

QUIVERA RESEARCH CENTER

BASELINE BIOLOGY OF BIRDS

AND MAMMALS AT

CHACO CANYON NATIONAL MONUMENT

NEW MEXICO

I Bird Communities of Four Habitats

II Annotated Species List of Birds

III Small Mammal Communities of Four Habitats

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GENERAL INTRODUCTION

The field work reported here was conducted during 1978-1980. During this period I have been studying birds and mammals at Chaco Canyon National Monument with two major goals in mind. One is to learn what species occur in the monument and what their habitat affinities are. This is straightforward and can be accomplished by simply listing the species found in each habitat and in the monument as a whole. The second goal has been to try to arrange the data in some way that will allow biologists to monitor changes that occur at Chaco Canyon in the future. These baseline data are necessary before Park Service personnel can determine whether their management practices are affecting wildlife positively or negatively. They are also necessary if changes in wildlife that might result from widespread environmental changes (such as those that might be caused by mineral development around the park) are to be detected.

Although many similar studies have resulted in species lists, such lists are of little value for management purposes. In spatially and temporally fluctuating environments, a simple cataloging of species present at a habitat site yields very little information that can be used to verify community changes, since component species come and go. For this reason, I felt it was imperative to employ a community measure that nearly any trained biologist could use and that would allow long-term comparisons of wildlife communities within, as well as among, habitats. Peet's review (1974) indicates that the most appropriate community index for conditions like those at Chaco is a diversity index. For communities with numerous rare species he has shown that the Shannon-Weaver Index $H' = -\sum p_i \log p_i$ (used in the following bird studies) is most sensitive to change. For

communities that are primarily composed of common species (like mammal communities at Chaco Canyon), he recommends using Hill's Index $H = 1/\sum p_i^2$. In both of these formulae, p_i is the proportion of the community made up of the i^{th} species. In these indices, diversity has two major components: 1) the number of species present (richness), and 2) the relative numbers of individuals of each species (evenness). The diversity index can be thought of as describing a number of "species equivalents" in an equally diverse community where all species present consist of equal populations. If each species in the community has equal populations, richness and diversity are the same. If the proportions of each species in the community are not equal, the diversity index will be lower than the richness. This is nearly always the case in natural systems. Evenness is the ratio of species actually present in the community to the number of "species equivalents" calculated from a diversity index for the community.

The value of using a community measure, instead of a list of species, is that if the resource base remains the same through time, the consuming community should remain similar even though the species composition might change. Likewise, if the resource base is altered, a difference should be detectable through a change in subsequent diversity indices.

PART 1

BASELINE BIOLOGY OF BIRDS AT
CHACO CANYON NATIONAL MONUMENT, NEW MEXICO:
COMMUNITIES OF FOUR HABITATS

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For two years I have been gathering population data on birds in four habitats at Chaco Canyon National Monument, San Juan County, New Mexico. Chaco Canyon is located in the center of the San Juan Basin (Fig. 1) which contains tremendous stores of coal and uranium, and is currently undergoing intensive mineral exploration. Boom towns with populations projected as high as 20,000 people are expected in the next 15-20 years. If these projections are realized, the National Park Service wants to be able to recognize changes that occur in the bird communities.

Bird species composition varies seasonally at Chaco Canyon as do population levels of the component species. Some species occupy only one habitat whereas others may occur in several. For these reasons simply listing the species that occur in each habitat is more confusing than enlightening to anyone trying to see patterns of bird use. To compare bird communities of different habitats, and to detect seasonal differences within communities, I have used the Shannon-Weaver index of diversity: $H' = -\sum p_i \ln p_i$ (Shannon and Weaver 1963). This index accounts for two factors: species number or richness, and the relative populations of the component species (evenness). Tramer (1969) found that diversity in breeding bird communities was highly correlated with richness. He suggests that correlation occurs because the territorial behavior of most breeding species causes relative populations, and, therefore, evenness, to remain stable and high. He predicts that during the non-breeding season evenness will become a more important part of diversity since the birds' behavior is non-territorial, and the birds will tend to cluster around food resources.

At Chaco Canyon migrating birds constitute an important part of the bird community during most months. If Tramer's hypothesis, that evenness

is dampened by territorial behavior, is correct, the diversity at Chaco Canyon should be affected more by fluctuations in evenness than are breeding populations where transient birds do not occur or are not considered by the observer.

METHODS

I conducted 77 bird censuses along five transects in four habitat types at Chaco Canyon National Monument. The censuses cover the period 17 October 1978 to 31 July 1980. Censuses were conducted from March through November; no mid-winter censuses were run. Each study site consisted of a 1.6 km transect marked by numbered stakes at 31 m intervals. All birds observed on the ground or in trees or shrubs were counted. If birds were seen overhead or outside of the transect boundaries, they were noted, but their numbers were not included in this report. All censuses were begun within 30 min after sunrise and usually lasted 1.5 to 2 h. Birds were counted as I walked along the transect with frequent stops (at least every 93 m) to listen and look for birds. Because birds sometimes flew ahead of me, I took special care to avoid recounting the same birds. All birds seen within a transect were given equal importance, regardless of activity. In this report breeding birds are not separated from non-breeding birds.

