Width of Forest Streamside Zones and Breeding Bird Abundance in Eastern Texas

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Abstract - We evaluated breeding bird communities in forested streamside zones in eastern Texas to determine threshold widths of riparian forest that were associated with the addition of mature-forest-breeding birds and loss of shrub-breeding birds. We observed an association of shrub-breeding birds with narrow streamside zones and an increasing number of mature forest species within wider streamside zones. Streamside zones also provided song perches for many shrub breeding species. Although many bird species increased or decreased in a generally linear pattern as streamside zone width increased, some species appeared to have threshold widths associated with their presence. The Acadian Flycatcher (*Empidonax virescens*), Yellow-throated Vireo (*Vireo flavifrons*), and Yellow-billed Cuckoo (*Coccyzus americanus*) seemed to require at least 70 m of forest width before their abundance increased. In contrast, the Blue Grosbeak (*Passerina caerulea*), Painted Bunting (*Passerina ciris*), and Prairie Warbler (*Dendroica discolor*) decreased markedly at widths greater than 20 m and were absent after streamside zone widths increased beyond 70 m. We were unable to detect a relationship between streamside zone width and abundance of 11 species of birds. Uncut forested streamside zones within pine plantations provided a variety of habitat for forest-breeding and shrub-breeding birds that would not have been present had streamside zones been cut during harvesting operations. Our results provide important information to help forest managers balance the habitat requirements of both shrub-breeding and forest-breeding birds when they harvest timber in southern pine forests.

Introduction

Mature pine (*Pinus* spp.) and pine-hardwood forests are being converted to pine plantations at an increasing rate in the southeastern United States. The area in pine plantations is expected to more than double, reaching 28% of total forest area by 2030 (USDA 1988). Forest bird communities, including many Neotropical migrants, are affected by this conversion (Dickson et al. 1995a), but little is known about avian use of these habitats in the southeastern United States (Dickson et al.

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1995b). Uncut forest retained along streams (forested streamside zones) within pine plantations can provide valuable habitat for birds that breed in mature forest. In addition, bird species of early successional forest may use forested streamside zones for breeding or song perches. Although the width of these linear forest patches certainly affects use by both early successional and mature forest bird species, width requirements are not precisely known.

Conceptually, forested streamside zones and their associated bird communities may be viewed as an extension of island biogeographic relationships (MacArthur and Wilson 1967, Robbins et al. 1989). As forest fragment size (island size) increases, the number of species, and often habitat complexity, also increase (Harris 1984; Harris and Wallace 1984; MacArthur and Wilson 1963, 1967). However, some bird species have threshold area requirements that must be reached before forest islands will be occupied (Forman et al. 1976, Galli et al. 1976, Lynch and Whitcomb 1978). In addition, forest fragment shape (blocked as opposed to linear) can also influence species richness and composition (Diamond 1975, 1976).

Although not true habitat islands, forested streamside zones created by harvesting practices that leave small, residual uncut strips of forest along streams, have the potential to exhibit species-area relationships. Because forested streamside zones could increase nest predation and brood parasitism rates due to their high edge to area ratio (Keyser et al. 1997), bird species favoring large patches of mature forest may be absent or much less abundant within forested streamside zones until some sufficient width of habitat becomes available. For example, Keller et al. (1993) sampled birds in 117 riparian forest corridors in Maryland and Delaware and noted that area-sensitive Neotropical migrants were encountered more frequently in wider riparian forests. Alternatively, species with a lower vulnerability to predation or brood parasitism may not require a threshold width and might increase in abundance in proportion to width of forested streamside zones. As a third possibility, bird species preferring shrubland or forest edge habitat might decrease linearly as forest width increases, or may only occupy forested streamside zones when forest width is narrower than some threshold.

