

Breeding Bird Species in Florida Forest Fragments

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Abstract: Breeding bird counts were conducted in 12 mesic hardwood hammock islands in north central Florida during April and May 1978. The number of species observed to defend territories in the habitat islands was a direct function of island area. The form of the species-area curve is sensitive to the criterion used to define a "breeding" species. If presence on 3 of 4 counts is required before a recorded species is considered to be a breeding species, then small islands are shown to support many fewer species and the slope of the species area curve is increased by 25%. The number of breeding bird species appears to double for every 7.25-fold increase in area. Small, disjunct habitat islands (≤ 30 ha) do not support a large proportion of the bird species characteristic of north Florida hardwood forests. The 12 islands studied supported only 64% of the species that breed in hardwood forests and only 46% of the 13 species that are restricted to this forest type. The species that do not reproduce in the small islands (area-sensitive species) deserve greater attention in nongame monitoring and conservation programs.

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Fragmentation has been identified as 1 of 3 major processes impacting forest wildlife habitat (Robbins 1979, Harris 1980, 1984). As large expanses of closed-canopy forest are subdivided into discrete patches, plant and animal communities "relax" to a lower number of species, and as the patches of habitat become smaller, the proportion of edge-tolerant and opportunistic species increases (Diamond 1972, Terborgh 1974, Whitcomb et al. 1981, Anderson and Robbins 1981, Lynch and Whigham 1984). Whereas the colonization of true islands may represent a more random process dependent on factors such as degree of isolation, southeastern habitat islands are annually exposed to the same battery of migrant birds returning north to reproduce. This suggests that random dispersal and isolation may be less important while habitat quality, size of area, and competition may be more important in determining the

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"colonists" of these forest fragments. These are also variables that managers and decision makers can manipulate and influence as further habitat is developed. The objectives of this study were to determine the relation between the breeding bird community and the size of north central Florida habitat islands and to determine if a pattern exists in the feeding guild structure of the different avian communities. This is journal series number 5582 of the Florida Agricultural Experiment Station.

Methods

The climax vegetation of the north-central Florida uplands formerly consisted of a forest of mixed mesophytic hardwoods (Monk 1965), but since most of this area is now in agricultural use or undergoing development, few areas of climax forest remain. These exist as a patchwork of generally autonomous islands.

Twelve different sized habitat islands (0.4, 0.8, 1.2, 1.4, 1.6, 2.8, 3.2, 4.8, 5.6, 8.0, 24.0, and 30.0 ha) of mesic hardwood forest were chosen on the basis of their similarity in: 1) tree species composition and age, 2) canopy height, 3) presence of all 3 layers of vegetation, 4) isolation from other patches of woods, 5) roughly circular shape, and 6) sharp surrounding edge (i.e., the edge was distinct from surrounding fields).

Each island was censused 4 times from 7 April to 31 May 1978 between 0600 and 0900 hours. An adaptation of the IPA point census (Ferry and Frochot 1970) was used. At least 6 5-minute counts were taken (more in larger islands) at designated points 100 m apart on each island to reduce the possibility that a resident species was silent (and thus would be missed by only 1 15-minute count in small islands). Only birds seen or heard within the island habitat were recorded. Nests and territorial displays were also noted. To help insure that tallies included only species that were utilizing an island for nesting (Table 1) and not those simply passing through the area, only species that were recorded on at least 3 of the 4 censuses were considered to be resident breeders (Williamson 1964). By correlating sightings with territorial displays, it is felt that determination of the actively breeding species was accomplished with as high a degree of accuracy as the spot map method (Dickson 1978).

For the purposes of analysis, all species were assigned to feeding guilds following the criteria of Willson (1974). Each species was characterized by a 3-digit number. The first number represents primary food habits (1 = seed eater, 2 = insectivore, 3 = omnivore, 4 = carnivore), the second represents the stratum most commonly used for foraging (1 = bark, 2 = ground, 3 = lower canopy, 4 = mid-canopy, 5 = upper canopy, 6 = ubiquitous habitats), and the third number represents the usual foraging behavior (1 = bark drill, 2 = bark glean, 3 = ground glean, 4 = foliage glean, 5 = hawk or sally).

