Some Effects of a Campground on Breeding Birds in Arizona[1]

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Abstract.--Over a three year period, breeding bird densities were found to be similar between a constructed campground and a relatively natural area when the campground was closed to campers. However, bird species composition differed between sites, the campground having relatively heavier bodied birds ($\bar{x}$ = 48.5 g) than the control area ($\bar{x}$ = 38.2 g). Once the campground was opened for human use, the breeding bird population decreased in density and diversity. On the control site the population either remained the same or increased.

INTRODUCTION

It has been well documented that the human manipulation of Southwestern habitats greatly affects the configuration of the avian community that will continue to utilize the area (e.g., Carothers et al. 1974, Carothers and Johnson 1975). These studies have primarily concerned themselves with phreatophyte control, channelization, and other water management practices. Very little research has dealt with the impact caused by the construction of permanent structures and human occupation of these areas (e.g., subdivisions, trailer parks, and campgrounds). The present study examines the effects of a U.S. Forest Service improved campground upon breeding birds.

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STUDY AREA

Two sites were chosen which appeared similar in vegetative structure, each being composed primarily of ponderosa pine with some cottonwood, Arizona walnut and other deciduous trees and shrubs. (Table 1 summarizes the vegetation analysis of the study areas.) Both sites are within Oak Creek Canyon, Sec. 27, T19N, R6E, Coconino County, Arizona, at an elevation of 1,646 m. One plot was located within the Cave Springs Campground; the other plot, control, was slightly north and across the Oak Creek.

The Cave Springs Campground study site is 4.0 ha. Extensive timber and shrub removal, construction of roads, pit toilets, and erection of tables has occurred here. The campground is open for public use from approximately Memorial Day to Labor Day of each year.

Control is approximately 2.0 ha. Relative to the campground, this area is undisturbed by human activities.

Though the two sites are small in area, thus making extrapolation of figures somewhat misleading, they encompass as much homogeneous habitat as possible. Further, the small size enabled the investigators to know the avian components intimately, and therefore we feel a very accurate count of species was achieved.

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Table 1.--Vegetation Analysis

Study Area		Tree Density Per Hectare	Basal Area (m^2) Per Hectare	Average Tree Height (m)
CAMPGROUND	Ponderosa Pine *Pinus Ponderosa*	437.1	2153.6	12.4
	*All other species	316.5	415.0	7.3
CONTROL	Ponderosa Pine	347.8	2118.4	14.0
	**All other species	1010.7	447.8	5.0

* *Acer negundo*, *Alnus oblongifolia*, *Juniperus scopulorum*, *Quercus gambelli*, *Populus lanceolata*, *Salix gooddingii*.

** *Acer negundo*, *Alnus oblongifolia*, *Fraxinus pennsylvanica* var. *velutina*, *Juniperus scopulorum*, *J. monosperma*, *Pinus edulis*, *Populus lanceolata*, *Quercus* spp.

METHODS

The populations of breeding birds were determined by the spot-map method (Williams 1936, Kendeigh 1944). On each census the location of singing males, song posts, and nest sites was recorded for each census and information on every species was later recorded onto species maps. Censusing was carried out from 4 April to 6 July 1973, 18 February to 1 July 1974, and 9 May to 10 July 1975; these periods included the entire observable breeding season. Densities were determined for each area before and after the date the campground was opened (e.g., 29 May 1973, 17 May 1974, and 16 May 1975). [Note: All densities were extrapolated to 40 ha to make inter-area comparisons easier.]

Foliage height diversity (FHD) was sampled along ten 100 m transects established at random throughout the study areas. Presence or absence of vegetation at 2 m intervals along the transects was noted at three layers chosen to approximate foliage stratification into herbaceous (0-0.6 m), shrub (0.6-4.49 m) and canopy ($\geq$4.5 m) layers. A 4.5 m rod marked at 0.6 m from one end was used to record the presence or absence of foliage for the herbaceous and shrub layers, and the ocular tube method (Winkworth and Goodall 1962) was used for the canopy layer. For recording the presence of vegetation in the herbaceous and shrub layers, it was necessary for green foliage to touch the vertically held rod.

