

Effects of Land Use Practices on Neotropical Migratory Birds in Bottomland Hardwood Forests

David N. Pashley¹ and Wylie C. Barrow²

DESCRIPTION OF THE SYSTEM

Bottomland hardwood forests (including bald cypress and tupelo swamp forests) are historically the dominant natural community of riverine floodplains of the southeastern United States. Their greatest single expanse was in the 21 million acre floodplain of the lower Mississippi River Valley from southern Illinois to coastal marshes along the Gulf of Mexico, but the community also occurs along rivers of the piedmont and southern coastal plain from Virginia to east Texas (Patrick et al. 1981). The biotic and physical features of this system are determined by hydrology and sedimentation (Bedinger 1981). A key factor in the evolution of bottomland hardwood plants has been their ability to persist under anaerobic conditions when soil becomes saturated with water. As a result, the distribution of species within the community is dependant to a large extent upon the timing, frequency, and duration of flooding (Huffman and Forsythe 1981).

A complex series of levees, meander scrolls, sloughs, and oxbow lakes is characteristic of alluvial plains (Taylor et al. 1990). Bottomland forests typically flood as rising rivers back into tributaries. As overbank flooding occurs and water spreads out and slows down, sediments and nutrients are deposited across the floodplain. The heaviest sediments drop out adjacent to the channel, resulting in natural levees that are higher and drier than land behind them. River meander curves produce point bars on the inside of meanders where water velocity is reduced and sediments drop out. Meanders tend to migrate downstream, and, as they become more exaggerated, stream segments are abandoned for more direct routes, leaving behind oxbow lakes (Bedinger 1981). All of this activity results in a complex topography of parallel ridges and swales in which a six inch difference in elevation can result in great differences in the duration and frequency of soil saturation and thus the species

of plants that grow on a site. Another influence on distributions are adaptations to the rich nutrient influx that may be as important as stress from inundation (Gosselink et al. 1981).

There is much variation and overlap among the 100 or so woody plant species inhabiting bottomland forests in their ability to deal with the peculiar stresses and opportunities inherent in this system. Areas that are inundated or saturated most of the time and only intermittently exposed are typically dominated by bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*). Somewhat drier areas that are saturated or inundated typically more than 25% of most growing seasons support such species as overcup oak (*Quercus lyrata*) and water hickory (*Carya aquatica*). Areas saturated or inundated periodically for a month or so, less than 25% of the growing season, in most years, feature a great diversity of tree species, including hackberry (*Celtis laevigata*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), sweetgum (*Liquidambar styraciflua*), Nuttall oak (*Q. nuttallii*), and willow oak (*Q. phellos*). Areas temporarily inundated in a minority of years support species less tolerant of anaerobic conditions such as cherrybark oak (*Q. falcata* var. *pagodaefolia*) and pecan (*Carya illinoensis*).

There are other disturbances that influence plant distribution. As in other southern deciduous forest types, tree fall is common, perhaps exacerbated here by the plastic nature of the saturated soil (Tanner 1986). Winds aggravate this, and occasional tornadoes and other storm events can knock down the overstory on significantly sized areas. Prior to European settlement and increasingly so again now, beaver activity can alter local hydrology and expose plants to more frequent or even continuous flooding. And last, although not well-documented, bottomland forests may have been subject to infrequent fires.

These disturbances cause mortality and influence regeneration, and thus affect species composition. There is not only a wide variety among plants in tolerance to soil saturation but also to shade (McKnight et al. 1981). Light gaps may be necessary for some dominant tree species to become established or achieve canopy height.

