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Neotropical Migratory Birds and The Bottomland Hardwood Forests: Migrating Toward a Healthier Ecosystem

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Introduction

Neotropical migratory birds are species that breed North of the Tropic of Cancer and spend the winter South of the same latitude (Deinlein 2003). Fifty percent of the world's birds, about 4,000 species, are neotropicals found in the Americas'; approximately 400 species of these migrate between the two continents (Berthold 1993).

A majority of neotropicals are songbirds such as warblers, thrushes, tanagers, and vireos, although some are shorebirds, raptors, and waterfowl (Berthold 1993). Due to the diversity of neotropical migratory bird species and their widely divergent habitat requirements, these birds have become an important health indicator of North, South, and Central Americas' ecosystems. Scientists have become alarmed because of the major decline in bird numbers that has been detected for several species over the last 3 decades. Ecologists are concerned that neotropical population changes are symptomatic of greater changes that suggest deteriorating habitat conditions (Simons 1999). Historically, forest birds that require extensive forest on breeding grounds and tropical wintering grounds (broadleaf tropical forests) have been of particular concern (Robbins, et al. 1992).

While the loss of habitat in migrant birds' breeding and wintering habitat has been studied and linked to the declining numbers of migrant birds, the deterioration of habitat en route has been shown to be an equally important factor. A major ecosystem used as breeding grounds and stopover habitat by neotropical birds are the bottomland hardwood forests of the Southeast United States. This habitat was historically vast, and one of the first terrestrial habitats that migrant birds would use to rest and restore energy supplies after the long trip over the Gulf of Mexico (Deinlein 2003).

This paper will focus on neotropical songbirds and their interactions with the bottomland hardwood forests along the floodplains and banks of the many rivers and streams in the Gulf and Atlantic Coastal Plains. The Nature Conservancy reports that there were approximately 52 million acres of riparian forest before European settlement, and by 1991 only 12 million acres remained (The Nature Conservancy 1992). The large matrix of bottomland forest in the Gulf Coast has been reduced to remnants mainly less than 250 acres, and surrounded by agricultural fields (Flynn 1999).

A correlation can be drawn between the declining numbers of several species of neotropicals and the extensive conversion of the bottomland hardwood forest to agriculture and other land uses. Attempts have been made to restore large amounts of bottomland hardwood forest for a variety of reasons, including the increase of certain neotropical migratory bird populations. Bottomland hardwood forest restorations have had limited successes (in regard to increasing neotropical migratory bird populations) and this paper will discuss reasons why these restorations failed or succeeded and what, if anything, can be done in future restorations to increase the populations of several neotropical migratory birds.

Neotropical Bird Migration

Migration evolved because the benefits of reproductive success in the insect-rich temperate zone and winter survival conditions of the tropics outweigh the costs of the long and difficult journey (Berthold 1993). Many neotropical species can travel a round trip distance of 13,000 miles in one season (Deinlein 2003). A one-way migration can take several weeks to 4 months with the birds traveling anywhere from 60-600 miles per flight; usually taking place at night (Berthold 1993). Due to the length and duration of flights, neotropical birds use stored lipid for energy during migratory flight and use stopovers to recover from the flight and restore lipid reserves for the next leg of the journey (Moore, et al. 1992). The length of these stopovers depends on several factors including adjustment to unfamiliar habitats that vary in suitability, resolving the conflicting demands of food gathering and vulnerability to predators, competition with other birds for food, responding to unfavorable weather, and correcting orientation errors (Moore, et al. 1992). Neotropical birds will need to use several of these stopover sites during migration, requiring a variety of suitable habitats to be available for each species. If these habitats are not available, the neotropical birds may not be able to reach their breeding grounds and reproduce. Moore, et al. (1992) suggests that a lack of suitable stopover habitat for a species along a migration route may result in death or the decline of a population.

Migration routes are not precise routes mechanically followed by neotropicals. There must be a degree of flexibility in the route due to unpredictable variables such as weather, energy availability at stopover sites, suitable habitat available, etc. While migration routes are not completely understood, it seems that all migratory birds use a variety of cues, with some species relying on some cues more than others (Berthold 1993). Some of the cues used by neotropicals are: the magnetic field of the earth, location of the setting sun, topographic features (rivers, mountains, coastlines), and prevailing weather/ wind patterns (Berthold 1993). There is also an element of genetics that instinctually tells the bird when and where to start flying (Deinlein 2003). All of these factors contribute to broad migration routes for a particular species.

