exceptional amounts of runoff in all channels. In particular, Devils Canyon and Queen Creek were flowing heavily during these sets, making auditory detections of birds more difficult.

The following sections discuss the results of our analyses of:

- Bird species diversity
- Bird species densities
- Time Interval Analysis of survey set time segments
- Effects of time of day
- Vegetation data
- Bird-vegetation correlations

Bird Species Diversity

Fifty-six bird species were observed on or adjacent to the Study Area during the winter surveys, as listed in Table 2a. During the breeding survey, 92 species were observed on or near the Study Area, as listed in Table 2b. The order of species in these tables follows the taxonomy of the American Ornithologists Union (AOU 2008).

During our winter survey, 54 bird species were recorded with distance estimates. Two other species were opportunistically observed in the Study Area during this effort. As noted above, the data from all survey points in specific biotic communities were combined to determine detection limits for each species in each biotic community.

During our breeding survey, 87 bird species were recorded with distance estimates. Five other species were observed in the vicinity but were not recorded at any points during a survey set. Again, the data from all survey points in specific biotic communities were combined to determine detection limits for each species in each biotic community. As in the winter survey, most breeding survey density estimates are based on relatively few observations, although the total number of observations is much higher in the breeding survey. Only 60 of 324 breeding density estimates (18.5 percent) are based on 10 or more observations within a biotic community type.

The numbers of winter survey species observed in the different biotic communities covered a broad range. On the low end, seven species were observed in the Interior Chaparral-scrub oak series and eight species were observed in the Interior Riparian Deciduous Forest of Rancho Rio Creek. On the high end, 26 species were observed in the Interior Chaparral-manzanita series and 28 species at the Interior Riparian Deciduous Forest at the ponds. The average number of species per biotic community in the winter survey was 16.7. As expected, the number of species observed in each biotic community tended to increase with each winter survey as migratory birds arrived when temperatures increased. Also as expected, the number of new species observed tended to decrease with later winter survey sets (although there were some exceptions for certain communities). These data are presented numerically in Table 3a and graphically in Figure 5a. The pattern is generally similar in each biotic community, although the total numbers of species differs.

The numbers of breeding survey species observed in the different biotic communities ranged from a low of 28 species in the Interior Chaparral-scrub oak series and Arizona Upland Subdivision of Sonoran Desertscrub to highs of 42 species in the Interior Riparian Deciduous Forest of Devils Canyon and 44 species in the Interior Chaparral-manzanita series. The average number of species per biotic community in the breeding survey was 36.0. Similar to the pattern observed during the winter, the number of species observed in a biotic community tended to increase with each survey event. Also as expected, the number of new species decreased with later survey sets, with the exception of the last survey in the Interior Riparian Deciduous Forest alder grove of Devils Canyon. These data are presented numerically in Table 3b and graphically in Figure 5b.

One obvious contrast between winter and breeding surveys is that many more species were observed in each biotic community during the breeding survey than in the winter survey. The minimum number of species per biotic community in the breeding survey was the same as the maximum number of species per biotic community in the winter survey. However, the difference between maximum and minimum numbers of species among biotic communities was much lower in the breeding survey. In winter the ratio of maximum to minimum number of species was 4.0, while in the breeding survey the maximum to minimum ratio was only 1.6.

Figures 6a and 6b show the percentage of bird species detected in each biotic community for each of the three survey sets in the winter and breeding surveys, respectively. In order to combine these winter survey results to generate a trend for the entire area, the data were normalized by converting to a percent of the total for each biotic community and then averaged. The results of this operation are shown in Figure 6c. The general pattern for the winter survey in this figure indicates that roughly 50 percent of the species were observed during the first survey set, another 30 percent were added in the second survey set, and the last survey set only added about 20 percent of the species. The breeding survey data general pattern is similar to that for the winter, except the curve is initially steeper, and it flattens more in the last survey set. Nearly 65 percent of the species were observed during the first breeding survey set, another 25 percent were added in the second survey set, and the last survey set only added about 10 percent of the species.

Bird Species Densities

The detection limits mentioned above were used to calculate densities for each species in each biotic community. These densities provide for reasonable statistical comparisons among biotic communities. Detection limits and densities that are based on very few observations are only approximate. Because birds were relatively sparse in most biotic communities in the Study Area during winter, only 17 out of 150 density estimates (11.3 percent) are based on 10 or more observations within a biotic community.

Total winter survey bird densities in the biotic communities within the Study Area (Table 3a) range from a low of about 1.2 birds per hectare in the Interior Chaparral-scrub oak series to a high of 11.3 birds per hectare in the Interior Chaparral-manzanita series. There is no obvious reason for the large difference in bird density between the scrub oak and manzanita Interior Chaparral points. Within this range, the three

Interior Riparian Deciduous Forest areas (alder grove in Devils Canyon, Devils Canyon, and the ponds) also had relatively high bird densities of between 8 and 9 birds per hectare. A weighted average of all biotic community types gives a density of 6.8 birds per hectare for the winter survey.

Despite this order-of-magnitude range, these winter survey bird density values are all very low, indicating that wintering birds are sparsely distributed in the Study Area and surrounding land. This result is consistent with our impressions during data collection that there were very few birds present. There were several points during each survey set at which no birds were observed, and at many points only a few individuals or species were recorded.

Total breeding survey bird densities in these biotic communities range (Table 3b) from a low of about 9.7 birds per hectare in the Interior Chaparral-scrub oak series to a high of 44.1 birds per hectare in the Interior Riparian Deciduous Forest alder grove in Devils Canyon. The Interior Chaparral-manzanita series also had a relatively high density at about 34.6 birds per hectare. A weighted average of all biotic communities gives a density of 23.3 birds per hectare during the breeding survey.

These breeding survey bird densities are all higher than the winter survey densities, and the minimum breeding survey bird density is comparable to the maximum winter survey bird density. In a pattern similar to the species diversity, the difference between maximum and minimum bird densities among biotic communities was lower in the breeding survey than in the winter survey. In winter, the ratio of maximum to minimum bird densities was 9.6, while in the breeding survey the maximum to minimum ratio was only 4.5.

Time Interval Analysis of Survey Sets

The survey data were also analyzed based on observations within different time segments in each survey set. Observations were recorded separately for the first 3 minutes, the next 2 minutes, and the final 5 minutes of the total 10-minute survey at each point. Surveyors hypothesized that most species and individuals would be seen during the 3-minute and 2-minute intervals, and that fewer new species and individuals would be added during the final 5-minute interval. The data collected during our winter surveys generally support this hypothesis, although there are variations among the different biotic communities. Time interval analyses for each biotic community type during the winter and breeding surveys, by species and by individual birds, are presented in Figures 7a and 7b through 15a and 15b.

These graphs show that most biotic communities have a similar pattern in winter, with many species and individuals observed during the first 5 minutes of a survey, and fewer species and individuals added later in the survey. These patterns are similar to the results for numbers of species and individual birds recorded during the three survey sets. Two notable exceptions are the Interior Chaparral-scrub oak series and Madrean Evergreen Woodland biotic communities. In both, the relationships between species, individuals, and time are nearly linear. In the scrub oak series, the linear relationships may be an artifact of the limited data set (i.e., few data points) for this biotic community. The Interior Chaparral-scrub oak series had the fewest total species and the lowest total density of birds of any of the biotic communities

surveyed. In contrast, the Madrean Evergreen Woodlands biotic community had a relatively high number of species and an average total bird density, and there is no obvious reason for the linear relationships.

In general, the patterns for breeding survey data are very similar to those based on the winter survey data. For the Interior Chaparral-manzanita series and Interior Riparian Deciduous Forest along Queen Creek, the shapes of the curves are almost identical. The Interior Chaparral-scrub oak series and Madrean Evergreen Woodlands breeding survey results were not as linear as the winter survey results, but they were generally more linear than the breeding results in other biotic community types. The similarity in patterns is interesting because the breeding survey results are based on many more species and individuals than the winter survey results.

The time interval data were combined for all survey points for the winter and breeding surveys, by species and individuals, as depicted in Figures 16a and 16b. The curves for species and individuals are not as pronounced as expected, probably because of the influence of the Madrean Evergreen Woodlands and Interior Chaparral-scrub oak series exceptions noted above. When these data are converted to percentages and replotted (Figures 17a and 17b), the same pattern as noted for species is present. For the winter surveys, these curves make it clear that between 70 and 75 percent of the species and individuals are recorded within the first 5 minutes of a survey, and 25 to 30 percent were recorded during the last 5 minutes. Even though the breeding survey plots are based on many more species and individual observations, the shapes of the curves are nearly identical between winter and breeding survey. During the breeding survey, about 70 percent of species and individuals were recorded during the first 5 minutes at a point, and only about 30 percent were recorded during the final 5 minutes. In several of the biotic communities, over 80 percent of species and/or individuals were recorded during the first 5 minutes. In the Interior Riparian Deciduous Forest along Rancho Rio Creek, 100 percent of the species were recorded in the first 5 minutes, but this biotic community type is very low in species diversity.

These results show a point of diminishing returns on survey time expenditures for both winter and breeding surveys. Most information is captured within the first 5 minutes, but enough species and individuals are added during the final 5 minutes to conclude that the final 5 minutes spent surveying are worthwhile. Longer survey periods are not likely to provide enough additional information to justify the time expenditure.

Effects of Time of Day

Our survey protocol includes the implicit assumption that bird activity will decrease in the middle part of the day, leading to a potential bias in density data. While this expected decrease in activity is likely because of high daytime temperatures during the summer, it seems less likely to occur during the winter. To test this assumption, we analyzed the numbers of species and individuals recorded during each 10-minute survey period, based on the time after sunrise that the survey period started. The data were separated into half-hour time intervals beginning with the time of sunrise, and the bird counts were averaged during those time intervals. Using time-after-sunrise eliminates any potential bias from

increasing day lengths and the start time at each survey point was varied so that no one survey point was surveyed during the same time after sunrise.

Results of this analysis, based on 150 survey periods (three sets of survey at 50 survey points) during winter and breeding survey, are shown numerically in Tables 5a and 5b, respectively. Figures 18a and 18b show these data graphically for species and individuals, respectively, but excluding statistical outliers described below.

For the winter survey (Table 5a), these data show a slight positive trend, indicating that both species and numbers of individuals are increasing with time of day, and not decreasing as was expected for breeding survey data. The correlation coefficients (r) for these relationships are 0.6561 for species and 0.5670 for individuals. Neither of these correlations is statistically significant at the $p = 0.05$ level. These results may be somewhat misleading, because the eighth and ninth time intervals have only one count each, thus not allowing any averaging of data. All other time intervals had at least 11 counts that were averaged. By chance, the count during the ninth time interval happened to have one of the highest number of species recorded on any count, and it also had a high number of individuals. These values are obvious outliers, and using the Dixon test, both of these values can be statistically rejected with a probable error of less than 0.01 (Sokal and Rohlf 1981). When these points are deleted, the remaining 148 counts in seven time intervals are plotted in Figures 18a and 18b for species and individuals, respectively. These data still show a very slight positive trend, but much less than with the outliers ($r = 0.5969$ for species and 0.1802 for individuals). Neither of these correlations is statistically significant at the $p = 0.05$ level (Rohlf and Sokal 1981).

The breeding survey results based on time of day for 150 point counts are shown numerically in Table 5b. For the species relationship, $r = 0.9358$, which is statistically significant at the $p = 0.01$ level; for the numbers of individuals, $r = 0.7803$, which is statistically significant at the $p = 0.05$ level. These results are a little surprising, in that they contradict our assumption of reduced bird activity later in the day. Activity may still decrease in the hottest part of the day, but the 4-hour period after sunrise is apparently not a long enough time to detect the anticipated decrease.

Vegetation Data at Bird Survey Points

The vegetation density and cover data for the 50 bird survey points are summarized by biotic community type in Table 6. The average tree density in these biotic communities ranged from lows of 70.7 trees per hectare in the Interior Riparian Deciduous Forest along Rancho Rio Creek and 94.5 trees per hectare in the Interior Chaparral-scrub oak series, to a high of 403.4 trees per hectare in the Interior Riparian Deciduous Forest alder grove in Devils Canyon. The maximum-to-minimum ratio for tree density is 5.7, indicating a wide range in densities.

The average tree canopy cover ranged from lows of 436 square meters per hectare (1 hectare = 10,000 square meters) in the Interior Chaparral-scrub oak series and 880 square meters per hectare in the Interior Chaparral-manzanita series to a high of 16,240 square meters per hectare in the Interior Riparian

Deciduous Forest alder grove in Devils Canyon. The maximum to minimum ratio for tree canopy cover is 37.2, indicating a very wide range in canopy cover. The two Interior Chaparral biotic community series were expected to have low tree canopy cover because they are predominantly shrub communities, and the trees are widely spaced and generally have low stature. The Interior Riparian Deciduous Forest alder grove has a high density of large-stature trees, and a calculated canopy cover greater than 10,000 square meters per hectare indicates an overlapping, closed canopy with multiple layers.

Twenty-three species of trees were recorded at least once as the closest tree in a bird survey point quarter (Table 7). Many of these tree species were only recorded in a single biotic community, and no tree species were recorded in all biotic communities. Emory oak and netleaf hackberry were found in the greatest numbers of biotic communities. Six other tree species, including four exotics, were recorded within 30 meters of at least one survey point. These species were Arizona cypress, alligator-bark juniper, Mexican paloverde (*Parkinsonia aculeata*), white mulberry (*Morus alba*), southern catalpa (*Catalpa bignonioides*), and tamarisk (*Tamarix* sp.).

The average cover of shrub species ranged from a low of 15 percent at the pond sites to a high of 42 percent in the Interior Chaparral-scrub oak series. Manzanita series cover was also relatively high, at 31 percent. High cover of shrubs is expected in chaparral communities, consistent with the observed low tree canopy cover. Thirty-six different shrub species were among the five most common shrubs for at least one of the survey points, as listed in Table 6. At least 19 other shrub species and several cactus species were recorded within 10 meters of at least one survey point. We did not attempt to compile a comprehensive plant species list for the Study Area, but we did record other common species observed within a 30-meter radius of each bird survey point. Over 180 plant species were recorded in this effort, as listed in Table 8.

Average herbaceous ground cover was generally very low in almost all biotic community types, ranging from a low of 1 percent in the Interior Chaparral-manzanita series to a high of 24 percent in the Interior Riparian Deciduous Forest pond sites community. Low herbaceous cover is expected in a semi-arid environment, and it is often dependent on the extent of recent rainfall events. Most of our vegetation measurements were completed prior to the onset of the summer monsoon season. The ponds had relatively high herbaceous cover because many areas that were underwater in the winter were dry and covered with herbaceous plants by late spring when our breeding survey began.

Bird-Vegetation Correlations

Winter and breeding survey data for bird species diversity and total tree density for all biotic community types are shown in Figure 19, and correlation coefficients (r) were calculated for these data. Neither the winter survey ($r = 0.0762$) nor the breeding survey ($r = 0.3851$) showed a significant correlation between species diversity and tree density.

Winter and breeding survey data for total bird density and total tree density across all biotic community types are shown in Figure 20. There was no significant correlation for the winter survey ($r = 0.3162$). The

breeding survey data suggest a positive correlation between bird density and tree density, but the relationship was not statistically significant ($r = 0.6421$, $p>0.05$) (Rohlf and Sokal 1981). This relationship is strongly influenced by the results from the Interior Riparian Deciduous Forest alder grove in Devils Canyon, which had high bird density and very high tree density.

Winter and breeding survey data for bird species diversity and total tree canopy cover for all biotic community types are shown in Figure 21. Neither the winter survey ($r = -0.0675$) nor the breeding survey ($r = 0.4572$) showed a significant correlation between species diversity and tree canopy cover. Winter and breeding survey data for total bird density and total tree canopy cover for all biotic community types are shown in Figure 22. There was no significant correlation for the winter survey ($r = 0.3014$). The breeding survey data suggest a positive correlation between bird density and tree canopy cover, but the relationship was not statistically significant ($r = 0.6428$, $p>0.05$). In each of these plots, the Interior Riparian Deciduous Forest alder grove appears to be an outlier because of its very high canopy cover.

Winter and breeding survey data for bird species diversity and shrub cover (on a percentage basis) for all biotic community types are shown in Figure 23. Both the winter survey data ($r = -0.4221$) and the breeding survey data ($r = -0.5568$) indicate a negative relationship between species diversity and shrub cover, but these trends are not statistically significant. Winter and breeding survey data for total bird density and shrub cover (on a percentage basis) for all biotic community types are shown in Figure 24. These data also indicate a negative relationship for the winter survey ($r = -0.5095$) and the breeding survey ($r = -0.1979$). However, each of these relationships is influenced by the Interior Chaparral-scrub oak series, which had relatively high shrub cover and very low bird species diversity and total bird density.

3.3 BIRD CENSUS SUMMARY AND CONCLUSIONS

The 2008 winter and breeding surveys using the VCPM has been successfully completed at the Study Area. These surveys covered 50 points grouped into nine different biotic community types. The winter survey results show that the diversity of birds encountered during this survey was relatively high. Fifty-four bird species were recorded during the winter survey point counts, and two other species were observed at other times on the site. The diversity of birds within a biotic community ranged from seven species in the Interior Chaparral-scrub oak series to a high of 28 species at the Interior Riparian Deciduous Forest surrounding the ponds. The winter densities of birds across the site were relatively low in all biotic communities, with densities ranging from 1.2 birds per hectare in the scrub oak chaparral to 11.3 birds per hectare in the Interior Chaparral-manzanita series. The weighted average density across all biotic community types is only 6.8 birds per hectare during the winter survey.

The density and diversity of birds in the breeding survey were much higher than in the winter survey in all biotic communities. Ninety-two (92) species were observed during breeding surveys. Species diversity ranged from lows of 28 species in the Arizona Uplands subdivision of the Sonoran Desertscrub biotic community and Interior Chaparral-scrub oak series to a high of 44 species in the Madrean Evergreen Woodlands. Bird densities ranged from a low of 9.7 birds per hectare in the Interior Chaparral-scrub oak

series to a high of 44.1 birds per hectare in the Interior Riparian Deciduous Forest alder grove in Devils Canyon. The weighted average density across all biotic community types in the breeding survey was 23.3 birds per hectare.

Observations within 3-minute, 2-minute, and 5-minute segments of the total time at each survey point showed the expected pattern of numerous species and individuals observed during the first segment, and relatively few species and individuals added during the final 5 minutes. Similar patterns were obtained in the winter and breeding surveys. Between 70 and 75 percent of species and individuals were observed during the first 5 minutes of a count, and the last 5 minutes added only 25 to 30 percent of species and individuals. Most biotic community types also showed this pattern, although the Interior Chaparral-scrub oak series and Madrean Evergreen Woodlands biotic communities showed nearly linear relationships of species and individuals with time. From these results, we conclude that 10 minutes is an appropriate time period for the surveys. A shorter time is likely to miss species and individuals, and a longer time is not likely to provide a return in observations proportional to the additional effort.

An analysis of the winter survey data for the possible effect of time of day on the surveys shows a slight positive trend for both species and numbers of individuals with the elapsed time after sunrise. However, these correlations are not statistically significant. From these results, we can conclude that time of day does not appear to be significant for surveying birds in the winter, although there may be somewhat more activity as the day becomes slightly warmer. During the breeding survey, our data indicate significant positive correlations with time of day for both numbers of species and numbers of individuals. This result is contrary to our expectation of decreasing activity during the day, but it also provides justification for using the full 4-hour period after sunrise.