All vegetative and avian diversity indices are computed as $H' = -\sum P_i \log_e P_i$ based on the Shannon-Wiener model of information theory (see Shannon and Weaver 1963) as it applies to biological parameters (MacArthur and MacArthur 1961; MacArthur 1965; Pielou 1966a,b; Lloyd et al. 1968).

Tree density, species composition and basal area were determined by the plotless point-quarter method of Cottam and Curtis (1956). Tree heights were determined by use of a clinometer. Samplings witha diameter at breast height (DBH) of less than 7.6 cm were treated as shrubs.

Avian standing crop biomass (SCB) was determined by taking the average adult weight (W) times the number of adults per unit area. Existence Energy (EE) or the amount of kcal consumed per ha per 24 hours was calculated from these two formulae:

$\text{Log EE} = 0.3581 + 0.5876 \text{ Log W}$ (for passerines)

$\text{Log EE} = 0.0649 + 0.6722 \text{ Log W}$ (for non-passerines).

These formulae give the energy requirements to maintain a constant weight at rest. To determine actual community energetics it would be necessary to include energy requirements of the immature birds, and the various energy demanding activities of breeding birds (e.g., singing, displaying, nest building). The limitations of this procedure notwithstanding, it is instructive to make inter- and intra-community comparisons with these low estimates of avian community energetics (see Karr 1968 and 1971).

RESULTS AND DISCUSSION

A total of 58 species (Table 2) of birds

Table 3.--Avian density and species richness

SPECIES	1973 CONTROL Before	1973 CONTROL After	1973 CAMPGROUND Before	1973 CAMPGROUND After	1974 CONTROL Before	1974 CONTROL After	1974 CAMPGROUND Before	1974 CAMPGROUND After	1975 CONTROL Before	1975 CONTROL After	1975 CAMPGROUND Before	1975 CAMPGROUND After
Mourning Dove	----	----	----	----	----	----	----	----	----	----	9.9	9.9
Broad-tailed Hummingbird	19.8	19.8	24.7	----	----	19.8	9.9	9.9	19.8	19.8	9.9	9.9
Red-shafted Flicker	----	----	9.9	9.9	----	----	9.9	9.9	----	----	9.9	19.8
Hairy Woodpecker	----	----	9.9	----	19.8	----	9.9	----	----	19.8	----	9.9
Yellow-bellied Sapsucker	----	----	----	----	----	----	9.9	----	----	----	----	9.9
Cassin's Kingbird	----	----	----	----	----	----	----	----	----	19.8	----	----
Black Phoebe	19.8	19.8	----	----	----	----	----	----	----	----	----	----
Western Flycatcher	19.8	19.8	----	----	----	----	----	----	----	----	----	----
Western Wood Pewee	----	39.5	----	9.9	----	19.8	----	19.8	----	39.5	----	----
Steller's Jay	39.5	19.8	49.5	24.7	19.8	----	19.8	19.8	19.8	19.8	19.8	19.8
White-breasted Nuthatch	----	----	9.9	9.9	----	----	29.7	19.8	----	----	----	----
Pygmy Nuthatch	----	----	----	----	19.8	19.8	19.8	9.9	19.8	19.8	9.9	19.8
House Wren	59.3	59.3	39.6	39.6	19.8	39.5	39.6	29.7	59.3	59.3	19.8	39.6
Robin	39.5	39.5	44.5	29.7	19.8	19.8	29.7	19.8	----	39.5	29.7	39.6
Solitary Vireo	49.4	49.4	9.9	----	----	19.8	9.9	9.9	19.8	19.8	----	----
Warbling Vireo	----	----	----	----	----	----	9.9	----	----	19.8	----	----
Virginia's Warbler	----	----	----	----	----	----	----	----	----	39.5	----	----
Grace's Warbler	----	----	9.9	----	----	19.8	19.8	----	----	9.9	29.7	19.8
Painted Redstart	----	----	9.9	----	19.8	39.5	9.9	----	----	----	----	----
Red-faced Warbler	----	19.8	----	----	----	19.8	----	4.9	----	----	----	----
Bullock's Oriole	19.8	19.8	14.8	14.8	----	19.8	19.8	19.8	----	19.8	----	19.8
Western Tanager	----	----	----	----	----	----	----	----	----	----	9.9	9.9
Hepatic Tanager	----	19.8	----	----	----	----	----	----	----	----	----	----
Summer Tanager	----	----	----	----	19.8	19.8	9.9	9.9	----	19.8	----	----
Black-headed Grosbeak	59.3	39.5	64.3	39.6	19.8	39.5	39.6	39.6	39.5	19.8	29.7	39.6
Lesser Goldfinch	----	----	----	----	----	----	----	----	----	19.8	----	----
Rufous-headed Towhee	----	----	----	----	----	----	----	----	19.8	19.8	----	----
Total Density	326.0	365.6	297.0	178.2	158.4	296.7	297.0	222.7	178.1	445.0	178.2	257.4
Species Richness	9	12	12	8	8	12	16	13	7	17	10	12
Weight/Individual	40.0	31.7	52.7	54.2	46.8	23.4	39.4	41.6	27.7	32.3	53.3	52.3
SCB	26078.4	23178.5	31315.7	19316.9	14830.2	13858.6	23397.6	18509.0	9854.2	28710.0	19013.8	26918.0
EE	11697.7	11438.6	12302.4	7698.6	6088.0	7785.7	10166.4	8079.5	4984.0	13783.8	7134.0	10203.0