Results

Species richness increased as a curvilinear function of area (Fig. 1). Least squares analysis of log transformed data yielded solutions to the allometric equation:

$$S = cA^z \tag{1}$$

- Where: S = number of species
 c = extrapolated intercept on y axis
 A = size of area (ha)
 z = slope value of log-log plot

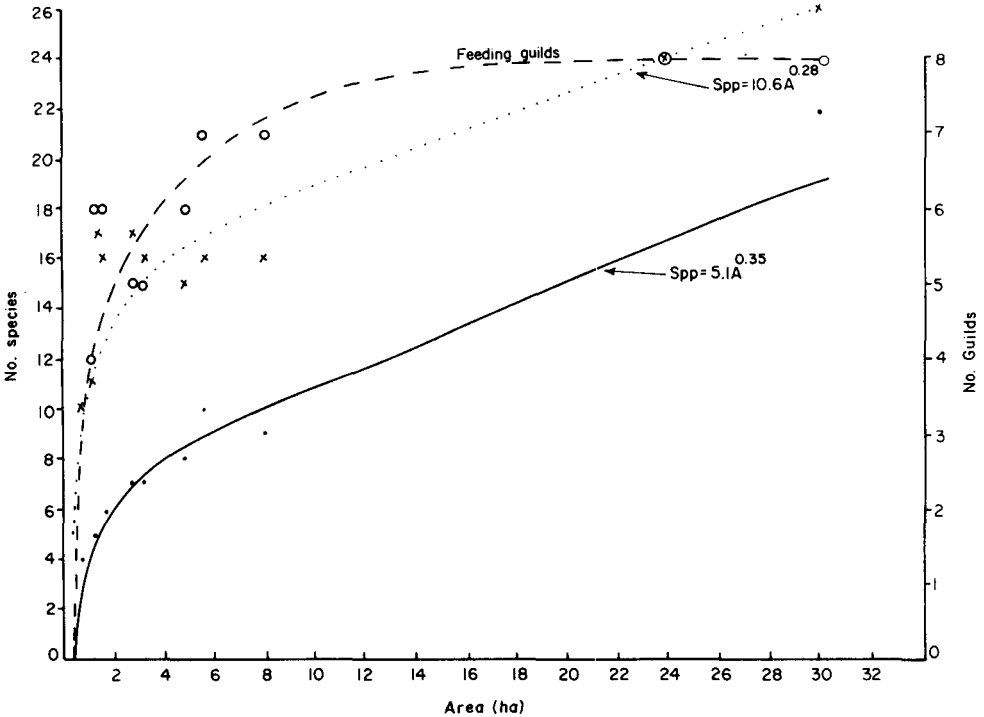


Figure 1. The species-to-area (solid line with dots) and guild-to-area (dashed line with circles) relations for 12 north-central Florida hardwood habitat islands. The dotted line (with x's) represents the species-area relation derived by including all species recorded on each island and shows the inflated values over those species judged to be actually nesting. The guild-to-area curve reaches its asymptote more quickly than the species-to-area curve, indicating that community packing is first accomplished by an increase in the number of guilds and subsequently by species packing within the guilds.

Table 1. List of 45 species known to breed in the mesic hardwood forests of north Florida, the species that only breed in those forests (Sprunt 1963), and those recorded on 3 of 4 censuses in the habitat islands of this study.

Species	Restricted to hardwood	Found in islands
Mississippi kite (<i>Ictinia mississippiensis</i>)		
Cooper's hawk (<i>Accipiter cooperii</i>)	x	
Red-tailed hawk (<i>Buteo jamaicensis</i>)		
Red-shouldered hawk (<i>Buteo lineatus</i>)	x	x
Broad-winged hawk (<i>Buteo platypterus</i>)	x	
Turkey (<i>Meleagris gallopava</i>)		
Northern bobwhite (<i>Colinus virginianus</i>)		x
Mourning dove (<i>Zenaidura macroura</i>)		x
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	x	x
Eastern screech-owl (<i>Otus asio</i>)		
Great-horned owl (<i>Bubo virginianus</i>)		x
Barred owl (<i>Strix varia</i>)	x	x
Common barn-owl (<i>Tyto alba</i>)		
Ruby-throated hummingbird (<i>Archilochus colubris</i>)		
Common flicker (<i>Colaptes auratus</i>)		
Pileated woodpecker (<i>Dryocopus pileatus</i>)	x	x
Red-bellied woodpecker (<i>Melanerpes carolinus</i>)		x
Downy woodpecker (<i>Dendrocopus pubescens</i>)		x
Hairy woodpecker (<i>Dendrocopus villosus</i>)		
Great-crested flycatcher (<i>Myiarchus crinitus</i>)		x
Acadian flycatcher (<i>Empidonax virescens</i>)	x	
Eastern wood pewee (<i>Contopus virens</i>)		
Blue jay (<i>Cyanocitta cristata</i>)		x
Common crow (<i>Corvus brachyrhynchos</i>)		x
Carolina chickadee		