In a previous study in eastern Texas, we examined the community-level associations of birds to 3 general widths of streamside zones (narrow, medium, and wide) and observed that bird abundance typically increased with increasing streamside zone width (Dickson et al. 1995b). Narrow forested streamside zones were used primarily by bird species associated with young brushy habitat and forest edge. Birds frequenting the wider zones were species associated with mature pine-hardwood and bottomland hardwood forest habitat in the southern US.

Using data from our previous study (Dickson et al.1995b), we evaluated abundance of breeding birds in 50-m long segments of forested streamside zones of varying widths to more precisely determine threshold widths of riparian forest that were associated with the addition of mature-forest breeding birds and loss of shrub-breeding birds. The identification of threshold widths of forest streamside zones is needed so that forest managers can make specific management recommendations for both shrubland and mature forest birds within southern pine plantations.

Study Areas

We surveyed breeding bird populations in forested streamside zones within 9 young pine plantations in Cherokee, Nacogdoches, and San Augustine counties in eastern Texas in 1984 and 1985. All of our study areas were located within extensive areas of continuous mixed-pine hardwood forest cover. Dominant overstory trees within these streamside zones were sweetgum (*Liquidambar styraciflua* Linnaeus), white oak (*Quercus alba* Linnaeus), southern red oak (*Q. falcata* Michaux), blackgum (*Nyssa sylvatica* Marshall), and loblolly pine (*Pinus taeda* Linnaeus). Overstory trees ranged from 15 to 22 m in height and from 40 to 60 years in age. Each forested streamside zone had an adjacent pine plantation on both sides that ranged in age from 2 to 5 years and 49 to 121 ha in size. All plantations were second growth pine-hardwood forest habitat that had been recently clearcut, mechanically site prepared, and planted to loblolly pine. Sites selected for sampling were similar in topography, soils, plant species composition, and surrounding land use patterns. Streamside zones sampled for birds were along first and second order intermittent streams. Planted pines were 0.5 to 2.0 m tall when the study was initiated in 1984. The plantations were primarily composed of young pines and other woody and herbaceous vegetation, such as oak (*Quercus* spp.) and sweetgum coppice, American beautyberry (*Callicarpa americana* Linnaeus), blackberry and dewberry (*Rubus* spp.), and sumac (*Rhus* spp.).

Methods

Breeding birds were surveyed along transects that coincided with the streambed within forested streamside zones on 9 different intermittent streams (see Dickson et al. 1995b). Forested streamside zones of three general width ranges: 3 narrow (5–25 m), 3 medium (30–40 m), and 3 wide (50–100 m) were sampled. Two 200-m transects (separated by 100 m) were delineated on each of the 9 intermittent streams yielding a total of 18 transects and 3600 m of transect (Fig. 1). Each transect was surveyed for bird species presence and abundance a total of 8 times

within 3 hours after sunrise during May to mid-June in 1984 and 1985 following guidelines proposed by Conner and Dickson (1980). Transects were surveyed by four observers (two visits to each transect per observer), and this should have distributed observer bias equally among streamside zones.

Another potential problem encountered during bird surveys is varying detectability among bird species and habitats, or as distance fromthe observer increases (Emlen 1971, Mayfield 1981). We examined relative abundance estimates of different species of birds detected within forested streamside zones of different widths. Thus, as forest strip width increased, the actual land area sampled also increased. We did not adjust abundance data for the increasing land area sampled as forest width increased. Therefore, abundances of some forest bird species were likely higher within the widest forested streamside zones. Because we made no comparisons among species, differences in detectability across species should not have been a problem.