In conjunction with our bird surveys, we collected vegetation data at each of the 50 survey points, and the data were summarized for each biotic community type. Tree densities in these biotic communities ranged from 70.7 trees per hectare in the Interior Riparian Deciduous Forest along Rancho Rio to 403.4 trees per hectare in the Interior Riparian Deciduous Forest alder grove along Devils Canyon. Tree canopy cover ranged from 436 square meters per hectare in the scrub oak series to 16,240 square meters per hectare in the Interior Riparian Deciduous Forest alder grove. Shrub cover was highest in the Interior Chaparral biotic community, with a cover of 42 percent in the scrub oak series and 31 percent in the manzanita series. The Interior Riparian Deciduous Forest vegetation around the ponds had the lowest shrub cover at 15 percent, but they had the highest herbaceous cover at 24 percent. Herbaceous cover was very low in most other biotic communities, but it was about 15 percent in the Madrean Evergreen Woodlands.

We evaluated possible correlations between bird species diversity and total bird density and the vegetation characteristics of total tree density, total tree canopy cover, and shrub cover. While there were some indications of positive and negative relationships, none of these correlations were statistically significant. In each case, these relationships were heavily influenced by either the alder grove Interior Riparian Deciduous Forest biotic community, which had very high tree density and tree canopy cover, or the scrub oak Interior Chaparral, which had very high shrub cover.

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TABLES

Table 1. Locations of Resolution Bird Survey Points. UTM coordinates, Region 12S, NAD27

Survey Point	Tag Number	Tagged Tree or Shrub Species*	Easting (m)	Northing (m)	Approximate Elevation (ft)
Arizona Upland					
A-1	1	VACA	492336	3682803	3,560
A-2	2	PRVE	492466	3682894	3,670
A-3	3	PAMI	492303	3682984	3,720
A-4	4	CAHO	492130	3682968	3,650
A-5	5	CAHO	492422	3683066	3,780
A-6	6	ACGR	492585	3683081	3,870
Chaparral-Manzanita					
CM-1	7	ARPU	496552	3685093	4,070
CM-2	8	ARPU	496456	3685686	4,110
CM-3	9	JUMO	496520	3685537	4,090
CM-4	10	QUEM	496673	3685419	4,110
CM-5	11	QUEM	496521	3685265	4,070
Chaparral-Scrub Oak					
CS-1	12	QUTU	494504	3684299	3,940
CS-2	13	CEMO	494440	3683668	4,020
CS-3	14	PIMO	494452	3683392	4,080
CS-4	15	CEMO	494456	3682928	4,120
CS-5	16	JUMO	494488	3682745	4,100
Devils Canyon					
D-1	17	PLWR	497052	3687132	3,990
D-2	18	PLWR	496978	3686933	3,985
D-3	19	PLWR	496957	3686780	3,950
D-4	51	PLWR	496952	3684635	3,800
D-5	21	PLWR	496942	3684408	3,780
D-6	22	PLWR	496952	3684213	3,770
D-7	23	ALOB	497444	3682078	3,600
D-8	24	ALOB	497466	3681879	3,580
D-9	25	ALOB	497452	3681676	3,560
D-10	26	ALOB	497506	3681477	3,540
D-11	27	ALOB	497529	3681276	3,530
D-12	28	ALOB	497550	3681082	3,510
Oak Woodland					
O-1	29	QUEM	495694	3685582	3,950
O-2	30	QUEM	495613	3685398	3,945
O-3	31	QUEM	495483	3685237	3,940
O-4	32	QUEM	495271	3685184	3,920
O-5	33	QUEM	495759	3684675	3,980
O-6	34	QUEM	495479	3684621	3,970
O-7	35	QUEM	494503	3684813	3,830
O-8	36	QUEM	494369	3684882	3,820
Ponds					
P-1	37	QUEM	494947	3685352	3,940
P-2	38	SAGO	495054	3685303	3,940
P-3	39	SAGO	495065	3684520	3,940
P-4	40	SAGO	494524	3684007	3,970
P-5	41	PRVE	496250	3681604	3,890

Table 1. Locations of Resolution Bird Survey Points. UTM coordinates, Region 12S, NAD27

Survey Point	Tag Number	Tagged Tree or Shrub Species*	Easting (m)	Northing (m)	Approximate Elevation (ft)
Queen Creek					
Q-1	42	QUEM	494604	3685661	3,850
Q-2	43	POFR	494512	3685561	3,840
Q-3	44	PLWR	494332	3685400	3,800
Q-4	45	POFR	494143	3685374	3,760
Q-5	46	PLWR	494019	3685411	3,720
Q-6	47	JUMA	493831	3685414	3,680
Rancho Rio Creek					
R-1	48	CEPA	495904	3682615	3,920
R-2	49	QUEM	496012	3682832	3,910
R-3	50	PIMO	496153	3682659	3,900

*Tree and Shrub Species:

ACGR = *Acacia greggii* – Catclaw Acacia
ALOB = *Alnus oblongifolia* – Arizona Alder
ARPU = *Arctostaphylos pungens* – Point-leaf Manzanita
CAHO = *Canotia holocantha* – Crucifixion Thorn
CELA = *Celtis laevigata* var. *reticulata* –Netleaf Hackberry
CEPA = *Celtis pallida* – Desert Hackberry
CEMO = *Cercocarpus montanus* – Mountain Mahogany
JUMA = *Juglans major* – Arizona Black Walnut
JUMO = *Juniperus monosperma* – One-seed Juniper
PAMI = *Parkinsonia microphylla* – Foothill Paloverde
PIMO = *Pinus monophylla* – Singleleaf Pinyon
PLWR = *Platanus wrightii* – Arizona Sycamore
POFR = *Populus fremontii* – Fremont Cottonwood
PRVE = *Prosopis velutina* – Velvet Mesquite
QUEM = *Quercus emoryi* – Emory Oak
QUTU = *Quercus turbinella* – Scrub Oak
SAGO = *Salix gooddingii* – Goodding Willow
VACA = *Vauquelinia californica* – Arizona Rosewood

Table 2a. Composite List of Bird Species Observed in Each Biotic Community During the Winter Survey

Scientific Name	Common Name	Biotic Community				
		AZ Up	Oaks	Chap	Rip	Ponds
Anas platyrhynchos	Mallard					✓
Anas crecca	Green-winged Teal					✓
Aythya valisineria	Canvasback					✓
Aythya americana	Redhead					✓
Aythya collaris	Ring-necked Duck					✓
Callipepla gambelii	Gambel's Quail	✓	✓	✓		✓
Buteo jamaicensis	Red-tailed Hawk	✓		✓		✓
Gallinago gallinago	Common Snipe				✓	✓
Geococcyx californianus	Greater Roadrunner			✓		✓
Megascops kennicottii	Western Screech-owl		✓			
Archilochus alexandri	Black-chinned Hummingbird		✓			
Calypte anna	Anna's Hummingbird	✓		✓	✓	
Melanerpes uropygialis	Gila Woodpecker	✓			✓	
Sphyrapicus nuchalis	Red-naped Sapsucker		✓		✓	
Picoides scalaris	Ladder-backed Woodpecker	✓	✓	✓	✓	
Colaptes auratus	Northern Flicker	✓	✓	✓	✓	✓
Sayornis saya	Say's Phoebe	✓		✓	✓	✓
Sayornis nigricans	Black Phoebe					✓
Lanius ludovicianus	Loggerhead Shrike					✓
Aphelocoma californica	Western Scrub-Jay		✓	✓	✓	✓
Corvus corax	Common Raven	✓	✓	✓	✓	
Baeolophus wollweberi	Bridled Titmouse		✓	✓	✓	
Auriparus flaviceps	Verdin	✓	✓	✓	✓	
Psaltriparus minimus	Bushtit			✓		
Campylorhynchus brunneicapillus	Cactus Wren	✓				✓
Salpinctes obsoletus	Rock Wren	✓	✓	✓	✓	✓
Catherpes mexicanus	Canyon Wren	✓	✓	✓	✓	✓
Thryomanes bewickii	Bewick's Wren	✓	✓	✓	✓	✓
Regulus calendula	Ruby-crowned Kinglet		✓	✓	✓	✓
Polioptila melanura	Black-tailed Gnatcatcher	✓		✓		
Sialia mexicana	Western Bluebird	✓	✓	✓	✓	
Myadestes townsendi	Townsend's Solitaire			✓	✓	
Catharus guttatus	Hermit Thrush					✓
Turdus migratorius	American Robin		✓		✓	✓
Mimus polyglottos	Northern Mockingbird	✓	✓	✓		
Toxostoma curvirostre	Curve-billed Thrasher	✓		✓		✓
Toxostoma crissale	Crissal Thrasher		✓	✓		
Phainopepla nitens	Phainopepla	✓	✓	✓	✓	
Dendroica coronata	Yellow-rumped Warbler				✓	✓
Pipilo chlorurus	Green-tailed Towhee					✓
Pipilo maculatus	Spotted Towhee		✓	✓	✓	✓
Pipilo fuscus	Canyon Towhee	✓	✓	✓	✓	
Pipilo aberti	Abert's Towhee				✓	
Aimophila ruficeps	Rufous-crowned Sparrow	✓	✓	✓	✓	
Amphispiza bilineata	Black-throated Sparrow	✓		✓		
Melospiza melodia	Song Sparrow				✓	✓
Zonotrichia leucophrys	White-crowned Sparrow		✓	✓	✓	✓
Junco hyemalis	Dark-eyed Junco		✓	✓	✓	✓

Table 2a. Composite List of Bird Species Observed in Each Biotic Community During the Winter Survey

Scientific Name	Common Name	Biotic Community				
		AZ Up	Oaks	Chap	Rip	Ponds
Cardinalis cardinalis	Northern Cardinal				✓	✓
Agelaius phoeniceus	Red-winged Blackbird					✓
Carpodacus mexicanus	House Finch	✓	✓	✓	✓	
Carduelis pinus	Pine Siskin				✓	
Carduelis psaltria	Lesser Goldfinch	✓		✓	✓	
Carduelis tristis	American Goldfinch				✓	

Table 2b. Composite List of Bird Species Observed in Each Biotic Community During the Breeding Survey

Scientific Name	Common Name	Biotic Community				
		AZ Up	Oaks	Chap	Rip	Ponds
Callipepla gambelii	Gambel's Quail	✓	✓	✓	✓	✓
Cathartes aura	Turkey Vulture	✓	✓	✓	✓	✓
Buteogallus anthracinus	Common Black-hawk				✓	
Buteo nitidus	Gray Hawk		✓			
Buteo swainsoni	Swainson's Hawk		✓			
Buteo albonotatus	Zone-tailed Hawk		✓		✓	
Buteo jamaicensis	Red-tailed Hawk				✓	
Falco peregrinus	Peregrine Falcon	✓			✓	
Streptopellia decaocto	Eurasian Collared Dove					✓
Zenaida asiatica	White-winged Dove	✓	✓	✓	✓	✓
Zenaida macroura	Mourning Dove	✓	✓	✓	✓	✓
Geococcyx californianus	Greater Roadrunner		✓	✓		
Bubo virginianus	Great Horned Owl				✓	
Glaucidium gnoma	Northern Pygmy-Owl		✓			
Aeronautes saxatalis	White-throated Swift	✓			✓	
Archilochus alexandri	Black-chinned Hummingbird			✓	✓	
Calypte anna	Anna's Hummingbird		✓	✓	✓	✓
Calypte costae	Costa's Hummingbird	✓				
Selasphorus rufus	Rufous Hummingbird				✓	
	Humingbird sp.	✓	✓	✓	✓	
Megaceryle alcyon	Belted Kingfisher				✓	
Melanerpes uropygialis	Gila Woodpecker				✓	
Picoides scalaris	Ladder-backed Woodpecker		✓	✓	✓	✓
Colaptes auratus	Northern Flicker				✓	✓
Contopus pertinax	Greater Pewee				✓	
Contopus sordidulus	Western Wood-Pewee				✓	
Empidonax wrightii	Gray Flycatcher		✓		✓	
Empidonax sp.	*Empidonax* flycatcher			✓	✓	
Sayornis saya	Say's Phoebe	✓	✓		✓	
Sayornis nigricans	Black Phoebe			✓	✓	✓
Myiarchus cinerascens	Ash-throated Flycatcher	✓	✓	✓	✓	✓
Myiarchus tyrannulus	Brown-crested Flycatcher			✓	✓	✓
Tyrannus vociferans	Cassin's Kingbird		✓	✓	✓	✓
Tyrannus verticalis	Western Kingbird			✓	✓	✓
Lanius ludovicianus	Loggerhead Shrike	✓				
Vireo bellii	Bell's Vireo		✓	✓	✓	✓
Vireo vicinior	Gray Vireo		✓	✓	✓	

Table 2b. Composite List of Bird Species Observed in Each Biotic Community During the Breeding Survey

Scientific Name	Common Name	Biotic Community				
		AZ Up	Oaks	Chap	Rip	Ponds
Vireo plumbeus	Plumbeous Vireo		✓		✓	✓
Vireo huttoni	Hutton's Vireo				✓	
Vireo gilvus	Warbling Vireo			✓	✓	
Aphelocoma californica	Western Scrub-Jay		✓	✓	✓	
Corvus corax	Common Raven	✓	✓	✓	✓	✓
Progne subis	Purple Martin				✓	
Tachycineta thalassina	Violet-green Swallow		✓		✓	✓
Stelgidopteryx serripennis	Northern Rough-winged Swallow					✓
Baeolophus wollweberi	Bridled Titmouse		✓	✓	✓	
Baeolophus ridgwayi	Juniper Titmouse		✓			
Auriparus flaviceps	Verdin		✓	✓	✓	
Psaltriparus minimus	Bushtit		✓	✓	✓	✓
Campylorhynchus brunneicapillus	Cactus Wren	✓			✓	✓
Salpinctes obsoletus	Rock Wren	✓	✓	✓	✓	✓
Catherpes mexicanus	Canyon Wren	✓	✓	✓	✓	✓
Thryomanes bewickii	Bewick's Wren	✓	✓	✓	✓	✓
Polioptila caerulea	Blue-gray Gnatcatcher	✓	✓		✓	
Polioptila melanura	Black-tailed Gnatcatcher	✓	✓	✓	✓	
Mimus polyglottos	Northern Mockingbird	✓	✓	✓	✓	✓
Toxostoma curvirostre	Curve-billed Thrasher	✓		✓		
Toxostoma crissale	Crissal Thrasher		✓	✓		✓
Phainopepla nitens	Phainopepla	✓	✓	✓	✓	✓
Vermivora celata	Orange-crowned Warbler		✓	✓		
Vermivora virginiae	Virginia's Warbler		✓			✓
Vermivora luciae	Lucy's Warbler		✓		✓	✓
Dendroica petechia	Yellow Warbler				✓	✓
Dendroica townsendii	Townsend's Warbler				✓	
Dendroica coronata	Yellow-rumped Warbler		✓		✓	✓
Wilsonia pusilla	Wilson's Warbler		✓		✓	
Icteria virens	Yellow-breasted Chat					✓
Piranga flava	Hepatic Tanager			✓		
Piranga rubra	Summer Tanager		✓		✓	✓
Piranga ludoviciana	Western Tanager		✓	✓	✓	✓
Pipilo chlorurus	Green-tailed Towhee	✓		✓	✓	
Pipilo maculatus	Spotted Towhee		✓	✓	✓	✓
Pipilo fuscus	Canyon Towhee	✓	✓	✓	✓	✓
Pipilo aberti	Abert's Towhee		✓			
Aimophila ruficeps	Rufous-crowned Sparrow	✓	✓	✓	✓	
Spizella passerina	Chipping Sparrow		✓			✓
Spizella breweri	Brewer's Sparrow			✓		
Spizella atrogularis	Black-chinned Sparrow	✓	✓	✓	✓	
Chondestes grammacus	Lark Sparrow			✓		✓
Amphispiza bilineata	Black-throated Sparrow	✓		✓	✓	
Zonotrichia leucophrys	White-crowned Sparrow		✓	✓		
Junco hyemalis	Dark-eyed Junco			✓	✓	
Cardinalis cardinalis	Northern Cardinal				✓	✓
Pheucticus melanocephalus	Black-headed Grosbeak				✓	
Agelaius phoeniceus	Red-winged Blackbird					✓

Table 2b. Composite List of Bird Species Observed in Each Biotic Community During the Breeding Survey

Scientific Name	Common Name	Biotic Community				
		AZ Up	Oaks	Chap	Rip	Ponds
Molothrus ater	Brown-headed Cowbird	✓	✓	✓	✓	✓
Icterus cucullatus	Hooded Oriole				✓	✓
Icterus bullocki	Bullock's Oriole				✓	
Icterus parisorum	Scott's Oriole	✓		✓	✓	
Carpodacus cassinii	Cassin's Finch				✓	
Carpodacus mexicanus	House Finch	✓	✓	✓	✓	
Carduelis psaltria	Lesser Goldfinch		✓	✓	✓	

Table 3a. Winter Survey Densities of Birds Recorded During Variable Circular Plot Surveys in Each Biotic Community

Scientific Name	Common Name	Winter Bird Densities (birds/hectare) per Biotic Community								
		AZ Upland	Alders (Devils Canyon)	Chaparral (Scrub Oak)	Chaparral (Manzanita)	Oak Woodlands	Riparian (Queen Creek)	Riparian (Devils Canyon)	Riparian (Rancho Rio)	Ponds
	Number of Replicate Points	**6**	**6**	**5**	**5**	**8**	**6**	**6**	**3**	**5**
Anas platyrhynchos	Mallard									0.227
Anas crecca	Green-winged Teal									0.509
Aythya valisineria	Canvasback									
Aythya americana	Redhead									1.061
Aythya collaris	Ring-necked Duck									1.194
Callipepla gambelii	Gambel's Quail	0.071				0.094				0.314
Buteo jamaicensis	Red-tailed Hawk	0.197								0.042
Gallinago gallinago	Common Snipe									0.236
Geococcyx californianus	Greater Roadrunner									
Megascops kennicottii	Western Screech-owl									
Archilochus alexandri	Black-chinned Hummingbird					0.212				
Calypte anna	Anna's Hummingbird	0.111	0.884		0.472			0.884		
Melanerpes uropygialis	Gila Woodpecker	0.283	0.393							
Sphyrapicus nuchalis	Red-naped Sapsucker					0.332				
Picoides scalaris	Ladder-backed Woodpecker				0.043	0.147		0.393		
Colaptes auratus	Northern Flicker	0.087	0.393		0.679	0.332		0.566	0.221	0.679
Sayornis saya	Say's Phoebe	0.111			0.043				0.221	0.042
Sayornis nigricans	Black Phoebe									0.398
Lanius ludovicianus	Loggerhead Shrike									0.033
Aphelocoma californica	Western Scrub-Jay			0.085	0.472	0.225	0.111	0.796	0.221	0.398
Corvus corax	Common Raven	0.037			0.015	0.083	0.098	0.035		
Baeolophus wollweberi	Bridled Titmouse		1.698		0.943	0.663		0.885		
Auriparus flaviceps	Verdin				0.236	0.147		0.442		

Table 3a. Winter Survey Densities of Birds Recorded During Variable Circular Plot Surveys in Each Biotic Community

