

Use of Oaks by Neotropical Migratory Birds in the Southwest¹

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Abstract.—We recorded 98 species of neotropical migratory birds in vegetation types containing oaks in southeastern Arizona and southern California. Neotropical migrants used these areas as breeding and migration habitat. Little similarity was found in the neotropical bird assemblages of California and Arizona. Within Arizona, bird assemblages were most similar between mixed-conifer forest and pine-oak woodland. Use of oaks for foraging ranged from 17.4% to 73.7% of the foraging attempts for the nine species studied. These birds each used species of oaks in unique proportions.

INTRODUCTION

Oaks (*Quercus* spp.) provide resources to meet life requisites of numerous resident and migratory birds. Specific needs provided by oaks and associated flora include food and cover, and nest, roost and perch sites. Some birds rely on oaks more than others, and some species exhibit preferences for certain types or structures of oaks. Lamb (1989) recognized 15 species of oaks in Arizona and New Mexico. More than 17 species of oaks occur in California (Block et al. 1990). This diversity of oaks is enhanced by the propensity of oaks to hybridize when ranges overlap. Oaks occur in a variety of vegetation types ranging from monotypic woodlands to understory components in conifer-dominated forests. They inhabit environments that range from xeric to mesic.

The importance of oaks for birds within a vegetation type can differ (Marshall 1957, Balda 1967), and the importance of oaks to birds can shift seasonally or yearly (Block 1989, 1990, 1991; Block and Morrison 1991). Marshall (1957) found higher densities of breeding birds in pine-oak and encinal woodlands than he found in the nine other vegetation types he surveyed in southeastern Arizona. Balda (1967) noted that 48% of the birds found in woodland types of the Chiricahua Mountains were not found in any other types.

Neotropical migratory birds typically breed in temperate environments of North America and winter in tropical environments of Central and South America. On their breeding grounds and along

migration routes these birds use a variety of habitats, many containing oaks, to supply resources required for reproduction and survival. The migratory habit sets these birds apart from many resident species because they require a variety of resources to meet a variety of conditions. For example, Hutto (1985) observed that migrating passerines in the Chiricahuas used different habitats from the ones used on the breeding grounds. Hutto (1985) thought that migratory birds were restricted to use of breeding habitat by nest-site requirements and hence could use a wider range of habitats during migration. Hence, oaks probably provide critical resources for both breeding and migrating birds that use them.

Population numbers of many species of neotropical migratory birds are believed to be declining (Finch 1991). Although the factors causing these population declines are unknown, habitat loss and fragmentation, both on breeding and wintering grounds, are assumed to be among the most important factors. Thus, information that details habitat associations and patterns of habitat use by these birds is critical to determining the effects of habitat change on their populations.

The purpose of this paper is to describe the types, general distributions, and macrohabitat associations of neotropical migratory birds during breeding and migration in southwestern forests and woodlands containing oaks. We will draw upon two studies — a completed project in southern California, and an ongoing study in the mountains of southeastern Arizona — to examine macrohabitat associations and use of oaks by foraging birds.

STUDY AREAS

The southern California study area was located on Tejon Ranch in the Tehachapi Mountains of Kern County. The ranch is a private holding encompassing about 100,000 ha, half of which is oak woodland. We confined our study area to about 2,500 ha of this oak

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woodland. The climate at Tejon Ranch is Mediterranean with hot, dry summers and cool, wet winters. Elevation ranges from 1100 to 1700 m. Major tree species include blue oak (*Quercus douglasii*), valley oak (*Q. lobata*), California black oak (*Q. kelloggii*), interior live oak (*Q. wislizenii*), canyon live oak (*Q. chrysolepis*), Brewer's oak (*Q. garryana* var. *breweri*), and California buckeye (*Aesculus californica*). These trees generally occur in stands of single species with mixes of stands along narrow ecotones. Exceptions to this pattern are mixed stands of buckeye, canyon live, interior live, California black, and Brewer's oaks that occur on the higher-elevation, north-facing slopes.