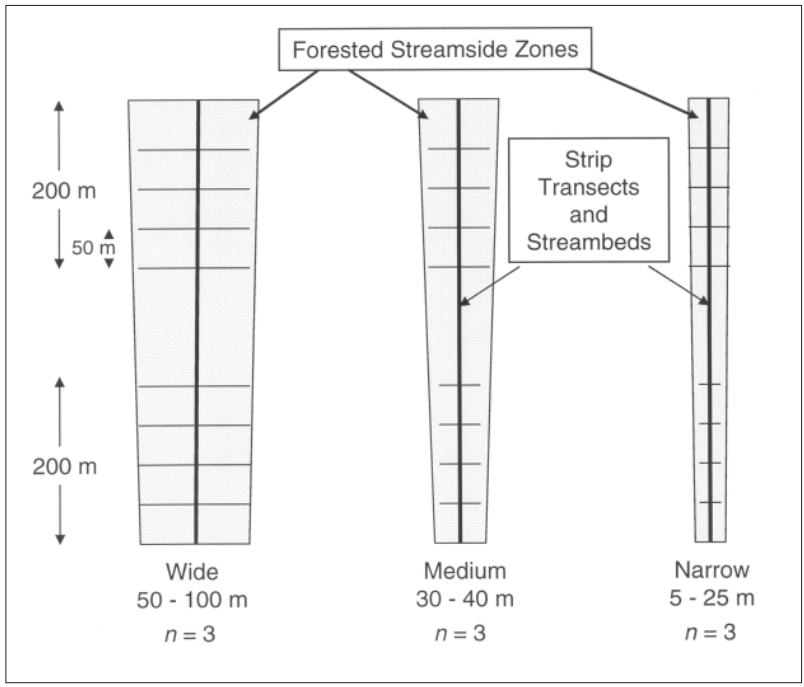


Figure 1. Schematic diagram of transects for surveying birds within forest streamside zones in eastern Texas, May–June 1984 and 1985. Two 200-m transects were located on each of three width classes of streamside zones. The survey design was replicated in three different areas for a total of 18 transects (see methods). Forested streamside zone width tended to increase as distance from headwater increased.

We divided surveyed transects into 50-m segments (n = 72) and determined the average width of each segment. We then assigned segments to ten 10-m width categories ranging between 0 and 100 m. Bird abundance data were averaged by species for each 50-m segment of transect. We did not detect annual differences in bird abundance and pooled data for the 2 years (Dickson et al. 1995b). We

Table 1. The relationship between bird abundance and width of forested streamside zone (Spearman correlation coefficient, r_s, n = 72) in pine-hardwood forests in eastern Texas during May and June 1984–1985.

Bird species	r_s	P
Species that steadily increased		
Downy Woodpecker	0.58	0.080
White-eyed Vireo	0.59	0.072
Red-eyed Vireo	0.82	0.004
Tufted Titmouse	0.90	< 0.001
Carolina Wren	0.56	0.093
Black-and-white Warbler	0.76	0.011
Kentucky Warbler	0.64	0.044
Summer Tanager	0.87	0.001
Northern Cardinal	0.76	0.013
Species that abruptly increased after a threshold was reached		
Yellow-billed Cuckoo	0.57	0.085
Pileated Woodpecker	0.81	0.005
Acadian Flycatcher	0.78	0.008
Yellow-throated Vireo	0.72	0.020
Species that steadily decreased		
Yellow-breast Chat	-0.50	0.138
Indigo Bunting	-0.81	0.004
Species that abruptly decreased		
Eastern Kingbird	-0.81	0.005
Prairie Warbler	-0.69	0.027
Blue Grosbeak	-0.64	0.047
Painted Bunting	-0.81	0.004
Orchard Oriole	-0.74	0.014
Species not associated with streamside zone width		
Northern Bobwhite	0.29	0.422
Red-headed Woodpecker	-0.54	0.104
Red-bellied Woodpecker	0.49	0.154
Hairy Woodpecker	0.36	0.304
Eastern Wood-Pewee	0.41	0.238
Blue Jay	0.31	0.377
Carolina Chickadee	0.41	0.244
Blue-gray Gnatcatcher	0.42	0.229
Gray Catbird	0.15	0.687
Hooded Warbler	0.36	0.304
Brown-headed Cowbird	-0.28	0.433
Total abundance	0.72	0.019
Species richness	-0.40	0.284

used Spearman's correlation analysis to examine relationships between forested streamside zone width and the abundance of individual bird species (n = 72).