At Chaco Canyon migrating birds were an important part of the bird communities during all seasons that I worked there. Since I wanted to examine the bird use of the habitats I did not eliminate migrants from the analysis, which would have underrepresented the bird communities. Furthermore, the measure of bird communities was the Shannon-Weaver index of diversity which requires that all species present in the community be

counted (Pielou 1974). Peet (1974) points out that the error due to missed species will be small in ecological studies. In this study $H' = -\sum p_i \ln p_i$ is used to describe the community found at each census. p_i is the proportion of the sample contributed by the i^{th} species. Evenness (J) = H'/H_{max} where H_{max} = the natural log of the number of species encountered. Richness is simply the number of species encountered. Richness (R) and J were then compared by correlation with H' to see which contributed most of the variability of H' in each habitat. (Note that since R and J are not independent of H' , statistical significance levels of r , the correlation coefficient, are not appropriate. r nevertheless, provides a relative measure of how closely related these factors are to H' .)

When a diversity index is used to describe bird communities the following assumption must hold: changes in species present in a habitat will be characterized by changes in relative populations of the component species. Likewise, if the habitat changes, a species' dispersion, and therefore, relative numbers, will change as well. This seems to be a reasonable assumption.

To determine whether there were differences among the bird communities of the five transects, the diversity indices calculated for each census were tested by a single factor analysis of variance and the Student-Newman-Keuls multiple range test (Zar 1974). Differences were considered significant where $p < .05$.

THE STUDY AREAS

I established five study areas at Chaco Canyon to gather avian population data (Fig. 2). The areas were chosen from Kelley and Potter's (1974) vegetation map of Chaco Canyon National Monument. The principal criteria for the choices

were that each area include habitat sufficient to lay out a transect 1.6 km long by 120 m wide, that habitat areas differ from each other and that, in combination, the areas constitute a representative sample of monument habitats. No effort was made to duplicate Scott's work (in prep.), since his study is more recent and his methods are similar to those used in this study.

Area 1. The Bench. Kelley and Potter refer to this habitat as Hilaria Bouteloua with Atriplex. However, A. Cully's analysis indicates that the dominant vegetation is Artemisia biglovii, Ephedra viridis and Hilaria jamesii (pers. comm.). The bird transect begins in the SE $\frac{1}{4}$, NW $\frac{1}{4}$, NE $\frac{1}{4}$ of section 11 T21N, R11W and runs WNW into section 3.

Area 2. Casa Chiquita. This habitat and Pueblo Bonito (Area 3) are indicated as the same on Kelley and Potter's map. Dominant vegetation consists of Sarcobatus vermiculatus and Atriplex canescens. The bird transect at Area 2 begins in the NE $\frac{1}{4}$, SW $\frac{1}{4}$, NW $\frac{1}{4}$ of section 11 T21N, R11W, and runs NW into section 3.

Area 3. Pueblo Bonito. The vegetation is somewhat denser than at Area 2 and contains more Atriplex canescens and less A. obovata. This transect begins at the visitor register at Chetro Kettle Ruin, passes the front of Pueblo Bonito Ruin and ends 30 m west of Kin Kletso Ruin.

Area 4. Pinyon-Juniper. The bird transect in the pinyon-juniper woodland begins in the SW $\frac{1}{4}$, NW $\frac{1}{4}$, SE $\frac{1}{4}$, section 26 T21N, R10W, and runs SSW for 1.6 km.

Area 5. The Wash. This habitat lies within the erosion channel of the Chaco River. Although the Chaco River drains a large area it is usually dry. The vegetation is characterized by cottonwoods, willows and tamarisk.

The bird transect begins in the middle of section 11 and continues down the wash in a westerly direction.

RESULTS

The results of the bird censuses are shown in Tables 1-5. The wash contains the greatest number of species (58) followed by the two floodplain sites, Casa Chiquita (45) and Pueblo Bonito (45), the pinyon-juniper site (41) and finally the bench (12) (see Fig. 3). In the wash the diversity of birds dropped during the winter when most birds in the monument were granivorous. The pinyon-juniper habitat exhibited a similar pattern of use; the greatest numbers of species occurred during seasons when insects were available. Seasonal use of the shrubby floodplain sites did not vary as much as the areas containing trees, which may be a function of winter seed availability on the clay soils of the floodplain.

The high diversity of birds occurring in the wash during the breeding season was probably related to the cottonwood trees found there. There were a number of species of birds that nest in the cottonwoods. These include Mourning Doves, Western and Cassin's Kingbirds, Ash-throated Flycatchers, Bullock's Orioles, Blue Grosbeaks and House Finches. Because of the scarcity of cottonwoods in the San Juan Basin, these species were probably attracted from a large area and concentrated in the monument, particularly along the wash. Many migrants, such as warblers, were also concentrated along the wash. Species that normally nest in cliffs were found nesting in the steep banks of the wash.