Scientific Name	Common Name	Winter Bird Densities (birds/hectare) per Biotic Community								
		AZ Upland	Alders (Devils Canyon)	Chaparral (Scrub Oak)	Chaparral (Manzanita)	Oak Woodlands	Riparian (Queen Creek)	Riparian (Devils Canyon)	Riparian (Rancho Rio)	Ponds
Psaltriparus minimus	Bushtit				0.236					
Campylorhynchus brunneicapillus	Cactus Wren	0.778								0.133
Salpinctes obsoletus	Rock Wren	0.590	0.393	0.531	0.265	0.147	0.393		0.283	0.340
Catherpes mexicanus	Canyon Wren	0.175	2.555	0.105	0.099	0.332	0.442	0.786		0.052
Thryomanes bewickii	Bewick's Wren	0.442		0.066	1.062	0.332	0.393	0.393		0.059
Regulus calendula	Ruby-crowned Kinglet				0.531	0.737		0.442		0.531
Polioptila melanura	Black-tailed Gnatcatcher	0.197		0.033	0.043					
Sialia mexicana	Western Bluebird	0.061	0.590		0.663	0.295		0.037		
Myadestes townsendi	Townsend's Solitaire			0.015						
Catharus guttatus	Hermit Thrush									0.043
Turdus migratorius	American Robin						0.197			0.118
Mimus polyglottos	Northern Mockingbird	0.049			0.133	0.027				
Toxostoma curvirostre	Curve-billed Thrasher	0.786			0.340					0.236
Toxostoma crissale	Crissal Thrasher				0.236	0.106				
Phainopepla nitens	Phainopepla	0.197			0.137	0.037		0.018		
Dendroica coronata	Yellow-rumped Warbler		0.197							0.118
Pipilo chlorurus	Green-tailed Towhee									0.059
Pipilo maculatus	Spotted Towhee		0.283	0.340	1.061	0.912		0.885	1.769	0.531
Pipilo fuscus	Canyon Towhee	0.849	0.197		0.424	0.553	0.590	1.327	1.769	
Pipilo aberti	Abert's Towhee								0.250	
Aimophila ruficeps	Rufous-crowned Sparrow	0.849			0.021					
Amphispiza bilineata	Black-throated Sparrow									
Melospiza melodia	Song Sparrow		0.283							0.085

Table 3a. Winter Survey Densities of Birds Recorded During Variable Circular Plot Surveys in Each Biotic Community

Scientific Name	Common Name	Winter Bird Densities (birds/hectare) per Biotic Community								
		AZ Upland	Alders (Devils Canyon)	Chaparral (Scrub Oak)	Chaparral (Manzanita)	Oak Woodlands	Riparian (Queen Creek)	Riparian (Devils Canyon)	Riparian (Rancho Rio)	Ponds
Zonotrichia leucophrys	White-crowned Sparrow				1.358	0.037				0.354
Junco hyemalis	Dark-eyed Junco		0.442		1.042	0.637	0.393	0.283	0.663	0.693
Cardinalis cardinalis	Northern Cardinal						0.442			0.118
Agelaius phoeniceus	Red-winged Blackbird									0.085
Carpodacus mexicanus	House Finch	0.221			0.663			0.283		
Carduelis pinus	Pine Siskin		0.098							
Carduelis psaltria	Lesser Goldfinch		0.307		0.087		0.197			
Carduelis tristis	American Goldfinch						1.327			
	Total Bird Density	6.091	8.713	1.175	11.304	6.387	4.583	8.455	5.397	8.688
	Total Number of Species	19	14	7	26	21	11	16	8	28

Table 3b. Breeding Survey Densities of Birds Recorded During Variable Circular Plot Surveys in Each Biotic Community

Scientific Name	Common Name	Breeding Bird Densities (birds/hectare) per Biotic Community								
		AZ Upland	Alders (Devils Canyon)	Chaparral (Scrub Oak)	Chaparral (Manzanita)	Oak Woodlands	Riparian (Queen Creek)	Riparian (Devils Canyon)	Riparian (Rancho Rio)	Ponds
	Number of Replicate Points	**6**	**6**	**5**	**5**	**8**	**6**	**6**	**3**	**5**
Callipepla gambelii	Gambel's Quail	0	0	0.531	0.679	0.207	0.221	0	1.572	0.472
Cathartes aura	Turkey Vulture	0.028	0.063	0.042	0.021	0.066	0.111	0.035	0.035	0.085
Buteogallus anthracinus	Common Black-hawk	0	0.885	0	0	0	0	0	0	0
Buteo swainsoni	Swainson's Hawk	0	0	0	0	0.006	0	0	0	0
Buteo albonotatus	Zone-tailed Hawk	0	0.197	0	0	0.013	0.035	0	0	0
Buteo jamaicensis	Red-tailed Hawk	0	0.016	0	0	0	0	0.018	0	0
Falco peregrinus	Peregrine Falcon	0.016	0.008	0	0	0	0	0	0	0
Streptopellia decaocto	Eurasian Collared Dove	0	0	0	0	0	0	0	0	0.133
Zenaida asiatica	White-winged Dove	0	2.751	0.099	0	0.256	0.553	0.774	0.221	0.236
Zenaida macroura	Mourning Dove	0.495	2.264	0.173	3.141	0.394	0.088	0.982	1.572	0.707
Geococcyx californianus	Greater Roadrunner	0	0	0.026	0	0.332	0	0	0	0
Aeronautes saxatalis	White-throated Swift	0.283	0.093	0	0	0	0.283	0	0	0
Archilochus alexandri	Black-chinned Hummingbird	0	0	0.531	0	0	0.442	0	1.769	0
Calypte anna	Anna's Hummingbird	0	0	1.019	0	1.474	0.071	0.442	1.769	1.358
Calypte costae	Costa's Hummingbird	0.442	0	0	0	0	0	0	0	0
	Humingbird sp.	1.327	0.442	0	0.340	0.663	0	0.442	0	0
Melanerpes uropygialis	Gila Woodpecker	0	0.141	0	0	0	0	0	0	0
Picoides scalaris	Ladder-backed Woodpecker	0	1.327	0	0	0.295	0	0.295	0.196	0.085
Colaptes auratus	Northern Flicker	0	0.393	0	0	0	0	0	0	0.059
Contopus pertinax	Greater Pewee	0	0.036	0	0	0	0	0	0	0

Table 3b. Breeding Survey Densities of Birds Recorded During Variable Circular Plot Surveys in Each Biotic Community

Scientific Name	Common Name	Breeding Bird Densities (birds/hectare) per Biotic Community								
		AZ Upland	Alders (Devils Canyon)	Chaparral (Scrub Oak)	Chaparral (Manzanita)	Oak Woodlands	Riparian (Queen Creek)	Riparian (Devils Canyon)	Riparian (Rancho Rio)	Ponds
Contopus sordidulus	**Western Wood-Pewee**	**0**	**0**	**0**	**0**	**0**	**0.111**	**0.221**	**0**	**0**
Empidonax wrightii	Gray Flycatcher	0	0	0	0	0	0.071	0	0.393	0
Empidonax sp.	*Empidonax* flycatcher	0	0.885	0	0	0	0	0	0	0
Sayornis saya	Say's Phoebe	0.442	0	0	0	0	0	0	0	0.295
Sayornis nigricans	Black Phoebe	0	0	0	0.340	0	0.442	0.111	2.264	0
Myiarchus cinerascens	Ash-throated Flycatcher	0.786	0.283	0.099	1.358	0.663	0.098	0.983	0.884	0.531
Myiarchus tyrannulus	Brown-crested Flycatcher	0	3.341	0.085	0	0	0.774	0.253	0.393	0.236
Tyrannus vociferans	Cassin's Kingbird	0	0.049	0.043	0.531	0.228	0.794	0.393	0.196	0.288
Tyrannus verticalis	Western Kingbird	0	0	0	0	0	0	0	0	0.042
Lanius ludovicianus	Loggerhead Shrike	0.283	0	0	0	0	0	0	0	0
Vireo bellii	Bell's Vireo	0	2.830	0.131	0	0.663	0.283	0.995	1.965	1.061
Vireo vicinior	Gray Vireo	0.786	0.221	0	1.698	0.332	0.036	0.849	0.283	0
Vireo plumbeus	Plumbeous Vireo	0	0	0	0	0.124	0	0.442	0	0.099
Vireo huttoni	Hutton's Vireo	0	0.283	0	0	0	0	0	0	0
Vireo gilvus	Warbling Vireo	0	0	0	0.531	0	0	0.283	0	0
Aphelocoma californica	Western Scrub-Jay	0	0	0.087	0.133	0.249	0.144	0.071	0.566	0
Corvus corax	Common Raven	0.197	0.124	0	0.009	0.093	0.062	0.141	0.055	0.021
Progne subis	Purple Martin	0	0	0	0	0	0.049	0	0	0
Tachycineta thalassina	Violet-green Swallow	0	0.197	0	0	0.027	0	0.008	1.769	0.398
Stelgidopteryx serripennis	Northern Rough-winged Swallow	0	0	0	0	0	0	0	0	0.236
Baeolophus wollweberi	Bridled Titmouse	0	0.442	0	0.663	0.425	0	0.885	0	0
Baeolophus ridgwayi	Juniper Titmouse	0	0	0	0	0.415	0	0	0	0
Auriparus flaviceps	Verdin	0	0	0.059	0.943	0.083	0	1.132	0.786	0
Psaltriparus minimus	Bushtit	0	0	2.717	0	0.663	0.212	0	0.786	2.123
Campylorhynchus	Cactus Wren	1.179	0	0	0	0	0	0	0	0.066

Table 3b. Breeding Survey Densities of Birds Recorded During Variable Circular Plot Surveys in Each Biotic Community

Scientific Name	Common Name	Breeding Bird Densities (birds/hectare) per Biotic Community								
		AZ Upland	Alders (Devils Canyon)	Chaparral (Scrub Oak)	Chaparral (Manzanita)	Oak Woodlands	Riparian (Queen Creek)	Riparian (Devils Canyon)	Riparian (Rancho Rio)	Ponds
brunneicapillus										
Salpinctes obsoletus	Rock Wren	2.654	0	0.663	0.531	0.292	0.049	0.083	0.442	0.118
Catherpes mexicanus	Canyon Wren	0.371	0.415	0.796	0.531	0.425	0.442	1.132	0.131	0.133
Thryomanes bewickii	Bewick's Wren	0.393	0.786	0.531	0.133	0.798	1.769	1.376	1.547	0.398
Polioptila caerulea	Blue-gray Gnatcatcher	0.071	0	0	0	0.849	0	0.111	0.885	0
Polioptila melanura	Black-tailed Gnatcatcher	0.885	0	0	0.340	0.663	0	0.885	0	0
Mimus polyglottos	Northern Mockingbird	0.774	0.197	0.026	0.087	0.189	0.022	0	0.393	0.085
Toxostoma curvirostre	Curve-billed Thrasher	0.566	0	0	0.236	0	0	0	0	0
Toxostoma crissale	Crissal Thrasher	0	0	0	0.472	0.074	0	0	0	0.133
Phainopepla nitens	Phainopepla	0.590	0.141	0.059	0.059	0.159	0.442	1.376	0.166	0.236
Vermivora celata	Orange-crowned Warbler	0	0	0.531	0	0	0	0	0	0
Vermivora virginiae	Virginia's Warbler	0	0	0	0	0	0	0	0	0.340
Vermivora luciae	Lucy's Warbler	0	0.590	0	0	0.249	0.197	0.663	0	0.085
Dendroica petechia	Yellow Warbler	0	11.943	0	0	0	1.415	0.849	1.769	0.531
Dendroica townsendii	Townsend's Warbler	0	0	0	0	0	0	0	0.221	0
Dendroica coronata	Yellow-rumped Warbler	0	0	0	0	0.494	0	0	0	0
Wilsonia pusilla	Wilson's Warbler	0	0	0	0	0.663	0	0.283	0	0.697
Icteria virens	Yellow-breasted Chat	0	0	0	0	0	0	0	0	0.059
Piranga flava	Hepatic Tanager	0	0	0.033	0	0	0	0	0	0
Piranga rubra	Summer Tanager	0	2.212	0	0	0.425	1.327	2.654	0	0.340
Piranga ludoviciana	Western Tanager	0	0	0	0.236	0.037	0	0	0	0.033
Pipilo chlorurus	Green-tailed Towhee	0.049	0	0	0.943	0	0	0	0	0
Pipilo maculatus	Spotted Towhee	0	1.965	0.255	1.592	0.479	0	1.376	0.442	0.087
Pipilo fuscus	Canyon Towhee	1.769	0.196	0.236	0.509	0.174	0	0.028	0.196	0.059
Pipilo aberti	Abert's Towhee	0	0	0	2.123	0.212	0	0	0	0

Table 3b. Breeding Survey Densities of Birds Recorded During Variable Circular Plot Surveys in Each Biotic Community

Scientific Name	Common Name	Breeding Bird Densities (birds/hectare) per Biotic Community								
		AZ Upland	Alders (Devils Canyon)	Chaparral (Scrub Oak)	Chaparral (Manzanita)	Oak Woodlands	Riparian (Queen Creek)	Riparian (Devils Canyon)	Riparian (Rancho Rio)	Ponds
Aimophila ruficeps	Rufous-crowned Sparrow	0.138	0	0.472	0	0.037	0	0.442	0	0
Spizella passerina	Chipping Sparrow	0	0	0	0	0.249	0	0	0	1.326
Spizella breweri	Brewer's Sparrow	0	0	0	1.887	0	0	0	0	0
Spizella atrogularis	Black-chinned Sparrow	0.786	0.022	0.170	3.185	0	0	0	0.141	0
Chondestes grammacus	Lark Sparrow	0	0	0	0.403	0	0	0	0	0.354
Amphispiza bilineata	Black-throated Sparrow	8.207	0	0	3.537	0	0	0.036	0	0
Zonotrichia leucophrys	White-crowned Sparrow	0	0	0	1.062	0.295	0	0	0	0
Junco hyemalis	Dark-eyed Junco	0	0	0	2.123	0	0	0	0	0
Cardinalis cardinalis	Northern Cardinal	0	0.566	0	0	0	0	0.197	0	0.236
Pheucticus melanocephalus	Black-headed Grosbeak	0	0.442	0	0	0	0	0	0	0
Agelaius phoeniceus	Red-winged Blackbird	0	0	0	0	0	0	0	0	0.099
Molothrus ater	Brown-headed Cowbird	0.885	0	0.217	0.340	0.108	0	1.965	0.491	1.179
Icterus cucullatus	Hooded Oriole	0	3.391	0	0	0	0.590	0.442	0	0
Icterus bullocki	Bullock's Oriole	0	0	0	0	0	0.197	0.442	0	0
Icterus parisorum	Scott's Oriole	1.179	0.036	0.052	0.472	0	0.393	0.221	0.141	0
Carpodacus cassinii	Cassin's Finch	0	1.327	0	0	0	0	0	0	0
Carpodacus mexicanus	House Finch	1.105	1.132	0.043	2.388	1.061	0.637	0.361	0.361	0
Carduelis psaltria	Lesser Goldfinch	0	1.415	0	1.019	0.332	1.327	1.769	0.566	0
Total density		26.686	44.047	9.726	34.595	15.935	13.687	26.446	25.005	15.059
Total number of species		28	40	28	36	44	33	42	33	40

Table 4a. Numbers of Species Observed in Each Biotic Community by Survey Period During the Winter Survey

	Survey Set 1		Survey Set 2		Survey Set 3	
	New Species	**Total Species**	**New Species**	**Total Species**	**New Species**	**Total Species**
Alders - Devils Canyon	4	**4**	5	**9**	5	**14**
Arizona Upland	14	**14**	2	**16**	3	**19**
Chaparral - Manzanita	13	**13**	8	**21**	5	**26**
Chaparral – Scrub Oak	4	**4**	1	**5**	2	**7**
Oak Woodland	16	**16**	1	**17**	4	**21**
Riparian - Devils Canyon	8	**8**	3	**11**	5	**16**
Riparian – Queen Creek	5	**5**	4	**9**	2	**11**
Riparian – Rancho Rio	3	**3**	5	**8**	0	**8**
Ponds	16	**16**	7	**23**	5	**28**

Table 4b. Numbers of Species Observed in Each Biotic Community by Survey Period During the Breeding Survey

	Survey Set 1		Survey Set 2		Survey Set 3	
	New Species	**Total Species**	**New Species**	**Total Species**	**New Species**	**Total Species**
Alders - Devils Canyon	30	**30**	4	**34**	6	**40**
Arizona Upland	22	**22**	4	**26**	2	**28**
Chaparral - Manzanita	28	**28**	8	**36**	0	**36**
Chaparral – Scrub Oak	13	**13**	12	**25**	3	**28**
Oak Woodland	30	**30**	8	**38**	6	**44**
Riparian - Devils Canyon	30	**30**	9	**39**	3	**42**
Riparian – Queen Creek	19	**19**	10	**29**	4	**33**
Riparian – Rancho Rio	27	**27**	6	**33**	0	**33**
Ponds	25	**25**	11	**36**	4	**40**

Table 5a. Time of Day Analysis – Winter Survey

Time Interval	Time After Sunrise (min)	Number of Survey Periods Per Time Interval	Average Number of Bird Species	Average Number of Individuals
1	0-29	30	2.0741	4.0000
2	30-59	24	2.5417	3.7917
3	60-89	23	2.8696	4.7826
4	90-119	23	2.9130	4.5217
5	120-149	21	3.0000	6.8095
6	150-179	16	2.4375	4.3750
7	180-209	11	2.4545	3.4545
8	210-239	1	4.0000	5.0000
9	240-269	1	9.0000	13.0000
	Total	**150**		

Table 5b. Time of Day Analysis – Breeding Survey

Time Interval	Time After Sunrise (min)	Number of Survey Periods Per Time Interval	Average Number of Bird Species	Average Number of Individuals
1	0-29	26	7.4800	12.4400
2	30-59	24	8.2083	12.6667
3	60-89	27	7.2593	10.9259
4	90-119	20	8.6000	12.2500
5	120-149	23	8.6522	12.7391
6	150-179	14	9.4286	13.3571
7	180-209	11	9.7273	14.4545
8	210-239	5	10.6000	14.8000
	Total	**150**		

Table 6. Vegetation Measurements at 50 Bird Survey Points

	Biotic Community								
	Oaks	**Upper Devils Canyon**	**Alder Grove**	**Queen Creek**	**Rancho Rio**	**Chaparral-Scrub Oak**	**Chaparral-Manzanita**	**Ponds**	**Arizona Upland**
Number of Points	8	6	6	6	3	5	5	5	6
Average density, trees/hectare	236.7	173.9	403.4	154.6	70.7	94.5	142.6	105.6	214.1
Average tree canopy cover, m^2/ha	4,069	3,786	16,240	2,596	1,063	436	880	2,266	1,121
Average shrub cover, %	26	24	20	20	28	42	31	15	27
Average herbaceous cover, %	15	2	2	2	6	2	1	24	3
Average elevation, ft amsl	3,920	3,880	3,550	3,780	3,910	4,050	4,090	3,940	3,710

Table 7. Tree and Shrub Species Density per Biotic Community Based on Modified Point-Centered Quarter Sampling Method