We averaged bird abundance within each 10-m width category (0–10, 11–20, … through 91–100 m) to obtain mean values for graphs (Fig. 2–6). Sample size for each of the 10 width categories varied between 6 and 8. We used graphs to examine patterns of bird abundance in relation to forested streamside zone width. Species were grouped by their apparent association with forested streamside zone width: species that steadily increased in abundance, species that abruptly increased after a threshold width had been reached, species that steadily decreased, and species that abruptly decreased. Eleven species that were not associated with forested streamside zone width were not graphed (Table 1). Eleven other species were detected too infrequently (< 20 detections over 2 years) to examine an abundance-streamside zone width relationship.

Results

Overall, total abundance of birds detected on surveys increased significantly as width of forested streamside zone increased (Table 1). Total abundance increased until streamside zone width reached 60 m,

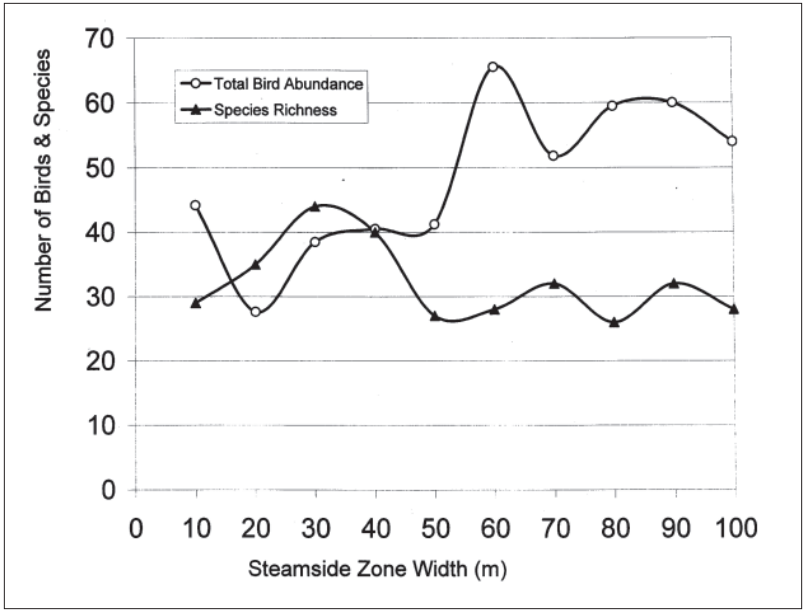
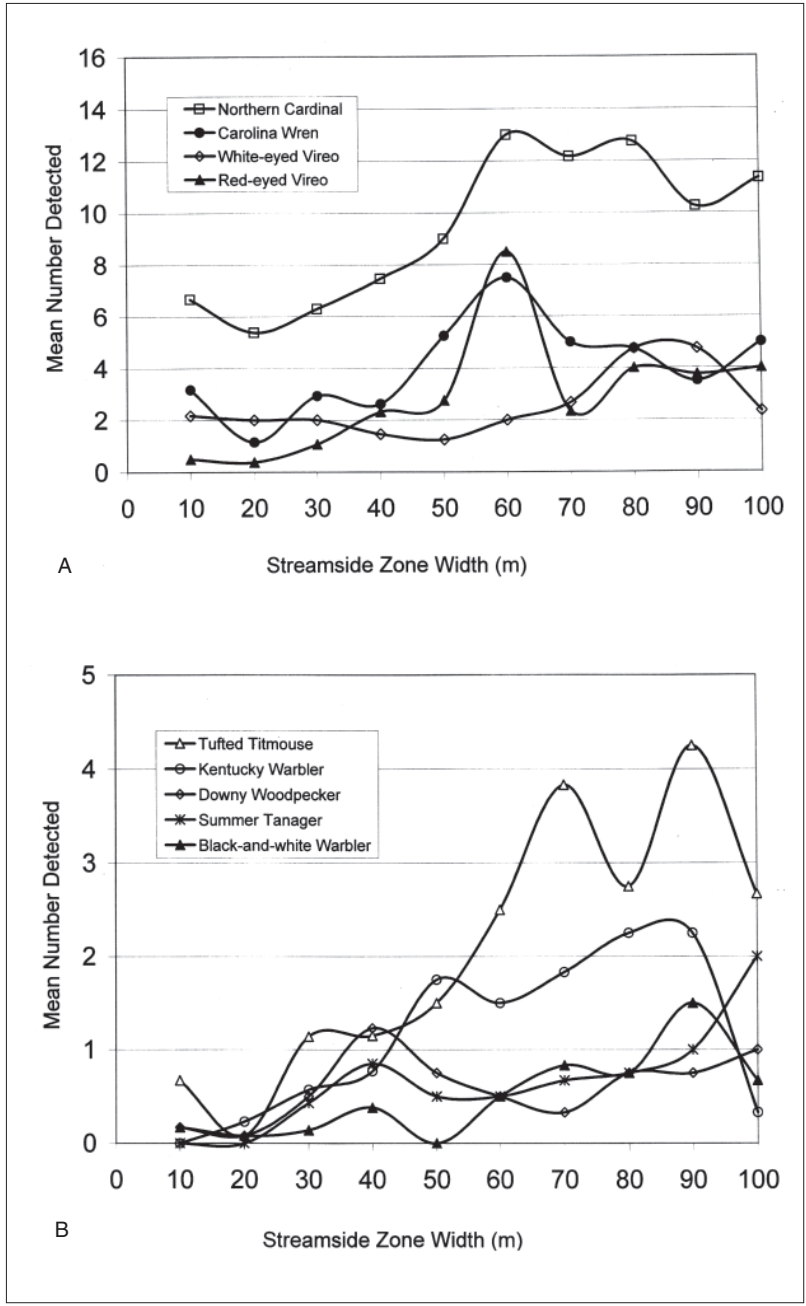