The other tree habitat, the pinyon-juniper, exhibited the second highest diversity during the breeding season, but very low diversity and few birds during the winter months. Many of the birds in the wash were

those usually confined to deciduous trees. Likewise, many of the birds found in the pinyon-juniper are species (such as Scrub Jays, Pinyon Jays and Plain Titmice) that are typical of and, to some extent, limited to, the pinyon-juniper habitat.

The lowest bird diversity and populations occurred on the bench during both summer and winter. During the breeding season the bench was inhabited by Black-throated Sparrows, Rock Wrens and Say's Phoebes. The other birds seen on the bench censuses were usually on the cliff tops singing. The cliffs provide the most conspicuous perches overlooking the floodplain and provide singing perches for House Finches and Mourning Doves. Occasionally Sparrow Hawks and other birds that nest in the cliffs were seen on the cliff tops, as well.

Casa Chiquita and Pueblo Bonito are both located in Kelley and Potter's (1974) Sarcobatus and Atriplex vegetation zone. Patterns of bird diversity for Casa Chiquita and Pueblo Bonito were similar throughout this study. Bird diversity was somewhat higher during 1980 at Pueblo Bonito than at Casa Chiquita, perhaps due to the better vegetative conditions at Pueblo Bonito.

At Casa Chiquita, diversity was highly correlated with richness and poorly correlated with evenness (see Table 6). At Pueblo Bonito species number was correlated with diversity, but so was evenness. At the wash, as at Pueblo Bonito, diversity was correlated with both species number and evenness. In the pinyon-juniper habitat and on the bench, diversity was correlated only with species numbers.

An analysis of variance test run on the diversity indices of the five transects (Fig. 3) indicated that the diversity of the five transects was not equal. Results of a Student-Newman-Keuls multiple range test showed the bench to be unique among the five habitats. Casa Chiquita, Pueblo Bonito and

the pinyon-juniper are grouped together; the wash is grouped with the pinyon-juniper and Casa Chiquita, but not with Pueblo Bonito.

DISCUSSION

The San Juan Basin is a large, homogeneous area predominantly of shrub grassland habitat. Most differences among habitats in the basin are small enough that there is a lot of overlap of habitat use by most species of birds. In addition to shrub grassland habitats, Chaco Canyon contains a riparian habitat characterized by at least two species of Populus, Salix sp. and Tamarix sp. The cottonwoods and willows were planted in the wash during the 1930's and 1950's; the tamarisk is exotic. Cottonwoods and willows are found in other isolated spots in the basin south of the San Juan river, but nowhere else are they as abundant as at Chaco Canyon. If the bird species that are limited to this deciduous riparian habitat are discounted, the diversity of the wash would probably be similar to that of Casa Chiquita and Pueblo Bonito. These habitats are similar to other wash-bottom habitats throughout the basin (Cully, unpub. man.).

During summer, most birds in the monument are insectivorous, and the greater foliage diversity in the wash and pinyon-juniper probably provide a greater variety of insects than do the other habitats. These habitats are characterized by lower populations and diversity of wintering birds than are the floodplain sites. Although foliage height diversity is lower in Casa Chiquita and Pueblo Bonito than in the wooded habitats, levels of annual production and grass cover are high. The lack of annuals on the bench and in the pinyon-juniper is probably reflected by the low numbers of wintering birds in those habitats. Seed production is also high in the wash and some juncos and White-crowned Sparrows occur there during the

winter. Their numbers are not generally as great as they are on the floodplains, however. Perhaps the sandier soils in the wash make finding seeds more difficult than do the loamy soils on the floodplain above.

There are two factors that can cause H' to vary: 1) richness, or the number of species present, and 2) evenness, or the relative populations of the component species. In every habitat at Chaco Canyon diversity was closely related to richness. At two of the transects, the wash and Pueblo Bonito, evenness was also closely related to diversity. H' was able to distinguish three of the four habitats sampled at Chaco Canyon. The two closest in diversity were the two floodplain sites that occupy nearly identical habitat. Although the distinction between the wash, pinyon-juniper and Casa Chiquita was not perfect, they were very nearly separated by the Student-Newman-Keuls multiple range test and a slightly larger sample size will probably complete this discrimination.

Tramer's (1969) suggestion that consistently high evenness caused by uniform spacing of breeding birds should leave richness to account for diversity seems to be borne out in the three habitats where breeding birds are the major inhabitants. The Pueblo Bonito transect was the only one consistently high in winter populations of birds. White-crowned Sparrows in loose winter flocks were the most abundant bird, accounting for more than half of the birds usually seen on that transect. The wash contains few wintering species, none of which are numerous. At that time of year, richness and evenness are low. During migration, however, and during the breeding season, the cottonwoods in the wash act as an oasis, both drawing large numbers of species and concentrating their numbers into a limited habitat. The result is that when diversity is high, so is evenness.