Table 2.--Species recorded on or immediately adjacent to the study area. [Note; Bird scientific names according to A.O.U. Checklist, 1957; and 32nd A.O.U. Supplement, Auk 90(2): 411-419.]

Red-tailed Hawk	Buteo jamaicensis
Turkey Vulture	Cathartes fasciata
Band-tailed Pigeon	Columba fasciata
Mourning Dove	Zenaidura macroura
Great Horned Owl	Bubo virginianus
Flammulated Owl	Otus flammeolus
White-throated Swift	Aeronautes saxatalis
Broad-tailed Hummingbird	Selasphorus playcercus
Belted Kingfisher	Megaceryle alcyon
Red-shafted Flicker	Colaptes cafer
Hairy Woodpecker	Dendrocopos villosus
Yellow-bellied Sapsucker	Sphyrapicus varius
Western Kingbird	Tyrannus verticalis
Cassin's Kingbird	Tyrannus vociferans
Black Phoebe	Sayornis nigricans
Western Flycatcher	Empidonax difficilis
Western Wood Pewee	Contopus sordidulus
Violet-green Swallow	Tachycineta thalassina
Steller's Jay	Cyanocitta stelleri
Common Raven	Corvus corax
Mountain Chickadee	Parus gambeli
Dipper	Cinclus mexicanus
White-breasted Nuthatch	Sitta carolinensis
Pygmy Nuthatch	Sitta pygmaea
Brown Creeper	Certhia familiaris
House Wren	Troglodytes aedon
Canyon Wren	Catherpes mexicanus
Mockingbird	Mimus polyglottos
Robin	Turdus migratorius
Hermit Thrush	Catharus guttata
Townsend's Solitaire	Myadestes townsendi
Ruby-crowned Kinglet	Regulus calendula
Solitary Vireo	Vireo solitarius
Warbling Vireo	Vireo gilvus
Virginia's Warbler	Vermivora virginiae
Yellow Warbler	Dendroica petechia
Audubon's Warbler	Dendroica auduboni
Grace's Warbler	Dendroica graciae
MacGillivray's Warbler	Oporonis tolmiei
American Redstart	Setophaga ruticilla
Painted Redstart	Setophaga picta
Red-faced Warbler	Cardellina rubrifrons
Wilson's Warbler	Wilsonia pusilla
Hooded Oriole	Icterus cucullatus
Bullock's Oriole	Icterus galbula
Brown-headed Cowbird	Moluthrus ater
Western Tanager	Piranga ludoviciana
Hepatic Tanager	Piranga flava
Summer Tanager	Piranga rubra
Rose-breasted Grosbeak	Pheucticus ludovicianus
Black-headed Grosbeak	Hesperiphona vespertina
Indigo Bunting	Passerina cyanea
Pine Siskin	Spinus pinus
American Goldfinch	Spinus tristis
Lesser Goldfinch	Spinus psaltria
Rufous-sided Towhee	Pipilo erythrophthalmus
Gray-headed Junco	Junco caniceps