Tanner (1986) reported on the tree species and size composition of a virgin bottomland hardwood stand in northeast Louisiana in which he studied Ivory-billed Woodpeckers in the

¹The Nature Conservancy of Louisiana, P.O. Box 4125, Baton Rouge, LA 70821

²U.S. Fish and Wildlife Service, National Wetlands Research Center, 6300 Ocean Dr., Corpus Christi, TX 78412

late 1930's. He found that the hydric extremes (almost always flooded and almost never flooded) were very distinct, but that continuous change was evident in the distribution of species across intermediate zones. Most interestingly, he found a very large number of small, young trees, including those species that are intolerant of shade, throughout the system. Although old trees were numerous, accidental death and turnover were frequent but spatially variable, resulting in a highly uneven age distribution. This contradicts notions of old growth bottomland hardwoods as a static, unproductive community consisting of a closed canopy of senescent trees. There is an emerging sense that old growth was a shifting mosaic of even-aged small patches of all ages, further complicated by minute differences in elevation and tolerances among a large number of woody plant species.

The bottomland forest then is a result of a combination of: 1) high productivity resulting from a long growing season and abundant water and nutrients; 2) topographic diversity which, although superficially minor, interacts with varying anaerobic tolerances of plants to produce a broad continuum of community types; and 3) a disturbance regime with a reoccurrence frequency sufficient to maintain a dynamic mosaic of recovering gaps of many ages across the landscape. As in other southern deciduous forests, much of the plant species diversity of bottomland hardwoods is a result of the woody, smaller-statured species of the understory.

NEOTROPICAL MIGRATORY BIRD USE OF BOTTOMLAND HARDWOOD FORESTS

Approximately 70 species of birds breed regularly in bottomland hardwood forests; about 30 of these are Neotropical migrants. At specific sites, from 48% to 65% of species recorded are Neotropical migrants. A study conducted in the Tensas River basin of northeast Louisiana revealed differences in use among bald cypress habitat, seasonally flooded forest, and non-flooded forest (Barrow 1990). The long-distance migrants encountered more frequently in bald cypress habitat than elsewhere were the Yellow-throated Warbler and Northern Parula. Five species, the Eastern Wood-Pewee, Great Crested Flycatcher, Yellow-throated Vireo, Prothonotary Warbler, and Blue-gray Gnatcatcher, were most common in the seasonally flooded zones. Areas that do not typically flood were used preferentially by the Red-eyed Vireo, American Redstart, Swainson's Warbler, and Hooded Warbler.

Differences in habitat use by other migrants are not readily apparent. Indeed, in a variety of forests, limited data suggest there may be little difference between tree species availability and bird use. In other words, the tree species composition of those zones may not be particularly important to many species of foraging birds.

Differences are apparent in comparison between use of early and later post-disturbance habitats. Several species are found most frequently in areas that have been disturbed and are recovering, along edges, or in shrub-maintained habitat. These include the Orchard Oriole, Yellow-breasted Chat, Indigo Bunting, and, at least in many areas, Wood Thrush.

A variety of habitat features in bottomland hardwood landscapes are absent or not well expressed in other forest ecosystems. The following microhabitat features are of apparent importance in influencing the distribution and abundance of Neotropical migrants:

Spanish moss (*Tillandsia usneoides*) - There is an apparent correlation between Spanish moss and Northern Parula distribution and abundance (Bent 1953, Barrow 1990). This epiphyte serves as nest support and concealment for breeding Northern Parulas and, to a lesser extent, Yellow-throated Warblers. The latter also frequently probe clumps of Spanish moss in search of arthropod prey. Spanish moss becomes rare to the north and does not occur in the northern Mississippi Valley.

Scour channels - Floodplain terraces are marked by parallel series of shallow depressions, results of changing stream course and regular flooding, that hold water through much of the year. Prothonotary Warblers forage in a variety of forest types, but tend to concentrate their nesting efforts in and along the margins of these channels. Several species of wading birds also forage regularly in these areas.

Canebrakes - Dense thickets of switchcane (*Arundinaria gigantea*) occur on oxbow lake margins, river banks, and floodplain terraces. Meanley (1971) and Eddleman et al. (1980) have noted that Swainson's Warblers are especially common in cane thickets. Remsen (1986) has hypothesized that Bachman's Warbler (now probably extinct) was a cane specialist on its breeding grounds in the southern United States. White-eyed Vireos, Hooded Warblers, and Kentucky Warblers also use canebrakes during the breeding season.

