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BIRD ABUNDANCE IN FLORIDA CITRUS GROVES

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Abstract.—We studied bird species composition and bird abundance in 13 Florida citrus groves. Birds were censused in the interiors and the perimeters of the groves. Total bird abundances in the groves averaged 1,199 birds/census count/100 ha, with a range of 468-2,450, and 30 bird species were recorded. The most abundant species were the Northern Cardinal, Mourning Dove, Common Ground-Dove, Brown Thrasher, Northern Mockingbird, and Rufous-sided Towhee. The Northern Cardinal was recorded in all groves, and the Brown Thrasher and Common Ground-Dove were recorded in all but one. Birds observed in the groves included those that nested there, breeding birds that nested in adjacent edge habitats, and transients that temporarily used the groves for foraging. Vegetation measurements taken within the groves, the proportions of the edge habitat types that surrounded each grove, and grove isolation from other citrus groves were studied to determine if they influenced bird abundance in the citrus groves. Citrus tree height and the percentages of the grove edge composed of herbaceous and of deciduous woodland habitats were the three variables correlated most frequently with bird abundance.

Citrus production is an important agricultural enterprise in Florida, California, Texas, and Central America. Because nearly 400,000 ha of native vegetation have been converted into citrus production (U.S. Census Bureau 1990), groves represent a substantial proportion of the habitat available to birds in some areas. Kale and Webber (1968), Webber and Kale (1969), and Lohrer (1991) counted birds in Florida citrus groves, but bird use of citrus groves has not been studied extensively, nor have the factors influencing use of citrus groves by breeding birds been evaluated. Winter bird use of citrus groves has been documented in Belize, Costa Rica, and Jamaica (C.S. Robbins, pers. comm.). Given the paucity of information on avian communities associated with citrus groves, our objectives were (1) to determine bird species composition and bird abundance in Florida citrus groves and (2) to evaluate the factors that likely influence bird use of groves.

Methods

Thirteen citrus groves on Merritt Island in Brevard County, Florida, were used as study sites. Eight of the groves were part of the Merritt Island National Wildlife Refuge; five were privately owned and managed. Study groves were 1.2-18.0 ha and contained either orange or grapefruit trees. Birds were counted within fixed-width transects from 10 May through 4 June, 1988. Four counts were conducted during the early morning, and two during the late afternoon or the early evening. Birds were not counted on days with strong wind or heavy rain. Counting was done within two types of 25m–wide transects consisting of adjacent tree rows and the area between them. "Grove-edge" transects were positioned between the outermost rows and columns of trees along the perimeter of the grove. The "mid-grove" transects were located within the interiors of the groves and ran the full length of the groves except where truncated by the grove-edge transects. Small groves were sampled entirely. Large groves were subsampled because they could not be completely traversed during the cool, early morning hours when birds were most active. When subsampling, transects were spaced at regular intervals throughout the grove (e.g., between every 3rd and 4th tree row) to insure representative sampling. Groves were generally rectangular in shape. During counts, all birds observed on the ground or in vegetation within the transect, as well as all those observed flying over the transect in search of ground-dwelling prey, were recorded. Birds observed flying over the transect in transit between two locations outside the transect area were not recorded. Species and behavior were recorded for all observations of birds. An effort was made to minimize multiple registrations of the same bird.

Numbers of individuals of each bird species observed during counts were totaled separately for the mid-grove and grove-edge transects in each citrus grove. Abundances were calculated for the most common bird species and for all species combined and were expressed as birds observed per census count per 100 ha.