were seen on or immediately adjacent to the study areas. Of these, 23 species nested on one or both of the study areas at least once during the three years of censusing. The density and species' richness (Whittaker 1970) are summarized in Table 3. The changes in these values and other resultant calculations prior to and after the opening of the campground are discussed below as indicators of human impact upon the breeding bird community.

Avian Density and Species Richness

Every species is apparently adjusted to breed at the time of year at which it can raise its young most efficiently (Immelmann 1971). For most northern temperate birds this nesting period extends from late spring to mid-summer (Lack 1950). This is certainly true for the Cave Springs area of Oak Creek Canyon, where breeding begins about mid-April and lasts through July. The campground opening date falls within this period.

1973.--In 1973 a total of 17 species nested on one or both of the study areas (Table 3). A 40 percent decrease in density occurred on the campground after the opening day. Part of the losses incurred were through direct human manipulation of the nest site. Forest Service employees, by removing trees and slash, destroyed 20 percent of the Steller's Jay nests. Campers destroyed 30 percent more of the Steller's Jay nests and 20 percent of the Robin nests by removing branches for firewood, making room for tents, and other reasons.

The parulid warblers, Solitary Vireos, Broad-tailed Hummingbirds, and Hairy Woodpeckers abandoned their nests but occasionally foraged within the area. No losses can be attributed to adults leaving with fledged young prior to the opening date. Of those actually nesting on 20 May 1973, breeding had not proceeded beyond the incubation stage.

The density on the control site increased 12.1 percent after the opening date. This was not due to individuals emigrating from the campground but rather to the arrival of mid-summer breeders, namely, the Red-faced Warbler, Western Wood Pewee, and Hepatic Tanager (Bent 1968).

After the opening of the campground, species richness went from 12 to 8 on the campground and increased from 9 to 12 on control.

1974.--In 1974 a total of 17 species nested on one or both of the study areas (Table 3). However, these were not the same 17 of 1973. There was a change of three species, with Black Phoebes, Western Flycatchers and Hepatic Tanagers being replaced by Pygmy Nuthatches, Warbling Vireos and Summer Tanagers. This area in Oak Creek is an ecotonal situation between confierous forest and a deciduous riparian habitat. The Summer Tanager prefers cottonwoods along streams for nest sites and apparently found conditions suitable in 1974. On the other hand, the Hepatic Tanager prefers pines and oaks and found Cave Springs acceptable in 1973. It is probably subtle environmental differences (i.e., temperature, rainfall, etc.) that determine which tanager will be present in what might be considered marginal habitat for either.

A 25 percent decrease in densities occurred on the campground, whereas there was a dramatic 87.3 percent increase on control. The campground was opened 12 days earlier than in 1973 and may account for the initially low density on control. It was simply too early for many species to be breeding. Yet initial densities on the campground matched 1973 figures. No satisfactory explanation has been found.

Species richness dropped from 16 to 13 on the campground and climbed from 8 to 12 on control.

1975.--During 1975 a total of 21 species nested on one or both of the study areas (Table 3). New breeders included Mourning Doves, Cassin's Kingbirds, Virginia's Warblers, Western Tanagers, Lesser Goldfinches, and Rufous-sided Towhees. In previous years all of these had either appeared as transients or nested within the canyon but off the study areas.