Tree and Shrub Species		**Vegetation Density (tree or shrub/hectare) per Biotic Community**								
Scientific Name	**Common Name**	**Oaks**	**Upper Devils Canyon**	**Alder Grove**	**Queen Creek**	**Rancho Rio**	**Chaparral-Scrub Oak**	**Chaparral-Manzanita**	**Ponds**	**Arizona Upland**
Tree Species										
Acacia greggii	Catclaw Acacia									26.7
Alnus oblongifolia	Arizona Alder			268.9						
Arctostaphylos pungens	Point-leaf Manzanita							28.5		
Canotia holacantha	Crown-of-thorns									80.3
Ceanothus greggii	Buckbrush						4.8			
Celtis laevigata	Netleaf Hackberry		29.0		54.1	45.0	4.8		5.4	
Cercocarpus montanus	Mountain Mahogany						52.5			
Fraxinus velutina	Velvet Ash		14.5	100.8						
Juglans major	Arizona Black Walnut				23.2					
Juniperus monosperma	One-seed Juniper		7.2				4.7	14.3		
Juniperus osteosperma	Utah Juniper					6.4				
Parkinsonia microphylla	Foothill Paloverde									44.6
Pinus monophylla	Single-leaf Pinyon		7.2		7.7	6.4	9.6			

Table 7. Tree and Shrub Species Density per Biotic Community Based on Modified Point-Centered Quarter Sampling Method

Tree and Shrub Species		Vegetation Density (tree or shrub/hectare) per Biotic Community								
Scientific Name	**Common Name**	**Oaks**	**Upper Devils Canyon**	**Alder Grove**	**Queen Creek**	**Rancho Rio**	**Chaparral-Scrub Oak**	**Chaparral-Manzanita**	**Ponds**	**Arizona Upland**
Platanus wrightii	Arizona Sycamore		65.2	16.8						
Populus fremontii	Fremont Cottonwood				15.5					
Prosopis velutina	Velvet Mesquite				15.5				21.8	44.6
Prunus emarginata	Bitter Cherry		7.2							
Quercus emoryi	Emory Oak	236.7	36.2		38.7		19.1	78.4	27.2	
Quercus griseus	Gray Oak		7.2	16.8						
Quercus turbinella	Scrub Oak							21.4		
Rhus ovata	Sugar Sumac									8.9
Salix gooddingii	Goodding Willow					6.4			49.1	
Vauquelinia californica	Arizona Rosewood									8.9
Shrub Species										
Agave chrysantha	Golden-flowered Agave							<1		
Aloysia wrightii	Wright's Beebrush									1
Ambrosia psilostachya	Western Ragweed	<1								
Amorpha fruticosa	False Indigo-bush				2					
Arctostaphylos pungens	Point-leaf Manzanita	15	6		1	10	7	9	6	
Baccharis sarathroides	Desert Broom	1	5		1				<1	
Calliandra eriophylla	Fairy Duster									6
Cephalanthus occidentalis	Buttonbush		2	9						
Celtis laevigata	Netleaf Hackberry		<1		<1		<1			
Cercocarpus montanus	Mountain Mahogany	<1	1		<1		2			
Crossosoma bigelovii	Ragged Rockflower						1			
Dalea formosa	Feather Dalea									1
Dasylirion wheeleri	Sotol		<1				<1	1		
Dodonaea viscosa	Hopbush			1	<1		1		<1	

Table 7. Tree and Shrub Species Density per Biotic Community Based on Modified Point-Centered Quarter Sampling Method

Tree and Shrub Species		Vegetation Density (tree or shrub/hectare) per Biotic Community								
Scientific Name	**Common Name**	**Oaks**	**Upper Devils Canyon**	**Alder Grove**	**Queen Creek**	**Rancho Rio**	**Chaparral-Scrub Oak**	**Chaparral-Manzanita**	**Ponds**	**Arizona Upland**
Encelia farinosa	Brittlebush									1
Ephedra trifurca	Longleaf Ephedra									1
Ericameria laricifolia	Turpentine Bush						2	1	<1	
Eriogonum fasciculatum	Flattop Buckwheat									<1
Fallugia paradoxa	Apache Plume	<1								
Fendlera rupicola	Cliff Fendlerbush									<1
Garrya wrightii	Wright's Silktassel	<1							1	
Gutierrezia sarothrae	Snakeweed	<1								4
Mahonia haematocarpa	Red Barberry		2	1		<1				
Mimosa aculeaticarpa	Catclaw mimosa	1	2	<1	2	5	1	7	1	
Nolina microcarpa	Beargrass	<1					<1	2		
Parthenium incanum	Mariola									6
Prunus virginiana	Chokecherry	<1								
Quercus turbinella	Scrub Oak	7	4	<1	9	19	26	10	5	
Rhamnus californica	California Buckthorn				<1					
Rhamnus crocea	Hollyleaf Buckthorn	<1	<1					<1		
Rhus trilobata	Skunkbush	1	1	1	1	4			1	
Simmondsia chinensis	Jojoba				<1					10
Sporobolus wrightii	Sacaton								1	
Tamarix sp.	Tamarisk								<1	
Toxicodendron rydbergii	Poison Ivy			8						
Vitis arizonica	Canyon Grape		1		3	3				

Table 8. Plant Species Recorded within 30 Meters of Survey Points

Scientific Name	Common Name
Acacia angustissima	White-ball Acacia
Acacia greggii	Catclaw Acacia
Acourtia wrightii	Perezia
Agave chrysantha	Golden-flowered Agave
Agave sp.	Agave
Allionia incarnata	Trailing Four-O'Clock
Alnus oblongifolia	Arizona Alder
Aloysia wrightii	Wright's Beebrush
Amaranthus sp.	Amaranth
Ambrosia psilostachya	Western Ragweed
Amorpha fruticosa	False Indigo-bush
Anisacantha thurberi	Chuparosa
Aquilegia chrysantha	Yellow Columbine
Arctostaphylos pungens	Point-leaf Manzanita
Aristida ternipes	Spidergrass
Aristida sp.	Threeawn
Artemisia ludoviciana	White Sagebrush
Artemisia sp.	Sagebrush
Asclepias linaria	Pine-needle Milkweed
Astrolepis sinuata	Wavy Cloak Fern
Baccharis salicifolia	Seepwillow
Baccharis sarathroides	Desert Broom
Baileya multiradiata	Desert Marigold
Bebbia juncea	Chuckwalla's Delight
Bothriochloa barbinodis	Cane Beardgrass
Bothriochloa laguroides	Silver Beardgrass
Bouteloua curtipendula	Side-oats Grama
Bouteloua gracilis	Blue Grama
Brickellia sp.	Brickellbush
Bromus rubens	Red Brome
Bromus tectorum	Cheatgrass
Bromus sp.	Brome
Calandrinia ciliata	Red Maids
Calliandra eriophylla	Fairy Duster
Canotia holacantha	Crown-of-thorns
Carex sp.	Sedge
Carnegiea gigantea	Saguaro
Catalpa bignonioides	Southern Catalpa
Ceanothus greggii	Buckbrush
Celtis laevigata	Netleaf Hackberry
Celtis pallida	Desert Hackberry
Cephalanthus occidentalis	Buttonbush
Cercocarpus montanus	Mountain Mahogany
Chamaesyce albomarginata	Rattlesnake-weed
Cheilanthes lindheimeri	Lindheimer's Lip Fern
Chenopodium album	Lambs-quarters
Chilopsis linearis	Desert-willow
Cirsium vulgare	Bull Thistle
Claytonia perfoliata	Miner's Lettuce
Clematis sp.	Virgin's Bower
Conyza canadensis	Canada Horseweed

Table 8. Plant Species Recorded within 30 Meters of Survey Points

Scientific Name	Common Name
Crossosoma bigelovii	Ragged Rockflower
Cryptantha sp.	Cryptantha
Cupressus arizonica	Arizona Cypress
Cuscuta indecora	Dodder
Cynodon dactylon	Bermudagrass
Cyperus sp.	Flatsedge
Cystopteris fragilis	Brittle Bladder Fern
Dalea formosa	Feather Dalea
Dasylirion wheeleri	Sotol
Datura wrightii	Sacred Datura
Daucus pusillus	American Carrot
Digitaria californica	Arizona Cottontop
Digitaria sanguinalis	Crabgrass
Dodonaea viscosa	Hopbush
Dyssodia porophylloides	San Felipe Dyssodia
Echinocereus fendleri	Fendler's Hedgehog
Echinodereus coccineus var. *arizicus*	Arizona Hedgehog
Eleocharis sp.	Spikerush
Elymus elymoides	Bottlebrush Squirreltail
Encelia farinosa	Brittlebush
Ephedra trifurca	Longleaf Ephedra
Eragrostis intermedia	Plains Lovegrass
Eriastrum diffusum	Miniature Woolstar
Eriastrum sp.	Woolstar
Ericameria laricifolia	Turpentine Bush
Erigeron divergens	Spreading Fleabane
Erigeron sp.	Daisy
Eriogonum fasciculatum	Flattop Buckwheat
Erodium cicutarium	Filaree
Fallugia paradoxa	Apache Plume
Fendlera rupicola	Cliff Fendlerbush
Ferocactus cylindraceus	California Barrel Cactus
Ferocactus wislizenii	Fishhook Barrel Cactus
Fouquieria splendens	Ocotillo
Fraxinus velutina	Velvet Ash
Gallium sp.	Bedstraw
Garrya wrightii	Wright's Silktassel
Gaurra coccinea	Scarlet Gaura
Gutierrezia sarothrae	Snakeweed
Helianthus annuus	Common Sunflower
Helianthus petiolaris	Prairie Sunflower
Heteropogon contortus	Tanglehead
Heterotheca subaxillaris	Camphor-weed
Isocoma tenuisecta	Burroweed
Juglans major	Arizona Black Walnut
Juncus mexicanus	Mexican Rush
Juncus sp.	Rush
Juniperus deppeana	Alligator-bark Juniper
Juniperus monosperma	One-seed Juniper
Juniperus osteosperma	Utah Juniper
Lesquerella gordoni	Bladderpod Mustard

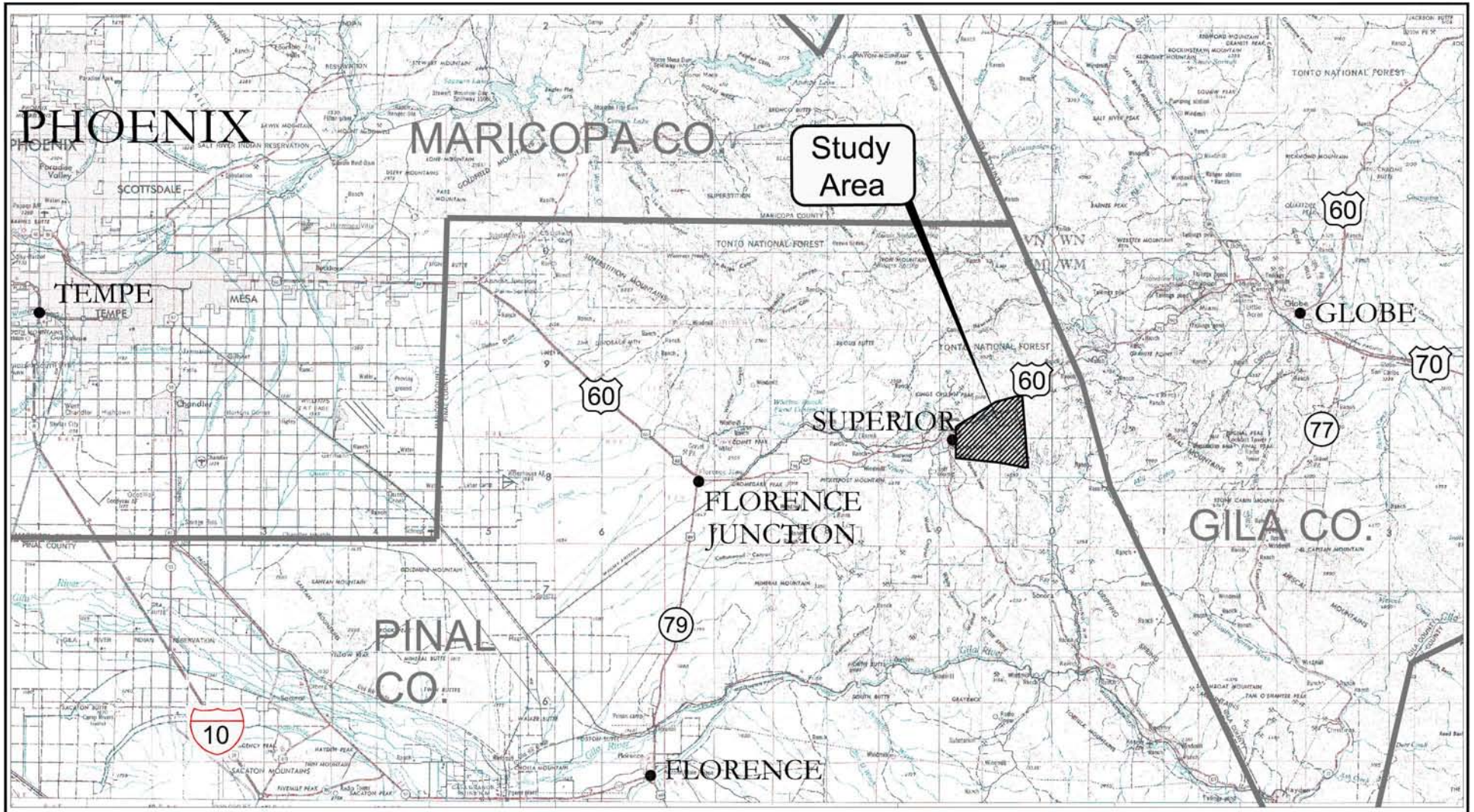
Table 8. Plant Species Recorded within 30 Meters of Survey Points

Scientific Name	Common Name
Nuttallanthus texana	Texas Toadflax
Lonicera albiflora	White Honeysuckle
Lonicera interrupta	Chaparral Honeysuckle
Lotus rigidus	Wiry Lotus
Lycium sp.	Wolfberry
Mahonia haematocarpa	Red Barberry
Marubium vulgare	Horehound
Melampodium leucanthum	Blackfoot Daisy
Melilotus alba	White Sweet-clover
Melilotus officinalis	Yellow Sweet-clover
Mentzelia sp.	Stick-leaf
Mimosa aculeaticarpa	Catclaw mimosa
Mimulus guttatus	Yellow Monkeyflower
Morus alba	White Mulberry
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia sp.	Deergrass
Nassella viridula	Green Needlegrass
Nicotiana glauca	Tree Tobacco
Nolina microcarpa	Beargrass
Opuntia acanthocarpa	Buckhorn Cholla
Opuntia engelmannii	Engelmann Prickly-pear
Opuntia spinosior	Cane Cholla
Orthocarpus purpurascens	Owl-clover
Parkinsonia aculeata	Mexican Paloverde
Parkinsonia microphylla	Foothill Paloverde
Parthenium incanum	Mariola
Parthenocissus inserta	Virginia Creeper
Pellaea truncata	Spiny Cliff Brake
Penstemon pseudospectabilis	Desert Penstemon
Penstemon sp.	Penstemon
Phorodendron coryae	Cory's Mistletoe
Pinus monophylla	Single-leaf Pinyon
Plantago patagonica	Woolly Plantain
Platanus wrightii	Arizona Sycamore
Polygonum aviculare	Protrate Knotweed
Polypogon monspeliensis	Rabbit's-foot Grass
Populus fremontii	Fremont Cottonwood
Prosopis velutina	Velvet Mesquite
Prunus emarginata	Bitter Cherry
Prunus virginiana	Chokecherry
Psilostrophe cooperi	Cooper's Paperflower
Quercus emoryi	Emory Oak
Quercus griseus	Gray Oak
Quercus turbinella	Scrub Oak
Rhamnus bettulaefolia	Birchleaf Buckthorn
Rhamnus californica	California Buckthorn
Rhamnus crocea	Hollyleaf Buckthorn
Rhus ovata	Sugar Sumac
Rhus trilobata	Skunkbush
Rubus sp.	Raspberry
Rumex crispus	Curly Dock

Table 8. Plant Species Recorded within 30 Meters of Survey Points

Scientific Name	Common Name
Rumex sp.	Dock
Salix gooddingii	Goodding Willow
Salsola tragus	Russian Thistle
Sambucus nigra	Mexican Elderberry
Senecio flaccidus	Threadleaf Groundsel
Setaria sp.	Bristlegrass
Simmondsia chinensis	Jojoba
Sonchus oleraceus	Common Sowthistle
Sorghum halepense	Johnson Grass
Sphaeralcea ambigua	Desert Globemallow
Sphaeralcea sp.	Globemallow
Sporobolus wrightii	Sacaton
Stephanomeria sp.	Wirelettuce
Tamarix sp.	Tamarisk
Tiquilia canescens	Shrubby Coldenia
Toxicodendron rydbergii	Western Poison Ivy
Tragopogon sp.	Salsify
Tribulus terrestris	Puncture-vine
Typha domingensis	Southern Cattail
Vauquelinia californica	Arizona Rosewood
Verbascum thapsus	Common Mullein
Verbena macdougallii	MacDougal Verbena
Verbena sp.	Verbena
Vitis arizonica	Canyon Grape
Xanthium strumarium	Common Cocklebur
Yucca baccata	Banana Yucca
Yucca elata	Soaptree Yucca
Zauschneria californica	Hummingbird Trumpet
Zinnia acerosa	Wild Zinnia

FIGURES



Pinal County, Arizona
Mesa 1:250,000 USGS Map

N
W E
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0 4 8

Approx. Scale 1 inch = 8 miles

Resolution Copper Mining

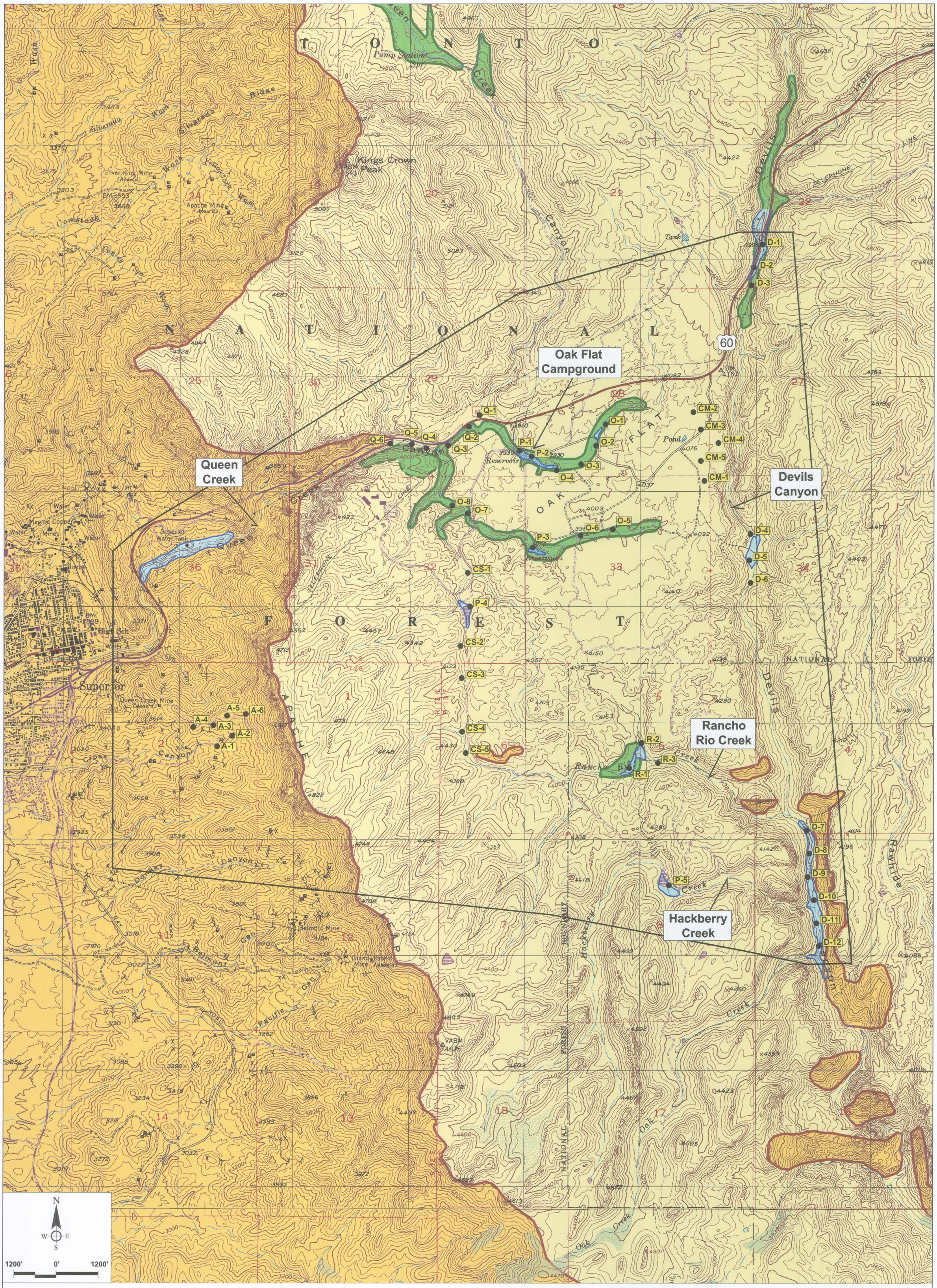
RAPTOR SURVEY AND 2008 BIRD CENSUS

Vicinity Map

Figure 1

WestLand Resources Inc.
Engineering and Environmental Consultants
4001 E. Paradise Falls Drive
Tucson, Az 85712 (520) 206-9585

DWG FullPath: M:\projects\807.16\Bird Survey Report 11-19-2008\Fig1 RS-vicinity-REGIONAL.dwg



LEGEND

- Study Area
- Arizona Upland Subdivision of Sonoran Desertscrub
- Madrean Evergreen Woodland
- Interior Chaparral
- Interior Riparian Deciduous Forest

Data Source: WestLand Resources-multiple field trips compared with Google Earth imagery to determine biotic communities. Based on Biotic Communities of the Southwest - Brown & Lowe (August 1980) classifications.