The Arizona study areas were located on five mountain ranges in southeastern Arizona: the Jhiricahua, Pinaleno, Santa Rita, Santa Catalina, and Huachuca mountains. Vegetation types of these mountains that we sampled include oak, oak-juniper and pine-oak woodlands, and mixed-conifer forests. Primary species of oaks are Emory oak (*Q. emoryi*), Arizona white oak (*Q. arizonae*), silverleaf oak (*Q. hypoleucoides*), netleaf oak (*Q. reticulata*), and Gambel oak (*Q. gambelii*). Oaks occur in monotypic stands often of Emory oak, or mixed stands of Emory and Arizona white oaks, alligator juniper (*Juniperus lepeanna*), and Mexican pinyon (*Pinus cembroides*), or in stands of pine-oak including Arizona white, silverleaf, netleaf, or Emory oaks mixed with Chihuahuan (*Pinus leiophylla*), Apache (*P. engelmannii*), ponderosa (*P. ponderosa*), or Mexican white (*P. exilis* var. *reflecta*) pines. Gambel oak is found as an understory component of mixed-conifer stands, which also include Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and various pine species.

METHODS

Field Methods

Tejon Ranch

A point-count method (Reynolds et al. 1980, Verner 1985) was used to sample bird populations during the 1986, 1987, and 1988 breeding seasons (March through June). Observers recorded all birds detected at fixed points during a 5-min period. One hundred points were established using a systematic-random-sampling procedure (Cochran 1977). Ten points were systematically arrayed along each of 10 transects. Points were from 300 to 400 m apart to ensure sampling independence among points (i.e., not counting the same bird at adjacent points).

Birds were counted at each point 3 times during the season to account for temporal variations in bird detectability.

Southeastern Arizona Mountains

We placed from 24 to 72 counting stations on each mountain range. Stations were arrayed at 300-m intervals on transects along random bearings. Two to six transects were placed on each mountain range.

We used the same methods to record birds as described above for Tejon Ranch. Points were assigned to vegetation type — oak, oak-juniper, pine-oak, mixed conifer — based on the dominant trees present.

We also recorded foraging observations for a subset of the birds by noting the species, height, diameter, and crown width of the tree where the birds were observed foraging. We also recorded data pertaining to location of the bird in the tree, perch and foraging substrates, and foraging maneuver. An observer watched a bird for 20 seconds but recorded information only from the second 10 seconds to avoid sampling only conspicuous behaviors of the bird. Species for which we collected foraging data included the elegant trogon (*Trogon elegans*), hermit thrush (*Catharus guttatus*), hepatic tanager (*Piranga flava*), black-headed grosbeak (*Pheucticus melanocephalus*), Virginia's warbler (*Vermivora virginiae*), Lucy's warbler (*V. luciae*), red-faced warbler (*Cardellina rubrifrons*), painted redstart (*Myioborus picta*), yellow-rumped warbler (*Dendroica coronata*), black-throated gray warbler (*D. nigrescens*), Grace's warbler (*D. graciae*), and olive warbler (*Peucedramus taeniatus*).

Data Analysis

We stratified counting stations in southeastern Arizona according to major cover types: mixed-conifer forest, pine-oak woodland, or oak woodland. We pooled data from all Arizona mountain ranges to ensure adequate sample sizes for general comparisons. Species were regarded as neotropical migratory birds if they appeared on the official list of migratory birds prepared by the Neotropical Migratory Bird Conservation Program (Gauthreaux 1991), although this list has been the subject of debate (SWCA 1991). We performed pairwise comparisons of the neotropical migratory birds found in the three Arizona cover types and the neotropical migrants from the Tehachapi Mountains using Jaccard's (1912) similarity coefficient to measure the proportion of the total species pool common to both areas.

We calculated Spearman rank-order correlation coefficients (Marascuilo and McSweeney 1977) on detection frequencies to compare rankings of species abundances among the three major cover types of southeastern Arizona. To evaluate the importance of oaks to bird foraging, we calculated the percentage of each species that used oak during foraging.

RESULTS

Observers recorded 114 species, including 73 neotropical migratory birds, during counts in Arizona. The largest number of species recorded was in pine-oak woodland and the fewest number was in oak woodland (table 1). California's Tehachapi Mountains contained the fewest number of recorded resident birds but had the largest number of neotropical migrant species (table 1). Similarity of neotropical

Table 1. - Numbers of resident and neotropical migrant bird species found in mountains of southeastern Arizona during the 1991 breeding season and the Tehachapi Mountains, California, during the 1986, 1987, and 1988 breeding seasons.