Figure 2. Mean species richness and total abundance of all bird species combined as a function of forested streamside zone width in eastern Texas, May–June 1984 and 1985.



Figures 3a and 3b. Mean abundance of bird species that increased steadily as forested streamside zone width increases in eastern Texas, May–June 1984 and 1985.

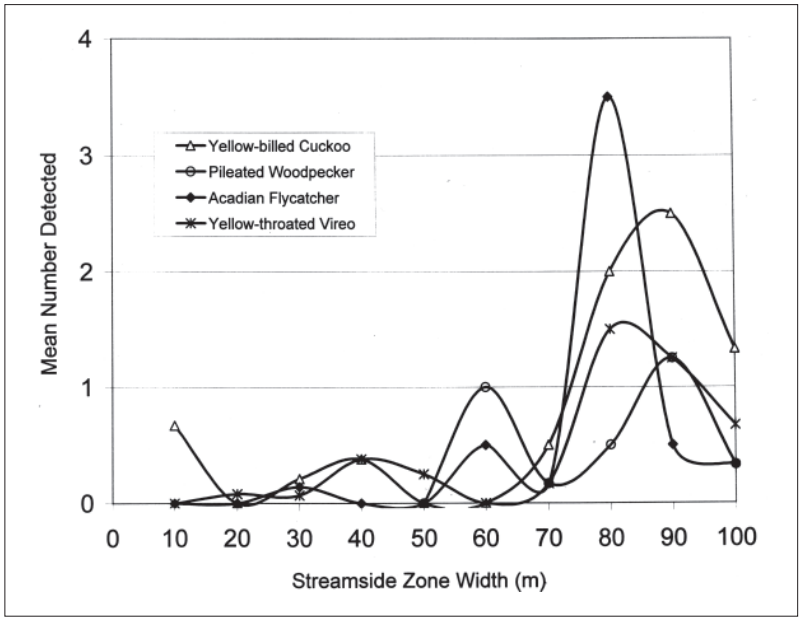


Figure 4. Mean abundance of bird species that increased markedly after reaching a forested streamside zone threshold width in eastern Texas, May–June 1984 and 1985.

