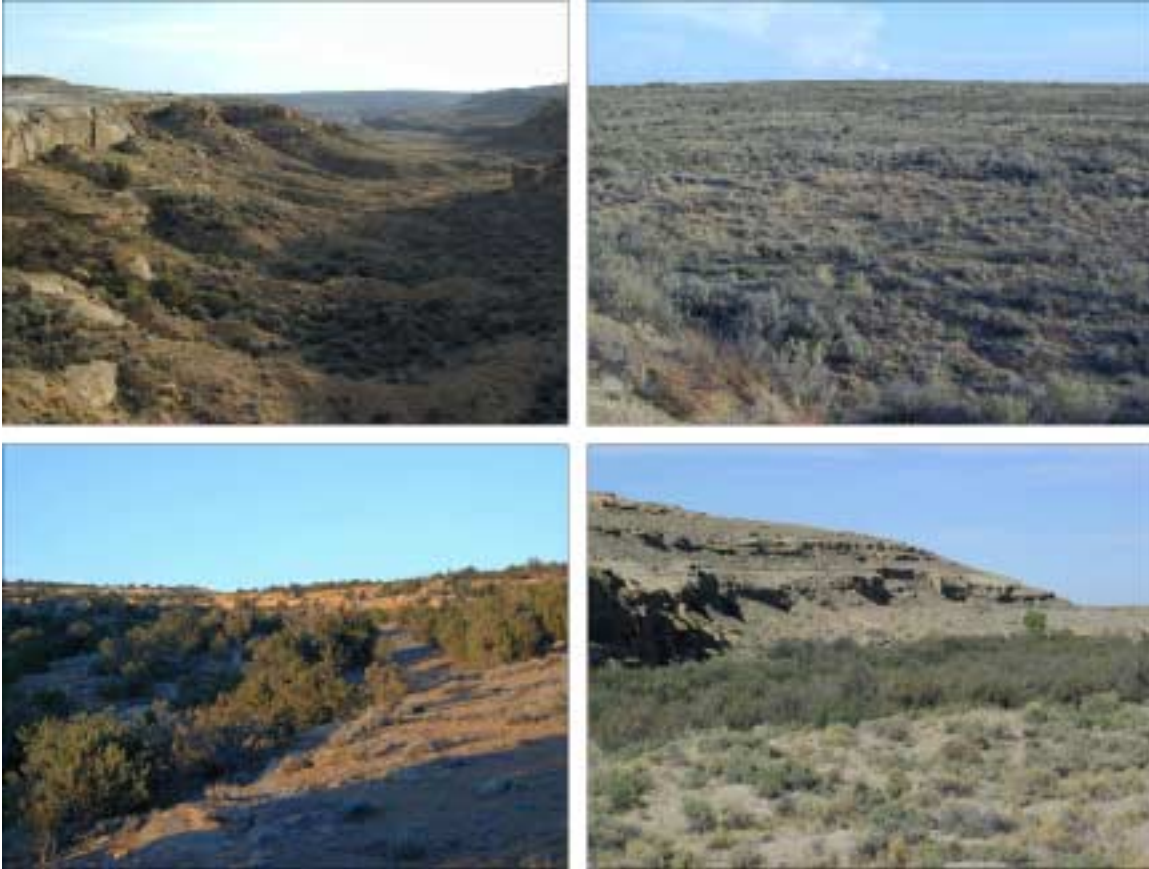


Bird Inventory of Chaco Culture National Historical Park



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INTRODUCTION

Chaco Culture National Historical Park (CCNHP), formerly known as Chaco Canyon National Monument, was established in 1907 to preserve significant archaeological features found in Chaco Canyon. The park now encompasses one of only two protected areas in the San Juan Basin and thus represents an “island” of protected biodiversity within a region that is otherwise impacted by grazing, mineral extraction, and development. The National Park Service has recently recognized the need to inventory, monitor, and properly manage the natural biological resources that co-occur with the cultural resources for which the park is named.

The biota of the San Juan Basin in the four corners region of New Mexico is influenced by an arid climate and annual temperature extremes. Drainage basin headwaters reach the continental divide 40 km east of CCNHP, passing through arid grasslands, sage steppe, pinyon-juniper communities, and mixed conifer forests. The 34,000 acre preserve comprises prominent mesas divided down the center by 20 km of Chaco Wash, trending to the northwest. Fajada Wash from the south and Gallo Wash from the northeast are the two principle tributaries joining Chaco Wash in the park. Only 250 meters separate the highest elevation of 2,090 m on Chacra Mesa from river level of Chaco wash where it exits the park at 1,840 m.

In 1979 and 1980, Jack Cully Jr. conducted the first systematic surveys of bird distribution by habitat in CCNHP (Cully 1981). Cully (1981) conducted bird surveys in the four main park habitats. His surveys comprised single line transects in each habitat, repeated over only three seasons. Because point counts and replicates were not

conducted, statistical analyses of Cully's data are not possible. Transects and detection sites are not geo-referenced, and therefore the study is not repeatable.

The purpose of our study was to inventory all major bird habitats at CCNHP, including recently acquired areas on Chacra Mesa and the north mesa, over two years. In addition, we sampled replicate transects in each habitat for a more thorough survey. We conducted variable circular plot point counts (VCP), to allow statistical analysis and density estimation. A total of eleven transects included three transects in canyon floor, mesa top, and riparian habitats, and two pinyon-juniper transects. Our study includes equal effort across all four seasons and thus represents the first survey of winter bird distribution in the park. All counts were stratified by habitat and season, allowing comparisons of species richness, species composition, and bird abundance, in breeding, wintering, and both migration seasons, across four habitats. This study is designed to be repeatable in future years, to address possible positive or negative population trends in bird species currently occurring in the park.

METHODS

We initiated field surveys of bird distribution in the fall of 1999. Two years of data were collected through eight seasons, ending in June of 2001. We sampled four habitats: canyon floor shrubland, mesa top grassland, pinyon-juniper woodland, and riparian.

Mesa top grassland included 36 sample points in the open shrub grassland, which dominates the mesa top communities of the park. Cliffhouse Sandstone and Eolian Sand soils support a variety of low-growing shrubs, grasses and intermittent juniper (*Juniperus*

monosperma) savannah. Two transects north of the visitor loop-road and one on south mesa were selected to best capture the variation in mesa top grassland communities.

Chacra Mesa sustains the only contiguous pinyon (*Pinus edulus*) juniper woodland in the park. Thirty points were sampled throughout the elevational range (1859 m-2073 m) of Chacra Mesa. There is a diverse shrub community associated with the pinyon-juniper habitat, including mountain mahogany (*Cercocarpus montanus*), cliffrose (*Cowania mexicana*), and intermittent clusters of sagebrush (*Artemisia spp.*). Spaced every 250 m, listening stations in pinyon-juniper stretch from the south boundary of the park to the northwestern cliffs of Chacra Mesa, providing the most complete sample of any habitat.

Canyon floor extends from the edge of wash or drainage features to the base of cliff face and benchlands. Thirty-four points were sampled in the alluvial valley floor and side canyons. Prominent shrubs such as four-wing saltbush (*Atriplex canescens*), greasewood (*Sarcobatus vermiculatus*) and big sagebrush (*Artemisia tridentata*, *Artemisia bigelovii*) occur among saccaton (*Sporobolus spp.*) and galleta (*Hilaria jamesii*) grasslands of the upper flood plain.

Riparian points were placed on three separate transects, throughout Chaco Wash. Species were only included in survey counts if they occurred within the walls of the wash. Any bird perched or foraging on the bank-top edge of the canyon floor zone was excluded. Chaco Wash sustains an intermittent cottonwood (*Populus spp.*) gallery forest. The understory varies from willow (*Salix exigua*), tamarisk (*Tamarix spp.*), rabbitbrush (*Crysothamnus nauseosus*), and sagebrush to adjacent shrub species from the greater floodplain. In the initial two seasons of the study we included 36 riparian survey points.

Following the winter of 2000, we added four points to the westernmost riparian transect to allow better understanding of the distribution of riparian bird species in a stretch of the wash dominated by tamarisk.

We conducted fixed radius, variable circular plot (VCP) point counts (Ralph et al. 1995, Bibby et al. 1992) along line transects in four habitats. In the initial winter season we tried VCP counts in several habitats and concluded that this method would not allow enough sampling time to detect most wintering species. All winter transects were therefore sampled with the line transect method, using a limited width of 100m to either side. The same transect lines were walked in winter as in breeding/migration in each habitat, and all species encountered within the specified width were documented.

We established permanent listening stations along transects within each habitat. We designed the study to capture variation in habitat vegetation and maximize the probability of species detections and the number of listening points, without leaving the prescribed habitat. We placed higher priority on sampling the range of habitat diversity within each habitat than on systematically avoiding edge habitat zones. We established 140 point count stations on eleven transects. There were three transects per habitat, except for pinyon-juniper. Due to the relatively limited distribution of the pinyon-juniper community on Chacra Mesa, two transects of 15 points were designed, giving at least 30 points per habitat.

Because vehicle access and travel time between transects were limited, we were able to conduct only one migration or breeding survey per day. To avoid pseudoreplication, we placed all listening stations a minimum of 250 m apart. In the more open habitats of canyon floor and mesa top, points were placed 300 m apart.

Coordinates of all listening points were taken in the field on a Garmin 12 GPS unit (Appendix 1). Data were stored in NAD 27 datum, with an estimated accuracy of 7.04 m (Minnesota Land Management Information Center 1999). All non-winter transects were begun within fifteen minutes of first light and completed by 10:15 am. Winter transects were conducted during mid-day, when highest bird activity was anticipated. All birds within 100m were recorded, noting first means of detection (visual, calling, singing, flyover, drumming, etc), and placed into distance categories of 25m, 50m, 100m, or 150m. Flyovers and birds beyond 100m were removed from the data analysis. Only one biologist conducted point counts, eliminating between-observer variation.

Our objective was to document at least 90% of the species occurring at CCNHP. When our standard methods might not have provided sufficient effort to detect non-vocal or rare species, we conducted additional species-specific target searches. Ferruginous Hawk (*Buteo Regalis*), Mountain Plover (*Charadrius montanus*), Burrowing Owl (*Athene Cunicularia*), Southwestern Willow Flycatcher (*Empidonax traillii extimus*), Gray Vireo (*Vireo vicinior*), and Bendire's Thrasher (*Toxostoma bendirei*) were deemed of sufficient conservation importance to merit independent site specific monitoring. Three species, Ferruginous Hawk, Mountain Plover, and Burrowing Owl have known associations with prairie-dog towns. Gunnison's prairie dogs (*Cynomys gunnisoni*) occur at three sites on the park boundary (Paul Whitefield, pers. comm.). Each location is very close to a census transect and was visited at least eight times. Many additional trips were made to these towns throughout the two-year study. Riparian habitat was not deemed suitable for breeding and thus did not warrant protocol surveys for the Southwestern Willow Flycatcher. We played taped songs and calls of the subspecies in the wash during the

breeding season, wherever habitat was marginally suitable. We searched opportunistically for Gray Vireo and Bendire's Thrasher throughout the survey and made several specific visits to possible breeding habitat during the breeding season.

Statistical analysis of bird detections by season and habitat were performed in Minitab 13 for Windows. We used a one-way analysis of variance (ANOVA) to compare relative abundance results between seasons in each habitat, and within season, between habitats. We compared years using Mann-Whitney U tests. We performed standard Bonferoni adjustments on the Mann-Whitney tests to compensate for the inflation of Type I error rates, which results from multiple tests.