Important stopover sites start to appear when looking at general migration routes. Over time, the forests of Central and Eastern North America have attracted many species of neotropical migratory birds because of the extrinsic benefits to the birds (Moore, et al. 1992). Migratory birds returning to North American forests to breed must either take an overland route through Mexico or a route across the Gulf of Mexico. Many birds take the 18-hour flight over the Gulf, and the coastal woodlands of the Gulf Coast become the first opportunity to rest and recover. Barrow, et al. (2000) observed migrant birds concentrating in habitats next to ecological barriers, such as deserts, large bodies of water, etc. Because of their location along the Northern shore of the Gulf of Mexico, bottomland hardwood forests have been shown to be a critical link in the migration routes of a large proportion of neotropical birds breeding in the United States; at least 70 species use bottomland hardwoods as a primary habitat (Twedt, et al. 1999).

Bottomland Hardwood Forests of the Southeast

In order to understand the destruction and restoration of bottomland hardwood forests, and the implications to neotropical populations it is important to understand the development and ecology of these dynamic ecosystems. Bottomland hardwood forests occur on floodplains primarily in the Atlantic and Gulf Coastal Plains created from broad stream valleys that cut through erodable sedimentary material (Hodges 1997). Hodges (1997) points out that the natural patterns of plant succession on the floodplain are in constant change due to processes of scouring and deposition of soil at different points in the channel and floodplain. Figure A. displays a feature distinguishing bottomland hardwood forests from other riparian forests. The rivers or streams associated with these forests cut through topography with very low relief, and the elevation of the forest floor is near or below the river base level. The topography, soils, hydrology, and corresponding vegetation structure is completely controlled by the flooding regime.

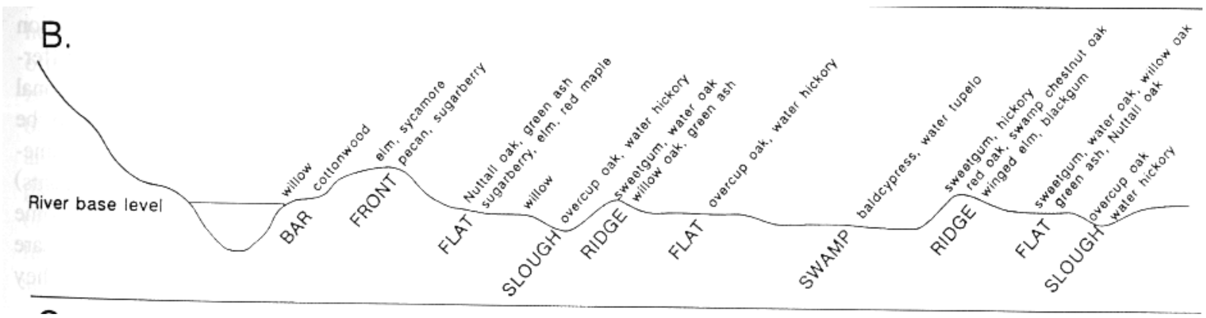

Figure A. Graphic adapted from Hodges (1997).

Figure B. shows the general succession of canopy species with the climax species of oak and hickory appearing after sedimentation has built up and mature soils have formed (Hodges 1997). These intricate processes are crucial to the development of the bottomland hardwood forest and have been severely disturbed by the land use changes of post European settlement.

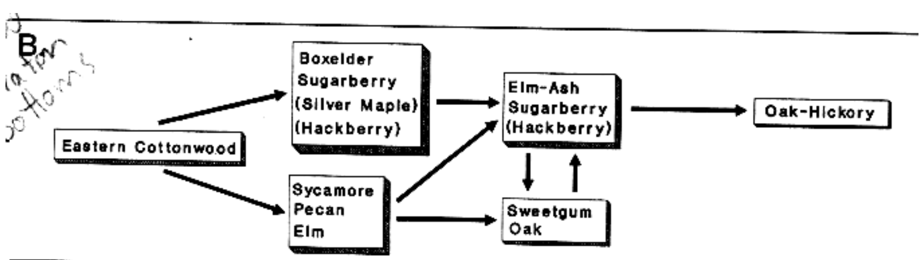

Figure B. Graphic adapted from Hodges (1997).

Natural disturbance has always been a part of the bottomland forest with tree falls caused by wind, ice storms, hurricanes, etc., causing gaps in the mature structure. These gaps regenerated as even aged groups of trees, resulting in a forest mosaic of species of varying ages (Pashley and Barrow 1992). Pashley and Barrow (1992) state that old growth bottomland hardwood forests were not a continuous closed canopy, but a mixture of patches ranging in age from very young to very old.

Human disturbance has been a part of the ecology of the bottomland hardwood forest for hundreds of years, at a scale that was similar to natural disturbances. Hamel and Buckner (1998) suggest that the forest in 1800 was probably secondary succession due to historic Native American agricultural practices. However, European settlers found that the floodplain forests contained highly fertile soils, and agriculture induced clearing and drainage began in the early 1800's (Stanturf, et al. 2001). Another clearing period occurred in the late 1970's because of a steep rise in soybean prices that led farmers to expand further into the forest, on areas that frequently flooded. Over the long term, these flooded areas were uneconomical for farming (Stanturf, et al. 2001). This land is subject to restoration under the Conservation Reserve Program and the Wetlands Reserve Program, and has the potential for 200,000 ha to be restored (Stanturf, et al. 2001).