	Arizona mountains			Tehachapi Mountains (n=100) -
	Mixed-conifer (n=72)*	Pine-oak (n=128)	Oak (n=48)	
Resident	33	43	31	24
Neotropical migrant	44	54	41	63

*Number of counting stations.

Table 2. - Jaccard (1912) coefficients comparing neotropical migrant birds found in mixed-conifer forest, pine-oak woodland, and oak woodland during the 1991 breeding season in the southeastern Arizona mountains and in the Tehachapi Mountains, California, during 1986, 1987, and 1988 breeding seasons.

	Mixed-conifer	Pine-oak	Oak
Tehachapi Mountains	0.31	0.28	0.26
Mixed conifer	-	0.66	0.40
Pine oak	-	-	0.45

migratory bird assemblages between study sites ranged from 0.26 to 0.66 (table 2). Little similarity was found between neotropical migratory bird assemblages in California and those in Arizona (table 2). The lack of similarity between the Tehachapi and Arizona groups of neotropical birds was attributable to species that were detected only in the Tehachapis or only in southeastern Arizona (table 3). In Arizona, pine-oak woodland and mixed-conifer forests were most similar (table 2). Ranking of species abundances were significantly correlated ($r_s = 0.74$, $P < 0.001$) between pine-oak and mixed-conifer, but not between pine-oak and oak ($r_s = 0.27$, $P > 0.05$) or mixed-conifer and oak ($r_s = 0.03$, $P > 0.5$). Species observed only in Arizona pine-oak woodlands included zone-tailed hawk, gray hawk, flammulated owl, elegant trogon, blue-throated hummingbird, and magnificent hummingbird (table 3). The northern mockingbird, loggerhead shrike, Lucy's warbler, black-chinned sparrow, and green-tailed towhee were observed only in the oak woodlands that we surveyed in Arizona. No species were unique to mixed-conifer forests (table 3).

Observers recorded 521 foraging observations of neotropical migratory birds in the Arizona mountains. Small sample sizes (from 1 to 5) for the elegant trogon, orange-crowned warbler, olive warbler, and Lucy's warbler precluded analysis for these species. Other species used oaks for foraging from 17.41 (hermit thrush) to 73.7% (black-throated gray warbler) of their foraging attempts (table 4). Silverleaf oak was used most frequently by the painted redstart, red-faced warbler, Grace's warbler, and Virginia warbler (table 4). The black-throated gray

warbler used silverleaf and Arizona white oaks with comparable frequencies (table 4). The black-headed grosbeak and hermit thrush used Arizona white oak with greater frequency than other oaks (table 4). Yellow-rumped warbler used silverleaf, Emory, and Gambel oaks with comparable frequencies (table 4).

DISCUSSION

We found 98 species of neotropical migratory birds using vegetation types containing oaks in southeastern Arizona and California. Most of these birds used these vegetation types for breeding; others such as hermit and Townsend's warblers used them as habitat during migration to and from their breeding grounds or during other parts of the year. For example, of the 63 species in the Tehachapi Mountains that we identified as neotropical migrants (based on Gauthreaux [1991]), 32 species were migrating, wintering, or incidental species that did not breed there (Block 1989). Far fewer of the neotropical birds found in our southeastern Arizona study areas were nonbreeding birds. Simply because some species did not breed in our study areas does not negate the importance of those habitats to the birds. Likely, the resources that these birds derived from the oaks were important to their survival and ultimate fitness.

We found little similarity in the species or relative abundances of birds found in oak woodlands compared with those found in pine-oak woodland or mixed-conifer forests. This apparent difference suggests that oak woodlands provide resources for unique assemblages of birds. Many of these birds have specific needs (such as nest sites as suggested by Hutto [1985]) or a combination of biological needs that are met by environmental conditions unique to oak woodlands. Thus; a particular species may be able to derive needed resources from oak woodland, but not from pine-oak woodland or mixed-conifer forest.

