# DRY CREEK LONG-TERM WATERSHED STUDY: THE EFFECTS OF HARVESTING IN STREAMSIDE MANAGEMENT ZONES AND ADJACENT UPLANDS OF RIPARIAN CORRIDORS ON AVIAN COMMUNITIES IN THE COASTAL PLAIN OF GEORGIA

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**Abstract—**We evaluated the effects of Best Management Practices (BMPs) harvesting on avian communities associated with headwater streams in the Georgia Coastal Plain. Two watersheds served as references, with no timber harvesting, and two treatment watersheds were clearcut with retention of Streamside Management Zones (SMZs) according to Georgia BMPs for forestry. Bird communities were surveyed in each watershed before and after harvest by variable-distance transect surveys. The bird community surveyed in each watershed was divided into foraging, nesting, and disturbance guilds. A Partners In Flight (PIF) composite score-based index was used to calculate the conservation value (CV) of those communities. Among variables measured, disturbance guilds showed the most apparent response to harvesting. This response, considered in the context of the CV index response, indicated that there was some changeover from high priority disturbance-sensitive species to moderate/high priority disturbance-tolerant species resulting from harvesting. We recommend the use of PIF scores and associated CV indexes along with other bird community variables in investigations of the value of SMZs for songbirds.

## INTRODUCTION

Streamside Management Zones (SMZs), as recommended by Best Management Practices (BMPs) guidelines in the Southeastern United States, are designed primarily to protect water quality during forestry activities and have been shown to do so effectively (Ward and Jackson 2004, Wynn and others 2000). Land managers are becoming increasingly interested in the protection SMZs afford wildlife that occupy riparian environments. Many recent studies in the Eastern United States focus on the relationship between riparian buffer strips and bird communities (Conner and others 2004, Hodges and Krementz 1996, Kilgo and others 1998, Meiklejohn and Hughes 1999). These studies' major interest has been on width requirements for forest interior species. Several researchers have concluded that riparian corridors >100 m are necessary to conserve avian communities associated with interior bottomland forest (Croonquist and Brooks 1993, Keller and others 1993, Kilgo and others 1998, Spackman and Hughes 1995). However, retaining riparian corridors >100 m may be impractical for some forest landowners, particularly on small headwater streams. Thus, there is a need for better information about how bird communities respond to minimum-width SMZs as recommended in forestry BMPs.

Researchers who have studied effects of riparian buffer width on bird communities have primarily used summary statistics and guilds to make inferences about bird communities. However, these analytical methods do not take into account the regional conservation needs of species in the study area. A recent tool for assessing the conservation value of habitat is Partners in Flight's (PIF) species prioritization scores for North American landbirds (Hunter and others 1993). These scores, which range in magnitude from 7 to 35, are based on a species' vulnerability and need for conservation action, including distribution, relative abundance, threats of decline or extirpation, population trend, and area importance. The scoring process and context of conservation application are described by Carter and others (2000). Since the introduction of the PIF scoring system, its most common application has been the sum of all the scoring components, known as the composite score. The composite score has been included in tables of species abundance and frequency to indicate species of highest concern and has also been used as a weighting factor in a conservation value index which, along with traditional summary statistics and information about species composition, creates a more complete picture of a site's value for birds (Nuttle and others 2003).

The bird conservation value concept can be applied to many management issues, including the question of how well minimum SMZs recommendations conserve bird communities associated with headwater streams. The minimum SMZs recommendations for forestry BMPs developed for Georgia are to leave 12 m of SMZs on each side of perennial streams for 0 to 20 percent slopes and 21 m for 21 to 40 percent slopes (Georgia Forestry Commission 1999). The Dry Creek Long-Term Watershed Study was designed to contribute to an assessment of the effectiveness of these recommendations for protecting water quality and hydrology, riparian environments, and associated biotic communities, including birds. This project, as part of the long-term study, evaluates the value of SMZs for conserving bird communities associated with headwater streams in the Georgia Coastal Plain using a combination of traditional summary statistics, guild-based evaluations, and a PIF composite score-based conservation value index.