● A-1 Location of Bird Survey Points & Biotic Community ID Number

ID Number Prefix	Biotic Community Type
A	Sonoran Desertscrub - Arizona Upland Subdivision
CM	Interior Chaparral - Manzanita Series
CS	Interior Chaparral - Scrub Oak Series
O	Madrean Evergreen Woodland - Oak Woodland
D[1]	Interior Riparian Deciduous Forest - Devils Canyon
P	Interior Riparian Deciduous Forest - Ponds
Q	Interior Riparian Deciduous Forest - Queen Creek
R	Interior Riparian Deciduous Forest - Rancho Rio Creek

1 - Points D7 - D12 = Interior Riparian Deciduous Forest - Devils Canyon Alders

Pinal County, Arizona
Superior, Pinal Ranch & Teapot Mountain
7.5' USGS Quadrangles

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Tucson, Az 85712 (520) 206-9585

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RAPTOR SURVEY AND 2008 BIRD CENSUS

Biotic Communities Map and Bird Survey Locations

Figure 2

M:\projects\807.16\Bird Survey Report 11-19-2008\Fig2 Combined Bio Comm-Rip Veg & 2008 Bird Census.dwg

Zone-Tailed Hawk Nest
Active 2003, 2004 & 2008

Zone-Tailed Hawk Nest
Active 2003, 2004 Status Unknown

Cooper's Hawk Nest
Active 2003

Western Screech Owl
2008

Peregrine Falcon Eyrie
Active 2003, 2004 & 2008

Great Horned Owl
2003

Scenic Drive

N
W E
S

0' 1000' 2000'

Scale 1 inch = 2000 feet

LEGEND

- *Study Area Boundary
- Fixed Point Cliff Survey
- Field of View from Fixed Points
- Approximate Location of Observed Raptors
- Linear Transect Survey
- Variable Transect Survey

* Study Area Extends Outside of the Area Depicted on this Figure

Pinal County, Arizona
Superior 7.5' USGS Map

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RAPTOR SURVEY AND 2008 BIRD CENSUS

Raptor Survey Locations

Figure 3

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Engineering and Environmental Consultants
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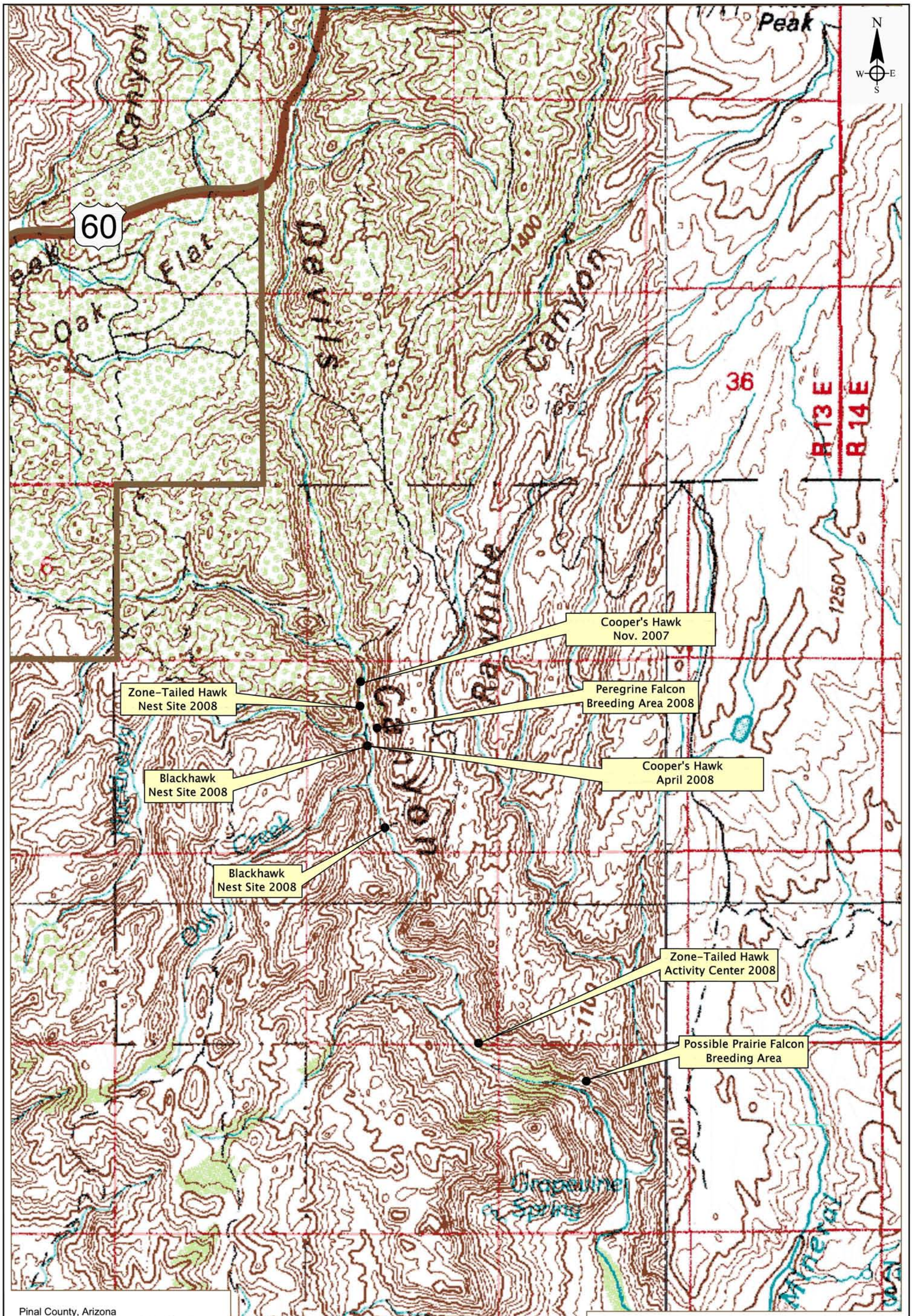
Tucson, Az 85712 (520) 206-9585

DWG FullPath: M:\projects\807.16\Bird Survey Report 11-19-2008\Fig3 rs--raptor-inventory-map.dwg



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RAPTOR SURVEY AND 2008 BIRD CENSUS

Opportunistic Raptor Observations in Devils Canyon

Figure 4

DWG FullPath: M:\projects\807.16\Bird Survey Report 11-19-2008\Fig4-devils canyon.dwg

Figure 5a
Number of Bird Species by Biotic Community - Winter Survey

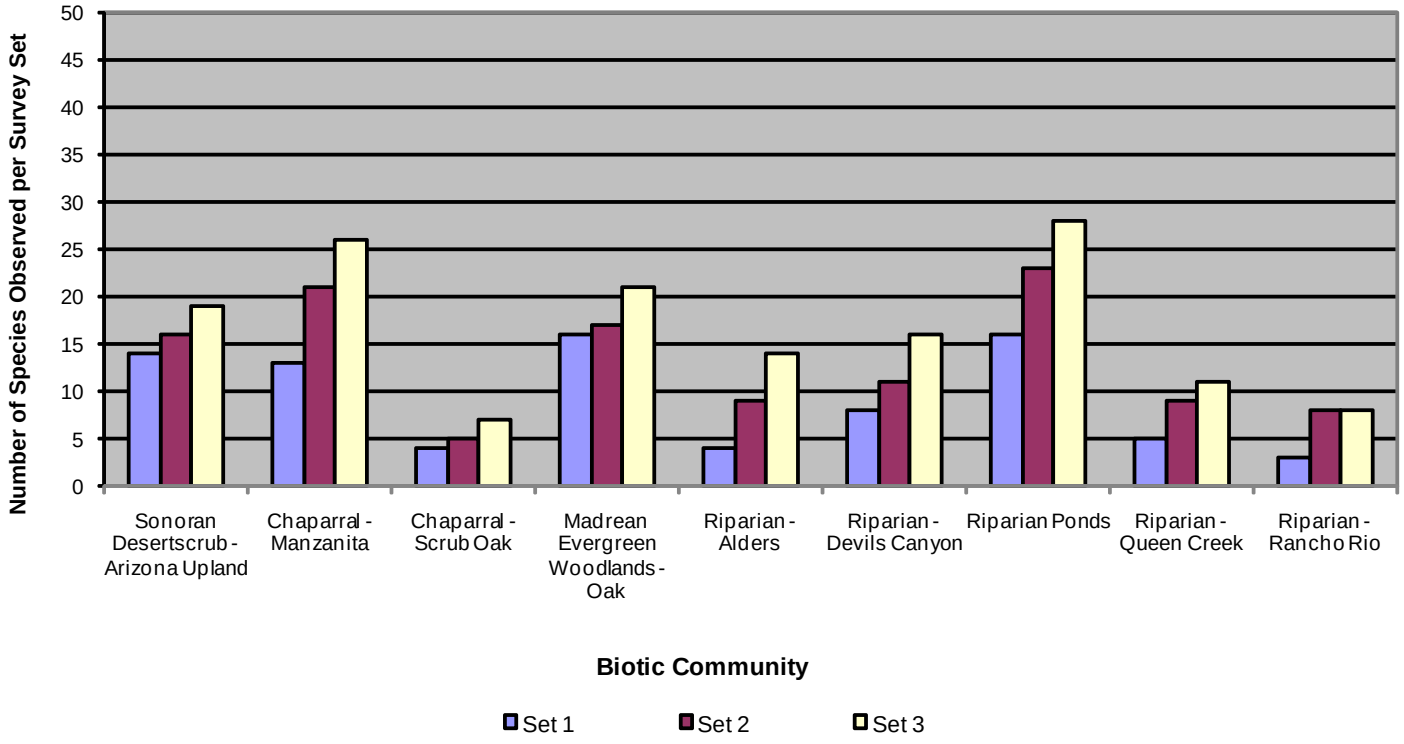


Figure 5b
Number of Bird Species by Biotic Community - Breeding Survey

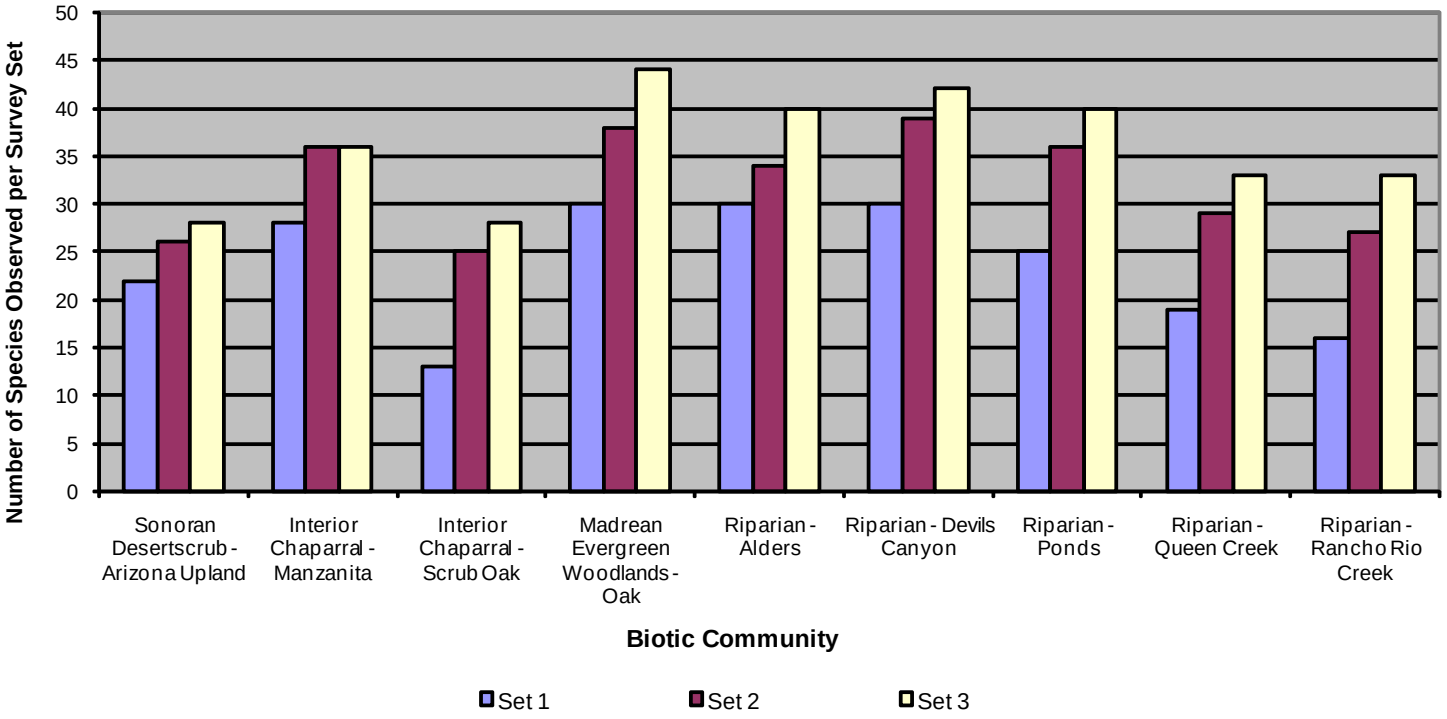


Figure 6a
Percent of Bird Species Detected in Each
Biotic Community by Survey Set - Winter Survey

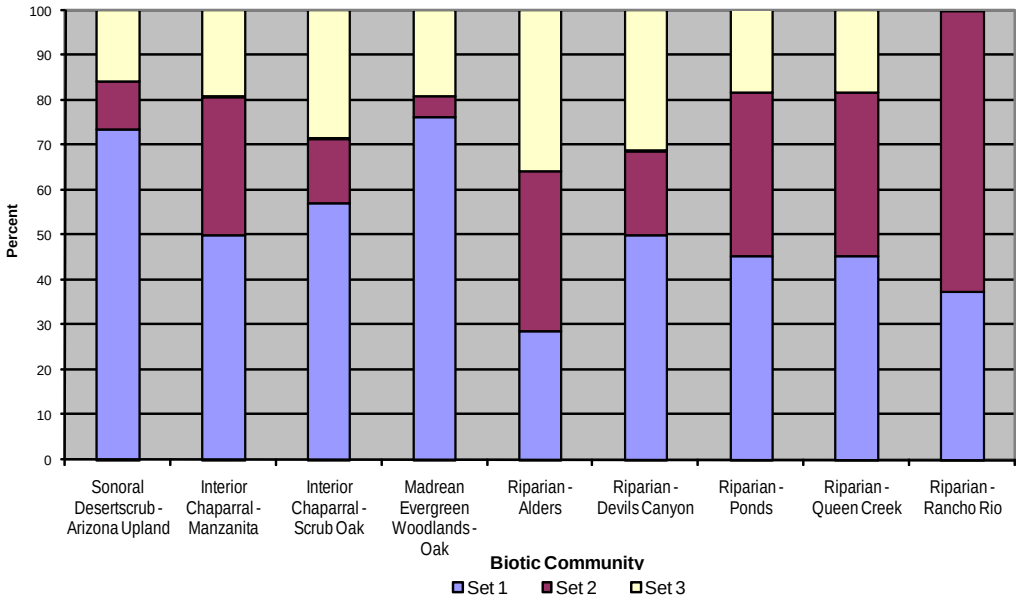


Figure 6b
Percent of Bird Species Detected in Each Biotic Community by Survey Set -
Breeding Survey