Many of the observed differences in the avifaunas of California and Arizona were attributed biogeographic differences. For example, the geographic distributions of many Arizonan birds do not extend to California, and vice versa (table 3). Further, some species occur in both regions and may breed in one region but only migrate through the other. Thus, range differences of birds and the great diversity of vegetation types containing oaks acted synergistically to provide suitable habitat for numerous breeding and migrating neotropical birds. Given the diversity of habitats and birds that use them, different management approaches probably will be needed for different situations.

We found that birds used oaks extensively for foraging. Different species of oaks were used in different proportions by each bird species we studied. Even birds such as Grace's warbler, red-faced warbler, and painted redstart that are closely tied to conifer-dominated habitats used oaks extensively for

Table 3. - Number of counting stations where neotropical migrant birds were detected in 3 major cover types (mixed-conifer forest, pine-oak woodland, and oak woodland) in southern Arizona mountains and oak woodlands of the Tehachapi Mountains, California. The lists for Arizona are based on the results of sampling 248 counting stations during 1991 breeding season; the Tehachapi Mountain list is derived from counts of 100 stations during 1986, 1987, and 1988 breeding seasons.

Species	Arizona mountains			Tehachapi Mountains (n=100)	Species	Arizona mountains			Tehachapi Mountains (n=100)
	Mixed-conifer (n=72) ^a	Pine-oak (n=128)	Oak (n=48)			Mixed-conifer (n=72) ^a	Pine-oak (n=128)	Oak (n=48)	
Killdeer					<i>Tree swallow</i>				
(<i>Charadrius vociferus</i>)	0	0	0	1	(<i>Tachycineta bicolor</i>)	0	0	0	1
Sharp-shinned hawk					<i>Violet-green swallow</i>				
(<i>Accipiter striatus</i>)	0	0	0	3	(<i>T. thalassina</i>)	9	1	0	95
Cooper's hawk					<i>Purple martin</i>				
(<i>A. cooperii</i>)	0	0	0	4	(<i>Progne subis</i>)	0	0	0	1
Red-tailed hawk					<i>Barn swallow</i>				
(<i>Buteo jamaicensis</i>)	2	1	2	30	(<i>Hirundo rustica</i>)	0	0	0	1
Zone-tailed hawk^b					<i>House wren</i>				
(<i>B. albonotatus</i>)	0	1	0	0	(<i>Troglodytes aedon</i>)	21	14	2	100
Cray hawk^b					Rock wren				
(<i>B. nitidus</i>)	0	1	1	0	(<i>Salpinctes obsoletus</i>)	0	3	8	0
Golden eagle					<i>Ruby-crowned kinglet</i>				
(<i>Aquila chrysaetos</i>)	0	0	0	4	(<i>Regulus calendula</i>)	0	2	2	6
Turkey vulture					<i>Blue-gray gnatcatcher</i>				
(<i>Cathartes aura</i>)	3	6	4	0	(<i>Poliophtila caerulea</i>)	5	3	3	23
American kestrel					<i>Southern mockingbird</i>				
(<i>Falco sparverius</i>)	0	0	1	3	(<i>Mimus polyglottus</i>)	0	0	9	0
Long-eared owl					<i>American robin</i>				
(<i>Asio otus</i>)	0	0	0	1	(<i>Turdus migatorius</i>)	43	33	0	53
Flammulated owl					<i>Townsend's solitaire</i>				
(<i>Otus flammeolus</i>)	0	1	0	0	(<i>Myadestes townsendi</i>)	7	0	0	1
Elegant trogon^b					<i>Hermit thrush</i>				
(<i>Trogon elegans</i>)	0	21	0	0	(<i>Catharus guttatus</i>)	56	40	1	5
Mourning dove					<i>Western bluebird</i>				