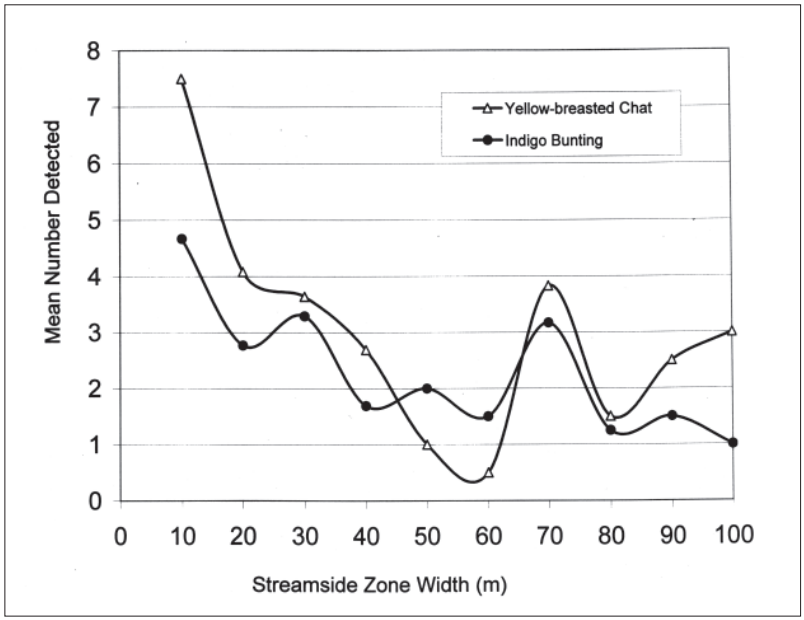


Figure 5. Mean abundance of bird species that decreased steadily as forested streamside zone width increased in eastern Texas, May–June 1984 and 1985.

decreased slightly at 70 m widths, and became fairly stable as width continued to increase (Fig. 2). Species richness was not significantly related to streamside zone width, but was somewhat higher at widths of 20 to 40 m (Table 1, Fig. 2).

The Northern Cardinal (*Cardinalis cardinalis* Linnaeus), Red-eyed Vireo (*Vireo olivaceus* Linnaeus), Tufted Titmouse (*Baeolophus bicolor* Linnaeus), Kentucky Warbler (*Oporornis formosus*), Summer Tanager (*Piranga rubra* Linnaeus), and Black-and-white Warbler (*Mniotilta varia* Linnaeus) increased in abundance as streamside zone width increased, whereas positive relationships for the Carolina Wren (*Thryothorus ludovicianus* Latham), White-eyed Vireo (*Vireo griseus* Boddaert), and Downy Woodpecker (*Picoides pubescens* Linnaeus) were not as strong (Figs. 3a and 3b, Table 1). The Red-eyed Vireo was somewhat variable in abundance after streamside zones exceeded 50 m in width (Fig. 3a, Table 1). Abundances of the Yellow-billed Cuckoo (*Coccyzus americanus* Linnaeus), Acadian Flycatcher (*Empidonax virescens* Vieillot), Yellow-throated Vireo (*Vireo flavifrons* Vieillot), and Pileated Woodpecker (*Dryocopus pileatus* Linnaeus) substantially increased only after streamside zones exceeded 60–70 m in width (Fig. 4, Table 1).