## STUDY AREA

The ongoing Dry Creek Long-Term Watershed Study is located on International Paper Company's Southlands Forest, which is approximately 16 km south of Bainbridge, GA (latitude 30.8 N, longitude 84.6 W), in the Coastal Plain physiographic

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*Citation for proceedings:* Connor, Kristina F., ed. 2006. Proceedings of the 13th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS–92. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 640 p.


Figure 1—Location of study area, with inset illustrating the four watersheds examined in the study.

province (fig. 1). The four watersheds (labeled from north to south as A, B, C, and D) in the study area range in size from 26.1 ha (Watershed A) to 46.6 ha (Watershed D). They are oriented in a roughly east-to-west direction and lie on the sharply sloping boundary between the Dougherty Plain and Tifton Upland Districts, known as the Pelham Escarpment. The Pelham Escarpment forms the southeastern border of the larger Apalachicola-Chattahoochee-Flint (ACF) River basin. As part of this basin, these headwater streams drain into the Dry Creek and on into the Flint River (Couch and others 1996). Ambient temperatures average a maximum of 26.2 °C and a minimum of 12.5 °C. Average annual precipitation is 138.7 cm (Southeast Regional Climate Center 2005). Prior to the study, overstory vegetation was dominated by *Liriodendron tulipifera* L., *Nyssa biflora* Walt., *Pinus glabra* Walt., and *Pinus taeda* L.

## PROCEDURES

### Overall Study Design

Two of the four watersheds (A and D) served as references with no timber harvesting, and two treatment watersheds (B and C) were clearcut-harvested and site-prepared according to Georgia BMPs for forestry during the months of September to November, 2003 (fig. 2). SMZs were 12 to 21 m wide on both stream sides.

### Bird Community Sampling

During 2003 and 2004, breeding bird communities within each watershed were surveyed using a single variable-distance transect running parallel to the stream within SMZs. In 2003, each transect was surveyed 6 times from June 2 to July 1, and in 2004 (the breeding season following harvest), each transect was surveyed 10 times from June 2 to July 3. Transects ranged from 300 to 675 m in length, depending on the length of SMZs available for sampling, and each transect was divided into 25-m segments. Bird communities were surveyed by walking each transect at a slow, steady rate and recording the distance perpendicular to the transect from which each bird was heard or seen. All watersheds were surveyed between 0600 and 0900 EST, and each survey was taken by the same observer. To decrease time bias, sampling was alternately initiated at the upstream or downstream end of a transect.

### Data Analysis

Because length of transect varied by watershed, overall abundance and species richness of bird species were standardized by unit area. Each bird species recorded was assigned to a foraging, nesting (Hamel 1992), and disturbance guild (Canterbury and others 2000). Disturbance guilds included disturbance-sensitive species (e.g. Hooded Warbler), disturbance-tolerant species (e.g., Indigo Bunting), and disturbance-neutral species (e.g., Carolina Wren) (Table 1). Relative abundance was used to make comparisons among guilds. Avian conservation value (CV) [equation (1)] was calculated for each sample in each watershed by summing the relative abundance of each species weighted by its PIF composite score after Nuttle (1997).