(<i>Zenaidura macroura</i>)	3	11	37	100	(<i>Sialia mexicana</i>)	1	2	3	81
White-winged dove					<i>Loggerhead shrike</i>				
(<i>Z. asiatica</i>)	0	0	2	10	(<i>Lanius ludovicianus</i>)	0	0	1	0
Band-tailed pigeon					<i>Cedar waxwing</i>				
(<i>Columba fasciata</i>)	15	14	0	1	(<i>Bombcilla cedrorum</i>)	0	0	0	2
Anna's hummingbird					<i>Phainopepla</i>				
(<i>Calypte anna</i>)	0	0	0	35	(<i>Phainopepla nitens</i>)	0	0	2	1
Broad-tailed hummingbird					<i>Solitary vireo</i>				
(<i>Selasphorus platycercus</i>)	36	18	7	0	(<i>Vireo solitarius</i>)	48	56	4	10
Rufous hummingbird					<i>Bell's vireo</i>				
(<i>S. rufus</i>)	1	1	0	0	(<i>V. bellii</i>)	1	5	2	0
Blue-throated hummingbird^b					<i>Warbling vireo</i>				
(<i>Lampornis clemenciae</i>)	0	2	0	0	(<i>V. gilvus</i>)	21	2	1	23
Magnificent hummingbird^b					<i>Yellow-rumped warbler</i>				
(<i>Eugenes fulgens</i>)	0	1	0	0	(<i>Dendroica coronata</i>)	37	29	0	76
Lewis woodpecker					<i>Townsend's warbler</i>				
(<i>Melanerpes lewis</i>)	0	0	0	1	(<i>D. townsendi</i>)	0	2	0	17
Red-breasted sapsucker					Hermit warbler				
(<i>Sphyrapicus ruber</i>)	0	0	0	2	(<i>D. occidentalis</i>)	1	1	0	26
Red-naped sapsucker					<i>Black-throated gray warbler</i>				
(<i>S. nuchalis</i>)	1	0	0	0	(<i>D. nigrescens</i>)	32	88	28	32
Western kingbird					Painted redstart^b				
(<i>Tyrannus verticalis</i>)	0	0	3	22	(<i>Myioborus picta</i>)	48	64	1	0
Cassin's kingbird					Red-faced warbler^b				
(<i>T. vociferans</i>)	0	14	18	0	(<i>Cardellina rubrifrons</i>)	56	57	0	0
Dusky-capped flycatcher^b					<i>Olive warbler^b</i>				
(<i>Myiarchus tuberculifer</i>)	14	67	7	0	(<i>Peucedramus taeniatus</i>)	9	7	0	0
Ash-throated flycatcher					Grace's warbler^b				
(<i>M. cinerascens</i>)	1	29	24	100	(<i>Dendroica graciae</i>)	50	54	0	0
Sulphur-bellied flycatcher^b					<i>Virginia's warbler^c</i>				
(<i>Myiodynastes luteiventris</i>)	5	12	0	0	(<i>Vermivora virginiae</i>)	8	16	0	0
Western wood-pewee					<i>Lucy's warbler</i>				
(<i>Contopus sordidulus</i>)	1	9	2	42	(<i>V. luciae</i>)	0	0	3	0
Greater pewee^b					<i>Nashville warbler</i>				
(<i>C. perfinax</i>)	34	37	0	0	(<i>V. ruficapilla</i>)	0	0	0	14
Olive-sided flycatcher					MacGillivray's warbler				
(<i>C. borealis</i>)	1	0	0	1	(<i>Oporornis tolmiei</i>)	0	0	0	2
Hammond's flycatcher					<i>Yellow warbler</i>				
(<i>Empidonax hammondi</i>)	0	0	0	4	(<i>Dendroica ptechia</i>)	0	0	0	1
Dusky flycatcher					<i>Orange-crowned warbler</i>				
(<i>E. oberholseri</i>)	1	4	1	3	(<i>Vermivora celata</i>)	4	2	0	20
Gray flycatcher					<i>Wilson's warbler</i>				
(<i>E. wrightii</i>)	0	0	2	2	(<i>Wilsonia pusilla</i>)	1	0	0	37
Pacific-slope flycatcher^c					<i>Brewer's blackbird</i>				
(<i>E. difficilis</i>)	0	0	0	1	(<i>Euphagus cyanocephalus</i>)	0	0	0	15
Cordilleran flycatcher^b					<i>Red-winged blackbird</i>				
(<i>E. occidentalis</i>)	27	9	0	0	(<i>Agelaius phoeniceus</i>)	0	0	0	4
Southern beardless-tyrannulet^b					<i>Western meadowlark</i>				
(<i>Camptostoma imberbe</i>)	0	1	0	0	(<i>Sturnella neglecta</i>)	0	0	0	24
White-throated swift					<i>Brown-headed cowbird</i>				
(<i>Aeronautes saxatalis</i>)	1	5	1	0	(<i>Molothrus ater</i>)	1	4	7	19