<u>Bottomland Hardwood Forest Restoration and the Effects on Neotropical Bird Populations</u>

Restoration of these bottomland hardwood forests was attempted in the 1992 Wetlands Reserve Program. The methods generally used were simply planting young oaks, oak saplings, and acorns (Twedt and Portwood 1997). In limited areas, the oaks established and are growing. However, the Stanturf, et al. (2001) study estimates that 90% of the restoration areas that were addressed, failed. Failure was the result of none, or very few, of the oak plantings establishing or growing. Two main causes for failure were identified: species were not adequately matched to the site, and contractor monitoring and knowledge was insufficient (Stanturf, et al. 2001). The oak species chosen were not the result of an understanding of the ecosystem, but a result of the goals at the time: the improvement of timber value and "quality wildlife habitat," which exclusively referred to game species (Twedt and Portwood 1997). A high proportion of mature oaks at harvest provided the maximum profit while providing high amounts of forage for waterfowl and other game species (Twedt and Portwood 1997).

Other restorations have been undertaken both before and after the initial Wetland Reserve Program and have been more successful at growing trees, but the impact of these plantings on the increase of neotropical migratory birds has not appeared. It is difficult to compare current neotropical bird populations to those that occurred before massive land use changes because the Breeding Bird Survey (BBS), which is the primary method for accurately counting birds, was only started in 1966 (Robbins, et al. 1992). They rely on trained volunteers and managers to count neotropical birds at certain sites with a variety of methods, but mostly counting bird numbers. Since the survey was started the BBS has noted a decline in forest birds that require extensive forest on breeding grounds.

Due to the apparent ineffectiveness of bottomland hardwood forest restorations on stopping or reversing the declining neotropical bird populations, it became clear that immature climax community tree species were not suitable habitat for a majority of bird species. Scientists began to look for habitat requirements other than particular tree species.

Twedt and Portwood (1997) hypothesized that the 3-dimensional structure of a forest may be more important than the tree species composition of the stand in providing habitat for neotropical birds. They compared the number of neotropical bird species present in oak planted stands 4-6 years old, to the number of species in cottonwood plantings aged 5-7 years. Cottonwood plantings included 36 avian species, many of which were forest species; while the oak stand contained only 9 bird species, which were mainly grassland species (Twedt and Portwood 1997). The fast growth and creation of structure by cottonwoods appears to resemble the structure of mature bottomland hardwood forest more than the structure of the slow growing oaks. Figure B. shows that cottonwoods, a pioneer species of the bottomland forest, could provide relatively quick habitat for neotropical birds; however, it is difficult to know whether this has any lasting impact on the population of migratory birds, because of the age of the trees studied.

One way to compare the effects of restoration on bird numbers is to compare the populations of birds in bottomland hardwood forests that have been restored, to populations in a mature forest. Migratory birds will preferentially choose higher quality habit within the same spatial area (Moore, et al. 1992). Twedt, et al (1999) compared the avian communities between mature mixed bottomland forests and several cottonwood plantations that were subject to different management techniques. They found that mature bottomland forests that began as planted cottonwood stands had bird communities similar to undisturbed mature bottomland forests (Twedt, et al. 1999). However, the natural bottomland forests contained a significantly higher number of specialist birds. Specialist birds require a specific habitat that may include particular species composition and structures like snags and woody debris for feeding and resting, that were absent from managed stands (Twedt, et al. 1999). These specialist species are among the most rare and threatened neotropicals.

Twedt, et al. (1999) assigned values to neotropicals based on how rare they were and generated scores for the mature and restored forest. The generated scores indicate that mature bottomland hardwood forests are twice as valuable for bird conservation than cottonwood plantations with minimal management regimes. This study shows that while cottonwoods can be used to provide habitat for many generalist species of neotropical birds, stands of high quality bottomland hardwood forest are still needed for specialist species that may be more threatened or rare.

Similar findings appeared when older, more mature restorations were compared to natural bottomland forests. Shear, et al. (1996) compared a 100- year old mature bottomland forest to two 50-year-old stands of restored bottomland hardwood forests; one planted and one restored by natural regeneration. They found structural similarities between both restored forests and the mature stand, but neither restored stand could replace the wildlife value (including, but not limited to neotropical birds) of the mature bottomland forest. Another important finding of this study was the succession from hydric to mesic species composition of all the forest stands, including the mature forest. Shear, et al. predicted that the bottomland species composition wouldn't last in any of the forests over the long term (1996).