RESULTS

Avian Diversity

We compiled a list of 128 species from point counts, line transect surveys, and informal observations (Table 1). Migratory species constituted 41 % (53 species) of all birds. Those birds observed during the breeding season, although not necessarily actively breeding in the park, made up 31 % (39 species) of detected species. Twenty-one percent (27 species) of species were documented as residents (non-migratory species occurring in all seasons). The remaining 7% (9 species) were wintering species. Point count or line transect data were from birds detected in the habitat during a survey, within 100 m of the observer. Of the 128 species detected, a subset of 96 detected during surveys was included in statistical comparisons of transects (i.e., informal observations made outside surveys were not included in analyses). The remaining 32 species were documented by habitat and season only.

Table 2 lists the frequency of species detections in each habitat. The table provides the number of detections and total counts of each species, and percentage of total detections and counts. We define a single detection as an encounter with a species, whether it is an individual or a flock. Once a species has been detected, the total number present in the group is termed the count. Results are broken down into breeding season versus all other seasons combined. Count by detections are plotted in Figure 1. A species commonly detected in groups of more than one bird will have a higher count/detection ratio than birds found singly. Hence, the House Finch (*Carpodacus mexicanus*), Chipping Sparrow (*Spizella passerina*), and Cliff Swallow (*Petrochelidon pyrrhonota*) are the species most commonly seen in large numbers, whereas Black-throated Sparrows (*Amphispiza bilineata*) and Rock Wrens (*Salpinctes obsoletus*), also very abundant, are more often detected as individuals. The 20 most abundant species in the park are labeled by acronym in the figure. These species account for 70% of total detections and 77% of total bird count.

Species Richness and Relative Abundance

The most common pattern in species richness among all habitats was the increase in total number of species during migrations (Figures 2-5). Total fall migration values for richness were the highest for all habitats, except in the mesa top habitat, which was exceeded by six species in spring migration. Winter species richness was consistently the lowest, varying from 17% to 26% of total richness in each habitat. The influx in spring and fall migrants is most visible on the riparian transects. Generally, a slight decline in total species count occurred between spring migration and breeding surveys in all

habitats. An exception occurred in the first year values for breeding season species richness in the pinyon-juniper and canyon floor habitats, where summer totals slightly exceed spring migration totals. Breeding season species richness explains 44% of total within-habitat species richness in riparian, compared to 49% in pinyon-juniper, 51% in mesa top, and 54% in canyon floor.

We compared relative abundance per point between years, controlling for habitat and season, to assess whether there was sufficient conformity between years (four habitats, four seasons) to lump yearly data for habitat comparisons. Out of a possible 16 comparisons, five were significantly lower in year two (alpha level = .0125, Bonferroni adjustment for multiple tests). More birds were seen on spring riparian transects in the first year. The first winter relative abundance totals in pinyon-juniper and mesa top communities were greater than in year two. Fall totals from canyon floor transects were also significantly higher in the first year. Given this disparity between years, we performed separate yearly analyses for habitat and seasonal differences.

We performed one-way analyses of variance for within-year comparisons of relative abundance between habitats and between seasons. In year one, relative abundance did not differ significantly among habitats in any season. In year two, the four habitats differed in relative abundance in fall ($F=6.23$, $P=0.001$, $df=3$), winter ($F=3.83$, $P=0.01$, $df=3$), and spring ($F=5.78$, $P=0.01$, $df=3$). In fall, riparian abundance was significantly higher than pinyon-juniper and canyon floor abundance. In winter, canyon floor abundance was higher than mesa top abundance, and in spring, mesa top relative abundance was significantly higher than riparian abundance.

We eliminated winter from the seasonal comparisons, because survey methods were different in winter from those in the other three seasons. Comparing seasons, there were again no significant differences in year one. In year two, abundance in riparian habitats varied across seasons ($F=4.35$, $P=0.015$, $df=2$), as did abundance in canyon floor ($F=8.10$, $P=0.001$, $df=2$). In riparian, fall abundance was significantly higher than spring abundance; in canyon floor, fall abundance was lower than spring and summer abundance.

Target Species

There is no evidence to suggest that Southwestern Willow Flycatchers are presently breeding at CCNHP. We used a taped recording of this flycatcher's characteristic song and call to attract breeding individuals. On two occasions during the breeding season, we surveyed dense stands of riparian shrubs. This amount of effort was less than that of the protocol survey, but sufficient to prove absence during this study, given the small size and marginal nature of the habitat.

Burrowing Owls were seen regularly within one mile of the northern park boundary. Given the current location of three separate prairie-dog towns, each on a separate edge of the park boundary (South Gap, south entrance, and northeast gate), Burrowing Owl breeding could be expected in any year, but we found no Burrowing Owls within the park during the study. The same general habitat was surveyed for Ferruginous Hawk and Mountain Plover. Mountain Plover searches were not limited to the distribution of the prairie-dog towns, but also included much of the mesa top grasslands where shrub cover was negligible and bare soil was readily visible. The best

potential Mountain Plover habitat in the park is along the eastern boundary, in the newly acquired tract of mesa top grassland. We searched for Ferruginous Hawks more widely in the park grasslands and shrublands. No Ferruginous Hawks or Mountain Plovers were seen during this study.

Bendire's Thrasher and Gray Vireo were considered possible breeders in the park. Gray Vireo inhabits dry hillsides sparsely covered with juniper. Bendire's Thrasher is found in open desert grasslands or arid shrublands. Each is ranked by New Mexico Partners in Flight as a highest priority management concern in its respective habitat (New Mexico Partners in Flight 2001). We conducted specific, habitat-based surveys for each of these species during the breeding season. We detected neither species within the park during the study.

Brown-headed Cowbirds (*Molothrus ater*) are a common breeding species of CCNHP. This species is a brood parasite that can lower productivity at individual host nests. Cowbirds utilize riparian corridors, because the probability that they can detect host nests is often high. The overall distribution of cowbirds is limited by the availability of foraging sites, and abundance is increased abundance in the vicinity of livestock and agriculture. Foraging habitat around livestock pastures beyond the park boundary is well within the range of cowbirds. One New Mexico study documented cowbirds traveling at least 12 km between breeding and foraging areas (Goguen and Mathews, 1999). Chaco Wash, because it contains an isolated and developed riparian woodland, would be the most likely cowbird search zone within the Chaco River headwaters. This highly mobile species was seen in all habitats; however, it was the second most common breeding species on riparian transects (Table 2, Riparian section).

DISCUSSION

The largest subset of birds in the park contains the stopover migratory species. In fall and spring, 41% (53 species) of all bird species detected used habitat within the park during migratory travel. The riparian corridor was used by 73% (39 species) of the migratory birds. The wood-warblers (family Parulidae) found in the park exemplify the extent of neotropical migrant use of riparian habitat. Twelve of 14 warbler species were found in Chaco wash at least part of the time during migration; however, we found no evidence of any warbler breeding in the park. The wash community constitutes an important component of the overall bird diversity of the park, which peaks during spring and fall migration.

In this context it is difficult to fully explain the drop in riparian relative abundance in the second spring. An associated drop in species richness did not occur, but total abundance in the second spring was less than half of the first year total. This may be a delayed consequence of the dry summer of the previous year. In addition, the two wettest months during the study, according to rainfall data collected at CCNHP, were in August of 1999 and March of 2000 (James Ramakka, pers. comm.). The wet monsoon season of 1999 coupled with appreciable winter moisture likely led to the higher riparian bird abundance in the spring of 2000. Without more years of data, it is not possible to determine whether such differences are normal year-to-year fluctuations.

The first year results for relative abundance were similar in all four habitats (mean counts of 7-8, Figure 6-9), yet riparian abundance in the second year was greater than canyon floor, mesa top, and pinyon-juniper habitats in which bird species rely on seed crops for forage. Mesa top and pinyon-juniper transects turned up significantly fewer

birds in the second winter, and canyon floor habitats had fewer birds in the second fall. Monsoonal moisture in 2000 was low, which may have contributed to a reduced seed crop in habitats other than riparian, where seeds are important food. These results expose a weakness of a two-year study. Climate may have affected relative abundance in the second year, but more years of data would be required to distinguish climate from other potential factors.

The greatest between-year variations in seasonal relative abundance occurred during fall and spring migrations. The breeding birds of CCNHP are adapted to a semi-arid ecosystem prone to ephemeral and inconsistent moisture. In contrast, stopover migrants can move quickly out of the park in dry or otherwise unfavorable conditions. In addition, territorial males tend to be more visible on the breeding grounds and may be more reliably detected than migrating birds. The 20 most common species in the park are either resident breeders or migrant breeders. This group makes up 70% of total detections and 77% of total count. More species may be present during migration, yet the common residents and breeders constitute the majority of bird occurrences. Not one of these common species is a habitat specialist. Only the Pinyon Jay (*Gymnorhinus cyanocephalus*) is found in fewer than three park habitats, and three species are found in three of four habitats. The remaining 16 most common species are able to utilize, in some capacity, all four major habitats within the park.

The fact that most of the species in this study are generalists that occur in small numbers suggests that all habitats in the park contribute to avian diversity. The pinyon-juniper and riparian habitats, however, provide the structure necessary to support the largest species richness. One result of the study is that riparian habitat harbors the largest

number of species, but this habitat appears to be more important as stopover habitat than as breeding habitat. The structure and diversity of vegetation in the wash has been increased since planting began in the 1930's (Lagasse et al. 1983). Removal of grazing pressure and establishment of riparian trees and shrubs has probably increased the distribution of riparian associates within the park.

Management Recommendations

Stephan Hall (1977) analyzed the late quaternary sedimentation of Chaco Wash (7000 B.P. to present) and described five eras of alluvial deposition. The two most recent erosional downcuts in the Chaco Canyon alluvial valley include the pre-Bonito channel (900-650 B.P.) and the late 19th century erosion of the present arroyo (Hall 1977). Bryan (1954) considered 1860 as the tentative date for the initiation of arroyo formation in Chaco Wash, a date that was based on W. H. Jackson's earlier observations and the recollections of two Navajos who grew up in the area. The beginning of channel erosion in the late 1800s has been attributed to a combination of climatic changes and changes in land use patterns (Love 1983). The morphology of the present-day wash is radically different from that evidenced by aerial photos taken in 1929 (Wells et al. 1983). Lagasse et al. (1983) comment, "The most striking characteristic of Chaco Wash in 1929 was almost complete absence of vegetation inside the incised arroyo walls. Vegetation did not play an important role in the interior processes of the wash until its introduction by man in the mid-1930s." Thus, the present aggradation of Chaco Wash is a natural process repeated through time, and evidence shows the vegetated terrace of the inner channel developed over the past 70 years (Lagasse 1983).

The present inner channel terrace is a recent formation representing geomorphology in flux. The contrast between a nearly bare arroyo channel in 1929 and the riparian vegetation in the present arroyo demonstrates the changes fluvial systems undergo in the arid southwest (Lagasse 1983). Chaco Wash does not provide perennial water, yet the channel flood plain sustains a vegetation community that includes riparian trees and shrubs. The density of deciduous trees and shrubs in Chaco Wash may well be an artifact of intensive planting, which may not mimic historic vegetative communities.

However, pollen grains of *Salix* spp. and *Quercus* spp. are evident in post-bonito (prehistoric) alluvial fills (Hall 1977), which suggests that riparian tree species occurred there long before twentieth-century humans planted cottonwoods and willows. There are several reasons to conserve this riparian community today: 1. evidence that riparian trees and shrubs of Chaco Wash existed in the region prior to historic time (1935-present), 2. cyclical arroyo formation and subsequent soil development are ancient, natural processes, and 3. riparian woodlands in New Mexico support a higher percentage of breeding avian species than other habitats (New Mexico Partners in Flight 2001).