In 1975 for the first time there was in increase in density (44.4 percent) on campground. In 1973 and 1974 breeding activity was well underway on the campground prior to the opening date. In 1975, however, colder temperatures, higher winds, and increased precipitation postponed breeding. In many species a positive correlation between temperature and the rate of testicular development or egg production has been found (Farner and Wilson 1957). In 1975 the average temperature two weeks prior to opening was 57.7°F and for the same period in 1973 and 1974 was 63.7°F and 62.5°F, respectively. Perusal of the 1975 censuses indicates almost no breeding activity (i.e., singing, displaying, nest building) before 16 May.

It is interesting to note that once breeding did commence, the maximum density reached was still less than the maximum measured in 1973 and 1974.

On control there was in increase of 149.8 percent. This phenomenal climb is also no doubt related to the later breeding period. Before the opening day, weather conditions were too severe for breeding to commence. In addition, several species that would normally nest elsewhere (e.g., Rufous-sided Towhees usually nest in the chaparrel found on the canyon walls and Lesser Goldfinches usually nest above the rim) were found on the control. Perhaps environmental conditions were relatively less severe within the canyon than elsewhere and these species chose to accept marginal habitat under these limitations.

Species richness went from 10 to 12 on the campground and 7 to 17 on control.

Yearly fluctuations of density on each area are difficult to explain because of so many determining factors. Not only local weather but events on the wintering grounds can play an important role in predicting a particular year's breeding population. Attempts to explain avian population fluctuations have so far led to only ambiguous conclusions (Von Haartman 1971). It is pertinent to note, though, that over the three-year period there was nearly twice the range of densities on control as the campground.

Avian Diversity and Habitat Diversity

MacArthur (1964) found a correlation between BSD and FHD in "tall forests of sycamores and cottonwoods" in southeastern Arizona. The relationship in this study between BSD and FHD was almost identical to what he and others found in earlier studies in eastern deciduous forests (MacArthur and MacArthur 1961, MacArthur et al. 1962). Austin (1970), working in "desert riparian" habitats in Nevada, plotted his data against MacArthur's (1964) regression line for BSD vs. FHD and found similar results. Carothers et al. (1974) found that in "desert riparian" habitats immediately adjacent to areas of relatively higher productivity but low avian densities, the BSD and FHD correlation no longer held. Yet, Carothers found that in "desert riparian" habitats immediately adjacent to areas of relatively the same productivity and having a compliment avian community, the BSD and FHD relationships did come close to MacArthur's regression line.

The BSD's and FHD's obtained in Oak Creek are summarized in Table 4 and graphed in Figure 1. Although the points do cluster around MacArthur's line, there is enough deviation to suggest other forces at work besides foliage height diversity.

As in Carother's study plots, this is a riparian system and MacArthur's line fails to take into account the added dimension of permanent water. Also, human disturbance is not considered. An additional downfall of FHD is that there has been no stipulation by past investigators when to measure FHD. As we see here, BSD and FHD vary through time (or sampling error). BSD was measured from the first signs of breeding to the opening date and then from that date to the end of breeding activity. On the other hand, FHD was measured once before and once after. It is possible that a day could be found during the vegetative growing season when the FHD would be such that BSD for the entire period matched MacArthur's line. This leads me to question the value of FHD as a predictor of BSD except in those specific cases studied by MacArthur and the need for

Table 4.--Bird species diversity and habitat diversity.

	CAMPGROUND				CONTROL			
	Bird Species Diversity (BSD)		Foliage Height Diversity (FHD)		Bird Species Diversity (BSD)		Foliage Height Diversity (FHD)	
	Before	After	Before	After	Before	After	Before	After
1973	2.19	1.95	.98	1.00	2.08	2.34	1.04	1.08
1974	2.62	2.42	.96	.98	2.08	2.43	1.06	1.05
1975	2.19	2.34	.97	1.01	1.83	2.71	.99	.97