The vegetation within each citrus grove was characterized in terms of grove age, tree height and canopy diameter, inter-canopy distance (spacing between canopy perimeters), relative openness below the tree canopy (height above ground of the lowest tree foliage), and coverage of herbaceous vegetation. Differences in these variables among the groves resulted from differences in citrus culture practices, which included the spacing pattern of trees, hedging and pruning, mowing, and spraying. Grove tree heights, canopy diameters, inter-canopy distances, and relative openness below the tree canopy were average values based on 10 randomly chosen trees per grove. The percent coverage of herbaceous vegetation was visually estimated once in each grove in June. Because herbaceous vegetation coverage was dependent upon when and if the groves were mowed or treated with herbicides, broad classes were used to categorize these measurements: 0-25, 26-50, 51-75, and 76-100%. Guinea grass (*Panicum maximum*), Bermuda grass (*Cynodon dactylon*), common ragweed (*Ambrosia artemisiifolia*), and common cattail (*Typha latifolia*) were the dominant herbaceous vegetation in the groves.

Study citrus groves were surrounded by other groves, residential areas, or undeveloped parts of the wildlife refuge. Groves were characterized on the basis of their relative isolation from other citrus groves. Isolation from other groves was estimated as less than 0.5, 0.5 to 2.0, or greater than 2.0 km.

The vegetation within edge habitats adjacent to each grove was classified into cover types based upon plant structure and composition. The cover types were herbaceous canal, wooded canal, Australian pine (*Casuarina cunninghamiana*), shrubland, deciduous woodland, roadside, and herbaceous. For each study grove, the lengths of the various edge habitat types bordering the grove were divided by the total length of edge to determine the percentages of each edge habitat type. Canals and ponds within the groves were considered internal edges and were treated as part of the total edge habitat.

Spearman's *rho* (Steel and Torrie 1980) was used to test for correlations between bird abundances (mid-grove and grove-edge combined) and vegetation variables characterizing the groves, the percent coverage of edge habitat types bordering study groves, and the degree of isolation of groves. Statistical significance was set at $P \leq 0.05$.

RESULTS AND DISCUSSION

BIRD USE OF CITRUS GROVES.—Bird abundances in the combined mid-grove and grove-edge portions of the 13 groves averaged 1,199 ± 574 (S.D.) birds observed per census count per 100 ha and ranged from 468 to 2,450. The most abundant species (listed in order of decreasing abundance) were Northern Cardinal, Mourning Dove, Common Ground-Dove, Brown Thrasher, Northern Mockingbird, and Rufous-sided Towhee (Table 1). Twelve of the most abundant species in the groves were among the 20 most commonly reported species in Breeding Bird Surveys in Florida (Cox 1987). The number of bird species counted in individual study groves ranged from 6 to 18 and averaged 10. The cardinal was observed in all 13 groves (Table 1), and the thrasher and ground-dove were observed in all but one grove. A total of 30 bird species was observed in the 13 study groves.

The average density of cardinals was higher than densities reported by others (Kale and Webber 1968, Webber and Kale 1969, Lohrer 1991). Factors that may account for our higher densities are the inclusion of juveniles in our numbers and the possibility of multiple registrations of the same individual. In several citrus groves, individuals may have been recorded more than once because trees were infrequently pruned and grew into tall, dense hedgerows that could allow a bird to easily slip undetected from one side to the other.

Bird species found in the citrus groves consisted of three groups: birds that nested there, birds that nested in adjacent edge habitats, and transients that temporarily occupied the groves. All three groups used the groves for foraging. The six most abundant species nested in the groves. The White-eyed Vireo and Carolina Wren were among the species that were frequently seen in the groves, but nested in the adjacent edges, and the American Redstart was one of the most commonly observed transients in the groves.

The most species and individuals were observed in the citrus groves during morning counts. Ten species were observed only during morning counts, most notably the American Redstart and Cattle Egret. The Carolina Wren, Rufous-sided Towhee, Downy Woodpecker, and Red-bellied Woodpecker were recorded in both morning and afternoon counts, but more often in the morning. Wild Turkeys and Black Vultures were the only species observed in afternoon but not in morning counts. In addition, Mourning Dove and Common Ground-Dove numbers were greater in afternoon counts than in morning counts.

Table 1. Bird Abundance and occurrence in the 13 Florida citrus groves. List only includes the most common species[a]. Values represent numbers of birds observed/census count/100ha.