Abundance of other species appeared to decrease as streamside zone width increased (Figs. 5 and 6). The Yellow-breasted Chat (*Icteria virens* Linnaeus) and Indigo Bunting (*Passerina cyanea*

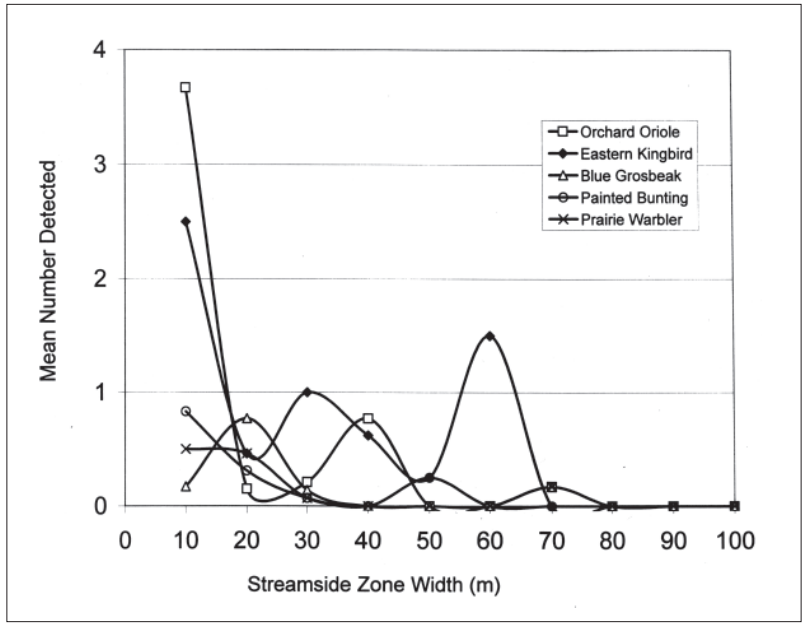


Figure 6. Mean abundance of bird species that decreased abruptly as forested streamside zone width increased in eastern Texas, May–June 1984 and 1985.

Linnaeus) steadily decreased in abundance as streamside zone width increased (Fig. 5, Table 1). The Orchard Oriole (*Icterus spurius* Linnaeus), Eastern Kingbird (*Tyrannus tyrannus* Linnaeus), Blue Grosbeak (*Passerina caerulea* Linnaeus), Painted Bunting (*P. ciris* Linnaeus), and Prairie Warbler (*Dendroica discolor* Vieillot) appeared to decrease abruptly in abundance as streamside zone increased (Fig. 6, Table 1).

Abundance of the Blue Jay (*Cyanocitta cristata* Linnaeus), Carolina Chickadee (*Poecile carolinensis* Audobon), Eastern Wood-Pewee (*Contopus virens* Linnaeus), Hooded Warbler (*Wilsonia citrina* Boddaert), Gray Catbird (*Dumetella carolinensis* Linnaeus), Northern Bobwhite (*Colinus virginianus* Linnaeus), and Red-bellied Woodpecker (*Melanerpes carolinus* Linnaeus) did not appear to be affected by streamside zone width (Table 1). Red-headed (*M. erythrocephalus* Linnaeus) and Hairy (*Picoides villosus* Linnaeus) woodpeckers showed no significant relationship with streamside zone width and were only observed in streamside zones that were 20 to 50 m wide. Blue-gray Gnatcatchers (*Polioptila caerulea* Linnaeus) increased six fold as streamside zone width exceeded 30 m, but the relationship was not significant (Table 1). Brown-headed Cowbird abundance did not appear to be associated with streamside zone width (Table 1), but generally was most abundant in streamside zones < 40 m wide, and was variable in abundance at widths of 50–100 m.