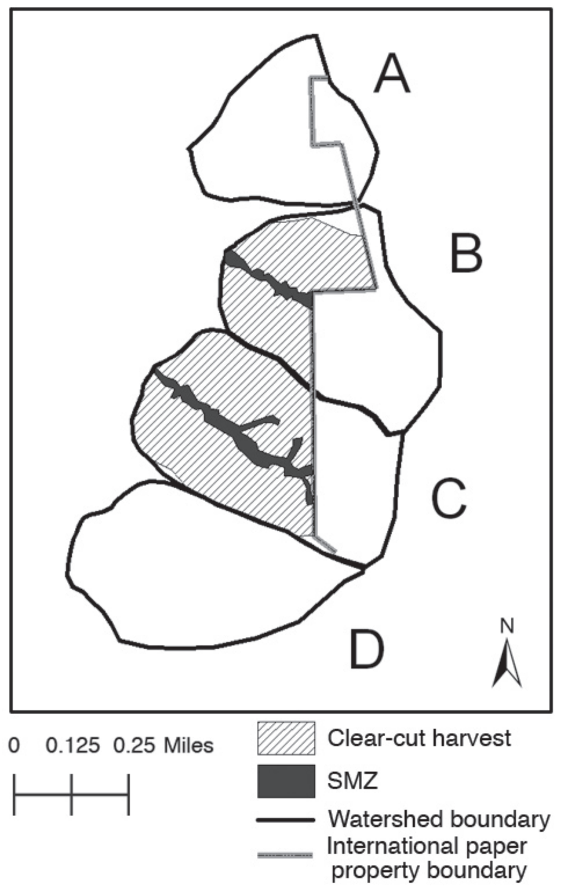


Figure 2—Treatments initiated in the fall of 2003. Watersheds A and D served as references and were not harvested.

**Table 1—List of all species recorded in the watersheds studied. Guild associations and PIF composite score are indicated for each species**.

| Species | Foraging guild[a] | Nesting guild[a] | Disturbance guild[b] | Southeastern Coastal Plain (BCR) |
|---|---|---|---|---|
| Wild Turkey *Meleagris gallopavo* | Ground | Ground/shrub | Neutral | 17 |
| Green Heron *Butorides virescens* | Other | Ground/shrub | Neutral | 18 |
| Red-shouldered Hawk *Buteo lineatus* | Other | Canopy | Neutral | 17 |
| Broad-winged Hawk *Buteo platypterus* | Other | Canopy | Neutral | 20 |
| American Woodcock *Scolopax minor* | Ground | Ground/shrub | Neutral | 21 |
| Northern Bobwhite | Ground | Ground/shrub | Neutral | 21 |
| Mourning Dove *Zenaida macroura* | Ground | Ground/shrub | Neutral | 13 |
| Yellow-billed Cuckoo *Coccyzus americanus* | Foliage | Canopy | Neutral | 21 |
| Barred Owl *Strix varia* | Other | Canopy | Sensitive | 15 |
| Ruby-throated Hummingbird *Archilochus colubris* | Other | Canopy | Neutral | 18 |
| Red-headed Woodpecker *Melanerpes erythrocephalus* | Bark | Cavity | Tolerant | 20 |
| Red-bellied Woodpecker *Melanerpes carolinus* | Bark | Cavity | Sensitive | 18 |
| Downy Woodpecker *Picoides pubescens* | Bark | Cavity | Neutral | 17 |
| Hairy Woodpecker *Picoides villosus* | Bark | Cavity | Sensitive | 18 |
| Northern Flicker *Colaptes auratus* | Bark | Cavity | Neutral | 18 |
| Pileated Woodpecker *Dryocopus pileatus* | Bark | Cavity | Sensitive | 17 |
| Acadian Flycatcher *Empidonax virescens* | Hawker | Canopy | Sensitive | 21 |
| Great Crested Flycatcher *Myiarchus crinitus* | Hawker | Cavity | Neutral | 19 |
| Eastern Kingbird *Tyrannus tyrannus* | Hawker | Canopy | Tolerant | 20 |
| White-eyed Vireo *Vireo griseus* | Foliage | Ground/shrub | Tolerant | 21 |
| Yellow-throated Vireo *Vireo flavifrons* | Foliage | Canopy | Neutral | 22 |
| Red-eyed Vireo *Vireo olivaceus* | Foliage | Canopy | Sensitive | 15 |
| Blue Jay *Cyanocitta cristata* | Foliage | Canopy | Neutral | 17 |
| American Crow *Corvus brachyrhynchos* | Ground | Canopy | Neutral | 12 |
| Fish Crow *Corvus ossifragus* | Ground | Canopy | Neutral | 18 |
| Carolina Chickadee *Poecile carolinensis* | Foliage | Cavity | Neutral | 21 |
| Tufted Titmouse *Baeolophus bicolor* | Foliage | Cavity | Neutral | 16 |
| Carolina Wren *Thryothorus ludovicianus* | Ground | Ground/shrub | Neutral | 17 |
| Blue-gray Gnatcatcher *Polioptila caerulea* | Foliage | Canopy | Neutral | 17 |
| Wood Thrush *Hylocichla mustelina* | Ground | Ground/shrub | Sensitive | 24 |
| Brown Thrasher *Toxostoma rufum* | Ground | Ground/shrub | Neutral | 19 |
| Northern Parula *Parula americana* | Foliage | Canopy | Sensitive | 22 |
| Swainson's Warbler *Limnothlypis swainsonii* | Ground | Ground/shrub | Sensitive | 27 |
| Louisiana Waterthrush *Seiurus motacilla* | Ground | Ground/shrub | Sensitive | 21 |
| Kentucky Warbler *Oporornis formosus* | Ground | Ground/shrub | Sensitive | 23 |
| Hooded Warbler *Wilsonia citrina* | Foliage | Ground/shrub | Sensitive | 21 |
| Yellow-breasted Chat *Icteria virens* | Foliage | Ground/shrub | Tolerant | 19 |
| Summer Tanager *Piranga rubra* | Foliage | Canopy | Neutral | 19 |
| Eastern Towhee *Pipilo erythrophthalmus* | Ground | Ground/shrub | Tolerant | 20 |
| Northern Cardinal *Cardinalis cardinalis* | Foliage | Ground/shrub | Neutral | 14 |
| Blue Grosbeak *Guiraca caerulea* | Foliage | Ground/shrub | Tolerant | 18 |
| Indigo Bunting *Passerina cyanea* | Foliage | Ground/shrub | Tolerant | 17 |
| Brown-headed Cowbird *Molothrus ater* | Ground | Other | Tolerant | 11 |