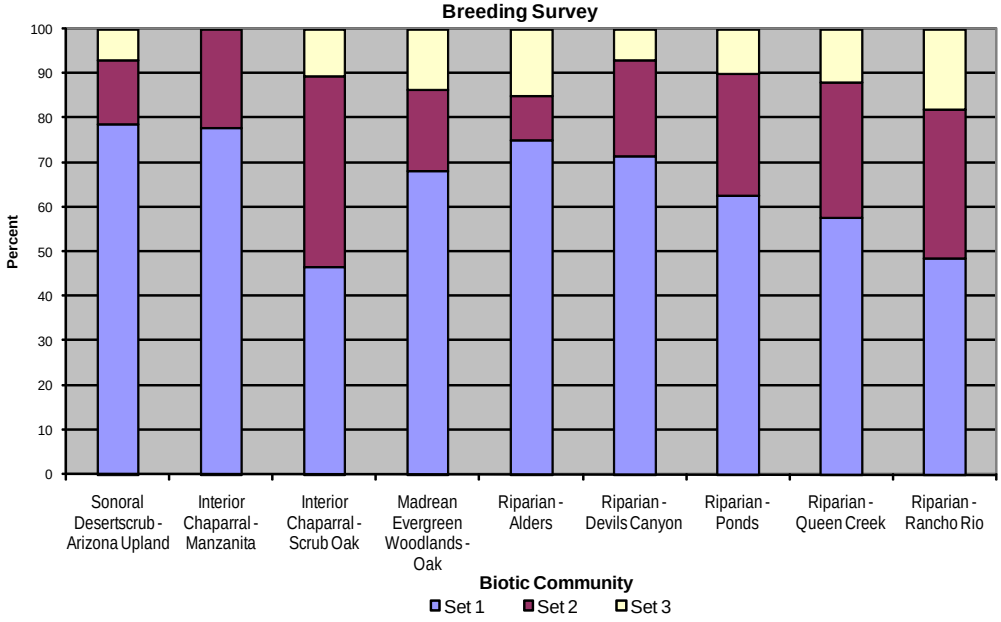


Figure 6c
Percent of Bird Species Detected by Survey Set
Normalized & Averaged

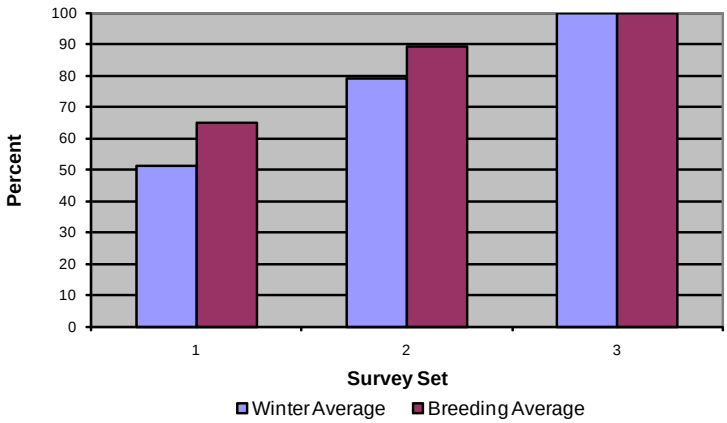


Figure 7a.
Time interval analysis for bird species in the Sonoran Desertscrub - Arizona Upland biotic community during the winter and breeding surveys

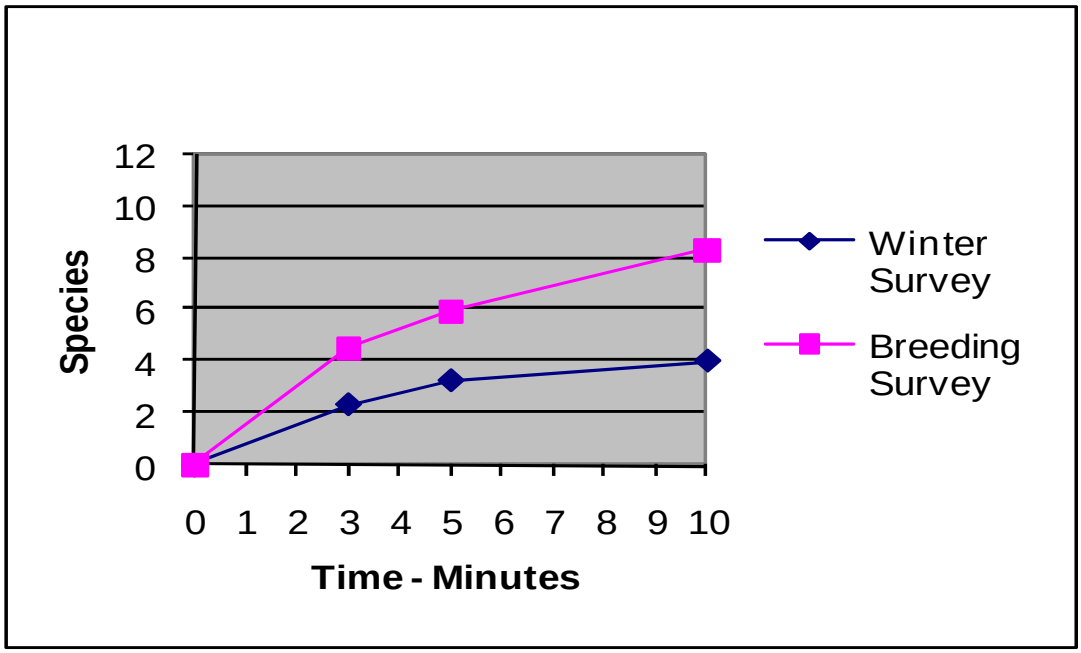


Figure 7b.
Time interval analysis for individuals in the Sonoran Desertscrub - Arizona Upland biotic community during the winter and breeding surveys

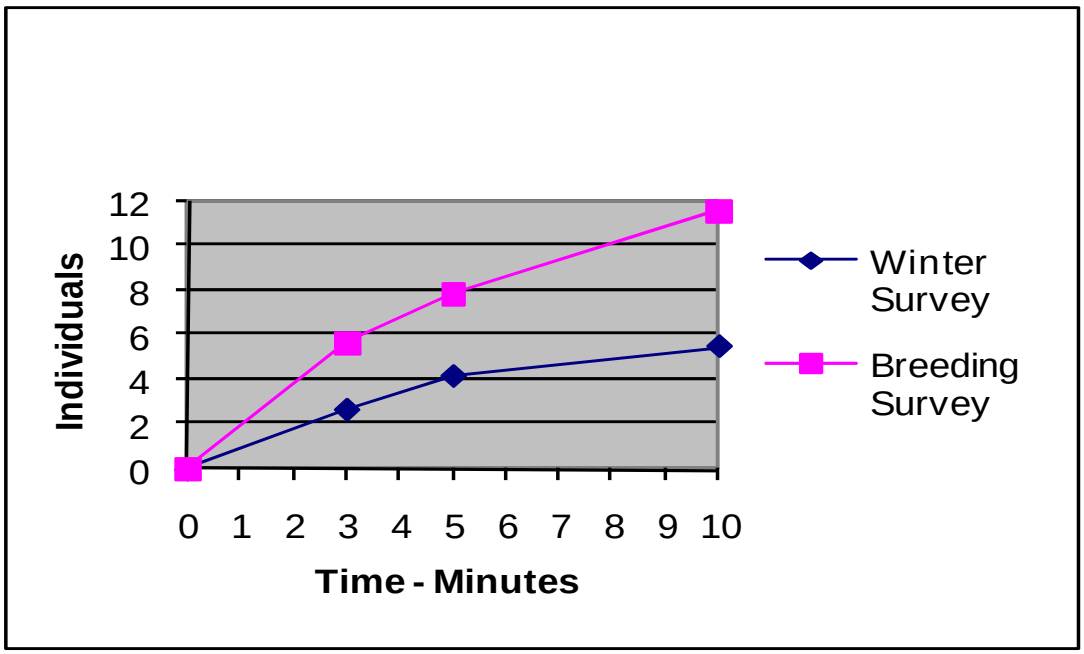


Figure 8a.
Time interval analysis for bird species in the Interior Chaparral - Manzanita biotic community during the winter and breeding surveys

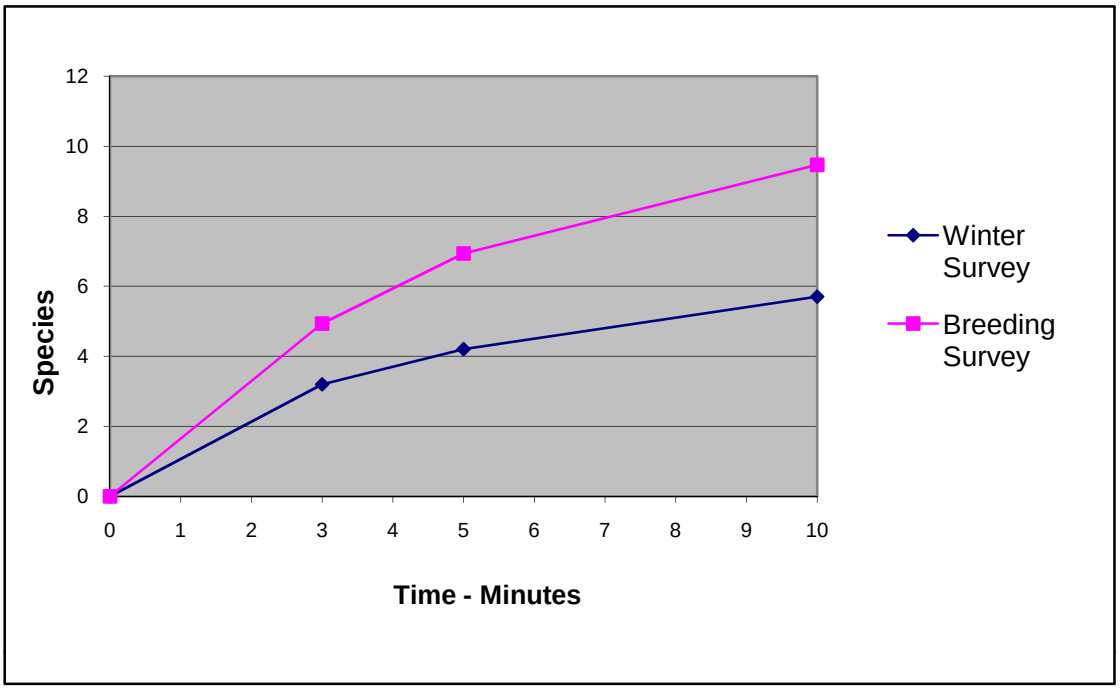


Figure 8b.
Time interval analysis for individuals in the Interior Chaparral - Manzanita biotic community during the winter and breeding surveys

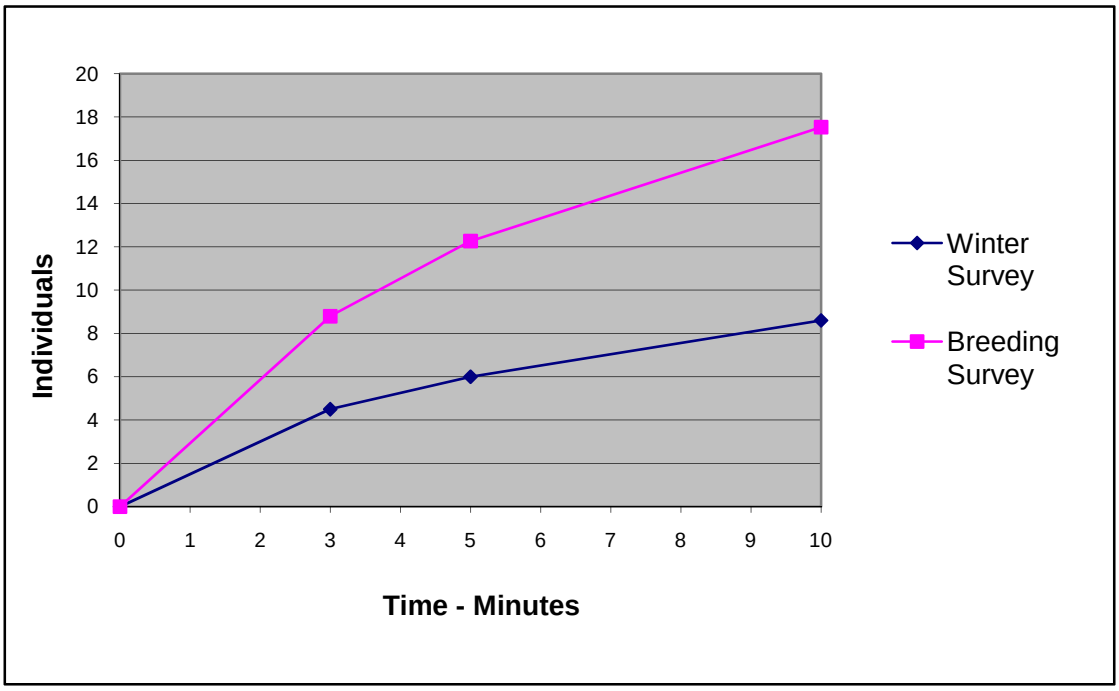


Figure 9a.
Time interval analysis for bird species in the Interior Chaparral - Scrub Oak biotic community during the winter and breeding surveys

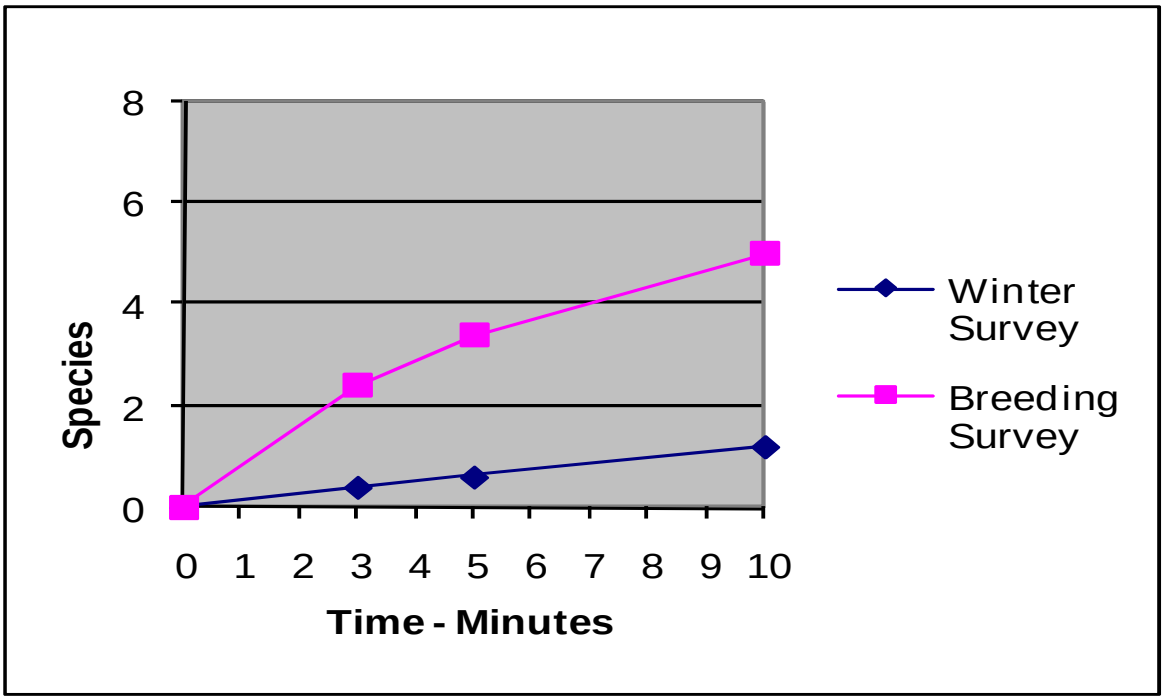


Figure 9b.
Time interval analysis for individuals in the Interior Chaparral - Scrub Oak biotic community during the winter and breeding surveys

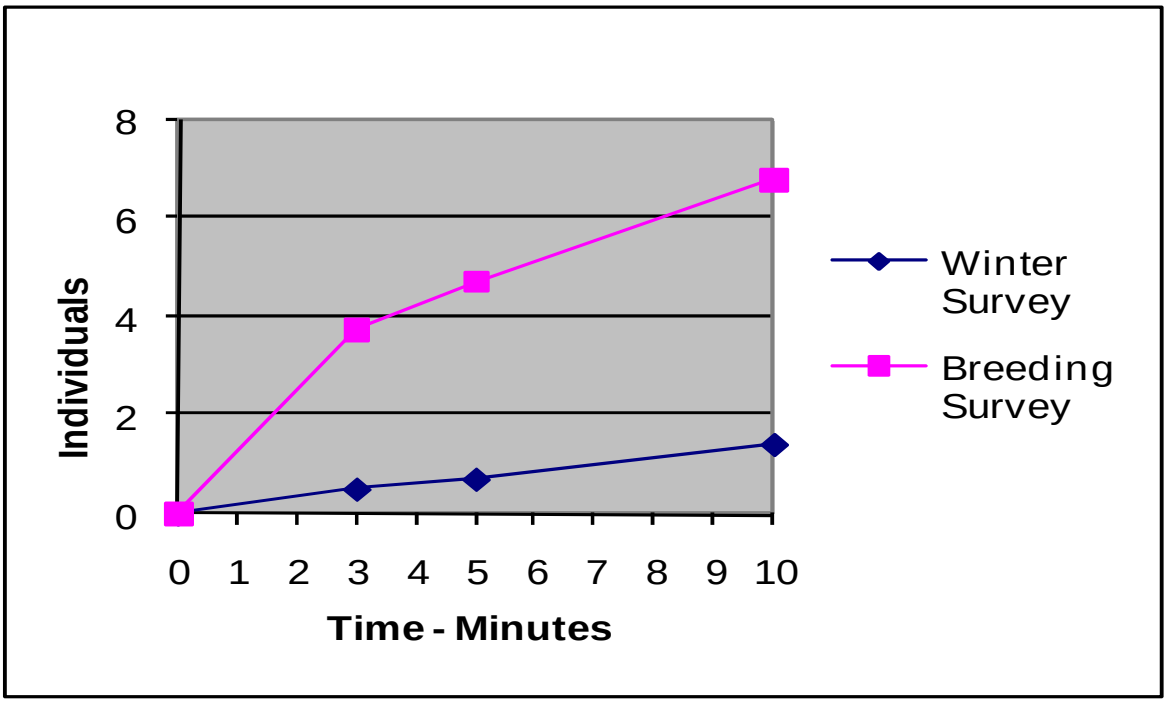


Figure 10a.
Time interval analysis for bird species in the Madrean Evergreen Woodland - Oak biotic community during the winter and breeding surveys

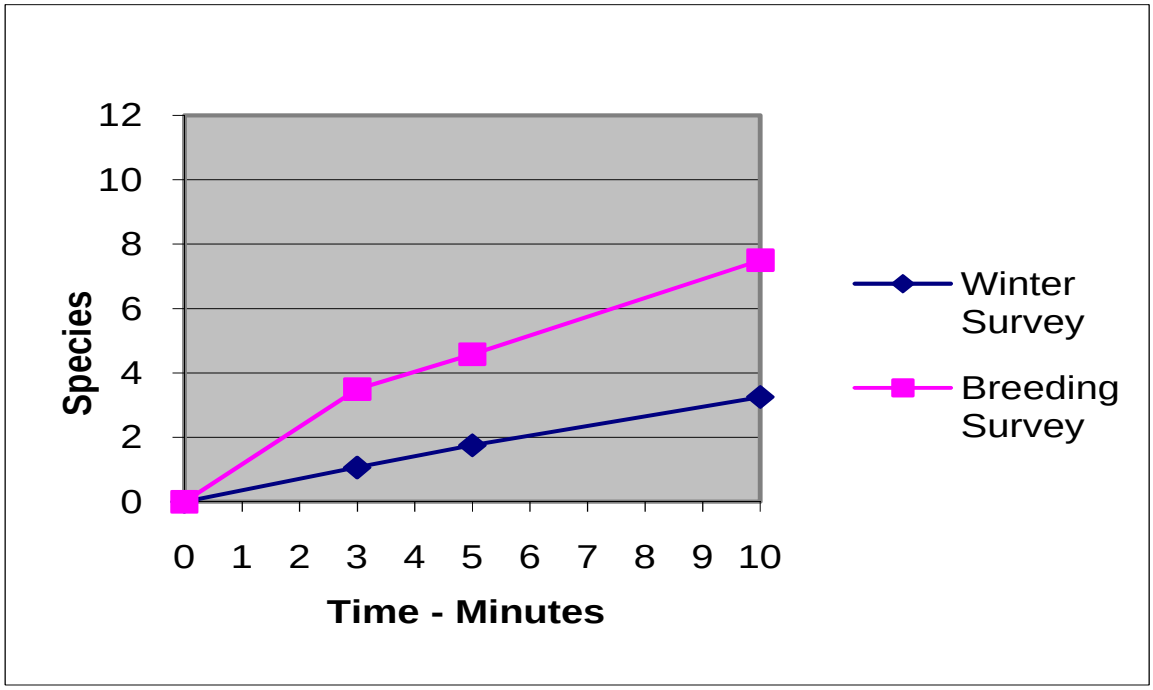


Figure 10b.
Time interval analysis for individuals in the Madrean Evergreen Woodlands - Oak biotic community during the winter and breeding surveys