Discussion

Hodges and Krementz (1996) suggested that forested strips along streams needed to be at least 100 m wide to benefit forest-breeding Neotropical migrants. We detected many species of Neotropical migrants and other bird species at widths less than 100 m, suggesting that narrow forested streamside zones do have some value. As with Dickson et al. (1995b), we observed an association of shrub-breeding birds with the narrow streamside zones and an increasing number of forest birds within wider streamside zones. Clearly, the uncut streamside zones provided habitat for some forest-dwelling birds that would not have been present otherwise. The streamside zones also provided song perches for many shrubby habitat species.

Total bird abundance was highest when streamside zones were 60 m wide. This was unexpected because the high total abundance cannot be explained by the presence of both mature forest birds and shrubby habitat birds at this width. In fact, species richness was nearly at its lowest level at the 60-m streamside zone width.

Although many species increased or decreased in a generally linear pattern as streamside zone width increased, some species seemed

to have threshold widths associated with their presence or absence. For example, the Yellow-billed Cuckoo, Acadian Flycatcher, Yellow-throated Vireo, and Pileated Woodpecker appeared to require a 60 to 70 m threshold width of forest. Conversely, abundance of the Orchard Oriole, Eastern Kingbird, Blue Grosbeak, Painted Bunting, and Prairie Warbler decreased markedly at 20 m, and these species disappeared entirely after forest widths increased beyond 70 m. These five species typically did not use the interior areas of streamside zones. Their use of tall trees and snags as song perches on the edges of streamside zones was likely the primary reason that many of these species were present.

Forest bird species that breed in small forest patches may incur higher rates of nest predation (Chasko and Gates 1982, Gates and Gysel 1978). In our study, forest birds that exhibited a threshold response to streamside zone width may be more vulnerable to nest predation or brood parasitism by Brown-headed Cowbirds at narrow forest widths (Small and Hunter 1988, Wilcove 1985, Yahner and Scott 1988), or may perceive that they are more vulnerable than species that steadily increased in abundance with increasing forest strip width. However, this hypothesis has yet to be tested. Other reasons why forest birds may avoid narrow streamside zones include low nest site availability or low food availability resulting from increased wind and sunlight penetration that desiccates leaf litter and other environments for invertebrates (Burke and Nol 1998). Streamside zones of 100 m in width are still fairly narrow from a forest interior perspective. As a result, forest species may be vulnerable to elevated risk of predation and brood parasitism at all streamside widths examined in our study.

The streamside zones provided habitat for woodpeckers, none of which would have been present if streamside zones had been cut during harvest operations. Red-headed Woodpeckers are known to prefer open park-like habitat with large live trees and snags (Conner 1976), whereas Hairy Woodpeckers are often associated with disturbance in forest landscapes (Shackelford and Conner 1997). Thus, the occurrence of these two species in only the narrow streamside zones widths was expected. The presence and increasing abundance of Downy and Pileated woodpeckers with increasing streamside zone width was also expected for these forest-dwelling woodpeckers (Shackelford and Conner 1997).

The presence of bird species within streamside zones does not necessarily equate with actual breeding or breeding success. It is unknown whether forest streamside zones provide a population level benefit from a landscape perspective (Donovan et al. 1995). Most likely, streamside zones serve as population sources for some species, but as sinks for

others. Serving as a population sink may have positive aspects. For example, Murphy (2001) suggested that even sink habitat could make a positive contribution to populations of Eastern Kingbirds. If all suitable habitats are occupied by breeding pairs of a species, even the net negative productivity that occurs in sink habitats could eventually provide future breeders by young dispersing to source habitats eventually to breed. The ultimate value of streamside zones to bird species at the population level still needs to be determined.

Forested streamside zones within pine plantations provided habitat for many mature-forest- and shrub-dwelling birds that would have been absent had the streamside zones been cut during harvesting operations. Any young produced by these species would contribute to populations in the general area and should be viewed as a positive conservation aspect of retention of uncut forest streamside zones. Our results provide important information on threshold widths of forest habitat for a variety of species. Such information can help forest managers balance the habitat requirements of both shrub-breeding and forest-breeding birds when they harvest timber in southern pine forests.

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