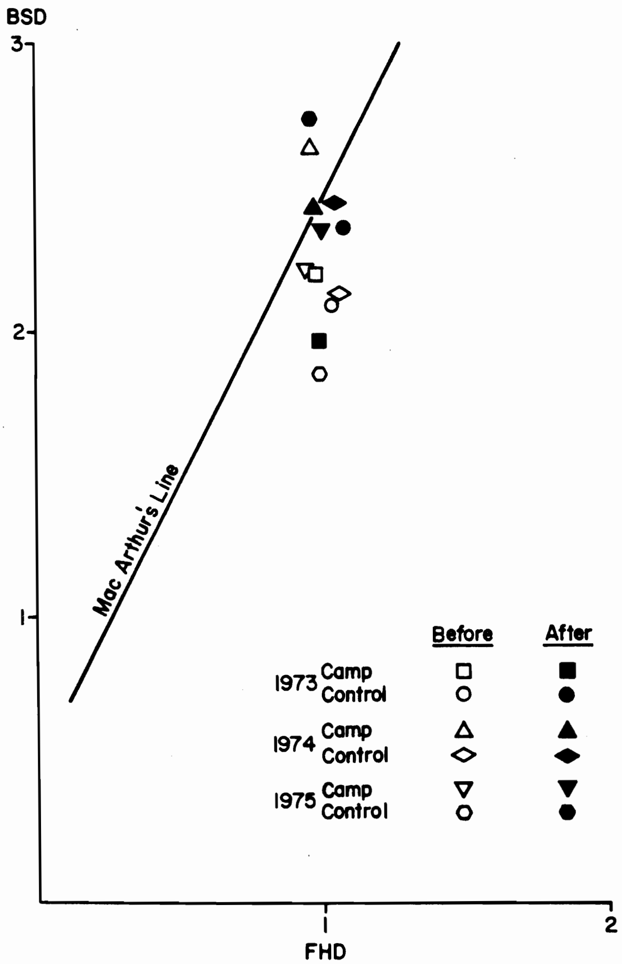

Figure 1.--Bird species diversity (SD) as a function of foliage height diversity (FHD) before and after occupation of the campground by campers. Regression line from MacArthur et al. 1966.

Table 5.--Individual bird weights[1] and individual existence energy.

Species	Weight in Grams	Existence Energy
Mourning Dove	137.5	31.79
Broad-tailed Hummingbird	4.0	2.94
Red-shafted Flicker	125.3	29.90
Hairy Woodpecker	69.8	20.15
Yellow-bellied Sapsucker	45.0	15.00
Cassin's Kingbird	45.4	21.47
Black Phoebe	18.6	12.71
Western Flycatcher	12.5	10.06
Western Wood Pewee	14.0	10.75
Steller's Jay	105.0	35.14
White-breasted Nuthatch	20.4	13.42
Pygmy Nuthatch	10.0	8.82
House Wren	10.5	9.08
Robin	88.0	31.67
Solitary Vireo	13.5	10.53
Warbling Vireo	11.3	9.48
Virginia's Warbler	8.4	7.97
Grace's Warbler	7.5	7.45
Painted Redstart	9.7	8.67
Red-faced Warbler	9.7	8.67
Bullock's Oriole	35.7	18.64
Western Tanager	28.0	16.16
Hepatic Tanager	40.0	19.93
Summer Tanager	35.5	18.58
Black-headed Grosbeak	46.0	21.63
Lesser Goldfinch	8.7	8.13
Rufous-sided Towhee	38.9	19.60

1 From Carothers et al. 1973, Marshall 1972, and collections of the Museum of Northern Arizona.

specific time limitations when these parameters are to be measured.

Examining BSD, we see that in 1973 and 1974 there was a decrease in diversity on the campground after it was opened. An increase occurred on control. In 1975, contol's diversity again increased but so did the campground's. The reason for this is, once again, the late breeding season in 1975 (see previous section).

Bioenergetics

In order to better understand the energetics and organization of these avian communities, it is important to look at standing crop biomess (SCB) and existence energy (EE) of the birds (Salt 1957, Karr 1968). The former is the total weight (in grams) of the entire avian community. In order to consider community metabolism, a conversion is made that reflects the difference in metabolism due to differences in body weight. This is expressed as existence energy (or Kcal) consumed by the total avian community (see Carothers et al. 1974 for limitations of this measure).