Rotenberry et al. (1979) found that in winter in the northern Great Basin, diversity was correlated with evenness rather than richness, whereas during the breeding season, the opposite was true. They believe their results imply that during the breeding season diversity is controlled by resource-based interspecific competition, but that during winter birds are regulated by a harsh climate. In this study, there don't appear to be seasonal differences in the extent to which richness and evenness influence diversity. A possible cause of this might be related to the importance to diversity of migrating species in the San Juan Basin during all seasons studied. The two habitats at Chaco Canyon that receive the most use by migrants exhibited the highest correlation between evenness and diversity. The other habitats are populated more by resident species, which have greater opportunities to become equilibrium species than do migrants. This results in a consistently high level of evenness, which I feel is a result of intraspecific, rather than interspecific, competition as proposed by Rotenberry et al. (1979). Transient species may not be present long enough at Chaco Canyon to develop stable interspecific or intraspecific relationships and, consequently, evenness can vary far more than in more stable communities.

At Pueblo Bonito and at the wash, high summer diversity is accompanied by high evenness. During November and March, when diversity is lowest, so is evenness. During the winter at Chaco Canyon, the most numerous birds are flocking granivorous species such as juncos and White-crowned Sparrows. I believe the differences between summer and winter bird communities are related to seasonal differences in resource availability. Even dispersal is practical during the summertime when insects are a widely available source of food. During the winter, however, birds have to rely on clumped resources such as seeds, or perhaps scale insects, with the result that flocking provides

a more effective foraging strategy. Consequently, the most common species are found either in large numbers or not at all.

Considering the range of variability of diversity indices at each habitat the Shannon-Weaver index provides a reliable and simple description of the bird communities at Chaco Canyon. In addition to showing whether communities are the same or different, this index might be able to provide clues about changes in the future. If evenness increases in certain habitats, it might be suggested that birds that formerly bred throughout the basin at low densities are being forced into more restricted habitat patches. This seems to occur now in the cottonwoods along the wash. On the other hand, if an aggressive exotic species, such as the Starling, becomes established in the monument, it could drive other species away, become more abundant itself and cause the overall diversity to decline.

The easiest and most efficient way to quantify the sort of baseline data gathered in this study is to reduce them to an index of diversity. Although there are several indices available, the Shannon-Weaver index is most sensitive to changes in rare species (Peet 1974), is easy to calculate and can discriminate subtle differences between communities. It should also be useful in detecting changes that occur through time within a community.

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Table 1. Birds observed on the bench transect. The first number in each column is the mean number of birds seen during that season. The number in parentheses indicates the number of censuses in which the species was encountered. Only birds observed on more than one census are listed. The number of species encountered only once is shown in brackets followed by the mean number of these individuals. The number of censuses during the season = n. B = breeding season, R = remaining.

Common name	Latin name	B n=5	R n=6
Rock Wren	<u>Salpinctes obsoletus</u>	9.00 (5)	3.83 (4)
House Finch	<u>Carpodacus mexicanus</u>	0.40 (2)	0.67 (2)
Brown Towhee	<u>Pipilo fuscus</u>		1.33 (4)
Black-throated Sparrow	<u>Amphispiza bilineata</u>	6.00 (5)	2.00 (2)
Other species		[3] 0.60	[8] 2.00

Table 2. Birds observed on the Casa Chiquita transect. The organization of this and the following three tables is the same as in Table 1.

Common name	Latin name	B n=8	R n=10
American Kestrel	<u>Falco sparvarius</u>	0.50 (3)	0.30 (2)
Mourning Dove	<u>Zenaida macroura</u>	11.25 (5)	
Broad-tailed Hummingbird	<u>Selasphorus platycercus</u>	0.25 (2)	
Cassin's Kingbird	<u>Tyrannus vociferans</u>	0.63 (3)	
Say Phoebe	<u>Sayornis saya</u>	3.63 (7)	0.80 (3)
Cliff Swallow	<u>Petrochelidon pyrrhonota</u>	13.75 (2)	
Common Raven	<u>Corvus corax</u>	2.25 (5)	0.40 (2)
Rock Wren	<u>Salpinctes obsoletus</u>	9.13 (8)	2.90 (4)
Mockingbird	<u>Mimus polyglottos</u>	1.13 (5)	
Blue-grey Gnatcatcher	<u>Polioptila caerulea</u>		0.20 (2)
Loggerhead Shrike	<u>Lanius ludovicianus</u>	0.50 (4)	1.00 (6)
Yellow-rumped Warbler	<u>Dendroica coronata</u>	1.63 (3)	
Western Meadowlark	<u>Sturnella neglecta</u>	2.25 (4)	
Bullock's Oriole	<u>Icterus galbula</u>	0.88 (3)	
Brown-headed Cowbird	<u>Molthrus ater</u>	1.38 (3)	
Blue Grosbeak	<u>Guiraca caerulea</u>	0.38 (2)	
House Finch	<u>Carpodacus mexicanus</u>	1.13 (4)	0.70 (4)
Brown Towhee	<u>Pipilo fuscus</u>	0.63 (2)	1.80 (6)
Lark Sparrow	<u>Chondestes gramacus</u>	0.50 (3)	
Black-throated Sparrow	<u>Amphispiza bilineata</u>	14.75 (8)	0.90 (4)
Sage Sparrow	<u>Amphispiza belli</u>		2.10 (4)

Table 2 continued.