Table 3. - continued from page 4

Species	Arizona mountains			Tehachapi Mountains (n=100)
	Mixed-conifer (n=72) ^a	Pine-oak (n=128)	Oak (n=48)	
Northern oriole (<i>Icterus galbula</i>)	0	0	1	93
Hooded oriole (<i>I. cucullatus</i>)	0	1	0	0
Scott's oriole (<i>I. parisorum</i>)	6	23	37	0
Western tanager (<i>Piranga ludoviciana</i>)	45	33	3	36
Summer tanager ^b (<i>P. rubra</i>)	0	6	2	0
Hepatic tanager ^b (<i>Piranga flava</i>)	7	66	12	0
White-crowned sparrow (<i>Zonotrichia leucophrys</i>)	0	0	0	17
Lark sparrow (<i>Chondestes grammacus</i>)	0	0	0	14
Black-chinned sparrow (<i>Spizella atrogularis</i>)	0	0	12	0
Chipping sparrow (<i>S. passerina</i>)	0	3	10	37
Fox sparrow (<i>Passerella iliaca</i>)	0	0	0	1
Rufous-sided towhee (<i>Pipilo erythrophthalmus</i>)	27	59	29	30
Green-tailed towhee (<i>P. chlorurus</i>)	0	0	1	0
Black-headed grosbeak (<i>Pheucticus melanocephalus</i>)	52	91	7	91
Yellow grosbeak (<i>P. chrysopheplus</i>)	0	0	1	0
Lazuli bunting (<i>Passerina amoena</i>)	1	2	0	18
Purple finch (<i>Carpodacus purpureus</i>)	0	0	0	19
Cassin's finch (<i>C. cassinii</i>)	2	2	0	1
American goldfinch (<i>Carduelis tristis</i>)	0	0	0	1
Lesser goldfinch (<i>C. psaltria</i>)	0	0	0	67
Lawrence's goldfinch' (<i>C. hwrenai</i>)	0	0	0	76
Pine siskin (<i>C. pinus</i>)	1	1	0	2

^aTotal number of counting stations sampled.

^bGeographic range does not extend to Tehachapi Mountains.

^cGeographic range does not extend to southeastern Arizona mountains.

foraging. Also, these neotropical migratory birds have additional activities (e.g., nesting, perching, roosting) that may require oaks. As these activities are studied in greater detail, our realization of the importance of oaks may become even greater.

Table 4. - Percent use of oaks by neotropical migratory birds found on the insular mountains of southeastern Arizona during the 1991 breeding season.

Species	n ^a	% Oak				
		Total	Arizona-white	Silverleaf	Emory	Gambel
Hermit thrush	23	17.4	17.4			
Yellow-rumped warbler	19	36.8		10.5	10.5	15.8
Black-throated gray warbler	99	73.7	29.3	30.3	13.1	1.0
Painted redstart	75	48.0	14.7	30.7	1.3	1.3
Red-faced warbler	85	43.5	7.1	24.7	1.1	10.6
Grace's warbler	58	32.7	6.9	24.1	1.7	
Virginia's warbler	32	34.4	6.3	21.9	3.1	3.1
Hepatic tanager	28	35.8	14.3	14.3	3.6	3.6
Black-headed grosbeak	90	52.2	23.3	17.8	7.8	3.3

^aSample size.

Thus, oaks provide a number of critical resources for many species of neotropical migratory birds in the Southwest. As the conservation of neotropical birds is becoming increasingly important, it is critical to understand the relationships between oaks and habitat needs of these birds. Only with such knowledge can resource managers provide appropriate conditions required by these species.

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This symposium focused on technologies that bridge the gap between research and its application in the management of woodlands. Topic areas include: ecology and **silvicultural** practices; growth, yield, and utilization potentials; livestock and **grazing** practices; wildlife habitat and **values**; and hydrology and watershed management. The proceedings include titles and abstracts of all papers in Spanish, a bibliography, and a summary of research needs.