The greatest threats to native vegetation in Chaco Wash are the encroachment of tamarisk and the increased aggradation of alluvial terraces. Land management practices in the Chaco Wash headwaters, such as overgrazing or shrub/woodland conversion to pasture, may increase rates of sedimentation in the wash. Sediment deposition during over-bank flow events results in soil development in the channel flood plain. This natural process, over time, distances surface plants from the water table and destabilizes soils.

The significance of tamarisk to bird distribution in Chaco Wash is unclear. There is no doubt that this tree species presently provides both cover and foraging habitat for

birds. However, there is very good evidence that persistence of tamarisk can lead to much greater ecological impacts, due to aggressive invasive capabilities. Impacts on riparian habitats from tamarisk include increased soil salinity, increased water consumption, decreased wildlife values, and crowding out of native wetland vegetation (Carpenter 1998). Present stands of tamarisk may have already degraded soils locally. If the National Park Service were to eliminate tamarisk in Chaco Wash, it should be controlled in conjunction with soil rehabilitation and restoration of native riparian habitat, to avoid impacts on breeding and, especially, migratory birds.

Certain measures could be taken to restore riparian habitat without endangering archaeological resources. Surface water impoundments and planting of native riparian shrubs, if constructed below Casa Chiquita, would not endanger cultural sites. They would, however, slow surface flows, allow pooling, and increase available surface water, which would encourage the re-establishment of native willows, grasses, and possibly cottonwoods. Such projects could mimic mesic sites already existing within the park, such as the Wijiji Oxbow, which provides excellent habitat for birds.

Trespass grazing, primarily by mules and horses on Chacra Mesa, is another bird management issue at CCNHP. In addition to the impact on soils and vegetation, domesticated livestock put native grasslands at risk, as dispersers of non-native seed. The southern and southeastern boundary fences on the mesa should be fenced, to eliminate the impact of these grazers on bird habitats.

A pioneering herd of elk, which has become established on CCHP during the last 6 years, could have similar impacts on both grassland and riparian habitats. In other protected arid systems uncontrolled elk herds have had significant adverse effects on

native plant communities (pers. comm. between J. Ramakka and L. Bender, USGS, NMSU Coop. Fish and Wildl. Res. Unit). In order to develop proper management strategies, the park is presently pursuing funding to study the population dynamics, habitat use, and potential impacts of elk on the park.

Brown-headed Cowbirds represent a possible threat to breeding birds, especially throughout the riparian zone and outlying floodplains. Brood parasitism was documented only once during the study, when an adult Black-throated Sparrow (*Amphispiza bilineata*) was observed feeding a fledgling cowbird. However, the impact of cowbirds will remain unknown without further study of breeding birds in Chaco Wash.

In conclusion, CCNHP supports a diverse avifauna over a large area and thus functions as a preserve containing several major biotic communities of the Colorado Plateau. The biological inventory results presented here can serve as a yardstick to measure the contribution of the park to regional bird biodiversity. Within the park, species assemblage information, by habitat and by season, provides a reference by which to gauge the effects of management activities and riparian restoration efforts. In keeping with National Park Service inventory and monitoring goals, this survey should be used as a basis for ongoing, regular monitoring of the avifauna at CCNHP.

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Table 1. Species List

Common Name*	Scientific Name	Habitat**				Status	
		C. F.	Mesa	P/J	Wash	Season	Abundance
Great Blue Heron	<i>Ardea herodias</i>				+	R	r
Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>				(+)	R	r
Turkey Vulture	<i>Cathartes aura</i>	+			+	B	c
Mallard	<i>Anas platyrhynchos</i>		(+)			R	x
Osprey	<i>Pandion haliaetus</i>				(+)	M	x
Northern Harrier	<i>Circus cyaneus</i>	+			+	B	u
Sharp-shinned Hawk	<i>Accipiter striatus</i>			+	+	M	o
Cooper's Hawk	<i>Accipiter cooperii</i>		+		+	B	c
Swainson's Hawk	<i>Buteo swainsoni</i>		(+)			B	r
Red-tailed Hawk	<i>Buteo jamaicensis</i>	(+)	(+)	(+)	(+)	R	c
Golden Eagle	<i>Aquila chrysaetos</i>				(+)	R	u
American Kestrel	<i>Falco sparverius</i>	(+)	(+)	(+)		R	c
Prairie Falcon	<i>Falco mexicanus</i>		+			R	u
Peregrine Falcon	<i>Falco peregrinus</i>		(+)			M	r
Wild Turkey	<i>Meleagris gallopavo</i>	(+)				R	x
Scaled Quail	<i>Callipepla squamata</i>	+	+	+		R	u
Sora	<i>Porzana carolina</i>		+			M	x
Killdeer	<i>Charadrius vociferus</i>	(+)				B	r
Franklin's Gull	<i>Larus pipixcan</i>				(+)	M	r
Mourning Dove	<i>Zenaida macroura</i>	+	+	+	+	B	a
Greater Roadrunner	<i>Geococcyx californianus</i>	(+)				R	r
Western Screech-Owl	<i>Otus kennicottii</i>	(+)				R	r
Great Horned Owl	<i>Bubo virginianus</i>			+	+	R	c
Long-eared Owl	<i>Asio otus</i>				+	B	u
Short-eared Owl	<i>Asio flammeus</i>			(+)		W	x
Common Nighthawk	<i>Chordeiles minor</i>	+	+	+		B	u
Common Poorwill	<i>Phalaenoptilus nuttallii</i>			+		B	u
White-throated Swift	<i>Aeronautes saxatalis</i>			(+)		B	a
Black-chinned Hummingbird	<i>Archilochus alexandri</i>	+		+	+	B	c
Broad-tailed Hummingbird	<i>Selasphorus platycercus</i>	+		+	+	B	c
Rufous Hummingbird	<i>Selasphorus rufus</i>			(+)		M	r
Lewis' Woodpecker	<i>Melanerpes lewis</i>		+			M	r
Red-naped Sapsucker	<i>Sphyrapicus nuchalis</i>				+	M	u
Williamson's Sapsucker	<i>Sphyrapicus thyroideus</i>				(+)	M	r
Downy Woodpecker	<i>Picoides pubescens</i>				+	M	u
Hairy Woodpecker	<i>Picoides villosus</i>				+	M	u
Northern Flicker	<i>Colaptes auratus</i>	+	+	+	+	R	c
Olive-sided Flycatcher	<i>Contopus cooperi</i>		+		(+)	M	r
Western Wood-Pewee	<i>Contopus sordidulus</i>	+		+	+	B	u
Willow Flycatcher	<i>Empidonax traillii</i>				(+)	M	o
Hammond's Flycatcher	<i>Empidonax hammondii</i>			+		M	o
Dusky Flycatcher	<i>Empidonax oberholseri</i>			+	+	M	o
Gray Flycatcher	<i>Empidonax wrightii</i>		+	+		B	c
Cordilleran Flycatcher	<i>Empidonax occidentalis</i>			+	+	M	u

Common Name*	Scientific Name	C. F.	Mesa	P/J	Wash	Season	Abundance
Unidentified <i>Epmidonax</i> spp.			+	+	+		
Say's Phoebe	<i>Sayornis saya</i>	+	+	+	+	B	c
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	+	+	+	+	B	c
Cassin's Kingbird	<i>Tyrannus vociferans</i>	+	+	+	+	B	c
Western Kingbird	<i>Tyrannus verticalis</i>			+	+	B	o
Northern Shrike	<i>Lanius excubitor</i>				+	W	x
Loggerhead Shrike	<i>Lanius ludovicianus</i>	+	+	+	+	R	c
Plumbeous Vireo	<i>Vireo plumbeus</i>			+	+	M	o
Warbling Vireo	<i>Vireo gilvus</i>				+	B	u
Western Scrub-Jay	<i>Aphelocoma californica</i>	+		+	+	R	c
Pinyon Jay	<i>Gymnorhinus cyanocephalus</i>		+	+		R	c
Common Raven	<i>Corvus corax</i>	+	+	+	+	R	c
Horned Lark	<i>Eremophila alpestris</i>	+	+	+	+	R	a
Violet-green Swallow	<i>Tachycineta thalassina</i>	+		+	+	M	o
Barn Swallow	<i>Hirundo rustica</i>		(+)	(+)		M	o
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	+	+	+	+	B	a
Mountain Chickadee	<i>Poecile gambeli</i>		+	+	+	M	u
Juniper Titmouse	<i>Baeolophus griseus</i>		+	+	+	R	c
Bushtit	<i>Psaltriparus minimus</i>		+	+	+	R	c
Red-breasted Nuthatch	<i>Sitta canadensis</i>				(+)	M	r
White-breasted Nuthatch	<i>Sitta carolinensis</i>			+	+	M	o
Brown creeper	<i>Certhia americana</i>			+	+	M	o
Rock Wren	<i>Salpinctes obsoletus</i>	+	+	+	+	B	a
Canyon Wren	<i>Catherpes mexicanus</i>	+		+	+	B	u
Bewick's Wren	<i>Thryomanes bewickii</i>	+	+	+	+	R	c
House Wren	<i>Troglodytes aedon</i>	+		+	+	M	u
Ruby-crowned Kinglet	<i>Regulus calendula</i>	+		+	+	M	u
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	+	+	+	+	B	c
Western Bluebird	<i>Sialia mexicana</i>			+		W	o
Mountain Bluebird	<i>Sialia currucoides</i>	+	+	+		R	u
Townsend's Solitaire	<i>Myadestes townsendi</i>		+	+	+	W	u
Hermit Thrush	<i>Catharus guttatus</i>	+		+	+	M	u
American Robin	<i>Turdus migratorius</i>	(+)		(+)		M	o
Northern Mockingbird	<i>Mimus polyglottos</i>	+	+	+	+	B	c
Sage Thrasher	<i>Oreoscoptes montanus</i>	+	+	+	+	B	u
Cedar Waxwing	<i>Bombycilla cedrorum</i>				(+)	M	r
Orange-crowned Warbler	<i>Vermivora celata</i>	+		+	+	M	u
Nashville Warbler	<i>Vermivora ruficapilla</i>				+	M	o
Virginia's Warbler	<i>Vermivora virginiae</i>			+	+	M	u
Northern Parula	<i>Parula americana</i>			(+)		M	x
Yellow Warbler	<i>Dendroica petechia</i>				+	M	r
Yellow-rumped Warbler	<i>Dendroica coronata</i>	+		+	+	M	u
Black-throated Gray Warbler	<i>Dendroica nigrescens</i>			+	+	M	o
Townsend's Warbler	<i>Dendroica townsendi</i>			+	+	M	o
Grace's Warbler	<i>Dendroica graciae</i>			+		M	r
Black-and-white Warbler	<i>Mniotilta varia</i>				+	M	x