Bald cypress - Bald cypress is typically found along the margins of rivers, sloughs, and oxbow lakes, often forming monospecific stands referred to as "cypress brakes." The exfoliating bark and branch structure provides excellent support for Spanish moss that is related to Northern Parula occurrence. In the Tensas River Basin, Yellow-throated Warblers were observed breeding only in habitats in which bald cypress was present. Over half of all Yellow-throated Warbler foraging observations were in bald cypress (Barrow 1990).

Vine tangles - Vine tangles are common along the margins of oxbow lakes and in light gaps created by tree falls. Furthermore, two species, *Parthenocissus quinquefolia* and *Rhus radicans*, grow abundantly on trees in a mature, closed canopy. Because vines climb by aerial rootlets and tendrils which adhere to the bark for support, they provide a carpet of foliage ranging from the ground to the canopy along the boles of trees. The result is greater foliage volume, which provides additional nest placement and foraging opportunities. White-eyed Vireo,

American Redstart, Kentucky Warbler, and Hooded Warbler frequently use vine foliage as a foraging substrate during the breeding season (Barrow 1990, Moser et al. 1990).

Palmetto thickets - Palmetto (*Sabal minor*) often forms dense thickets in the understory of floodplain forests. Meanley (1971) considered "scrub palmetto" habitat to be one of three main plant formations selected by Swainson's Warblers in southern floodplains. Barrow (1990) found that Swainson's Warblers foraged in the ground leaf litter at sites with greater palmetto density than that which was randomly available. Like Spanish moss, palmetto does not occur in the northern stretches of the Mississippi Valley.

HISTORICAL CHANGES IN LAND USE

The majority of wetland acreage in the continental United States at the time of European colonization was bottomland hardwood forest (Turner et al. 1981). It has been estimated that there were approximately 130 million acres of forested wetlands in the lower 48 states at that time, with about 57% of this, largely bottomland hardwoods, in the Southeast (Harris and Gosselink 1990). Reduction in the acreage covered by this habitat and alterations in the character of the forest that remains has been accompanied by a reduction in population sizes of the birds present in the system.

Perhaps the earliest alteration in this system was caused by heavy trapping and local extirpation of beaver from the seventeenth century onward. Other early changes in flooding regimes occurred as streams were cleared of snags and obstructions to improve navigation. Levees were built to control flooding; by 1828 levees along the Mississippi in south Louisiana were essentially continuous (McPhee 1989). Reduced flooding made agricultural endeavors more feasible, and more land was cleared, drained and farmed. Federal government programs encouraged this conversion (Turner et al. 1981). Timber in the last extensive virgin stands was harvested in the 1940's. High soybean prices drove more clearing, often producing marginal agricultural land, in the 1960's and 1970's. Changes in economic conditions and government programs have greatly reduced the rate of clearing and conversion since about 1980. Most recently there have been some small-scale efforts at reforestation.

The loss of bottomland hardwoods is perhaps five times higher than for any other major hardwood forest type in the United States (Abernethy and Turner 1987). Estimating the current area of remaining forest is difficult; the best available figure for the Mississippi River Valley is 4.9 million acres (Creasman et al. 1992). Sheer acreage is not the only measure of loss. Because of changes in flooding and disturbance and varying histories of management, tree species composition and age distribution as well as the status of cavity trees, etc., are probably very different from pre-settlement conditions. Perhaps more critically, much of what is left consists of fragments embedded in a sea of agriculture. This potentially increases nest

predation and parasitism. These changes over the course of several centuries surely had as a consequence an equivalent reduction in total forest bird population size. Loss of habitat in general, as well as changes in the character of that forested habitat that remained, brought about the demise of the Ivory-billed Woodpecker, Bachman's Warbler, and mammals including the red wolf and Florida panther.