[a] From Hamel (1992).
[b] From Canterbury and others (2000).

$$CV = \sum_{i=1}^{n} RA_i * PIF \qquad (1)$$

for species i=1 to n

where:

$CV$ = conservation value,

$RAi$ = relative abundance of the $i^{th}$ species, and

$PIF$ = PIF composite concern score of the $i^{th}$ species.

A general linear model was constructed which included the effects of years, treatments, and replications. Analysis of variance (ANOVA) was used to analyze the model and determine differences in abundance and species richness between treatments and between years. All calculations were performed using SAS, and all comparisons were made with $\alpha$=0.05.

## RESULTS AND DISCUSSION

When examining bird communities within each watershed, we found no significant differences between pre- and post-harvest species richness/ha. Abundance/ha did not change significantly in each watershed after harvest, except in Watershed B (Treatment), where it was significantly lower following harvest (p=.0021).

Relative abundance of foraging and nesting guilds showed few clear trends in response to harvest. We detected no significant differences between pre- and post-harvest relative abundance of ground or foliage foragers within each watershed. Bark foragers (e.g., woodpeckers) increased post-harvest in Watershed B (Treatment; p=.0278), likely as a result of an open pine stand left on a portion of one slope on the downstream end of Watershed B. Hawkers (e.g., flycatchers) increased post-harvest in Watershed A (Reference; p=.0366) but decreased in Watershed B (Treatment; p=.0138) following harvest. There was no statistical difference in the relative abundance of cavity nesters in each watershed before and after harvest. Ground/shrub nesters increased after harvest in Watershed A (Treatment; p=.0433) and Watershed C (Treatment; p=.0403), and canopy nesters decreased in Watershed C (Reference; p=.0029).