Common Name*	Scientific Name	C. F.	Mesa	P/J	Wash	Season	Abundance
American Redstart	<i>Setophaga ruticilla</i>				(+)	M	x
Macgillivray's Warbler	<i>Oporornis tolmiei</i>	+		+	+	M	u
Wilson's Warbler	<i>Wilsonia pusilla</i>	+			+	M	c
Western Tanager	<i>Piranga ludoviciana</i>	+		+	+	M	o
Green-tailed Towhee	<i>Pipilo chlorurus</i>	+	+	+	+	B	u
Spotted Towhee	<i>Pipilo maculatus</i>		+	+		M	o
Canyon Towhee	<i>Pipilo fuscus</i>	+	+	+	+	R	c
Cassin's Sparrow	<i>Aimophila cassinii</i>	+	+			B	o
American Tree Sparrow	<i>Spizella arborea</i>	(+)				W	r
Chipping Sparrow	<i>Spizella passerina</i>	+	+	+	+	B	a
Clay-colored Sparrow	<i>Spizella pallida</i>		(+)			M	r
Brewer's Sparrow	<i>Spizella breweri</i>	+	+	+	+	B	c
Vesper Sparrow	<i>Pooecetes gramineus</i>	+	+	+	+	M	u
Lark Sparrow	<i>Chondestes grammacus</i>	+	+	+	+	B	c
Black-throated Sparrow	<i>Amphispiza bilineata</i>	+	+	+	+	B	a
Sage Sparrow	<i>Amphispiza belli</i>	+	+		+	R	c
Lark Bunting	<i>Calamospiza melanocorys</i>		+			M	r
Song Sparrow	<i>Melospiza melodia</i>	+			+	W	o
White-throated Sparrow	<i>Zonotrichia albicollis</i>	(+)			(+)	W	o
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	+		+	+	W	u
Dark-eyed Junco	<i>Junco hyemalis</i>	+	+	+	+	W	c
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	+			+	M	o
Blue Grosbeak	<i>Guiraca caerulea</i>				+	B	c
Lazuli Bunting	<i>Passerina amoena</i>				(+)	B	r
Indigo Bunting	<i>Passerina cyanea</i>				+	B	r
Dickcissel	<i>Spiza americana</i>		+			M	r
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	(+)				R	r
Western Meadowlark	<i>Sturnella neglecta</i>	+	+	+	+	B	c
Yellow-headed Blackbird	<i>X. xanthocephalus</i>				+	M	o
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>				(+)	M	r
Common Grackle	<i>Quiscalus quiscula</i>	(+)				M	x
Brown-headed Cowbird	<i>Molothrus ater</i>	+	+	+	+	B	c
Bullock's Oriole	<i>Icterus bullockii</i>				+	B	o
Scott's Oriole	<i>Icterus parisorum</i>	+	+		+	B	u
House Finch	<i>Carpodacus mexicanus</i>	+	+	+	+	R	a
Pine Siskin	<i>Carduelis pinus</i>				(+)	M	r
Lesser Goldfinch	<i>Carduelis psaltria</i>			+	+	B	o
American Goldfinch	<i>Carduelis tristis</i>				+	M	o
House Sparrow (I)	<i>Passer domesticus</i>	(+)				R	o
total =128		62	53	74	93		

*(I)=introduced, non-native species, **(+)) identifies species detected outside transect counts

R=resident, B=breeding season, M=fall and/or spring migration, W=winter.

a=abundant - easy to find, numerous, c=common - certain in suitable habitats, u=uncommon -not often seen, but regular inhabitant, o=occasional - usually seen a few times a season, r=rare - seen once every few years,

x=accidental - recorded, unexpected

Table 2.
Canyon Floor

	Detections (% of total detections)		Count (% of total count)	
	breeding season		all remaining seasons	
	detections	count	detections	count
Turkey Vulture	0 (0.0)	0 (0.0)	1 (0.2)	5 (0.4)
Northern Harrier	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Scaled Quail	3 (1.0)	4 (1.1)	1 (0.2)	8 (0.7)
Mourning Dove	2 (0.7)	3 (0.8)	1 (0.2)	1 (0.1)
Black-chinned Hummingbird	1 (0.4)	1 (0.3)	1 (0.2)	1 (0.1)
Broad-tailed Hummingbird	2 (0.7)	2 (0.5)	1 (0.2)	1 (0.1)
Northern Flicker	0 (0.0)	0 (0.0)	2 (0.4)	2 (0.2)
Western Wood-Pewee	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Say's Phoebe	25 (8.7)	34 (9.0)	34 (6.1)	38 (3.3)
Ash-throated Flycatcher	5 (1.7)	6 (1.6)	5 (0.9)	5 (0.4)
Cassin's Kingbird	1 (0.4)	1 (0.3)	1 (0.2)	1 (0.1)
Loggerhead Shrike	4 (1.4)	11 (2.9)	14 (2.5)	14 (1.2)
Western Scrub-Jay	0 (0.0)	0 (0.0)	1 (0.2)	4 (0.3)
Common Raven	0 (0.0)	0 (0.0)	1 (0.2)	2 (0.2)
Horned Lark	15 (5.2)	25 (6.6)	20 (3.6)	92 (8.0)
Rock Wren	47 (16.3)	56 (14.8)	78 (14.0)	108 (9.3)
Canyon Wren	1 (0.4)	1 (0.3)	4 (0.7)	4 (0.3)
Bewick's Wren	1 (0.4)	1 (0.3)	9 (1.6)	9 (0.8)
House Wren	0 (0.0)	0 (0.0)	4 (0.7)	4 (0.3)
Ruby-crowned Kinglet	0 (0.0)	0 (0.0)	3 (0.5)	4 (0.3)
Blue-gray Gnatcatcher	0 (0.0)	0 (0.0)	9 (1.6)	10 (0.9)
Mountain Bluebird	1 (0.4)	1 (0.3)	0 (0.0)	0 (0.0)
Hermit Thrush	0 (0.0)	0 (0.0)	2 (0.4)	2 (0.2)
Northern Mockingbird	21 (7.3)	28 (7.4)	8 (1.4)	8 (0.7)
Sage Thrasher	1 (0.4)	1 (0.3)	3 (0.5)	3 (0.3)
Orange-crowned Warbler	0 (0.0)	0 (0.0)	4 (0.7)	4 (0.3)
Macgillivray's Warbler	0 (0.0)	0 (0.0)	5 (0.9)	5 (0.4)
Wilson's Warbler	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Western Tanager	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Green-tailed Towhee	1 (0.4)	1 (0.3)	10 (1.8)	10 (0.9)
Canyon Towhee	24 (8.3)	31 (8.2)	68 (12.2)	90 (7.8)
Cassin's Sparrow	6 (2.1)	7 (1.9)	0 (0.0)	0 (0.0)
Chipping Sparrow	0 (0.0)	0 (0.0)	10 (1.8)	33 (2.9)
Brewer's Sparrow	0 (0.0)	0 (0.0)	43 (7.7)	117 (10.1)
Vesper Sparrow	0 (0.0)	0 (0.0)	6 (1.1)	10 (0.9)
Lark Sparrow	6 (2.1)	8 (2.1)	4 (0.7)	4 (0.3)
Black-throated Sparrow	61 (21.2)	81 (21.4)	75 (13.5)	105 (9.1)
Sage Sparrow	0 (0.0)	0 (0.0)	17 (3.1)	51 (4.4)
Song Sparrow	0 (0.0)	0 (0.0)	2 (0.4)	3 (0.3)
White-crowned Sparrow	0 (0.0)	0 (0.0)	14 (2.5)	66 (5.7)
Dark-eyed Junco	0 (0.0)	0 (0.0)	8 (1.4)	43 (3.7)

	breeding season		all remaining seasons	
	detections	count	detections	count
Black-headed Grosbeak	1 (0.4)	1 (0.3)	0 (0.0)	0 (0.0)
Western Meadowlark	32 (11.1)	35 (9.2)	40 (7.2)	47 (4.1)
Brown-headed Cowbird	3 (1.0)	4 (1.1)	0 (0.0)	0 (0.0)
Scott's Oriole	6 (2.1)	6 (1.6)	0 (0.0)	0 (0.0)
House Finch	18 (6.3)	30 (7.9)	44 (7.9)	239 (20.7)
total	288	379	557	1157

Mesa Top

	Detections (% of total detections)		Count (% of total count)	
	breeding season		all remaining seasons	
	detections	count	detections	count
Cooper's Hawk	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Prairie Falcon	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Scaled Quail	6 (2.1)	8 (1.7)	2 (0.4)	6 (0.6)
Sora	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Mourning Dove	2 (0.7)	2 (0.4)	3 (0.6)	4 (0.4)
Lewis' Woodpecker	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Northern Flicker	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Olive-sided Flycatcher	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Gray Flycatcher	0 (0.0)	0(0.0)	9 (1.7)	12 (1.2)
Say's Phoebe	18 (6.4)	20(4.3)	30 (5.5)	38 (3.7)
Ash-throated Flycatcher	1 (0.4)	1(0.2)	0 (0.0)	0 (0.0)
Cassin's Kingbird	1 (0.4)	2(0.4)	3 (0.6)	3 (0.3)
Loggerhead Shrike	2 (0.7)	2(0.4)	8 (1.5)	9 (0.9)
Pinyon Jay	1 (0.4)	17(3.7)	5 (0.9)	23 (2.3)
Common Raven	1 (0.4)	1(0.2)	1 (0.2)	1 (0.1)
Horned Lark	77(27.3)	178(38.6)	140 (25.8)	354 (34.9)
Mountain Chickadee	0 (0.0)	0 (0.0)	2 (0.4)	4 (0.4)
Juniper Titmouse	2 (0.7)	2 (0.4)	6 (1.1)	7 (0.7)
Bushtit	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Rock Wren	9 (3.2)	9 (2.0)	39 (7.2)	42 (4.1)
Bewick's Wren	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Blue-gray Gnatcatcher	0 (0.0)	0 (0.0)	5 (0.9)	5 (0.5)
Mountain Bluebird	0 (0.0)	0 (0.0)	11 (2.0)	42 (4.1)
Townsend's Solitaire	0 (0.0)	0 (0.0)	3 (0.6)	4 (0.4)
Northern Mockingbird	18 (6.4)	25 (5.4)	4 (0.7)	4 (0.4)
Sage Thrasher	0 (0.0)	0 (0.0)	3 (0.6)	4 (0.4)
Green-tailed Towhee	0 (0.0)	0 (0.0)	3 (0.6)	3 (0.3)
Spotted Towhee	0 (0.0)	0 (0.0)	4 (0.7)	4 (0.4)
Canyon Towhee	4 (1.4)	6 (1.3)	14 (2.6)	18 (1.8)
Cassin's Sparrow	2 (0.7)	2 (0.4)	0 (0.0)	0 (0.0)
Chipping Sparrow	0 (0.0)	0 (0.0)	23 (4.2)	100 (9.9)
Brewer's Sparrow	2 (0.7)	3 (0.7)	21 (3.9)	31 (3.1)
Vesper Sparrow	0 (0.0)	0 (0.0)	1 (0.2)	2 (0.2)
Lark Sparrow	19 (6.7)	25 (5.4)	12 (2.2)	16 (1.6)
Black-throated Sparrow	71 (25.2)	100 (21.7)	77 (14.2)	108 (10.7)
Sage Sparrow	10 (3.5)	12 (2.6)	20 (3.7)	35 (3.5)
Lark Bunting	0 (0.0)	0 (0.0)	3 (0.6)	4 (0.4)
Dark-eyed Junco	0 (0.0)	0 (0.0)	7 (1.3)	13 (1.3)
Dickcissel	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Western Meadowlark	27 (9.6)	32 (6.9)	59 (10.9)	78 (7.7)
Brown-headed Cowbird	4 (1.4)	6 (1.3)	1 (0.2)	1 (0.1)
Scott's Oriole	1 (0.4)	1 (0.2)	5 (0.9)	9 (0.9)

	breeding season		all remaining seasons	
	detections	count	detections	count
House Finch	4(1.4)	7(1.5)	9(1.7)	21(2.1)
total	282	461	542	1014