Although the gross reduction in populations resulting from habitat changes must be assumed, the question remains as to whether populations are continuing to decline in the fragmented and altered habitat that remains. In an analysis of Breeding Bird Survey (BBS) data for the 25-year period from 1966 to 1990, Wiedenfeld et al. (unpubl. ms.) found that the Mississippi Alluvial Plain was one of five physiographic areas in the continental coverage of BBS in which extremely notable declines occurred. Of the 65 bird species they examined, 77% of those breeding in this area had declined. Declining species include interior forest birds such as Prothonotary Warbler, and also second growth or edge species such as the Orchard Oriole and Yellow-breasted Chat. Because much of this occurred during a period when the availability of forested habitat remained fairly stable, it must be inferred that factors other than sheer loss of bottomland hardwood habitat were contributing to these declines. A simple explanation based upon deterioration of winter grounds is unlikely in that the declining species use different habitats in different regions. As many populations of these birds are stable in other physiographic areas, it must be inferred that declining quality as well as quantity of bottomland hardwood breeding habitat has been a contributing factor. Whether fragmentation, an altered hydrological regime, or a plant species composition that may reflect historical silvicultural treatments more than natural conditions are causing migratory bird population declines is unknown.

MANAGEMENT RECOMMENDATIONS

There are two levels of management recommendations. The first is at a local level, in which the manager of a stand of forest or other habitat is in a position to decide what measures to take to most benefit migratory bottomland hardwood birds. The second is at the landscape or ecosystem level, at which decisions need to be made regarding the Mississippi River Alluvial Plain and other bottomland hardwood systems throughout the Southeast.

On the local level, the optimal condition is a very large forested tract on which a natural disturbance regime maintains a shifting mosaic of relatively even-aged patches the size of treefall gaps and of a great variety of ages. A hands-off, passive management strategy should be adopted where possible, such as on public lands, or on private, non-industrial forest sites on which the owner chooses to manage for natural values. Naturally occurring disturbances will inevitably create habitat for early successional species. Recent experience in south Louisiana with Hurricane Andrew is dramatic evidence that managers need not

create gaps. Land that is ultimately intended for a natural area management scheme is often acquired in a degraded condition in which passive management is unlikely to achieve a desired level of ecosystem function in any reasonable time frame. In these cases, initial silvicultural or other efforts by managers to correct past abuses may be necessary.

One rationale for intentional creation of openings is to allow for oak regeneration, as oaks are important food sources for a number of species of wildlife and are desirable for quality timber production. However, Abrams (1992) argued, without specific attention to bottomland hardwood forests, that oak dominance in much of the eastern United States has been an artifact of anthropogenic management rather than a typical late successional condition. Fire, in particular, promoted the dominance and stability of oak by reducing shade and stimulating oak regeneration at the expense of more shade tolerant species. In bottomland hardwoods, flooding and perhaps occasional ground fires may have been sufficient to remove litter and allow oak seedling survival; subsequent treefall gaps could have stimulated growth. In any case, there is much that is not known concerning the "natural" abundance of oaks in bottomland hardwoods or the dynamics that promoted oak regeneration. Creation of openings to promote oak growth will initially provide habitat for some early gap bird species, but the ultimate result should not be construed as being particularly necessary for or beneficial to forest-dwelling Neotropical migratory birds. Indeed, if openings provide habitat for nest parasites or predators, and the extent of this is not known, they can potentially be extremely damaging.

Recommendations for public land managers may not be appropriate for private lands on which timber production is the highest priority. The three broad categories of silvicultural practices that managers of these lands have to choose among are large clearcuts (or other practices such as shelterwood or seedtree cuts in which large areas are essentially cleared), group selection or small clearcuts, and individual selection. Because of species-specific habitat preferences, no single choice will have a similar effect on all Neotropical migrants, and each practice will provide benefits for at least some species. Regardless of the harvest practice chosen, caution should be exerted to ensure the health of what remains. Whereas sensitive practices can leave a relatively intact ground cover from which prompt regeneration can be expected, heavy disturbance of soils will stimulate the establishment of weedy species, slow regeneration, and create unfavorable conditions for most birds.