Dark-eyed Junco	<u>Junco hyemalis</u>	2.70 (5)
Grey-headed Junco	<u>Junco caniceps</u>	0.20 (2)
Brewer's Sparrow	<u>Spizella breweri</u>	0.80 (2)
White-crowned Sparrow	<u>Zonotrichia leucophrys</u>	2.10 (4)
Other species	[12] 2.54	[14] 4.10

Table 3. Birds observed on the Pueblo Bonito transect.

Common name	Latin name	B n=8	R n=11
American Kestrel	<u>Falco sparverius</u>	0.38 (3)	
Mourning Dove	<u>Zenaida macroura</u>	0.88 (4)	
Ash-throated Flycatcher	<u>Myiarchus cinerascens</u>	0.38 (2)	
Say Phoebe	<u>Sayornis saya</u>	1.25 (6)	0.55 (2)
Cliff Swallow	<u>Petrochelidon pyrrhonota</u>	16.25 (3)	
Common Raven	<u>Corvus corax</u>	0.50 (2)	
Mountain Chickadee	<u>Parus gambelii</u>		0.55 (2)
Bewick's Wren	<u>Thryomanes bewickii</u>		0.18 (2)
Canyon Wren	<u>Catherpes mexicanus</u>		0.55 (3)
Rock Wren	<u>Salpinctes obsoletus</u>	13.12 (8)	4.73 (4)
Mockingbird	<u>Mimus polyglottos</u>	2.75 (8)	
Blue-grey Gnatcatcher	<u>Polioptila caerulea</u>		1.55 (3)
Loggerhead Shrike	<u>Lanius ludovicianus</u>	0.88 (2)	0.27 (3)
Yellow-rumped Warbler	<u>Dendroica coronata</u>	0.63 (2)	
Western Meadowlark	<u>Sturnella neglecta</u>	0.75 (3)	
Bullock's Oriole	<u>Icterus glabula</u>	0.88 (2)	
Brown-headed Cowbird	<u>Molothrus ater</u>	0.25 (2)	
House Finch	<u>Carpodacus mexicanus</u>	1.00 (6)	4.27 (6)
Green-tailed Towhee	<u>Pipilo chlorurus</u>		0.36 (3)
Rufous-sided Towhee	<u>Pipilo erythrophthalmus</u>		0.18 (2)
Brown Towhee	<u>Pipilo fuscus</u>	3.38 (8)	4.82 (11)
Black-throated Sparrow	<u>Amphispiza bilineata</u>	17.00 (8)	4.82 (5)
Sage Sparrow	<u>Amphispiza bellii</u>		5.27 (7)

Table 3 continued.

Dark-eyed Junco	<u>Junco hyemalis</u>	1.27 (5)
Chipping Sparrow	<u>Spizella passerina</u>	0.45 (2)
Brewer's Sparrow	<u>Spizella breweri</u>	1.75 (3)
White-crowned Sparrow	<u>Zonotrichia leucophrys</u>	31.36
Other species		[13] 2.67 [17] 2.34

Table 4. Birds observed on the pinyon-juniper transect.

Common name	Latin name	B n=6	R n=7
Mourning Dove	<u>Zenaida macroura</u>	2.17 (5)	0.43 (2)
Common Nighthawk	<u>Chordeiles minor</u>	0.67 (3)	
Black-chinned Hummingbird	<u>Archilochus alexandri</u>	0.33 (2)	
Broad-tailed Hummingbird	<u>Selasphorus platycercus</u>	0.83 (2)	
Ash-throated Flycatcher	<u>Myiarchus cinerascens</u>	1.00 (2)	
Say Phoebe	<u>Sayornis saya</u>	0.50 (3)	0.43 (2)
Grey Flycatcher	<u>Empidonax wrightii</u>	0.67 (2)	0.71 (2)
Scrub Jay	<u>Aphelocoma coerulescens</u>		0.71 (3)
Pinon Jay	<u>Gymnorhinnus cyanocephalus</u>	1.33 (3)	0.71 (2)
Plain Titmouse	<u>Parus inornatus</u>	2.33 (4)	3.29 (3)
House Wren	<u>Troglodytes aedon</u>		0.43 (2)
Canyon Wren	<u>Catherpes mexicanus</u>		0.29 (2)
Rock Wren	<u>Salpinctes obsoletus</u>	4.33 (6)	3.00 (4)
Mockingbird	<u>Mimus polyglottos</u>	0.50 (3)	
Mountain Bluebird	<u>Sialia curucoides</u>	1.00 (2)	
Blue-grey Gnatcatcher	<u>Polioptila caerulea</u>	1.00 (2)	
Loggerhead Shrike	<u>Lanius ludovicianus</u>		0.29 (2)
House Finch	<u>Carpodacus mexicanus</u>	4.67 (4)	
Brown Towhee	<u>Pipilo fuscus</u>		0.57 (2)
Black-throated Sparrow	<u>Amphispiza bilineata</u>	4.17 (6)	1.86 (3)
Dark-eyed Junco	<u>Junco hyemalis</u>		4.00 (3)
Chipping Sparrow	<u>Spizella passerina</u>		2.14 (3)
Other species		[8] 1.52	[18] 4.70

Table 5. Birds observed along the wash transect.