Pinyon/Juniper

	Detections (% of total detections)		Count (% of total count)	
	breeding season		all remaining seasons	
	detections	count	detections	count
Sharp-shinned Hawk	0 (0.0)	0 (0.0)	2 (0.4)	2 (0.3)
Scaled Quail	0 (0.0)	0 (0.0)	1 (0.2)	2 (0.3)
Mourning Dove	4 (1.5)	5 (1.4)	7 (1.4)	12 (1.6)
Great Horned Owl	1 (0.4)	1 (0.3)	2 (0.4)	2 (0.3)
Common Nighthawk	1 (0.4)	1 (0.3)	0 (0.0)	0 (0.0)
Common Poorwill	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Black-chinned Hummingbird	1 (0.4)	1 (0.3)	0 (0.0)	0 (0.0)
Broad-tailed Hummingbird	0 (0.0)	0 (0.0)	3 (0.6)	3 (0.4)
Northern Flicker	2 (0.8)	2 (0.6)	8 (1.6)	9 (1.2)
Western Wood-Pewee	2 (0.8)	2 (0.6)	2 (0.4)	2 (0.3)
Dusky Flycatcher	0 (0.0)	0(0.0)	2(0.4)	2(0.3)
Gray Flycatcher	9 (3.4)	9 (2.5)	30 (5.8)	31 (4.2)
Cordilleran Flycatcher	0 (0.0)	0 (0.0)	3 (0.6)	3 (0.4)
Say's Phoebe	9 (3.4)	12 (3.4)	20 (3.9)	20 (2.7)
Ash-throated Flycatcher	22 (8.3)	25 (7.0)	8 (1.6)	8 (1.1)
Cassin's Kingbird	5 (1.9)	5 (1.4)	0 (0.0)	0 (0.0)
Western Kingbird	0 (0.0)	0 (0.0)	1 (0.2)	2 (0.3)
Loggerhead Shrike	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Plumbeous Vireo	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Western Scrub-Jay	4 (1.5)	5 (1.4)	20 (3.9)	24 (3.2)
Pinyon Jay	10 (3.8)	31 (8.7)	21 (4.1)	79 (10.6)
Common Raven	2 (0.8)	2 (0.6)	4 (0.8)	5 (0.7)
Horned Lark	3 (1.1)	4 (1.1)	2 (0.4)	2 (0.3)
Violet-green Swallow	1 (0.4)	1 (0.3)	0 (0.0)	0 (0.0)
Mountain Chickadee	0 (0.0)	0 (0.0)	5 (1.0)	8 (1.1)
Juniper Titmouse	21 (7.9)	25 (7.0)	77 (15.0)	100 (13.4)
Bushtit	9 (3.4)	26 (7.3)	20 (3.9)	67 (9.0)
White-breasted Nuthatch	0 (0.0)	0 (0.0)	2 (0.4)	2 (0.3)
Brown Creeper	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Rock Wren	25 (9.4)	27 (7.6)	30 (5.8)	35 (4.7)
Canyon Wren	0 (0.0)	0 (0.0)	2 (0.4)	2 (0.3)
Bewick's Wren	40 (15.0)	43 (12.1)	50 (9.7)	54 (7.3)
House Wren	0 (0.0)	0 (0.0)	2 (0.4)	2 (0.3)
Ruby-crowned Kinglet	0 (0.0)	0 (0.0)	9 (1.8)	10 (1.3)
Blue-gray Gnatcatcher	1 (0.4)	1 (0.3)	24 (4.7)	27 (3.6)
Western Bluebird	0 (0.0)	0 (0.0)	5 (1.0)	16 (2.2)
Mountain Bluebird	2 (0.8)	2 (0.6)	2 (0.4)	3 (0.4)
Townsend's Solitaire	0 (0.0)	0 (0.0)	13 (2.5)	15 (2.0)
Hermit Thrush	0 (0.0)	0 (0.0)	2 (0.4)	2 (0.3)
Northern Mockingbird	7 (2.6)	7 (2.0)	2 (0.4)	3 (0.4)
Sage Thrasher	0 (0.0)	0 (0.0)	2 (0.4)	9 (1.2)
Virginia's Warbler	0 (0.0)	0 (0.0)	4 (0.8)	4 (0.5)

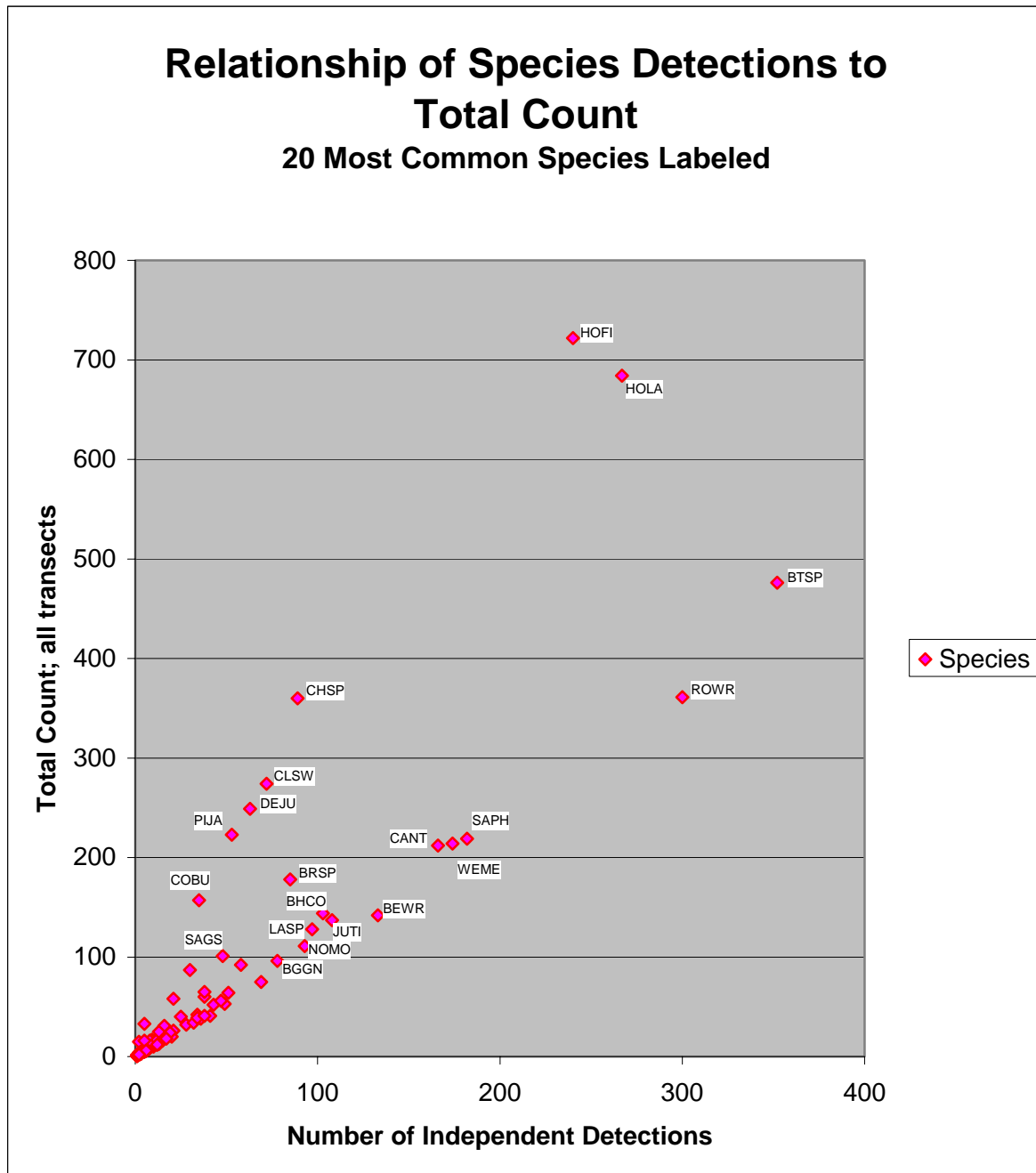
	breeding season		all remaining seasons	
	detections	count	detections	count
Yellow-rumped Warbler	0 (0.0)	0 (0.0)	3 (0.6)	6 (0.8)
Black-throated Gray Warbler	0 (0.0)	0 (0.0)	3 (0.6)	4 (0.5)
Townsend's Warbler	0 (0.0)	0 (0.0)	3 (0.6)	3 (0.4)
Grace's Warbler	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Macgillivray's Warbler	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Western Tanager	1 (0.4)	1 (0.3)	5 (1.0)	5 (0.7)
Green-tailed Towhee	0 (0.0)	0 (0.0)	3 (0.6)	3 (0.4)
Spotted Towhee	0 (0.0)	0 (0.0)	7 (1.4)	8 (1.1)
Canyon Towhee	12 (4.5)	12 (3.4)	15 (2.9)	18 (2.4)
Chipping Sparrow	3 (1.1)	3 (0.8)	17 (3.3)	35 (4.7)
Brewer's Sparrow	0 (0.0)	0 (0.0)	2 (0.4)	2 (0.3)
Vesper Sparrow	0 (0.0)	0 (0.0)	2 (0.4)	3 (0.4)
Lark Sparrow	23 (8.6)	31 (8.7)	11 (2.1)	15 (2.0)
Black-throated Sparrow	20 (7.5)	21 (5.9)	12 (2.3)	15 (2.0)
White-crowned Sparrow	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Dark-eyed Junco	0 (0.0)	0 (0.0)	16 (3.1)	27 (3.6)
Black-headed Grosbeak	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Western Meadowlark	1 (0.4)	1 (0.3)	2 (0.4)	2 (0.3)
Brown-headed Cowbird	7 (2.6)	7 (2.0)	1 (0.2)	1 (0.1)
House Finch	16 (6.0)	41 (11.5)	17 (3.3)	22 (3.0)
Lesser Goldfinch	2 (0.8)	2 (0.6)	0 (0.0)	0 (0.0)
total	266	356	514	744

Riparian

	Detections (% of total detections)		Count (% of total count)	
	breeding season		all remaining seasons	
	detections	count	detections	count
Great Blue Heron	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Turkey Vulture	2 (0.6)	15 (3.5)	2 (0.3)	13 (1.0)
Northern Harrier	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Sharp-shinned Hawk	0 (0.0)	0 (0.0)	3 (0.4)	3 (0.2)
Cooper's Hawk	5 (1.6)	5 (1.2)	6 (0.8)	7 (0.5)
Mourning Dove	16 (5.2)	24 (5.6)	7 (1.0)	12 (0.9)
Great Horned Owl	1 (0.3)	1 (0.2)	8 (1.1)	8 (0.6)
Long-eared Owl	2 (0.6)	4 (0.9)	1 (0.1)	1 (0.1)
Black-chinned Hummingbird	3 (1.0)	3 (0.7)	4 (0.6)	4 (0.3)
Broad-tailed Hummingbird	2 (0.6)	2 (0.5)	9 (1.3)	13 (1.0)
Red-naped Sapsucker	0 (0.0)	0 (0.0)	7 (1.0)	7 (0.5)
Downy Woodpecker	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Hairy Woodpecker	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Northern Flicker	0 (0.0)	0 (0.0)	17 (2.4)	21 (1.6)
Western Wood-Pewee	7 (2.3)	7 (1.6)	5 (0.7)	6 (0.5)
Hammond's Flycatcher	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Dusky Flycatcher	0 (0.0)	0 (0.0)	4 (0.6)	4 (0.3)
Cordilleran Flycatcher	0 (0.0)	0 (0.0)	3 (0.4)	4 (0.3)
Say's Phoebe	18 (5.8)	21 (4.9)	22 (3.1)	28 (2.1)
Ash-throated Flycatcher	17 (5.5)	17 (4.0)	8 (1.1)	10 (0.8)
Cassin's Kingbird	3 (1.0)	3 (0.7)	1 (0.1)	1 (0.1)
Western Kingbird	1 (0.3)	2 (0.5)	0 (0.0)	0 (0.0)
Northern Shrike	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Loggerhead Shrike	0 (0.0)	0 (0.0)	4 (0.6)	4 (0.3)
Plumbeous Vireo	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Warbling Vireo	3 (1.0)	3 (0.7)	10 (1.4)	10 (0.8)
Western Scrub-Jay	10 (3.2)	11 (2.6)	16 (2.2)	20 (1.5)
Common Raven	1 (0.3)	1 (0.2)	0 (0.0)	0 (0.0)
Horned Lark	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Violet-green Swallow	1 (0.3)	1 (0.2)	0 (0.0)	0 (0.0)
Cliff Swallow	1 (0.3)	27 (6.3)	0 (0.0)	0 (0.0)
Mountain Chickadee	0 (0.0)	0 (0.0)	6 (0.8)	8 (0.6)
Juniper Titmouse	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Bushtit	0 (0.0)	0 (0.0)	5 (0.7)	63 (4.8)
White-breasted Nuthatch	0 (0.0)	0 (0.0)	4 (0.6)	4 (0.3)
Brown Creeper	0 (0.0)	0 (0.0)	2 (0.3)	2 (0.2)
Rock Wren	28 (9.0)	31 (7.2)	41 (5.7)	50 (3.8)
Canyon Wren	0 (0.0)	0 (0.0)	3 (0.4)	3 (0.2)
Bewick's Wren	4 (1.3)	5 (1.2)	28 (3.9)	29 (2.2)
House Wren	0 (0.0)	0 (0.0)	30 (4.2)	32 (2.4)
Ruby-crowned Kinglet	0 (0.0)	0 (0.0)	26 (3.6)	27 (2.0)
Blue-gray Gnatcatcher	0 (0.0)	0 (0.0)	39 (5.4)	53 (4.0)