(<i>Parus carolinensis</i>)		
Tufted titmouse		
(<i>Parus bicolor</i>)		x
White-breasted nuthatch		
(<i>Sitta carolinensis</i>)		
Carolina wren		
(<i>Thryothorus lucovianus</i>)		x
Northern mockingbird		
(<i>Mimus polyglottus</i>)		
Brown thrasher		
(<i>Toxostoma rufum</i>)		x
Wood thrush		
(<i>Hylocichla mustelina</i>)	x	
Blue-gray gnatcatcher		
(<i>Poliopitila caerulea</i>)	x	x
White-eyed vireo		
(<i>Vireo griseus</i>)		x
Yellow-throated vireo		
(<i>Vireo flavifrons</i>)		
Red-eyed vireo		
(<i>Vireo olivaceus</i>)	x	x
Swainson's warbler		
(<i>Limnothlypis swansonii</i>)	x	
Northern Parula		
(<i>Parula americana</i>)		x
Yellow-throated warbler		
(<i>Dendroica dominica</i>)		
Louisiana waterthrush		
(<i>Seiurus motacilla</i>)	x	
Common yellowthroat		
(<i>Geothlypis trichas</i>)		x
Hooded warbler		
(<i>Wilsonia citrina</i>)	x	
Summer tanager		
(<i>Piranga rubra</i>)		x
Western cardinal		
(<i>Cardinalis cardinalis</i>)		x
Blue grosbeak		
(<i>Guiraca caerulea</i>)		x
Indigo bunting		
(<i>Passerina cyanea</i>)		x

The specific parameter values of the breeding bird (seen at least 3 of 4 times) species-area relation were:

$$S = 5.12 A^{0.35} \quad (2)$$

$$(r^2 = 0.79)$$

When all species recorded on 1 or more of the 4 censuses are included in the analysis, the intercept value is doubled while the slope value is somewhat reduced:

$$S = 10.57 A^{0.28} \quad (3)$$

$$(r^2 = 0.73)$$

Comparison of the 2 curves reveals that use of all species recorded 1 or more times greatly inflates the number of species that appear to be breeding in a habitat patch. This is especially so for very small patches. For example,

whereas no species was judged to have established a breeding territory in the 0.4 ha habitat island, 5 species were recorded 1 or more times. Similarly, whereas 11 species were recorded for the 0.8-ha island, only 5 species were recorded 3 or more times. In both the 24- and 30-ha islands, 14 of 23 and 22 of 26 species, respectively, were judged to be defending territories.

Solving the least squares equation analytically indicates that on average, a doubling of the number of breeding bird species will accompany every 7.25-fold increase in island size. This result has great importance to planners and impact analysts who desire to maintain species richness.

The sequence in which breeding species are added to the list as island size increases is shown in Table 2. Four species representing 3 guilds were found on virtually every island. These were cardinal (334), Carolina wren (234), red-eyed vireo (254), and northern parula (254). All are reported to have small (1.0- to 1.5-ha) territories except the Carolina wren (2.6 ha) (Fitch 1958). The only island that did not support wrens had a considerably reduced understory layer.

Four species representing 4 new guilds were present at nearly all islands larger than 1.2 ha. These were tufted titmouse (242), red-bellied woodpecker (211), great-crested flycatcher (255), and summer tanager (254). These species are all reported to have territory sizes larger than 1.4 ha (Fitch 1958).

Five additional species representing 2 new guilds were added as island size reached 4.8–5.6 ha. These were blue jay (364), common crow (364), northern bobwhite (123), mourning dove (123), and yellow-billed cuckoo (254). Bobwhites and mourning doves are not typically forest birds, but neither was found with regularity in smaller islands. This probably results more from variation in surrounding matrix than the habitat islands themselves.