Common name	Latin name	B n=8	R n=8
Turkey Vulture	<u>Cathartes aura</u>	19.25 (8)	3.88 (4)
American Kestrel	<u>Falco sparverius</u>		0.25 (2)
Mourning Dove	<u>Zenaida macroura</u>	23.63 (8)	3.63 (3)
Great-horned Owl	<u>Bubo virginianus</u>	0.38 (2)	
Black-chinned Hummingbird	<u>Archilochus alexandri</u>	0.50 (4)	
Flicker	<u>Colaptes cafer</u>		1.25 (4)
Downy Woodpecker	<u>Picoides pubescens</u>		0.25 (4)
Western Kingbird	<u>Tyrannus verticalis</u>	2.13 (6)	
Cassin's Kingbird	<u>Tyrannus vociferans</u>	2.75 (5)	
Ash-throated Flycatcher	<u>Myiarchus cinerascens</u>	0.50 (3)	
Say Phoebe	<u>Sayornis saya</u>	0.38 (2)	0.63 (2)
Grey Flycatcher	<u>Empidonax wrightii</u>	0.25 (2)	
	<u>Empidonax sp.</u>		0.50 (2)
Western Wood-pewee	<u>Contopus sordidulus</u>	0.38 (2)	
Mountain Chickadee	<u>Parus gambelii</u>		2.25 (2)
House Wren	<u>Troglodytes aedon</u>		1.13 (2)
Rock Wren	<u>Salpinctes obsoletus</u>	3.63 (7)	1.63 (3)
Mockingbird	<u>Mimus polyglottos</u>	3.75 (7)	
Bendire Thrasher	<u>Toxostoma bendirei</u>	0.25 (2)	
Robin	<u>Turdus migratorius</u>		0.38 (3)
Blue-grey Gnatcatcher	<u>Polioptila caerulea</u>		0.88 (4)
Ruby-crowned Kinglet	<u>Regulus calendula</u>		1.13 (2)
Loggerhead Shrike	<u>Lanius ludovicianus</u>	1.00 (5)	0.25 (2)

Table 5 continued.

Yellow-rumped Warbler	<u>Dendroica coronata</u>	5.63 (3)	1.75 (4)
MacGillivray's Warbler	<u>Oporornis tolmiei</u>		0.88 (2)
Wilson Warbler	<u>Wilsonia pusilla</u>		1.63 (2)
Bullocks Oriole	<u>Icterus galbula</u>	11.75 (6)	
Brown-headed Cowbird	<u>Molothrus ater</u>	4.00 (7)	1.63 (2)
Western Tanager	<u>Piranga ludovicianus</u>	1.25 (3)	
Black-headed Grosbeak	<u>Pheucticus melanocephalus</u>	0.38 (2)	
Blue Grosbeak	<u>Guiraca caerulea</u>	2.38 (6)	
House Finch	<u>Carpodacus mexicanus</u>	8.00 (8)	24.00 (6)
Green-tailed Towhee	<u>Pipilo chlorura</u>	0.38 (2)	1.13 (2)
Brown Towhee	<u>Pipilo fuscus</u>	1.50 (2)	1.00 (2)
Pine Siskin	<u>Carduelis pinus</u>		1.13 (2)
Black-throated Sparrow	<u>Amphispiza bilineata</u>	2.88 (6)	
Dark-eyed Junco	<u>Junco hyemalis</u>		9.25 (7)
White-crowned Sparrow	<u>Zonotrichia leucophrys</u>		5.88 (4)
Song Sparrow	<u>Melospiza melodia</u>		0.38 (2)
Other species		[21] 4.29	[13] 5.81

Table 6. Relationship of H' to evenness and richness. r is a correlation coefficient; n represents the number of censuses run on each transect.