Clearcuts will provide habitat for some declining species such as Orchard Oriole and Yellow-breasted Chat. However, a site in an even-aged, short rotation clearcut cycle will not provide suitable habitat for many forest-dwelling bird species. However, if it is necessary to extract a given volume of timber from a stand, it is quite possible that a single clear cut is preferable to multiple small clearings. The single cut will create a much shorter linear distance of edge, and if an edge effect reduces bird reproductive success well into the interior of remnant forest, could have a less negative impact of the

remaining forest bird populations. Any negative effects of clearcuts can be mitigated to some extent by a lengthening of the rotation period.

Group selections, in which areas from about 1/4 to one acre are cleared, mimic in some ways a natural disturbance regime. This is the practice followed by the Anderson-Tully Company, the largest private landowner in the lower Mississippi River Valley. Preliminary studies have shown good densities of the full range of forest migrants on at least some of these lands. Larger group selection cuts may have all the negative features of clear cuts with the added impacts of greater edge and more roads.

Individual tree selection more closely mimics treefall disturbances. In one type of individual selection, trees are harvested in the same size and species ratios as those existing in a natural forest; this can potentially result in high quality conditions for birds. From a silvicultural perspective, removal of individual trees may be untenable if it does not create a sufficient light gap to allow regeneration of desired timber species. A diameter cut is a different method in which all merchantable trees above a certain size are removed, leaving a forest in which smaller individuals are allowed to move into larger diameter size classes in subsequent years. Although this may not initially be detrimental to most bird species, it must be cautioned that diameter cuts change the tree species composition of a forest, eventually leaving little but commercially undesirable individuals and a lack of a seed source for desired species. Thus, this practice, often referred to as "high grading", may ultimately be harmful to migratory birds.

At least six species respond positively to selective cutting operations that mimic treefalls. The Carolina Wren (a permanent resident), White-eyed Vireo, American Redstart, Swainson's Warbler, Kentucky Warbler, and Hooded Warbler all prefer microhabitats with foliage density profiles typical of 10-25 year old treefall gaps (Barrow 1990, Barrow and Hamilton, in prep.). Canopy gaps allow increased light intensity to reach the forest floor, promoting growth of denser foliage beneath the canopy than in the forest as a whole. Larger openings also promote dense vegetation, but none of the five above migrants tended to use areas that lacked a relatively closed canopy. Larger group selection cuts would fail to provide benefit to these species; the size of the largest group selection cut that would not be harmful is not known.

The effects of creating gaps or edges on nest parasitism and predation and forest-dwelling bird success are virtually unknown in bottomland hardwood forests. One thing that is clear, however, is that if a manager clears, for example, 10% of a forest of whatever size or configuration, at least 10% of the habitat for and populations of forest-dwelling birds will be gone. Whether more than 10% of the forest-dwelling bird population will be lost is dependant upon the placement of the clearing and the effects of it and its edges. There are some mitigating factors, in that habitat will be created for open area, edge, and shrub species. The desirability of this change depends upon the relative status of forest and shrub birds in the landscape under

consideration. Given that forested habitat in Southeastern bottomland hardwood systems has been so greatly reduced, further clearing of forest should be considered, in general, detrimental to Neotropical migratory birds.

There are few conclusive data as to the relationship between management practices and breeding success of Neotropical migratory birds, the ultimate measure of suitability. Regardless of which management practice is chosen, there should be consideration given to protection of special habitat features of value for birds:

- Removal of all old and large trees, particularly bald cypress, will have a negative impact on Eastern Wood-Pewees, Yellow-throated Warblers, and Yellow-throated Vireos (Barrow 1990, Moser et al. 1990).
- Removal of dead snags will reduce populations of species that forage or nest in them, including migrants such as Eastern Wood-Pewee and Prothonotary Warbler as well as permanent resident woodpecker and other species.
- Loss of Spanish moss can be deleterious to the Northern Parula and Yellow-throated Warbler.
- Canebrakes are increasingly rare and sizeable remaining patches are worthy of consideration for protection.