	breeding season		all remaining seasons	
	detections	count	detections	count
Townsend's Solitaire	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Hermit Thrush	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Northern Mockingbird	24 (7.7)	26 (6.1)	7 (1.0)	7 (0.5)
Orange-crowned Warbler	0 (0.0)	0 (0.0)	8 (1.1)	11 (0.8)
Nashville Warbler	0 (0.0)	0 (0.0)	2 (0.3)	3 (0.2)
Virginia's Warbler	0 (0.0)	0 (0.0)	14 (2.0)	19 (1.4)
Yellow Warbler	0 (0.0)	0 (0.0)	2 (0.3)	2 (0.2)
Yellow-rumped Warbler	0 (0.0)	0 (0.0)	30 (4.2)	52 (3.9)
Black-throated Gray Warbler	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
Townsend's Warbler	0 (0.0)	0 (0.0)	3 (0.4)	3 (0.2)
Black-and-white Warbler	1 (0.3)	1 (0.2)	0 (0.0)	0 (0.0)
Macgillivray's Warbler	1 (0.3)	1 (0.2)	25 (3.5)	27 (2.0)
Wilson's Warbler	2 (0.6)	2 (0.5)	44 (6.1)	53 (4.0)
Western Tanager	0 (0.0)	0 (0.0)	5 (0.7)	5 (0.4)
Green-tailed Towhee	1 (0.3)	1 (0.2)	23 (3.2)	23 (1.7)
Canyon Towhee	12 (3.9)	14 (3.3)	16 (2.2)	22 (1.7)
Chipping Sparrow	0 (0.0)	0 (0.0)	28 (3.9)	140 (10.6)
Brewer's Sparrow	0 (0.0)	0 (0.0)	15 (2.1)	18 (1.4)
Vesper Sparrow	0 (0.0)	0 (0.0)	2 (0.3)	4 (0.3)
Lark Sparrow	8 (2.6)	9 (2.1)	9 (1.3)	13 (1.0)
Black-throated Sparrow	22 (7.1)	28 (6.5)	13 (1.8)	17 (1.3)
Sage Sparrow	0 (0.0)	0 (0.0)	1 (0.1)	3 (0.2)
Song Sparrow	0 (0.0)	0 (0.0)	19 (2.7)	23 (1.7)
White-crowned Sparrow	1 (0.3)	1 (0.2)	14 (2.0)	19 (1.4)
Dark-eyed Junco	0 (0.0)	0 (0.0)	32 (4.5)	166 (12.5)
Blue Grosbeak	36 (11.6)	39 (9.1)	7 (1.0)	13 (1.0)
Indigo Bunting	1 (0.3)	1 (0.2)	0 (0.0)	0 (0.0)
Western Meadowlark	0 (0.0)	0 (0.0)	2 (0.3)	2 (0.2)
Yellow-headed Blackbird	0 (0.0)	0 (0.0)	2 (0.3)	2 (0.2)
Brown-headed Cowbird	36 (11.6)	42 (9.8)	22 (3.1)	33 (2.5)
Bullock's Oriole	5 (1.6)	6 (1.4)	2 (0.3)	3 (0.2)
Scott's Oriole	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)
House Finch	34 (11.0)	74 (17.2)	33 (4.6)	167 (12.6)
Lesser Goldfinch	1 (0.3)	1 (0.2)	0 (0.0)	0 (0.0)
American Goldfinch	0 (0.0)	0 (0.0)	2 (0.3)	15 (1.1)
total	310	429	716	1325

Figure 1.



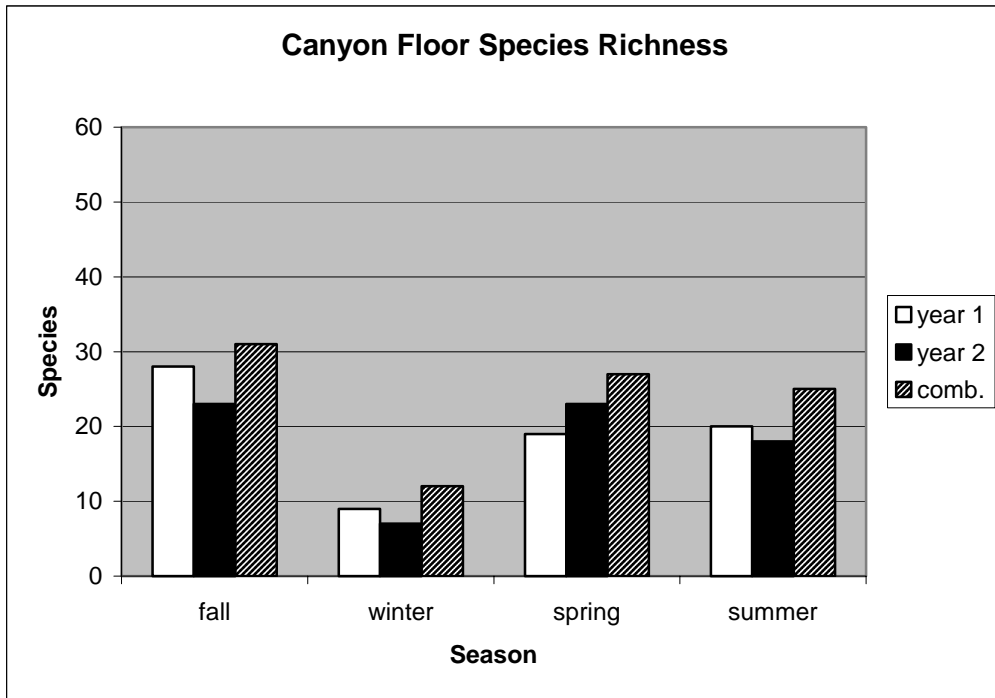
Abbreviations:

BEWR=Bewick's Wren, BGGN=Blue-gray Gnatcatcher, BHCO=Brown-headed Cowbird, BRSP=Brewer's Sparrow, BTSP=Black-throated Sparrow, CANT=Canyon Towhee, CHSP=Chipping Sparrow, CLSW=Cliff Swallow, COBU=Bushtit, DEJU=Dark-eyed Junco, HOFI=House Finch, HOLA=Horned Lark, JUTI=Juniper Titmouse, LASP=Lark Sparrow, NOMO=Northern Mockingbird, PIJA=Pinyon Jay, ROWR=Rock Wren, SAGS=Sage Sparrow, SAPH=Say's Phoebe, WEME=Western Meadowlark.

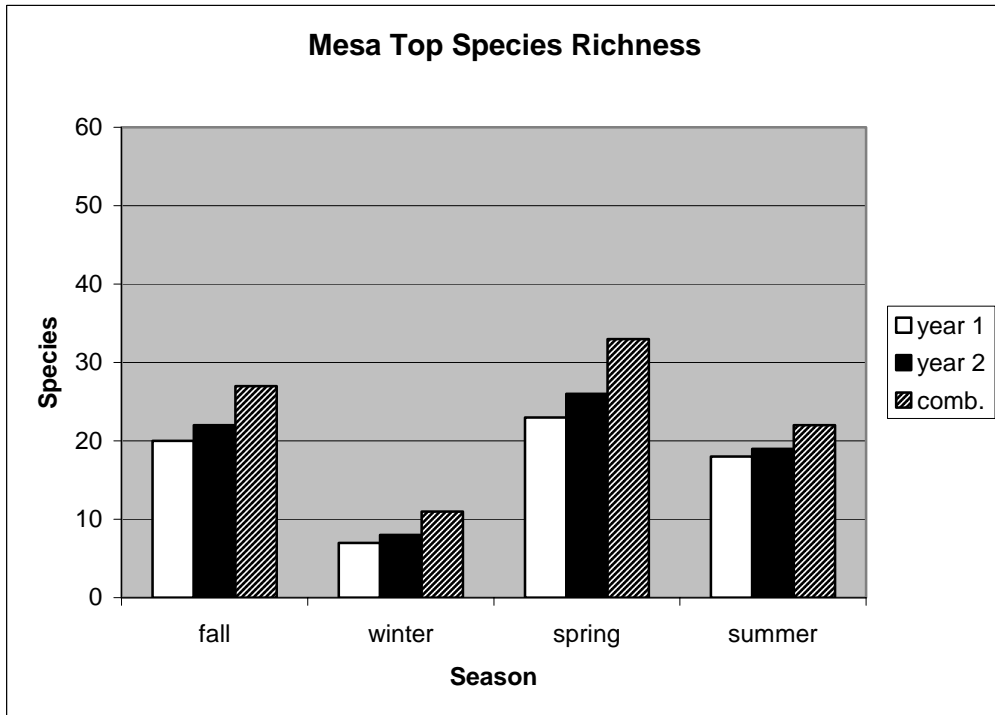
Note: 20 labeled species account for 70% of total detections and 77% of total count.

Figures 2-5. Avian species richness in four habitats.