Disturbance guilds exhibited a clearer response than foraging and nesting guilds. Not surprisingly, relative abundance of disturbance-sensitive species in reference watersheds (A and D) did not change significantly after harvest but significantly decreased in both treatment watersheds (B and C; p≤.0008; fig. 3a). In contrast, relative abundance of disturbance-tolerant species significantly (p≤.010) increased in both treatment watersheds while remaining the same or decreasing (p=.0385) in both reference watersheds (fig. 3b). Disturbance-neutral species were no more abundant post-harvest than pre-harvest in all watersheds but B (Treatment; p=.0108; fig 3c).

The CV of bird communities within each of the four watersheds was not significantly different before harvest, with the exception of Watershed B, which had the lowest CV of all four watersheds. After harvest, CV remained high in reference watersheds while decreasing in Watershed C to about the level of Watershed B, which stayed about the same post-harvest (fig. 4a). Although the decrease of CV in Watershed C following harvest was significant (p=.0021), the magnitude of the decrease was such (1.3 units or 6.6 percent) that CV remained relatively high (fig 4b).

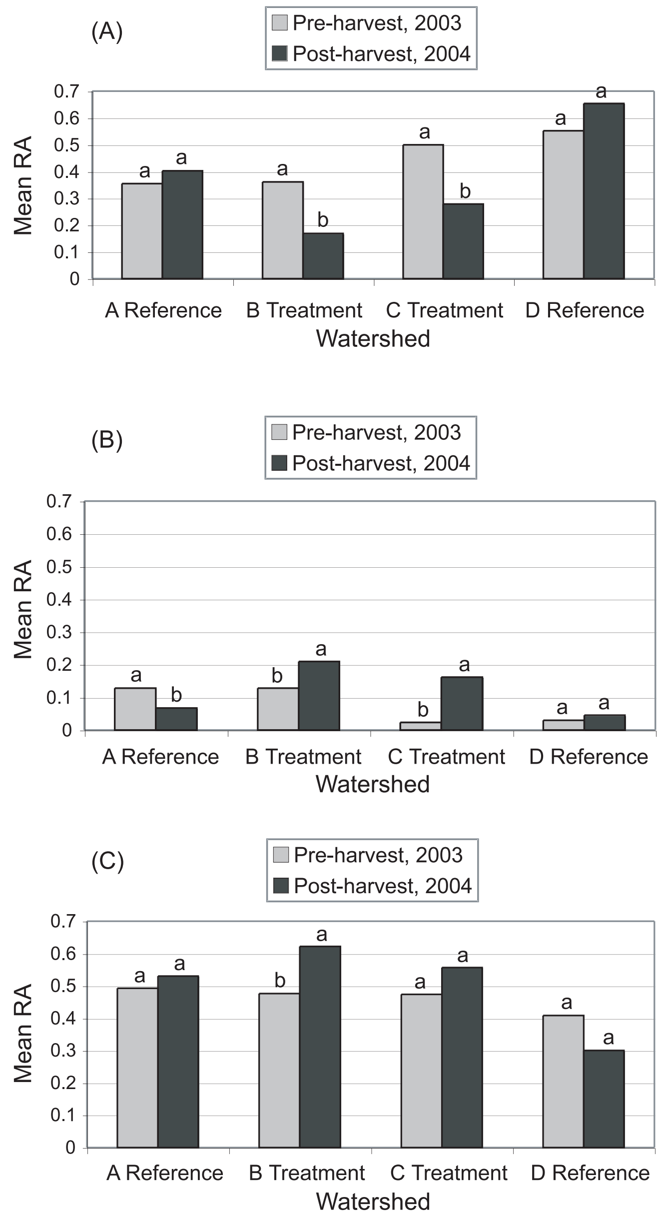


Figure 3—Mean relative abundance of disturbance-sensitive (A), disturbance-tolerant (B), and disturbance-neutral species (C) in watersheds before and after harvest.