Species	Mid-grove		Grove-edge		Number of groves occupied	
	Mean±SD	Range	Mean±SD	Range	Mid-grove	Grove-edge
Turkey Vulture (*Cathartes aura*)	3.2 ± 7.7	0.0 - 21.6	0.7 ± 2.6	0.0 - 9.3	2	1
Northern Bobwhite (*Colinus virginianus*)	11.6 ± 28.8	0.0 - 86.6	0.6 ± 1.4	0.0 - 4.4	2	2
Mourning Dove (*Zenaida macroura*)[b]	127.0 ± 202.9	0.0 - 757.6	51.6 ± 60.8	0.0 - 214.3	10	11
Common Ground-Dove (*Columbina passerina*)[b]	120.9 ± 140.1	0.0 - 476.2	30.4 ± 27.8	0.0 - 80.0	10	11
Red-bellied Woodpecker (*Melanerpes carolinus*)[b]	14.3 ± 21.0	0.0 - 59.5	12.4 ± 14.0	0.0 - 44.4	6	9
Downy Woodpecker (*Picoides pubescens*)[b]	13.5 ± 32.8	0.0 - 113.8	3.1 ± 6.8	0.0 - 23.8	1	2
Great Crested Flycatcher (*Myiarchus crinitus*)	3.0 ± 10.9	0.0 - 39.2	2.0 ± 5.0	0.0 - 16.7	3	4
Blue Jay (*Cyanocitta cristata*)	2.7 ± 6.8	0.0 - 21.6	1.8 ± 6.6	0.0 - 23.8	2	1
Carolina Wren (*Thryothorus ludovicianus*)	6.1 ± 18.1	0.0 - 64.9	13.9 ± 16.5	0.0 - 55.6	2	8
Northern Mockingbird (*Mimus polyglottos*)[b]	57.9 ± 137.5	0.0 - 500.0	15.9 ± 33.6	0.0 - 119.0	5	5
Brown Thrasher (*Toxostoma rufum*)[b]	70.5 ± 77.9	0.0 - 297.6	8.1 ± 10.0	0.0 - 27.8	12	7
White-eyed Vireo (*Vireo griseus*)[b]	7.5 ± 17.2	0.0 - 59.5	2.4 ± 6.0	0.0 - 16.7	3	2
American Redstart (*Setophaga ruticella*)	14.8 ± 17.4	0.0 - 45.4	1.8 ± 5.2	0.0 - 18.7	7	2
Northern Cardinal (*Cardinalis cardinalis*)[b]	356.5 ± 269.6	106.0 - 1,041.7	154.2 ± 87.2	21.8 - 303.0	13	13
Rufous-sided Towhee (*Pipilo erythrophthalamus*)[b]	43.1 ± 67.1	0.0 - 216.4	17.8 ± 23.3	0.0 - 83.3	7	8
Red-winged Blackbird (*Agelaius phoeniceus*)[b]	8.3 ± 30.0	0.0 - 108.2	2.5 ± 6.1	0.0 - 16.7	1	2

[a]Other species that occurred in small numbers (<3.5 birds observed/census count/100 ha): Cattle Egret (*Bubulcus ibis*), Great Egret (*Casmerodius albus*), Black Vulture (*Coragyps atratus*), American Kestrel (*Falco spaverius*), Wild Turkey (*Meleagris gallopavo*), Yellow-billed Cuckoo (*Coccyzus americana*), Northern Flicker (*Colaptes auratus*), Hairy Woodpecker (*Picoides villosus*), American Crow (*Corvus brachyrhynchos*), Fish Crow (*C. ossifragus*), Blackpoll Warbler (*Dendroica striata*), Common Yellowthroat (*Geothlypis trichas*), Painted Bunting (*Passerina ciris*), and Brown-headed Cowbird (*Molothrus ater*).

[b]Confirmed nesting activity in citrus groves.