Managers can have a quite different problem from how to manage existing forest habitat in cases where the land in question has been in agricultural production. In these cases, reforestation is recommended. Many of the considerations in how to reforest revolve around soils and hydrology and the nature of the plant community appropriate for a site. Choosing proper species for regeneration is critical to success. Off-site seed acquisition is often required. Where natural regeneration is part of reforestation efforts, the source of seed fall must be taken into account, with the understanding that heavier seeded species are less likely to uniformly establish themselves than are light seeded species. Soil microorganisms perhaps necessary for success of some vascular plants may have been eradicated under agricultural treatment. Consultation with experts, such as those at the USDA Southern Forest Experiment Station in Stoneville, MS, and the Louisiana Department of Wildlife and Fisheries, should include consideration of these and other topics in reforestation planning. In general, reforestation will do the most good adjacent to existing forested tracts by increasing patch size and reducing the effects of fragmentation. Reforestation along streams will increase connectivity and improve water quality, but the benefits to Neotropical migrants as nesting habitat and migratory corridors may be outweighed by the extreme edge conditions created.

Reforestation is a local activity that is important in management decisions at watershed, physiographic area, regional, ecosystem, or landscape scales. All management decisions of consequence should be made at these larger scales, with perhaps the physiographic area considered a management unit (Sharitz et al. 1992). Decisions made at an individual refuge

or other small component of an ecosystem may or may not be wise from the perspective of a larger, more relevant geographic scale. Maximizing species diversity of a refuge, for example, often has the unintended effect of reducing regional species diversity by encouraging widespread habitat generalists at the expense of narrowly distributed specialized species.

There needs to be collaboration at the ecosystem level among researchers and managers. There is a great deal concerning the natural history of these birds, their response to various management practices, and the natural dynamics of bottomland hardwood forests that needs further investigation. Identification of practical information needs and networking among researchers can be one of the many benefits of the Partners in Flight process.

Ultimately, the goal is to reverse population declines among Neotropical migrants in the bottomland hardwood system of the Southeast. It can be said with some assurance that creation of more forested habitat and reduction of fragmentation will help to bring this about. Since habitat availability appears to have stabilized and declines appear to continue, however, the solution of some lingering mysteries will be necessary to achieve lasting success.

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LITERATURE CITED

- Abernethy, Y. and R. Turner. 1987. U.S. forested wetlands: status and changes 1940-1980. *Bioscience* 37:721-927.
- Abrams, M.D. 1992. Fire and the development of oak forests. *Bioscience* 42:346-353.
- Barrow, W.C. 1990. Ecology of small insectivorous birds in a bottomland hardwood forest. Unpubl. Ph.D. Diss., Louisiana State Univ., Baton Rouge.
- Bedinger, M.S. 1981. Hydrology of bottomland forests of the Mississippi Embayment. Pages 161-176 in J.R. Clark and J. Benforado eds. *Wetlands of bottomland hardwood forests*. Elsevier Science Publishing Co., Amsterdam.
- Bent, A. C. 1953. Life histories of North American wood warblers. *Bull. U.S. Nat. Mus.* 203:1-734.
- Creasman, L., N.J. Craig, and M. Swan. 1992. The forested wetlands of the Mississippi River: An ecosystem in crisis. *The Nature Conservancy of Louisiana*, Baton Rouge. 24 p.