Six species representing 3 guilds (1 new) were present as size increased to 24.0 ha. These were downy and pileated woodpeckers (both 211), blue-gray gnatcatcher (254), barred owl, great-horned owl, and red-shouldered hawk (all 462). Territory size for the downy is reported as 12.6 ha; for the pileated, >40 ha; for the gnatcatcher about 1.0 ha; much greater than our island sizes for all 3 raptors (Fitch 1958).

Whereas the number of species gradually increased over a large range of island sizes, the increase in number of guilds occurred more rapidly in the small islands than in the larger sized islands (Fig. 1). In other words, early additions to the species complex represented the addition of different feeding guilds but later additions occurred within already-established guilds. The observed guild expansion was primarily limited to 4 guilds. The insectivorous, high-canopy, foliage gleaners (254) increased to 5 members in the largest island size (northern parula, red-eyed vireo, summer tanager, yellow-billed cuckoo, and blue-gray gnatcatcher). These species represent a great range of body and bill sizes and, therefore, are probably not subject to intense competition for food. No species was observed to breed in an island smaller than its reported terri-

Table 2. The number of times a species was recorded on each island, totals for all species, and breeding species (seen at least 3 of 4 times). Territory sizes after Fitch (1958).

Species	Territory size (ha)	Habitat islands (ha)												
		0.4	0.8	1.2	1.4	1.6	2.8	3.2	4.8	5.6	8.0	24.0	30.0	
Cardinal	1.2	2	4	4	4	4	4	4	4	4	4	4	4	4
Northern Parula		0	4	2	3	3	4	4	4	4	3	3	3	3
Red-eyed Vireo	0.8	0	4	4	0	1	4	4	1	3	0	1	4	4
Carolina wren	2.6	0	4	0	4	4	4	4	4	4	4	4	4	4
Tufted titmouse	1.4	0	1	3	4	4	3	3	3	2	0	4	4	4
Great-crested flycatcher	2.6	1	3	4	3	3	3	4	4	4	4	4	4	4
Red-bellied woodpecker	6.8	0	1	1	3	3	1	2	4	4	4	4	4	4
Summer tanager	1.7	0	0	0	4	3	3	3	4	4	4	4	4	4
Yellow-billed cuckoo	2.4	1	0	2	1	1	1	4	1	3	3	3	4	4
Blue jay		0	1	2	4	1	1	2	1	4	4	4	4	4
Common crow		0	1	3	1	2	1	1	1	3	0	3	3	3
Downy woodpecker	12.6	0	0	0	1	0	0	1	2	0	0	3	3	3
Blue-gray gnatcatcher	1.0	0	1	0	0	1	1	0	0	2	1	0	4	4
White-eyed vireo	1.2	0	1	0	0	0	4	4	0	4	0	1	3	3
Mourning dove	3.2	0	0	1	0	1	0	0	0	2	3	4	4	4
Northern bobwhite		0	0	0	1	0	0	0	0	3	0	2	3	3
Pileated woodpecker		0	0	1	0	2	0	1	1	0	2	1	3	3
Barred owl	30.0	0	0	0	0	0	0	0	0	0	0	3	1	0
Great-horned owl	53.4	0	0	0	0	0	0	0	0	0	0	0	0	3
Red-shouldered hawk	64.0	0	0	0	0	0	0	0	0	0	0	0	0	4
Red-tailed hawk	132.0	0	0	0	0	0	0	0	0	0	0	1	1	1
Northern mockingbird	0.4	0	0	0	1	0	1	0	0	0	1	2	1	1
Brown thrasher		0	0	0	3	0	0	0	0	0	0	1	0	0
Blue grosbeak	0.6	1	0	0	0	0	0	0	0	0	0	1	0	0
Indigo bunting		0	0	0	1	0	0	0	3	0	0	0	4	4
Rufus-sided towhee	1.8	0	0	0	1	0	1	0	0	0	0	4	0	4
Red-winged blackbird		0	0	0	0	0	1	1	0	0	0	0	4	4
Common yellowthroat	1.4	1	0	0	1	0	0	0	0	0	0	1	4	4
Common flicker		0	0	0	0	0	0	0	0	0	0	1	0	0
Yellow-throated warbler		0	0	0	0	0	0	0	1	1	0	0	0	0
Yellow-throated vireo		0	0	0	0	0	1	0	0	0	0	0	0	0
Total species seen at least 3 of 4 times		5	11	11	17	14	17	15	15	16	14	24	24	24
		0	5	5	9	7	8	8	8	12	10	13	22	22

tory size, and all except the gnatcatcher colonized in the order of reported territory size.