In harvested watersheds, the change in species composition (i.e., disturbance-sensitive versus disturbance-tolerant) and the retention of relatively high CV index scores suggests that there was a changeover from relatively high-priority disturbance-sensitive species to moderate/high-priority disturbance-tolerant species. In Watershed B, Acadian Flycatcher and Hooded Warbler, two relatively high-priority (PIF=21) disturbance-sensitive species, both significantly (p<.0032) declined in relative abundance following harvest. Three disturbance-tolerant species, Eastern Kingbird (PIF=20), Blue Grosbeak (PIF=18), and Indigo Bunting (PIF=17), increased in response to harvest (p<.0006). Watershed C showed a significant (p<.0169) decrease in relative abundance of 4 high-priority (PIF>20) species (Yellow-throated Vireo, Northern Parula, Louisiana Waterthrush, and Hooded Warbler), which likely made a large contribution to the decrease in CV. However,

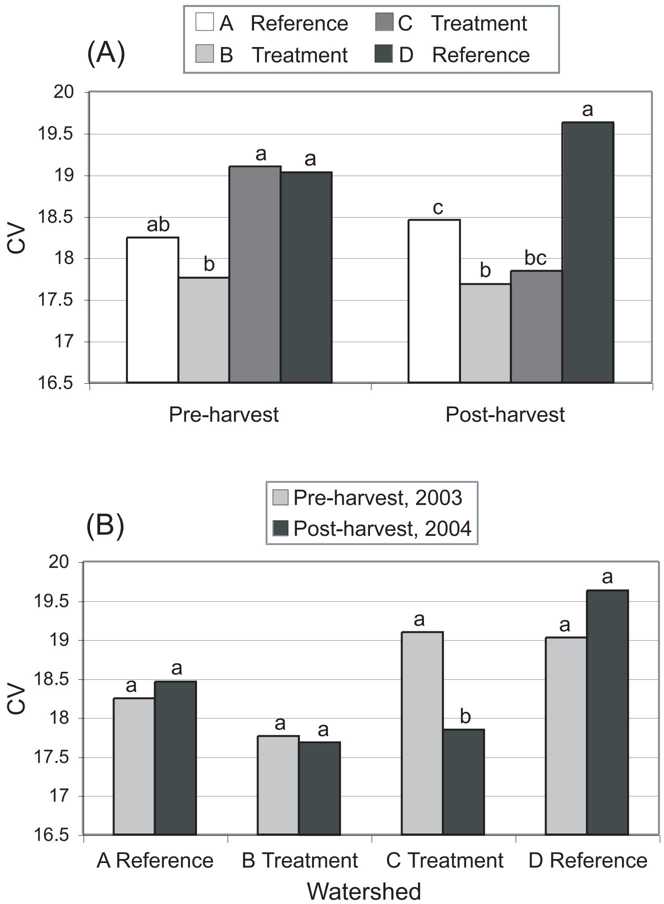


Figure 4—Conservation Value (CV) comparison among watersheds both before and after harvest (A) and between years within each watershed (B).

this decrease was probably mitigated to some extent by the significant ($p<.0472$) increase in relative abundance of a relatively high-priority early-successional species (Eastern Towhee, PIF=20) and the sustained relative abundance of Acadian Flycatcher (PIF=21), which before harvest made up roughly 10 percent of bird abundance in Watershed C.

## CONCLUSIONS

Although abundance, species richness, and relative abundance of foraging and nesting guilds showed few readily apparent patterns related to disturbance, the use of disturbance guilds and PIF score-based indexes suggests that implementation of minimum Georgia SMZs recommendations in this study resulted in some changeover from high priority disturbance-sensitive species to moderate/high priority disturbance-tolerant species. PIF scores are being increasingly applied to management decisions by highlighting conservation needs of bird communities, and when interpreted in the context of other variables (such as disturbance guilds), they can be a meaningful way to make pre- and post-disturbance comparisons of a bird community's conservation value. We recommend that future research on SMZs and bird communities use PIF scores and associated conservation value concept along with other bird community variables to help guide forest wildlife management decisions.

## ACKNOWLEDGMENTS

We thank National Council for Air and Stream Improvement, National Fish and Wildlife Foundation, International Paper Company, and Clemson University for funding and assistance. Thanks also to Dr. Billy Bridges for statistical guidance and to reviewers for their helpful comments.