Bird abundances in the interiors of the citrus groves were usually greater and more variable than were those in the grove perimeters (Table 1). Although we expected to find the greatest abundance of birds in the grove perimeters, we sampled less area in the perimeters of the groves than in the interiors. Differences in sampling effort would influence the likelihood of detection. The number of bird species observed in individual groves ranged from 1 to 15 mid-grove and from 3 to 14 in the perimeter. Twenty-six bird species were observed in the interiors of the 13 study groves, whereas 27 species were recorded in the grove perimeters. The most abundant species mid-grove were also usually the most abundant species in the grove perimeters. Exceptions were the Carolina Wren, which was among the most common species in the perimeters, and the American Redstart, which was among the dominants mid-grove.

CHARACTERISTICS OF CITRUS GROVES.—Of the measured vegetation parameters, tree height differed the least among the groves; tree canopy diameter, the most (Table 2). Three groves were immediately adjacent to other groves, seven were 0.5 to 2.0 km from other groves, and the remaining three were greater than 2.0 km from other groves.

Table 2. Characteristics (means, S.D., and ranges) of the 13 Florida study groves.

Characteristic	Mean ± SD	Range
Age (years)	51 ± 20	25-90
Size (ha)	5.7 ± 5.4	1.2-18.0
Tree height (m)	4.1 ± 0.5	3.4-5.5
Tree canopy diameter (m)	6.3 ± 1.2	4.8-8.8
Inter-canopy distance (m)	2.0 ± 0.6	0.9-3.2
Openness below canopy (m)	1.2 ± 0.7	0.1-2.4
Coverage of herbaceous vegetation[a]	3.0 ± 0.8	2.0-4.0

[a]Based on these cover classes: 1 = 0-25%, 2 = 26-50%, 3 = 51-75%, and 4 = 76-100%.

Generally, those groves most isolated from other citrus groves were not in residential areas, but were surrounded by undeveloped areas of the wildlife refuge.

Canals commonly bordered the citrus groves on Merritt Island and, accordingly, the predominate edge types were herbaceous canal and wooded canal. The Australian pine edge consisted of a canal planted with closely spaced Australian pines about 18 m tall. Deciduous woodland edge had greater than 75% canopy coverage of both shrubs and trees, whereas shrubland edge had greater than 75% canopy coverage of shrubs but less than 25% canopy coverage of trees. Roadside edge consisted of herbaceous vegetation and paved roads. In some instances, citrus groves or residences bordered the opposite side

of the road adjacent to the study grove. The herbaceous edge was distinguished by dense herbaceous ground cover and by few or no shrubs and trees.

RELATIONSHIPS BETWEEN BIRD ABUNDANCE AND GROVE CHARACTERISTICS.— Bird abundances were significantly correlated with grove age, tree height, inter-canopy distance, the degree of isolation of the citrus groves, and the percentages of four of the six edge habitat types (Table 3). Older citrus groves tended to have a greater abundance of woodpeckers than did younger groves, indicating that the age of citrus groves is important to woodpeckers. A larger percentage of dead and dying trees in older groves than in younger groves may help explain this correlation.

Tree height was positively correlated with the numbers of crows, vultures, Northern Cardinals, and total number of species present in the study groves. Thus, it seemed an important determinant of bird abundance, even though the range of average tree height was small (3.4-5.5 m). Crows were common nest predators in the citrus groves (Crowe 1992) and may have been responding to the abundance of the other species. Dow (1969) found that Northern Cardinals select trees that provide maximum foliage density for nest concealment. Because the shortest trees in the groves were either young trees or older, dying trees that provided less foliage than mature trees did, cardinals may have avoided short trees. Dow also reported that cardinals prefer high song perches.

The negative correlation between inter-canopy distance and cardinal abundance also may reflect this species' preference for well-concealed nest sites. We found that cardinals tended to choose nest trees with closed canopies (Crowe 1992). Erhart and Conner (1986) also reported that adequate nesting cover was important for cardinals.