1973.--The SCB of control decreased slightly after 29 May, although density increased. This is possible because the average weight per individual bird decreased from 40.0 g to 31.7 g. Table 3 shows that several small-bodied birds, Western Wood Pewees and Red-faced Warblers, did move onto the area; see Table 5 for weights. Two larger species, Steller's Jays and Black-headed Grosbeaks, moved off the area.

The campground had a drastic SCB decrease; however, the average weight per individual remained essentially constant (52.7 g to 54.2 g). The decrease can therefore only be attributed to a general loss of birds of all sizes.

The initial and final differences between the average weight per individual values on the control and campground show that relative to each other light-weight birds inhabited the control and heavier birds inhabited the campground.

The existence energy values were initially the same but after the opening the campground EE showed a decrease of 37.3 percent.

We see then that before the intrusion of campers the two areas differed in the average weight per individual by 12.7 g but the EE was the same. Following campground occupation, the average weight per bird became more dissimilar (22.5 g), and the total community EE was nearly halved on the campground.

1974.--The SCB of control, once again, decreased slightly after the opening, although density increased. Again, this was due to a decrease in the average weight per individual bird (46.8 g to 23.4 g) caused by an influx of smaller-bodied species (Table 3 and 4).

The campground SCB decreased greatly, as in 1973, and the average weight per individual remained fairly constant.

In 1974, larger-bodied birds occupied the control initially, but this changed sharply after the opening of the campground.

EE values on control changed upwardly 27.8 percent, whereas the campground's was decreased by 22.3 percent.

Once again, the opening appears to be detrimental to the birds in the campground.

1975.--The overall trends remained the same in 1975. Smaller-bodied birds made up a majority of the population on control. The increase in SCB and EE on the campground, of course, was related to the density increase that year.

SUMMARY AND MANAGEMENT ALTERNATIVES

After three breeding seasons, several phenomena were discerned: 1) although bird densities on the campground and control are similar before the campground opening date, the average weights of an individual bird is greater on the campground ($\overline{x}$ = 48.5 g) than on control ($\overline{x}$ = 38.2 g) and 2), population density and species diversity (H') decrease when the campground is occupied by people.

In other words, the presence of the campground produced a significant shift in the avian community to heavier bodied birds relative to the natural control area. This is probably a response to the "opening" of the habitat during campground construction. Inhabitation of the campground by people causes a direct reduction in the numbers and kinds of breeding birds.

Those in managerial posistions might consider the following suggestions:

1. Locations for new campgrounds should be carefully scrutinized in terms of usage by wildlife. In this specific case, riparian habitats are very important to birds and of such a limited extent in the Southwest that further destruction of habitat needs to be discouraged.

2. Existing campgrounds should be periodically closed to allow regeneration of vegetation and reduce stress on resident wildlife. This is being done in Oak Creek Canyon, but much too often the reason behind the closure is financial rather than ecological.

3. Opening the campground before or after the height of the breeding season may be better for the avifauna. If people are already present when birds arrive to nest, the birds may be able to find suitable habitat elsewhere instead of "wasting energy" by attempting to breed and then being disrupted during incubation. Of course, not opening the campground until after breeding season would be ideal for the birds but probably very impractical for the campers.

4. Habitat manipulation should be carefully controlled. This includes breaking off branches

for firewood, trenching for tents, running of noisy equipment, and even clearing of snags, slash, and brush by USFS crews.

5. Educational programs may be the only effectual solution of human recreation and wildlife problems. Government agencies have had very good results in some public educational canpaigns (e.g., Smokey the Bear). There is no reason the general public could not be exposed to broad ecological concepts such as camping with less impact.

Finally, it is hoped that studies of this type and education of the public will lead to a happy medium between preserving native wildlife and also allowing human enjoyment of an area.

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