## LITERATURE CITED

Canterbury, G.E.; Martin, T.E.; Petit, D.R. [and others]. 2000. Bird communities and habitat as ecological indicators of forest condition in regional monitoring. Conservation Biology. 14(2): 544-558.

Carter, M.F.; Hunter, W.C.; Pashley, D.N.; Rosenberg, K.V. 2000. Setting conservation priorities for landbirds in the United States: the Partners In Flight approach. Auk. 117(2): 541-548.

Conner, R.N.; Dickson, J.G.; Williamson, J.H.; Ortego, B. 2004. Width of forest streamside zones and breeding bird abundance in eastern Texas. Southeastern Naturalist. 3(4): 669-682.

Couch, C.A.; Hopkins, E.H.; Hardy, P.S. 1996. Influences of environmental settings on aquatic ecosystems in the Apalachicola-Chattahoochee-Flint River Basin. U.S. Geological Survey Water Resources Investigations Report. 95-4278. 58 p.

Croonquist, M.J.; Brooks, R.P. 1993. Effects of habitat disturbance on bird communities in riparian corridors. Journal of Soil and Water Conservation. 48(1): 65-70.

Georgia Forestry Commission. 1999. Georgia's Best Management Practices for forestry. 68 p.

Hamel, P.B. 1992. The land manager's guide to the birds of the South. Chapel Hill, NC: The Nature Conservancy, Southeastern Region. 437 p.

Hodges, M.F., Jr.; Krementz, D.G. 1996. Neotropical migratory breeding bird communities in riparian forests of different widths along the Altamaha River, Georgia. Wilson Bulletin. 108(3): 496-506.

Hunter, W.C.; Carter, M.F.; Pashley, D.N.; Barker, K. 1993. Partners in Flight species prioritization scheme. In: Finch, D.M.; Stangel, P.W., eds. Status and management of neotropical migratory birds. Gen. Tech. Rep. RM-229. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 109-119.

Keller, C.M.E.; Robbins, C.S.; Hatfield, J.S. 1993. Avian communities of riparian forests of different widths in Maryland and Delaware. Wetlands. 13(2): 137-144.

Kilgo, J.C.; Sargent, R.A.; Chapman, B.R.; Miller, K.V. 1998. Effect of stand width and adjacent habitat on breeding bird communities in bottomland hardwoods. Journal of Wildlife Management. 62(1): 72-83.

Meiklejohn, B.A.; Hughes, J.W. 1999. Bird communities in riparian buffer strips of industrial forests. The American Midland Naturalist. 141(1): 172-184.

Nuttle, T.J. 1997. Response of breeding bird communities to afforestation of hardwood bottomland sites in Mississippi. Mississippi State, MS: Mississippi State University, Department of Wildlife and Fisheries. 68 p. M.S. thesis.

Nuttle, T.; Leidolf, A.; Burger, L.W., Jr., 2003. Assessing conservation value of bird communities with Partners in Flight-based ranks. Auk. 120(1): 541-549.

Southeast Regional Climate Center. 2005. Bainbridge, Georgia, climate information. http://climate.engr.uga.edu/bainbridge/index.html. [Date accessed: May 9, 2005].

Spackman, S.C.; Hughes, J.W. 1995. Assessment of minimum stream corridor width for biological conservation: species richness and distribution along mid-order streams in Vermont, USA. Biological Conservation. 71: 325-332.

Ward, J.M.; Jackson, C.R. 2004. Sediment trapping within forestry streamside management zones: Georgia Piedmont, USA. Journal of the American Water Resources Association. 40(6): 1421-1431.

Wynn, T.M.; Mostaguimi, S.; Frazee, J.W. [and others]. 2000. Effects of forest harvesting Best Management Practices on surface water quality in the Virginia Coastal Plain. Transaction of the American Society of Agricultural Engineers. 43(4): 927-936.