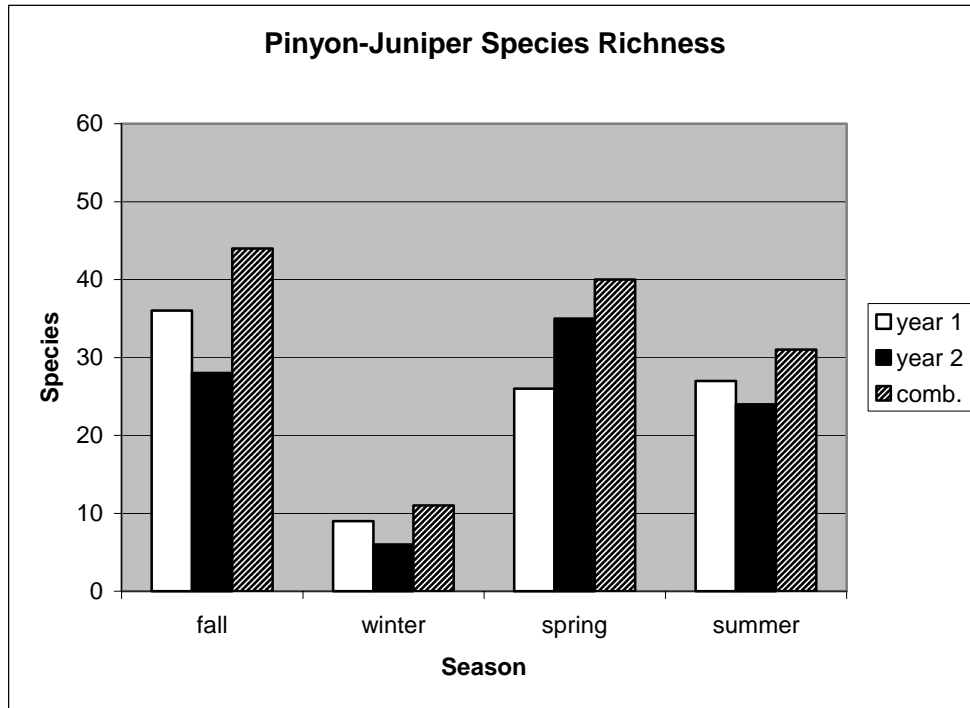
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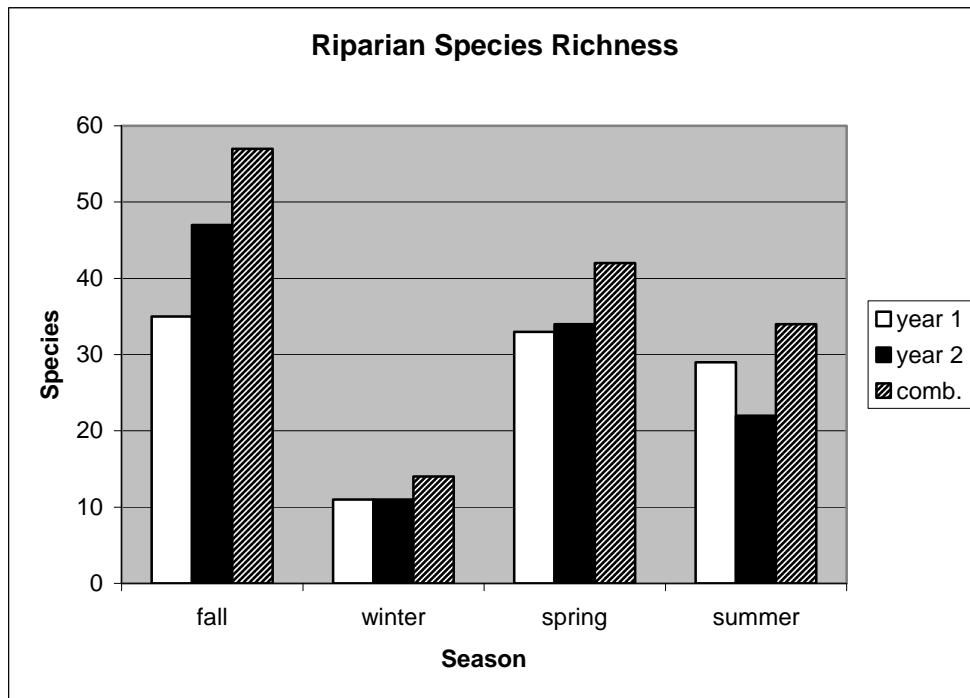
3.



4.

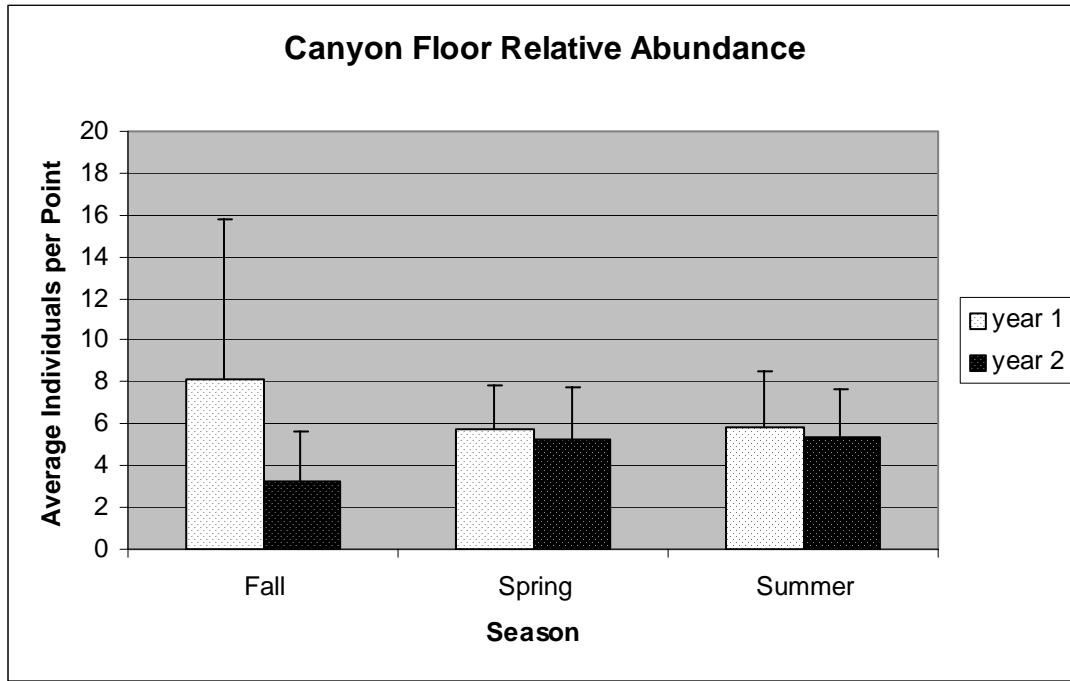


5.

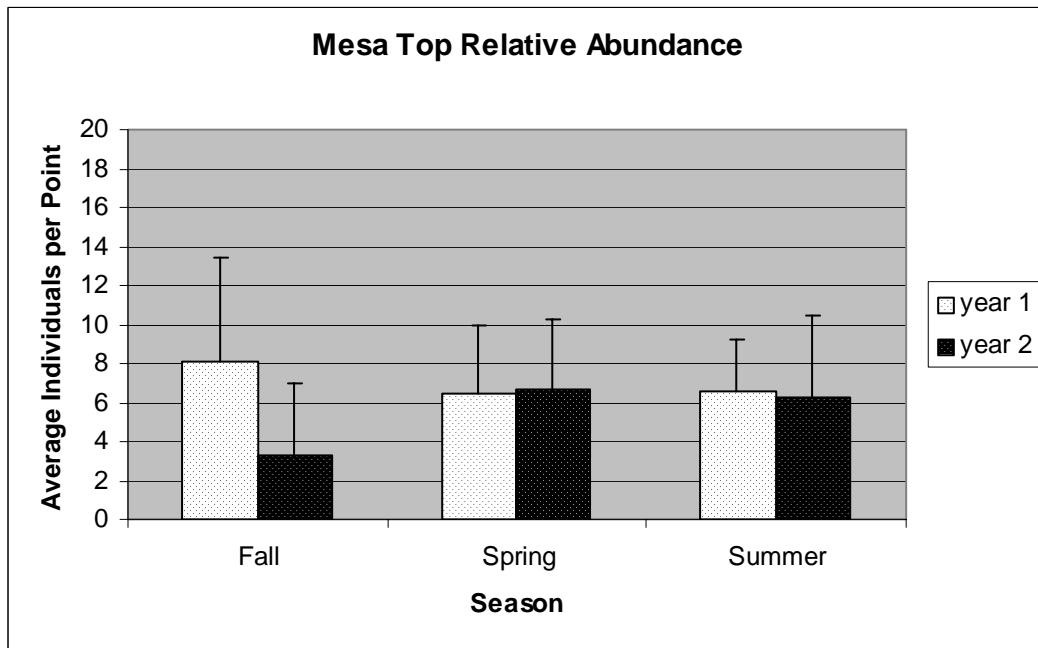


Figures 6-9. Avian relative abundance in four habitats.

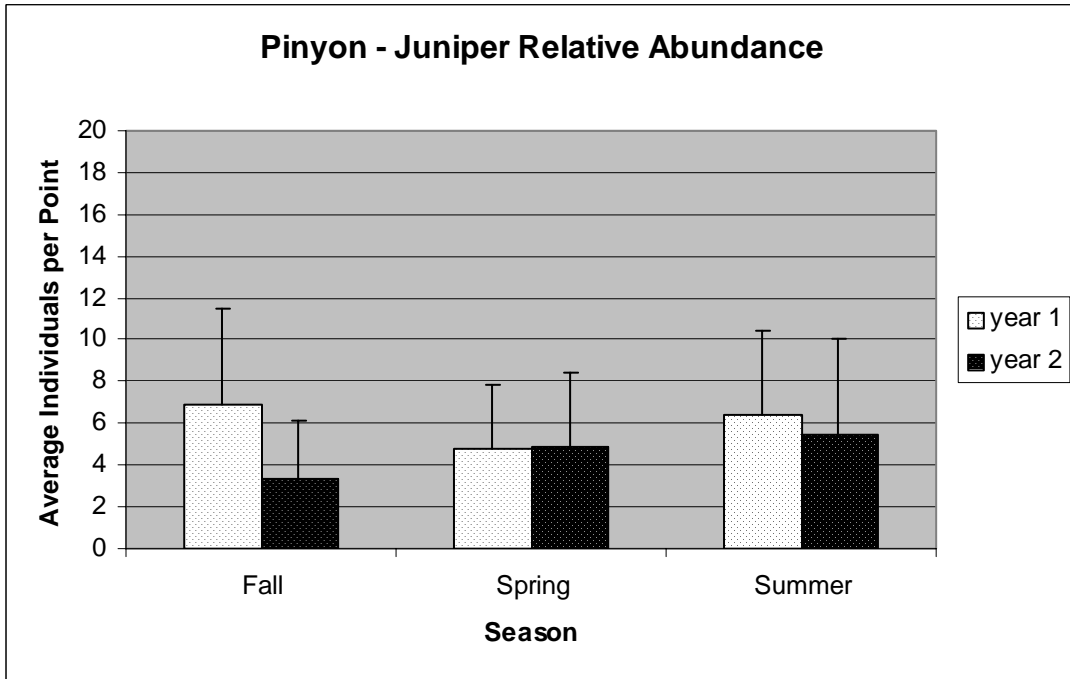
6.



7.



8.



9.