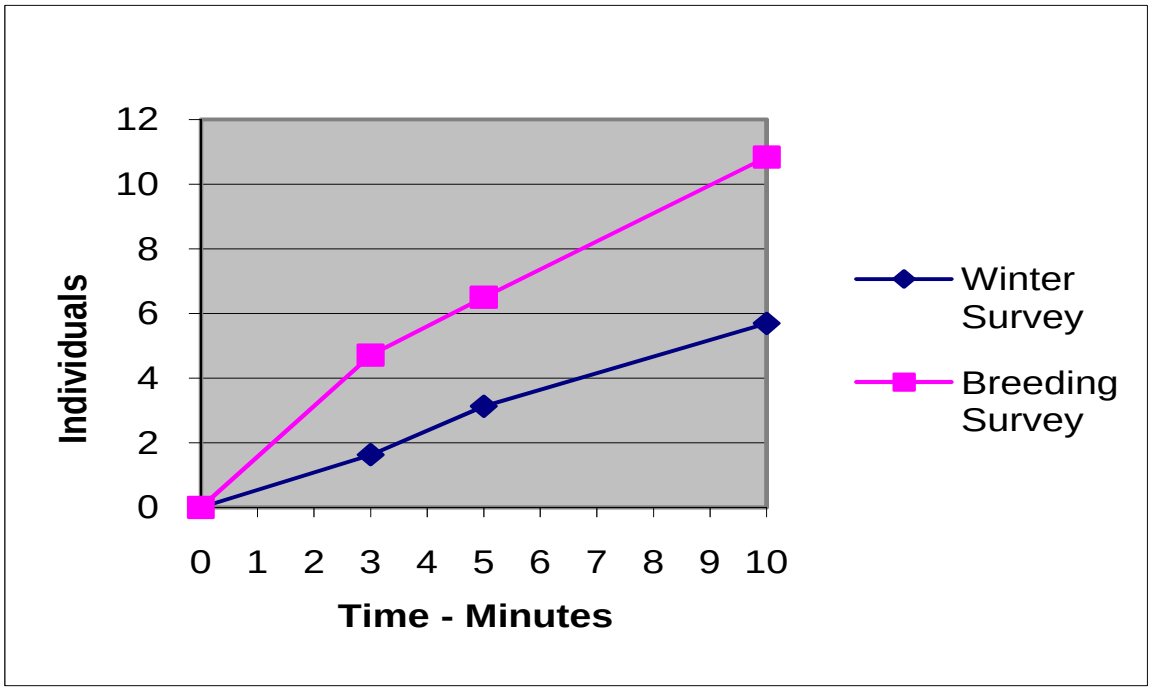


Figure 11a. Time interval analysis for bird species in the Interior Riparian Deciduous Forest Alder biotic community in Devils Canyon during the winter and breeding surveys

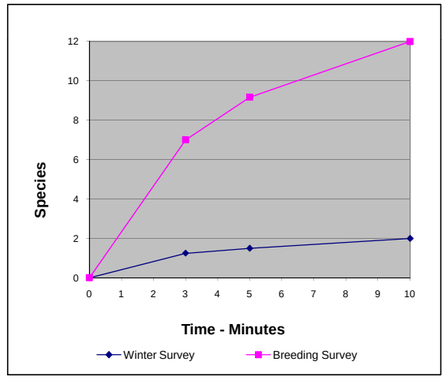


Figure 12a. Time interval analysis for bird species in the Interior Riparian Deciduous Forest - Devils Canyon biotic community during the winter and breeding surveys

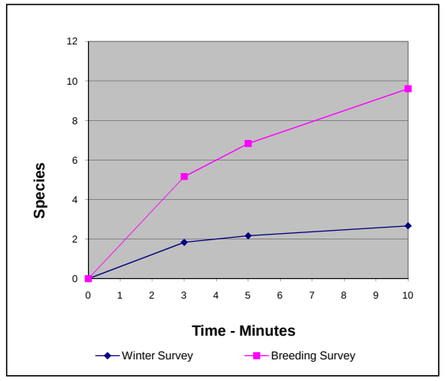


Figure 13a. Time interval analysis for bird species in the Interior Riparian Deciduous Forest - Queen Creek biotic community during the winter and breeding surveys

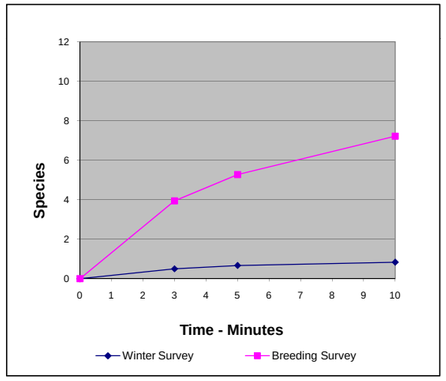


Figure 14a. Time interval analysis for bird species in the Interior Riparian Deciduous Forest - Rancho Rio Creek biotic community during the winter and breeding surveys

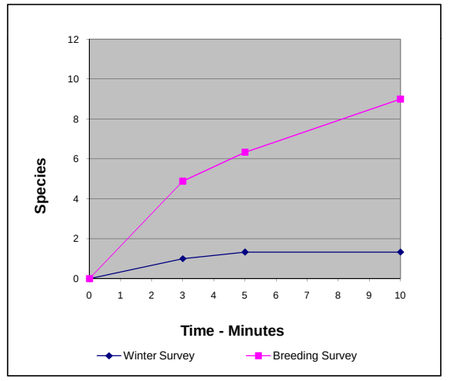


Figure 15a. Time interval analysis for bird species in the Interior Riparian Deciduous Forest - Ponds biotic community during the winter and breeding surveys

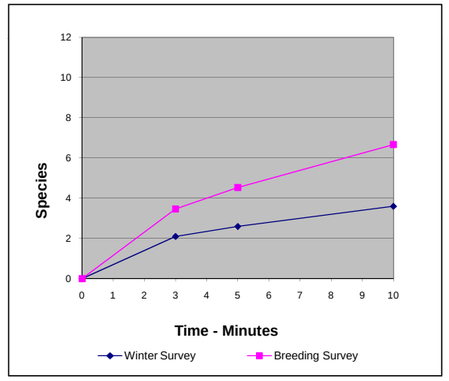


Figure 11b. Time interval analysis for individuals in the Interior Riparian Deciduous Forest Alder biotic community in Devils Canyon during the winter and breeding surveys

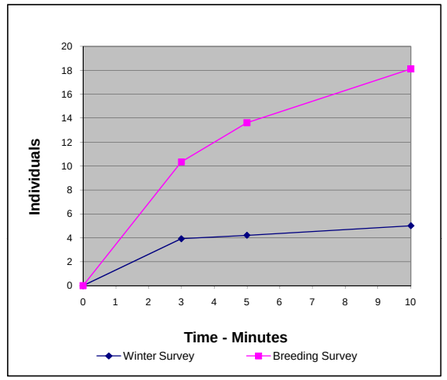


Figure 12b. Time interval analysis for individuals in the Interior Riparian Deciduous Forest - Devils Canyon biotic community during the winter and breeding surveys

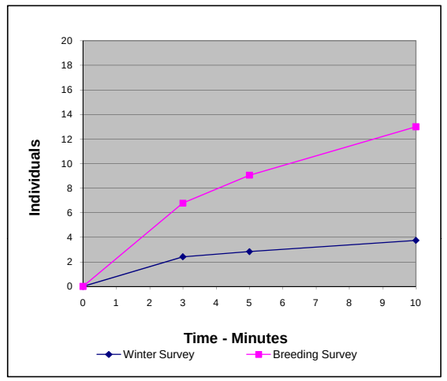


Figure 13b. Time interval analysis for individuals in the Interior Riparian Deciduous Forest - Queen Creek biotic community during the winter and breeding surveys

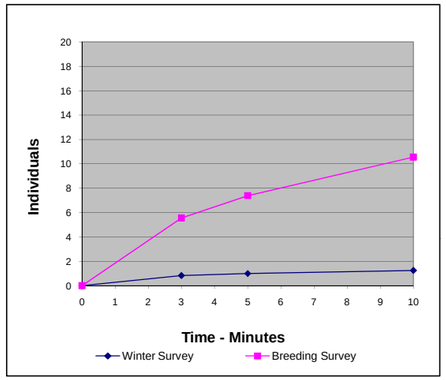


Figure 14b. Time interval analysis for individuals in the Interior Riparian Deciduous Forest - Rancho Rio Creek biotic community during the winter and breeding surveys

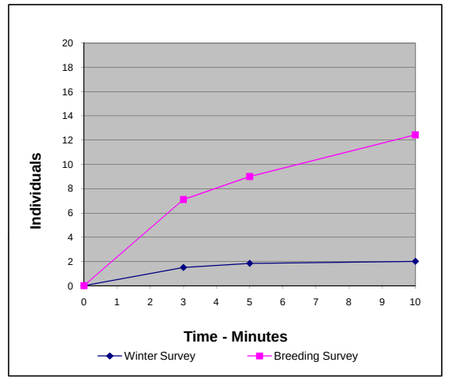


Figure 15b. Time interval analysis for individuals in the Interior Riparian Deciduous Forest - Ponds biotic community during the winter and breeding surveys

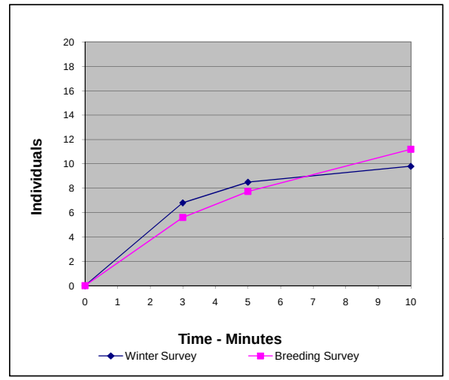


Figure 16a
Time interval analysis for bird species for all biotic communities during winter and breeding surveys

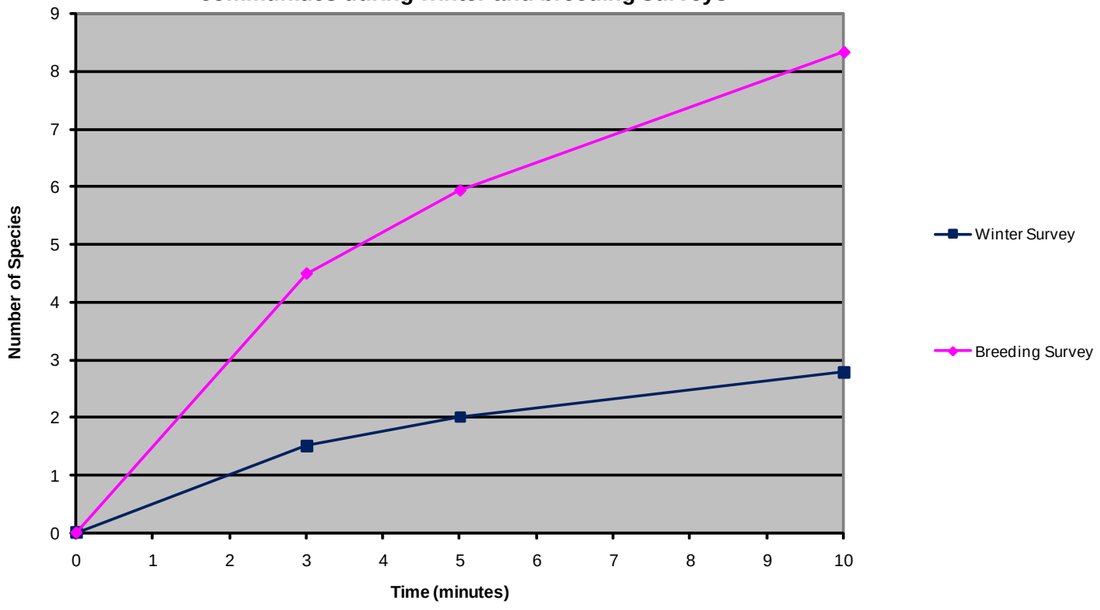


Figure 16b
Time interval analysis for individuals for all biotic communities during winter and breeding surveys

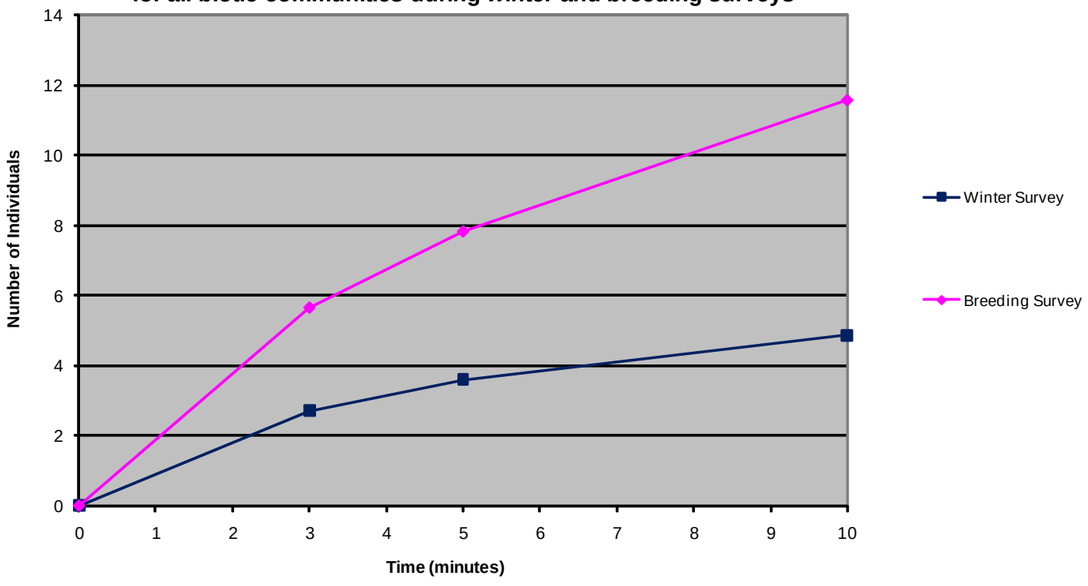


Figure 17a
Time interval analysis for bird species for all biotic communities (%)

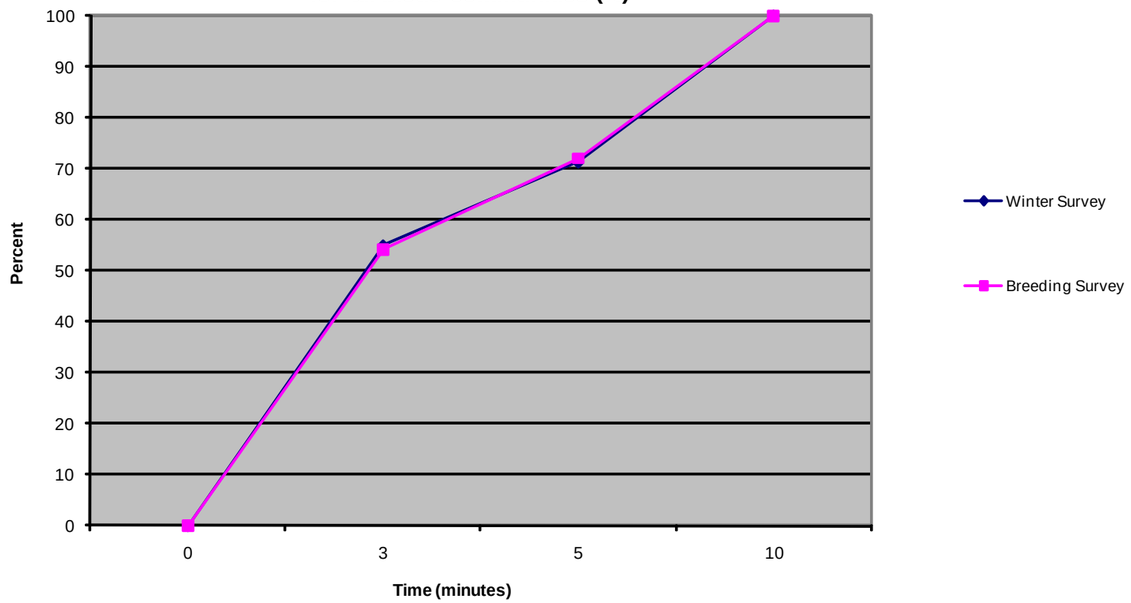


Figure 17b
Time interval analysis for individuals for all bioitic communities (%)

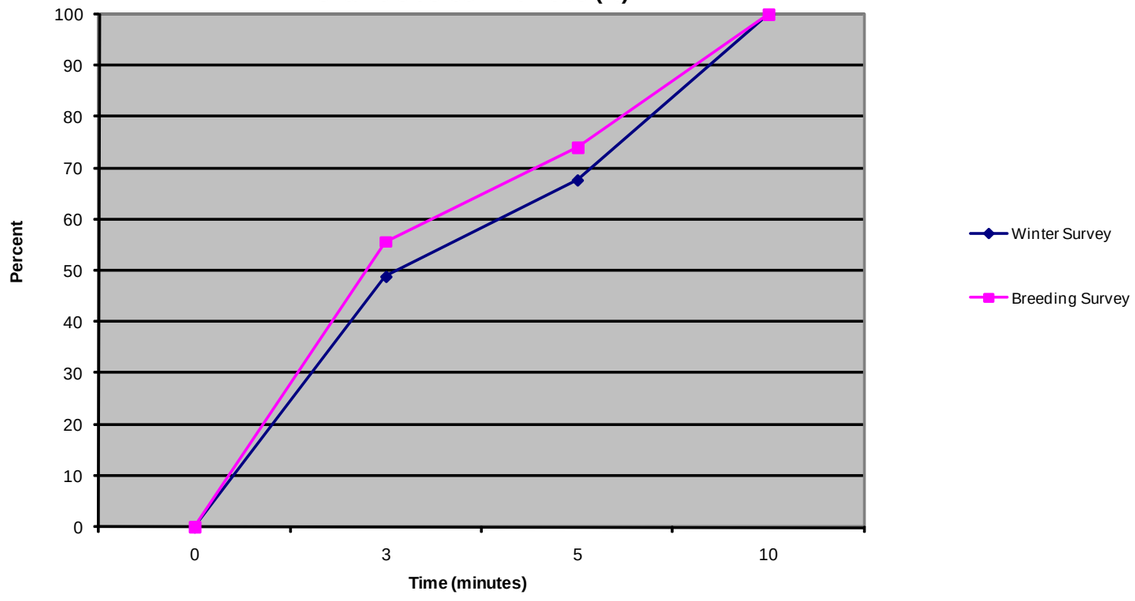


Figure 18a.
Time of day analysis for bird species during the winter* and breeding surveys