The insectivorous bark drilling guild (211) expanded to 3 species in the 30-ha island. Although the red-bellied woodpecker (6.8-ha territory) was found on most every island, the downy (12.0 ha) and pileated woodpeckers (40 to 50 ha) occurred only when larger island sizes were reached.

Discussion

The number of breeding bird species occupying habitat islands in north-central Florida seems to increase as a direct function of island size. Using the number of species recorded on all censuses, as is commonly done, greatly over-emphasizes the importance of small habitat islands as nesting habitat since many of the recorded species probably do not actually breed there. A large proportion of such recorded species is using the island for foraging or is simply passing through, and the actual number of species that breed in the habitat island is smaller.

Requiring that the species be observed on 2, 3, or even 4 counts does not ensure that entries are actually breeding species, but it does decrease the probability of error. Perhaps more importantly, it reveals that the shape of the species-to-area relation (i.e., slope of the log-log line) is highly sensitive to human-imposed census criteria. In this study, the slope of the species-area relation was increased by 25% (from 0.28 to 0.35) by changing the census criterion from presence on 1 or more counts to presence on at least 3 of 4 counts.

Knowledge of the specific habitat characteristics that allow larger areas to support more species is important when explaining species richness on a given habitat island, but such knowledge is not critical to further use of the species-to-area relation in impact analyses or the design of forests to be managed in the future. Just as life insurance companies deal in trends and probabilities without speculating on how an individual is to die, species-to-area patterns may be used without quibbling about individual factors or even individual patches.

In this study, species seemed to colonize the islands in a regular, orderly fashion. Given a uniform habitat, similar-sized islands had the same complement of the species present. As island size increased, the species included on smaller islands were retained and new species were added.

Because the same species occurred in all similarly-sized islands, it appears that chance plays a modest role and that "assembly rules" (Diamond 1975) may be operative. It is believed this is because the annual spring exposure to a diverse array of species over several millennia has selected for species which integrate into communities on the basis of habitat size and structure.

Whereas most north Florida bird species appear to colonize an island only when it is large enough to include their entire territory, there are many exceptions to this. Raptors and "edge species" may only require the forest habitat

for nesting while using large expanses of surrounding matrix for foraging. Others, such as Carolina wrens, red-bellied woodpeckers, and pileated woodpeckers, may simply reflect that reported home ranges are average figures and subject to much variability. Florida birds also seem to be smaller (Sprunt 1963) than those of higher latitudes, such as Kansas, where Fitch (1958) did his work. Florida environments have higher primary productivity which may translate to smaller home ranges and territory size.

Several species observed in this study reflected colonization patterns described by Diamond (1975). "Supertramps" are found in fields and early successional stages of growth and not within forest islands except at the edge. It is believed that the indigo bunting fits this caricature. "C-tramps" are found on all but the very smallest islands and the great-crested flycatcher reflected this pattern. "High-S" species occur only on the largest islands, where many species are already present; examples from this study are the pileated woodpecker and blue-gray gnatcatcher.

Of 45 species of birds that commonly breed in expansive tracts of north Florida mesic hardwood forest, only 24 used the 12 forest island fragments during the 1978 breeding season. The overwhelming majority of these 24 species are common throughout residential and agricultural areas of north Florida. Their management and/or conservation demands little attention from professional managers. The 21 species that did not breed in the forest fragments are principally wide-ranging birds such as raptors and turkey or dense woodland species such as the hooded warbler. Of 13 bird species that only breed in hardwood forest, 6 were observed in the habitat islands. Again, these are reasonably common in man-dominated environments. The 7 hardwood species not found in the fragments are generally rare (e.g., Cooper's hawk) and/or tend to be wet-site species. Thus, drainage may have concomitantly reduced habitat quality. Although north Florida is the southern limit to the breeding range for several of the notably absent species, all 45 are known to breed in the 2,000-ha San Felasco State Preserve within 20 km of the forest fragments.

Years of research will be required to document the specific proximal cause for the decline of species such as the white-breasted nuthatch. Until that research is complete, it is suggested that more general patterns, such as species-area relations, may be used to guide land use decisions. Continued fragmentation of Florida's forests will certainly accentuate the problem of species loss. Nongame programs should commit substantial efforts toward maintenance of continuous tracts of forest rather than encouraging further fragmentation in the name of wildlife management.

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