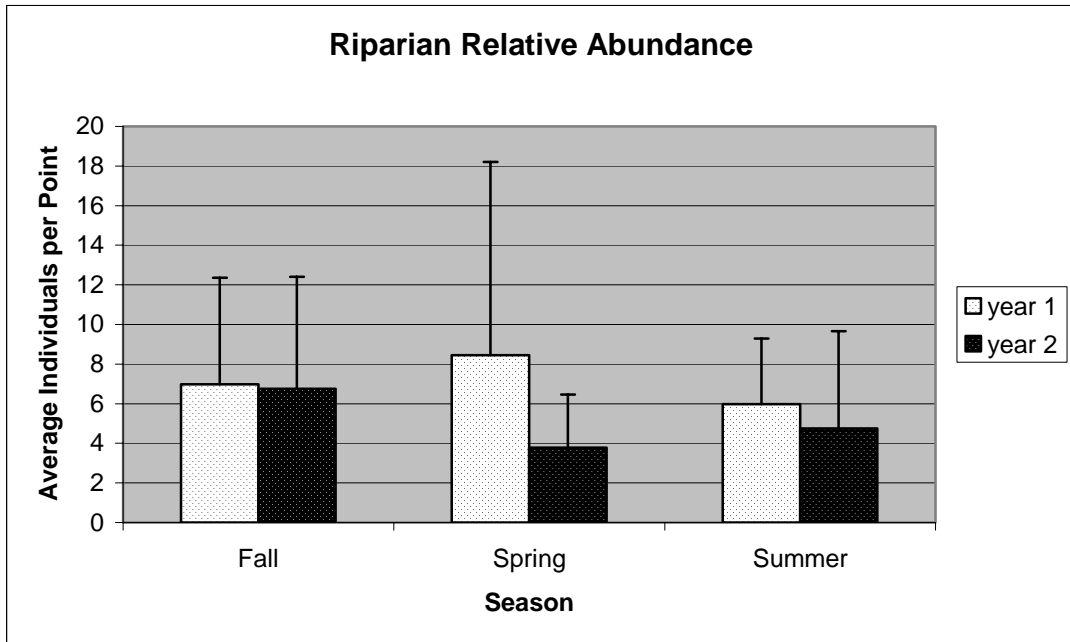


Figure 10. Winter Relative Abundance

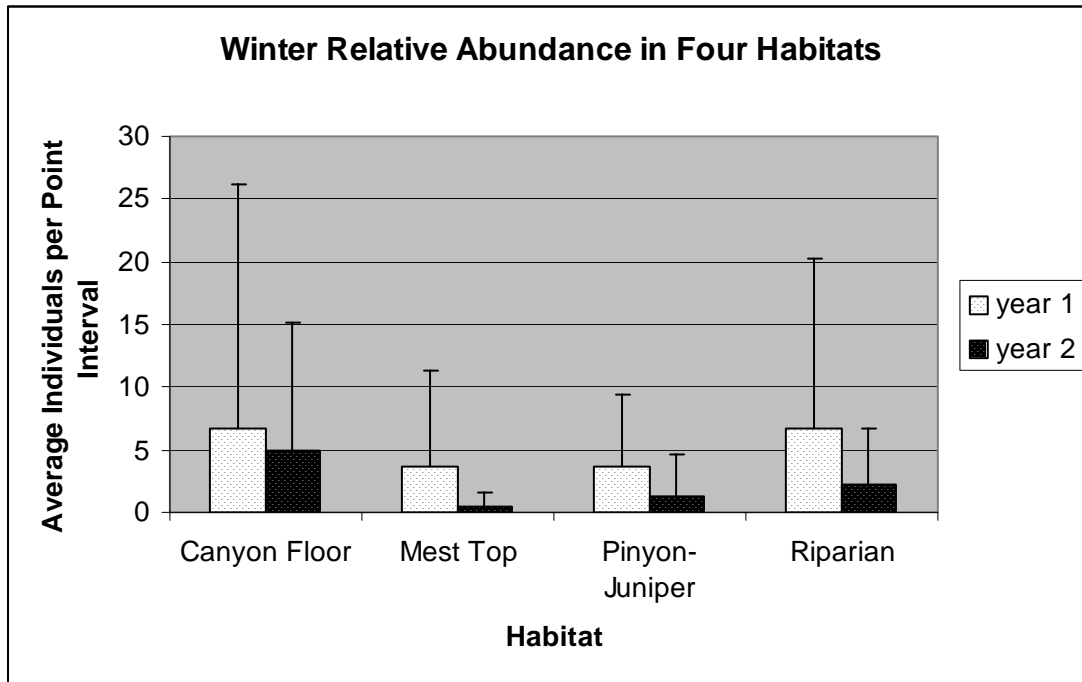
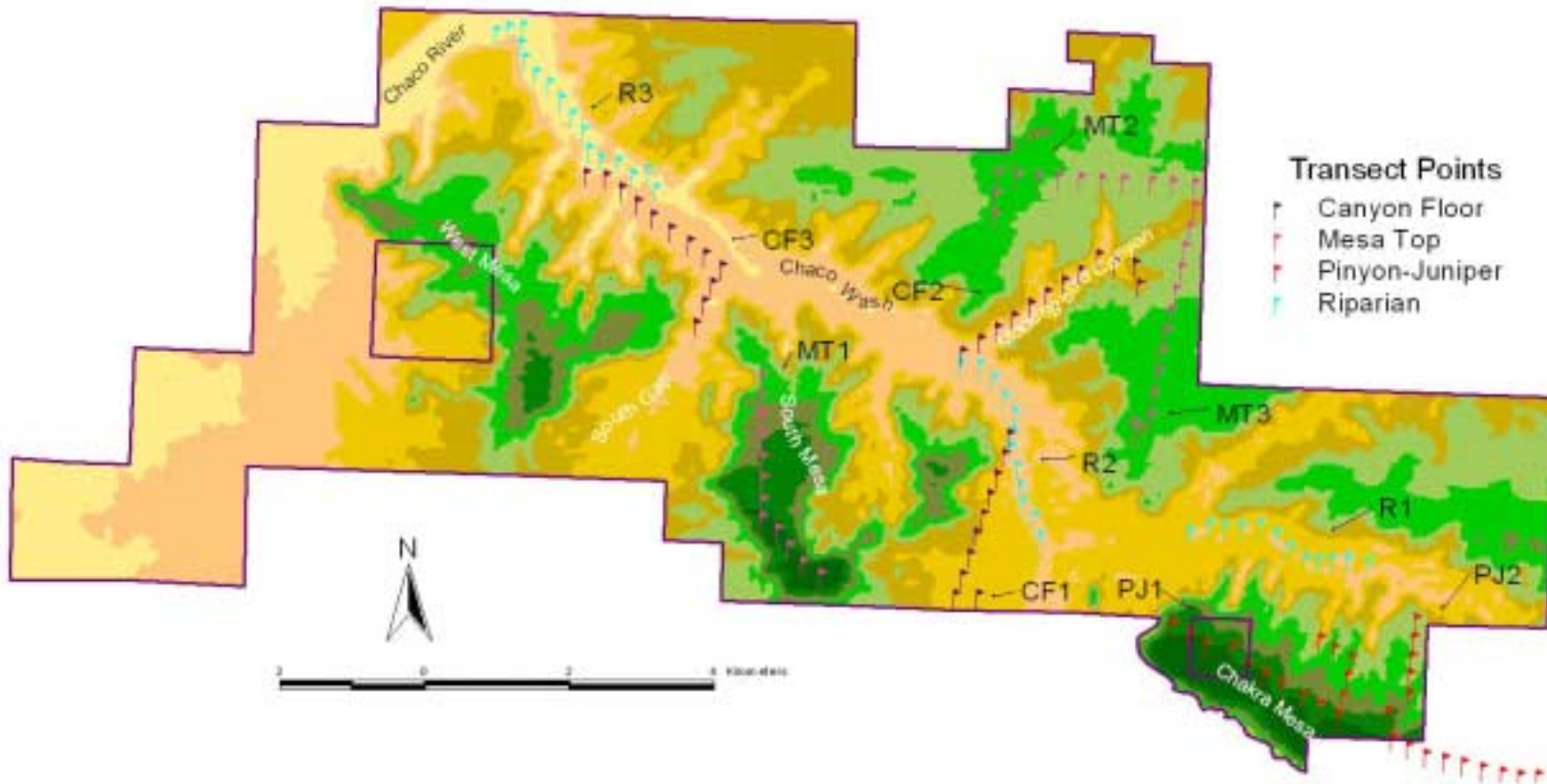


Figure 11. Map of Transect Points



Appendix 1. GPS UTM
coordinates, in NAD 27.

CF1	1	3989693	236258	MT1	11	3990148	233836	PJ2	8	3987598	242192
CF1	2	3989688	235950	MT1	12	3989984	234085	PJ2	9	3987492	242433
CF1	3	3989965	236041	MT2	1	3995391	239250	PJ2	10	3987436	242692
CF1	4	3990253	236140	MT2	2	3995408	238949	PJ2	11	3987367	242951
CF1	5	3990540	236235	MT2	3	3995420	238660	PJ2	12	3987299	243212
CF1	6	3990808	236326	MT2	4	3995436	238263	PJ2	13	3987237	243485
CF1	7	3991081	236421	MT2	5	3995451	237964	PJ2	14	3987200	243729
CF1	8	3991357	236525	MT2	6	3995461	237669	PJ2	15	3987198	243982
CF1	9	3991641	236620	MT2	7	3995474	237374	R1	1	3990156	241654
CF1	10	3991919	236686	MT2	8	3995486	237084	R1	2	3990213	241363
CF2	1	3993061	236049	MT2	9	3995500	236808	R1	3	3990185	241138
CF2	2	3993226	236286	MT2	10	3995517	236529	R1	4	3990170	240952
CF2	3	3993389	236523	MT2	11	3995238	236505	R1	5	3990217	240772
CF2	4	3993552	236753	MT2	12	3994953	236482	R1	6	3990361	240566
CF2	5	3993714	236988	MT3	1	3995075	239251	R1	7	3990541	240375
CF2	6	3993883	237212	MT3	2	3994790	239186	R1	8	3990681	240150
CF2	7	3994037	237440	MT3	3	3994507	239117	R1	9	3990644	239896
CF2	8	3994188	237670	MT3	4	3994220	239056	R1	10	3990649	239672
CF2	9	3994391	237924	MT3	5	3993925	238986	R1	11	3990670	239467
CF2	10	3994292	238143	MT3	6	3993635	238921	R1	12	3990576	239177
CF2	11	3994284	238429	MT3	7	3993348	238864	R2	1	3990505	237111
CF2	12	3993987	238482	MT3	8	3993059	238797	R2	2	3990787	237038
CF3	1	3993442	232368	MT3	9	3992763	238735	R2	3	3990987	236881
CF3	2	3993749	232487	MT3	10	3992471	238676	R2	4	3991214	236840
CF3	3	3994003	232599	MT3	11	3992174	238634	R2	5	3991476	236806
CF3	4	3994244	232732	MT3	12	3992053	238412	R2	6	3991739	236720
CF3	5	3994416	232502	PJ1	1	3989091	240974	R2	7	3991974	236756
CF3	6	3994591	232276	PJ1	2	3988963	241178	R2	8	3992226	236773
CF3	7	3994762	232014	PJ1	3	3988826	241405	R2	9	3992455	236624
CF3	8	3994944	231777	PJ1	4	3988572	241346	R2	10	3992691	236477
CF3	9	3995134	231562	PJ1	5	3988315	241292	R2	11	3992876	236291
CF3	10	3995317	231337	PJ1	6	3988041	241229	R2	12	3992895	236013
CF3	11	3995493	231124	PJ1	7	3988173	240985	R3	1	3995316	231820
CF3	12	3995519	230844	PJ1	8	3988295	240741	R3	2	3995583	231709
MT1	1	3992725	233281	PJ1	9	3988467	240438	R3	3	3995514	231502
MT1	2	3992433	233277	PJ1	10	3988597	240216	R3	4	3995691	231303
MT1	3	3992186	233277	PJ1	11	3988736	239976	R3	5	3995734	231056
MT1	4	3991881	233286	PJ1	12	3988968	239782	R3	6	3995865	230894
MT1	5	3991593	233293	PJ1	13	3989019	239408	R3	7	3996132	230824
MT1	6	3991304	233288	PJ1	14	3989162	239182	R3	8	3996351	230662
MT1	7	3991009	233283	PJ1	15	3989290	238939	R3	9	3996568	230510
MT1	8	3990766	233279	PJ2	1	3989358	242312	R3	10	3996775	230345
MT1	9	3990608	233485	PJ2	2	3989097	242282	R3	11	3996927	230159
MT1	10	3990378	233655	PJ2	3	3988850	242245	R3	12	3997129	230013
				PJ2	4	3988591	242219	R3	13	3997326	229963
				PJ2	5	3988331	242201	R3	14	3997567	229983
				PJ2	6	3988062	241922	R3	15	3997557	229783
				PJ2	7	3987724	241968	R3	16	3997506	229616