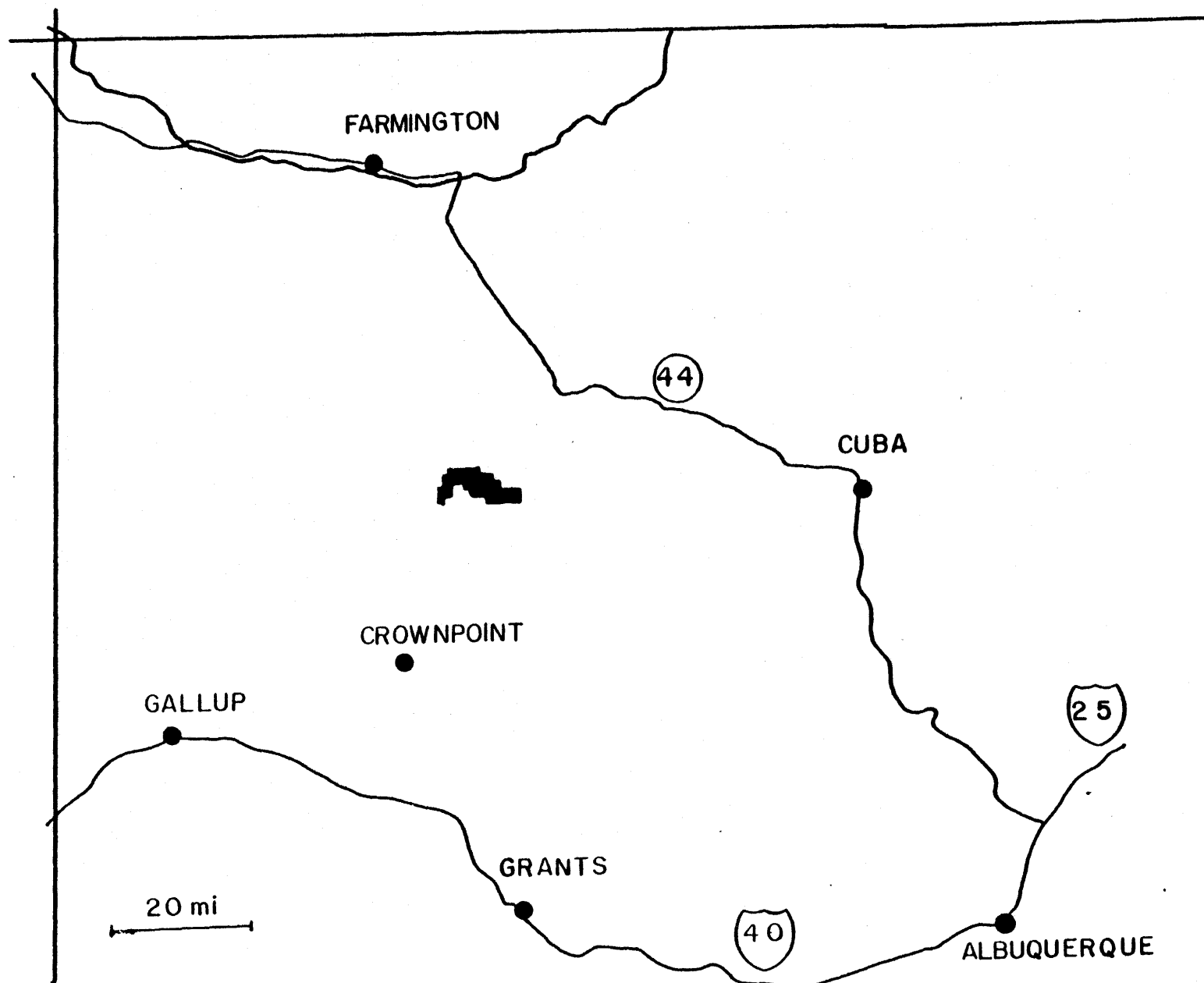
Habitat	n	r H:J	r H:R
Bench	11	-.0829	.8973
Casa Chiquita	18	.2806	.7420
Pueblo Bonito	19	.9254	.8106
Pinyon-Juniper	13	.1721	.8675
Wash	16	.8426	.8935