- Eddleman, W. R., K.E. Evans, and W. H. Eldes. 1980. Habitat characteristics and management of Swainson's Warbler in southern Illinois. *Wildl. Soc. Bull.* 8:228-233.
- Gosselink, J.G., S.E. Bayley, W.H. Conner, and R.E. Turner. 1981. Ecological factors in the determination of riparian wetland boundaries. Pages 197-219 in J.R. Clark and J. Benforado, eds. *Wetlands of bottomland hardwood forests*. Elsevier Science Publishing Co., Amsterdam.
- Harris, L.D. and J.G. Gosselink. 1990. Cumulative impacts of bottomland hardwood forest conversion on hydrology, water quality, and terrestrial wildlife. Pages 259-322 in J.G. Gosselink, L.C. Lee, and T.A. Muir, eds., *Ecological processes and cumulative impacts: Illustrated by bottomland hardwood wetland ecosystems*. Lewis Publ., Inc., Chelsea, MI.
- Huffman, R.T., and S. W. Forsythe. 1981. Bottomland hardwood forest communities and their relation to anaerobic soil conditions. Pages 187-196 in J. R. Clark and J. Benforado, eds. *Wetlands of bottomland hardwood forests*. Elsevier Science Publishing Co., Amsterdam.
- McKnight, J.S., D.D. Hook, O.G. Langron, and R.L. Johnson. 1981. Flood tolerance and related characteristics of trees of the bottomland forests of the southern United States. Pages 29-69 in J.R. Clark and J. Benforado, eds. *Wetlands of bottomland hardwood forests*. Elsevier Science Publishing Co., Amsterdam.
- McPhee, J. 1989. *The control of nature*. Farrar Straus Giroux, New York. 272 p.
- Meanley, B. 1971. Natural History of Swainson's Warbler. U. S. Dept. of Interior, Bur. of Sport Fish and Wildl., N. A. Fauna No. 69, Washington, D. C. 90 p.
- Moser, E.B., W.C. Barrow, and R.B. Hamilton. 1990. An exploratory use of correspondence analysis to study relationships between avian foraging behavior and habitat. P. 309-317 in M.S. Morrison, C.J. Ralph, J. Verner, and J.R. Jehl, Jr., eds. *Avian foraging theory, methodology, and applications*. Studies in Avian Biology No. 13, Cooper Ornith. Soc., Allen Press, Lawrence KS.
- Patrick, W.H. Jr., G. Dissmeyer, D.D. Hook, V.W. Lambou, H.M. Leitman, and C.H. Wharton. 1981. Characteristics of wetland ecosystems of southeastern bottomland hardwood forests. Pages 276-300 in J.R. Clark and J. Benforado, eds. *Wetlands of bottomland hardwood forests*. Elsevier Science Publishing Co., Amsterdam.
- Remsen, J.V., Jr. 1986. Was Bachman's Warbler a bamboo specialist? *Auk* 103:216-219.
- Sharitz, R.R., L.R. Boring, D.H. Van Lear, and J.E. Pinder, III. 1992. Integrating ecological concepts with natural resource management of southern forests. *Ecol. Appl.* 2:226-237.
- Tanner, J.T. 1986. Distribution of tree species in Louisiana bottomland forests. *Castanea* 51:168-174.
- Taylor, J.R., M.A. Cardamone, and W.J. Mitsch. 1990. Bottomland hardwood forests: their functions and values. Pages 13-86 in J.G. Gosselink, L.C. Lee, and T.A. Muir, eds. *Ecological processes and cumulative impacts; illustrated by bottomland hardwood wetland ecosystems*. Lewis Publishers, Inc., Chelsea, MI.
- Turner, R.E., S.W. Forsythe, and N.J. Craig. 1981. Bottomland hardwood forest land resources of the southeastern United States. Pages 13-38 in J.R. Clark and J. Benforado, eds. *Wetlands of bottomland hardwood forests*. Elsevier Science Publishing Co., Amsterdam.
- Wiedenfeld, D.A., L.R. Messick, and F.C. James. unpubl. ms. Population trends in 65 species of North American birds: 1966-1990.