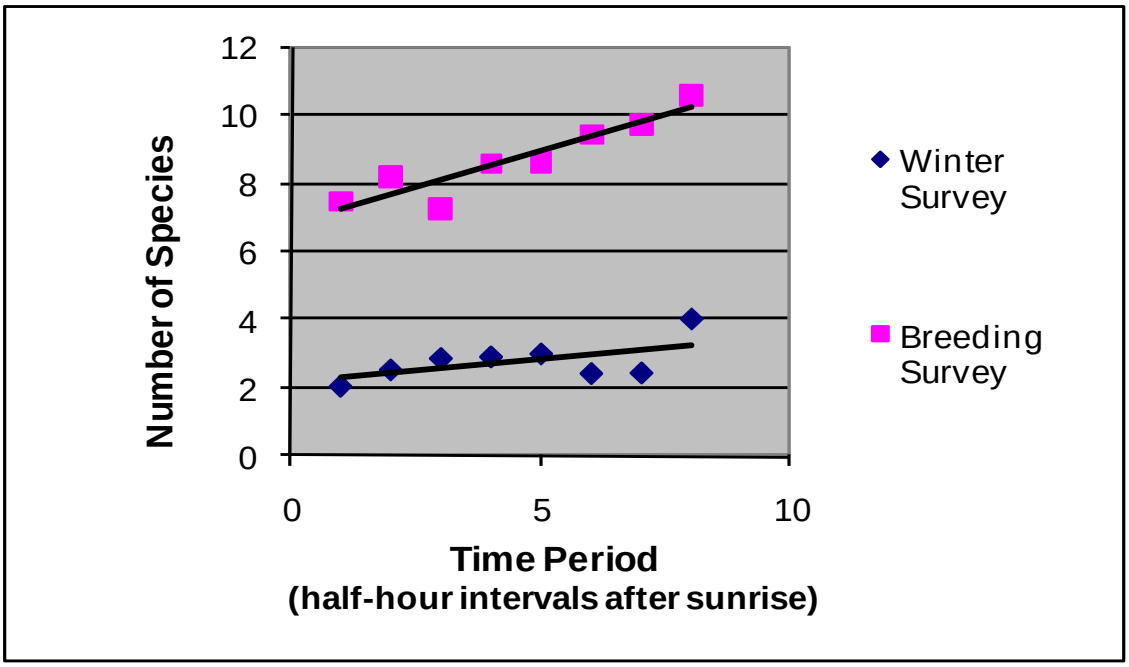
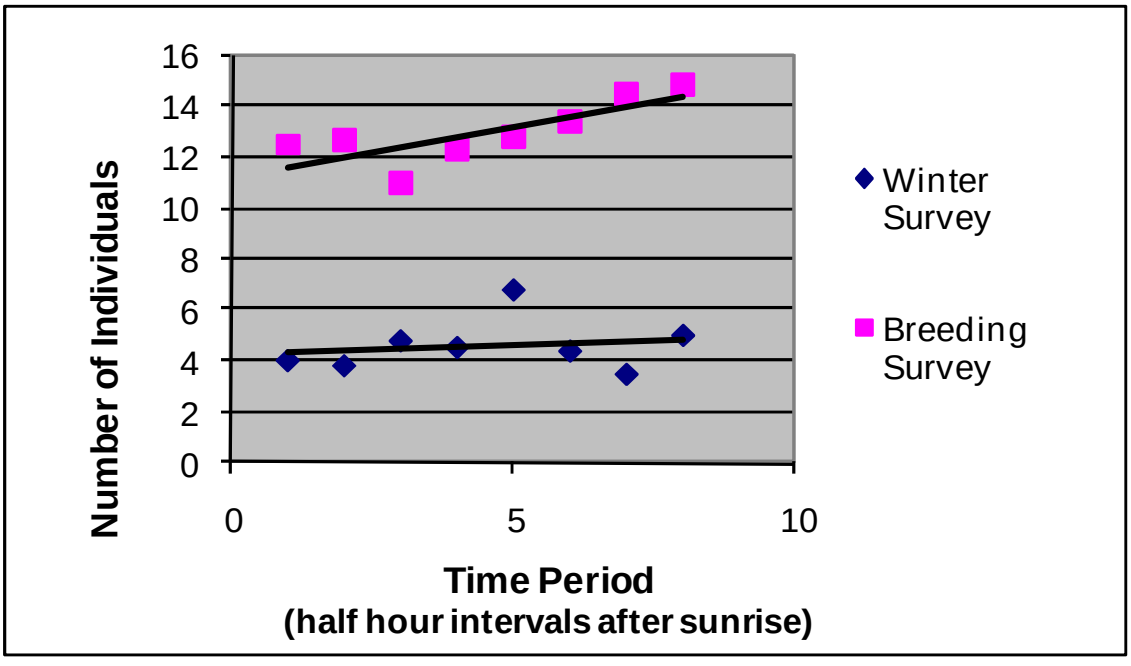


Figure 18b.
Time of day analysis for individuals during the winter* and breeding surveys



*Outliers have been excluded from the winter season for this graphic.

Figure 19.
Relationships between bird species diversities and total tree densities in the winter and breeding surveys

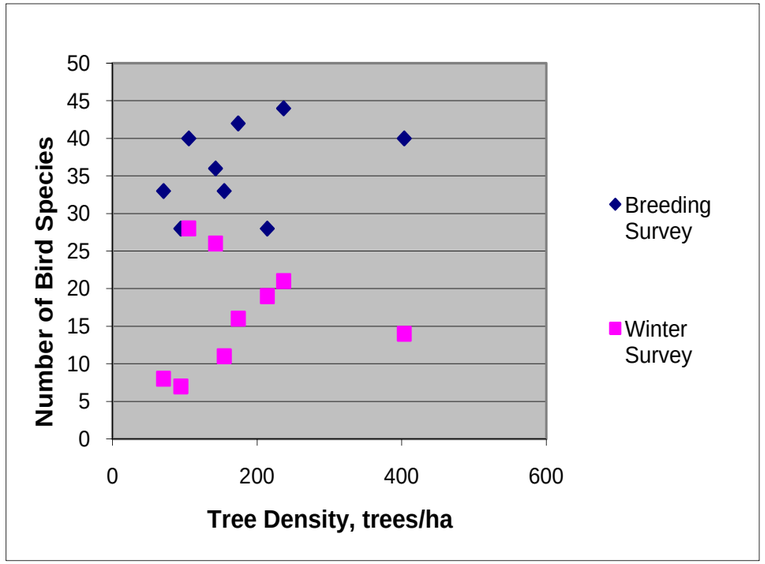


Figure 20.
Relationships between total bird densities and total tree densities in the winter and breeding surveys

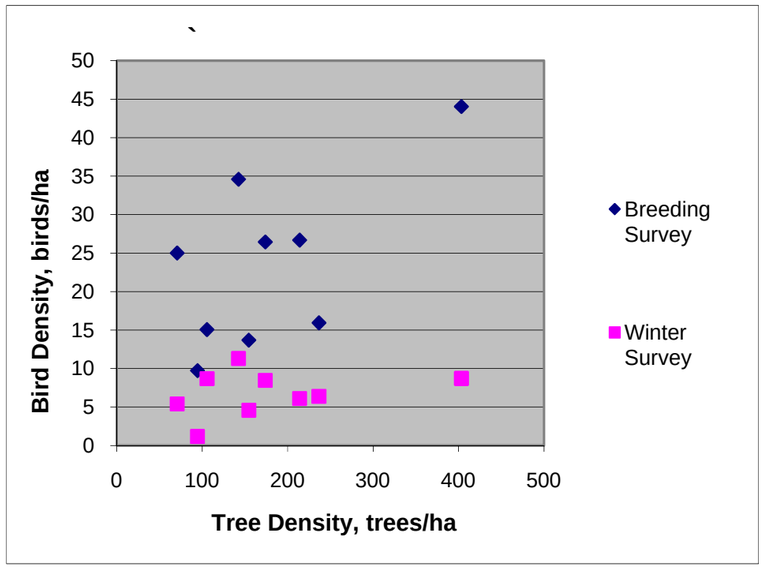


Figure 21.
Relationships between bird species diversities and total tree canopy cover in the winter and breeding surveys

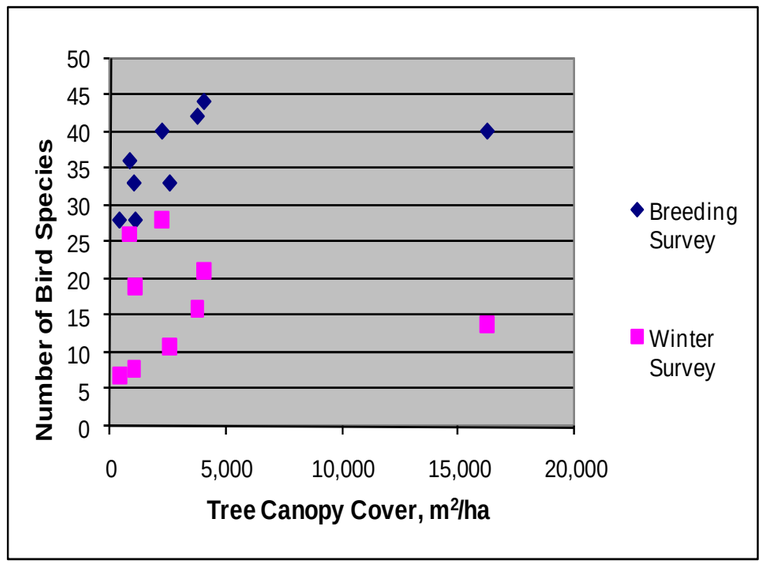


Figure 22.
Relationships between total bird densities and total tree canopy cover in the winter and breeding surveys

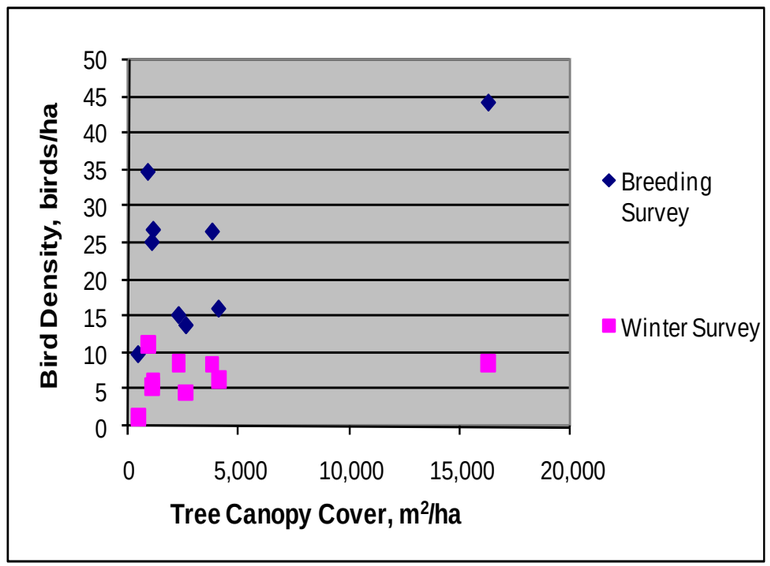


Figure 23.
Relationships between bird species diversities and percent shrub cover in the winter and breeding surveys

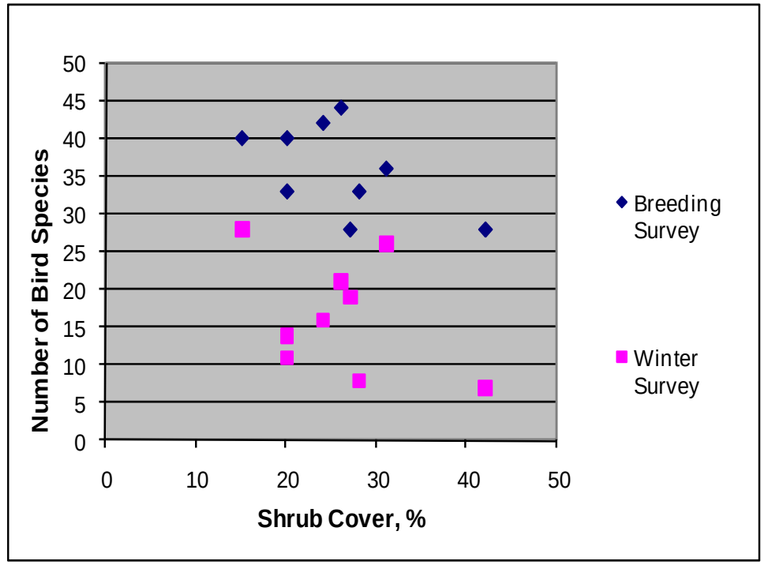
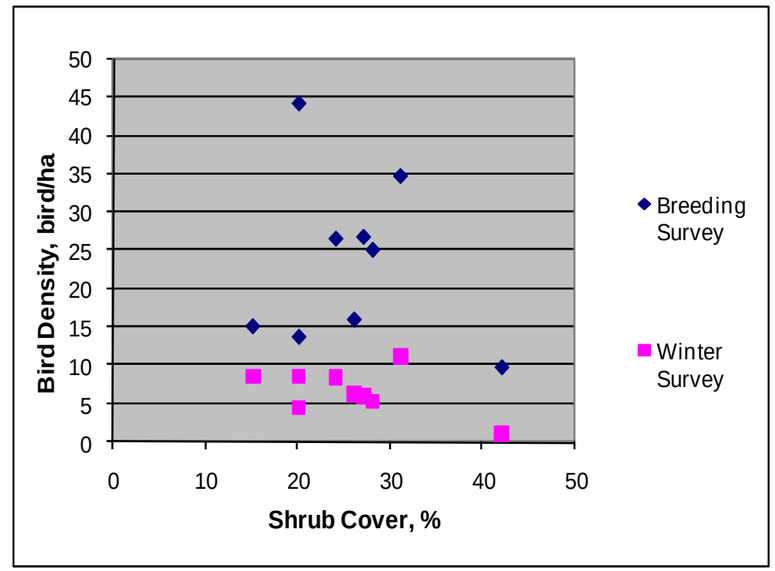


Figure 24.
Relationships between total bird densities and percent shrub cover in the winter and breeding surveys



APPENDIX A

SAMPLING METHOD JUSTIFICATION

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Determining accurate bird population densities is a difficult problem. Many techniques for estimating bird populations have been reviewed by Ralph and Scott (1981). Each technique is designed for specific circumstances and has certain limitations, and no single method can be applied to all situations. For all methods the observer must be able to identify birds that are encountered quickly and accurately, and determine accurately the distance at which the bird is heard or seen. When bird densities are reported, there is an implicit assumption that the birds have been correctly identified and the distances recorded from point-to-bird are accurate.

Two general categories of procedures for population estimates include spot-mapping and individual counting techniques. The spot-mapping method maps breeding territories by plotting the locations of singing males within a designated area. This method is not particularly suitable for the Resolution Study Area because it requires large areas (at least 10 hectares) of homogeneous biotic community to get reasonable density estimates (Szaro and Jakle 1982), and areas of this size are not available for several of the biotic communities present within the Study Area. In addition, this method is unsuitable for winter surveys when most birds are not defending territories.

Within the category of individual count methods, two general approaches are transects and point counts. Emlen (1971) first proposed a method for converting transect counts to densities, with subsequent modifications (Emlen 1977; Emlen 1984). All variants of the transect method require a large area of homogeneous landscape to allow a transect length of 1.0 to 1.5 km (Szaro and Jakle 1982).

The variable circular-plot method (VCPM) is a point count census procedure based on observations from single points (Reynolds, et al. 1980). Reynolds et al. suggested a number of reasons why VCPM would be the preferred survey method over that of Emlen's transect counts in complex vegetation types and rugged terrain, factors relevant to the uplands and canyons of the Study Area. Rugged terrain greatly reduces the attention of the observer on a transect, such that many birds may be missed. The VCPM is particularly appropriate for sites with small patches of biotic communities that lack large, homogeneous stands. In addition, this method may be used for wintering or migratory birds, as well as for breeding birds. Szaro and Jakle (1982) compared the VCPM with spot-mapping methods in selected biotic communities near Superior, Arizona. They found virtually no difference in density estimates between the methods, but they recommended the VCPM for censuring sites with small biotic community islands. The VCPM was also used in summer and winter seasons in a study comparing riparian and upland biotic communities in the Huachuca Mountains (Strong 1987; Strong and Bock 1990). Since 1980, VCPM has been utilized by a large number of ornithologists in estimating bird populations.[1] Some of these studies using VCPM have provided long-term population trends of rare bird species (Johnson et al. 2006) and explored the effect of catastrophic events on avian communities (Knopf and Sedgwick 1987), the alteration of biotic community by logging at different scales (Leupin et al. 2004, Vergara and Schlatter 2006), and the effect of local

[1] By July 2007, Science Citation identifies 238 published, peer-reviewed articles that have cited Reynolds et al. (1980). Most of these articles are using the VCPM as their methodology in assessing bird densities.

human disturbance and alteration on avian communities (e.g., Blakesley and Reese 1988). Since Reynolds et al. (1980), statistical approaches for analyzing data collected using the VCPM have been further refined (ex. Buckland 1987, Quang 1993, Davis et al. 2000, Farnsworth et al. 2002, Alldredge et al. 2007). Dettmers et al. (1999) provided an empirical comparison of point count duration and repeat visits on the data obtained using VCPM. Jiménez (2000) looked at the effect of size of plot, duration of plot, and number of plots, when each was varied one at a time, on species richness and overall density in a Chilean rainforest. Wilson et al. (2000) found that with line transects, they detected more species, more individuals, and more birds per unit time of Nearctic-Neotropical migrants in a Mississippi bottomland hardwood forests, than with the VCPM. [However, Wilson's bottomland forests are easier to traverse than our Study Area; VCPM would remain preferred under our conditions.]

Using the VCPM is appropriate for bird survey in the Resolution Study Area because the riparian biotic communities in this area are distributed in long, narrow strips along canyon bottoms surrounded by upland vegetation, and the encinal woodlands are present in patches that are interspersed with chaparral and along drainage bottoms. In addition, using the VCPM will provide comparable results for wintering and breeding birds. For these reasons, we believe that the VCPM is the most appropriate census technique to collect data on baseline bird population densities within the Study Area.

Using the VCPM, an observer stands at a central point and counts the number of birds seen or heard within a specified time period. To improve the quality of the density estimates, each point is counted multiple times during a season. During each counting period, a distance from the central point is estimated for each individual bird. For each species, observations are grouped in concentric rings based on the radial distance from the central point. An incremental density may be calculated for each ring based on the number of birds observed and the area within that ring. A detection limit is defined for each species at the distance at which the next larger ring has an incremental density less than 50 percent of that in the next smaller ring. Different species have different detection limits because their size or behavior makes them more or less obvious to the observer. To obtain a more reliable estimate of species' detection limits, observations from replicate plots in a single biotic community type may be combined, and the resulting detection limit would be used for each plot within that biotic community type. The final density estimate for a species within a biotic community type is based on the total number of individuals at distances less than or equal to the detection limit divided by the circular area that extends to the detection limit and divided by the number of observation periods in that biotic community.