The abundances of vultures and Brown Thrashers were positively correlated with the degree of isolation of the study groves from other citrus groves. This correlation may have reflected an affinity of Brown Thrashers for the natural vegetation bordering the isolated study groves. The natural vegetation in the edges was an association of mixed hardwoods and pines which included cabbage palmetto (*Sabal palmetto*), laurel oak (*Quercus laurifolia*), slash pine (*Pinus elliottii*), groundsel tree (*Baccharis halimifolia*), longleaf pine (*P. palustris*), live oak (*Q. virginiana*), winged sumac (*Rhus copallina*), wax myrtle (*Myrica cerifera*), coastal plain willow (*Salix caroliniana*), and elderberry (*Sambucus canadensis*). Optimal Brown Thrasher habitat has been described as dense thickets and hedgerows or hardwood draws that have young trees and shrubs with low canopy coverage (Cade 1986). Because the mixed hardwood/pine association consisted of a shrub layer of variable canopy coverage and scattered trees, these

Table 3. Significant (P≤0.05, df=11) Spearman rank correlation coefficients comparing bird abundances with citrus grove variables.

	Grove Characteristics				Percentage of Edge Habitat			
Species	Age of grove	Tree height	Inter-canopy distance	Degree of isolation	Herbaceous canal	Herbaceous	Deciduous woodland	Roadside
Vultures[a]		0.650		0.573				
Mourning Dove							-0.594	
Woodpeckers[b]	0.553							
Crows[c]		0.583						
Carolina Wren					0.546	-0.553		
Northern Mockingbird							-0.570	0.584
Brown Thrasher				0.636			-0.557	
Northern Cardinal		0.594	-0.575			-0.615		
Total Number of Species		0.619						

[a]Vultures = Turkey and Black.

[b]Woodpeckers = Red-bellied, Northern Flicker, Downy, Hairy, and Pileated.

[c]Crows = Fish and American.

edges may have provided favorable habitat for Brown Thrashers. Although this is the most likely explanation for the correlation between Brown Thrasher abundance and the degree of isolation of the groves, it does not explain why thrashers were not more abundant in the grove-edge than at mid-grove (Table 2).

The abundances of five species were correlated with the proportions of the various edge habitat types. Northern Mockingbird abundance was positively correlated with the percentage of roadside edge bordering the groves, but groves with the most roadside edge also were those in residential areas. Stewart and Robbins (1958) and Woolfenden and Rohwer (1969) found high densities of mockingbirds in suburban residential areas, and Woolfenden and Rohwer described the ideal mockingbird habitat as large lawns with an abundance of shrubs. The percentage of deciduous woodland edge surrounding groves seemed to influence negatively the abundance of Northern Mockingbirds, Brown Thrashers, and Mourning Doves. Because deciduous woodland edges had closed shrub and tree canopies, the correlation suggests that these species avoid heavily wooded habitats. Woolfenden and Rohwer (1969) found that, in addition to residential areas, Northern Mockingbirds preferred land only moderately wooded. Harris et al. (1963) reported that Mourning Doves select nest sites adjacent to open habitats that provide an unobstructed view and flight path. The herbaceous edge appeared to have a negative effect on the abundance of Northern Cardinals and Carolina Wrens. Although these two species are known to favor woody vegetation, their abundances were not correlated with edges that had a predominance of trees or shrubs. Given that the herbaceous canal edge is similar to the herbaceous edge, the positive correlation between the abundance of Carolina Wrens and the herbaceous canal edge seems to be spurious.

We found that bird abundance in the Merritt Island citrus groves was correlated with several of the habitat variables that we measured. Such information may allow us to predict which groves will be most attractive to birds. Determining which habitat variables birds respond to in citrus groves is important because of the ongoing conversion of land use into citrus production. Undoubtedly, more birds will be forced to use citrus groves for foraging and nesting. Ultimately, we need to know whether citrus groves represent favorable breeding habitat or sinks for breeding bird populations, especially for species whose numbers are declining, such as the Common Ground-Dove (Robbins et al. 1986). To further understand bird selection and use of citrus groves, future research should address the issues of food availability, nest-site selection and nesting outcome, and the effects of citrus culture practices on survival and reproduction.

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