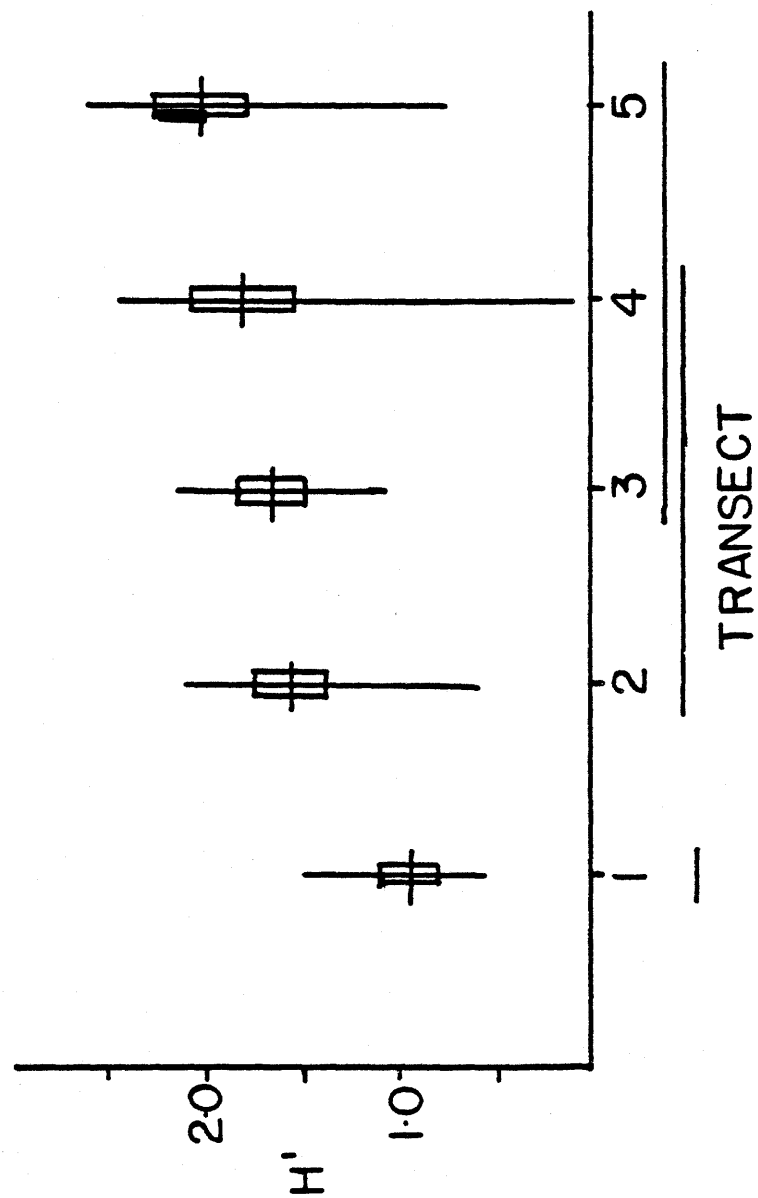
FIGURE LEGENDS

Figure 1. Map of northwestern New Mexico showing the location of Chaco Canyon National Monument near the center of the San Juan Basin.

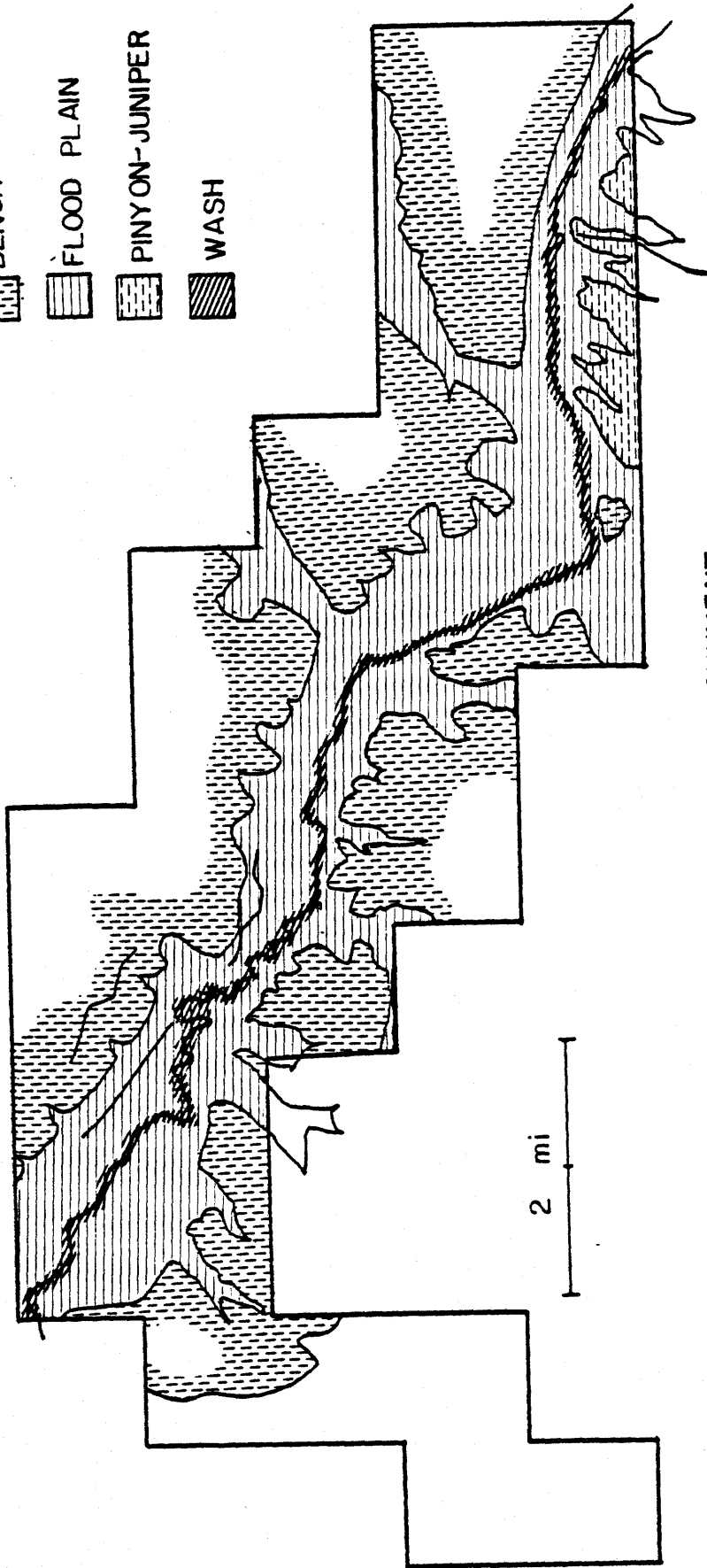
Figure 2. Habitat distribution within Chaco Canyon National Monument.

Figure 3. Diversity (H') of birds at the five transects at Chaco Canyon. The vertical line represents the range; the rectangle is the mean $\pm$ one standard deviation, and the horizontal line is the mean. The transect number and the number of censuses were: 1) bench $n = 11$; 2) Pueblo Bonito $n = 19$; 3) Casa Chiquita $n = 18$; 4) pinyon-juniper $n = 13$; 5) wash $n = 16$.





-  BENCH
-  FLOOD PLAIN
-  PINYON-JUNIPER
-  WASH



CHACO CANYON NATIONAL MONUMENT