The forest hydrology and vegetation naturally succeed from wet to mesic species. However, understanding this ecosystem becomes even more complicated with the hydrologic manipulation of post European settlement society. Stanturf, et al. (2001) believes that the hydrologic manipulation of humans has created a problem with picking reference sites as targets for bottomland forest restoration, without regard for the current hydrology. The levee and drainage network used by farmers has created sites that are drier on the protected side of the levee than they would naturally be (Stanturf, et al. 2001). Bottomland forest species may not be able to survive in the new hydrologic regime. The problem with reference stands is one of the factors that Stanturf, et al. (2001) described as a possible reason for the failure of large scale restoration efforts, such as the Wetlands Reserve Program, that tried to restore a large portion of bottomland hardwood forest in 1992. A few reference stands were used to broadly apply species composition across the floodplain. The uniquely diverse structure and species composition of the bottomland hardwood forest can't be restored without addressing the hydrology that has been drastically changed.

The large number of neotropicals dependent on remaining patches requires the diversity of habitats provided by bottomland forests. Barrow, et al. (2000) studied the disruption and restoration of habitat in the Chenier Plain of Coastal Texas that included bottomland hardwood forests. They recommended that no single restoration or rehabilitation plan would have a similar effect on all migrant birds, and each restoration or management plan will provide benefits for at least some species (2000). However, they emphasized addressing understory habitat in the Chenier Plain, because it is the most degraded layer and crucial to some neotropical habitat (Barrow, et al. 2000).

The Chenier study presented some recommendations for restoration and rehabilitation of stopover habitats for neotropical migrants that emphasized further study of stopover ecology. There is a need to understand the diversity and structural complexity of plant communities that need to provide habitat for generalist as well as specialist bird populations, and the need to recognize key areas across the broader landscape that could effect migration success (Barrow, et al. 2000). This study suggested that doing something in the highly degraded agricultural matrix is better than doing nothing, for most neotropicals. However, specialist species require a certain quality and quantity of habitat. Providing habitat for these rare or even endangered specialist birds requires an understanding of the multiple layers that make up the bottomland hardwood forest. Species such as the Cerulean Warbler, Swainson's Warbler, and Prothonotary Warbler have been identified as some of the species with the highest priority for protection because of their low numbers and potential for extinction (Twedt, et al. 1999). These birds use the bottomland hardwood forest for breeding and as stopover habitat. The following habitat area requirements have been identified for successful breeding: Cerulean Warbler – 4,700 ha, Swainson's Warbler – 8,000 ha, and Prothonotary Warbler – 2,700 ha (Twedt, et al. 1999). These areas could be used as minimum areas for protection or restoration of portions of the bottomland forest across the landscape.

Geographic Position of the Bottomland Hardwood Forest

Further research has shown that understanding habitat relationships at a larger scale, across migratory pathways, may be just as important as understanding the complexity of structural requirements of neotropicals at the habitat scale. Moore, et al. (1992) suggested that suitable stopover habitat should be managed across a wide range of migratory pathways, and a number of quality habitats distributed across the landscape may be better than a few large patches.

Subsequent studies have given more credibility to this theory, most notably the Tankersley and Orvis (2003) study that modeled the geography of migratory pathways and stopover habitats for neotropical migratory birds. They undertook a spatial analysis of stopover habitat in the eastern United States, and then modeled potential migratory paths between stopover habitats. They used fixed nightly distances in a range of distance traveled along a possible migration route, and tried to match them with suitable habitat patches. Their models tested the migration success of a species traveling northwest, north, or northeast from a wide range of points along the gulf coast. Individuals traveling northeast had the highest rate of a successful migration with abundant stopover patches, while travel north had the least success (Tankersley and Orvis 2003). Northeast migration success may have been due to the large amount of quality habitat patches in the Appalachian Mountains. The low success rates for birds crossing directly north along the Mississippi Alluvial Plain may have been due to the lack of habitat that historically contained a high percentage of bottomland hardwood forest (Tankersley and Orvis 2003).

Migration geography appears to be important, and migrants must be able to find suitable habitat, placed in the right locations all along the migratory path, in order to address the multiple variables of migration. Their models also show a lack of quality habitat at key locations in the Southeast that caused many pathways to fail (2003). Many of these habitats would fall into the historic spread of the bottomland hardwood forest.

Conclusion

The bottomland hardwood forest is a crucial habitat for successful migration and the significant loss has contributed to the decline in neotropical birds numbers since the 1966 BBS was started. Restoration has been tried for various reasons. There has been some success in protecting and increasing the numbers of generalist species using fast growing cottonwoods to provide structure. However, the specialist species are not affected and tend to be the rare or threatened species. Species composition and other factors such as shrub layer and snags seem to be important and need to be studied further. There also needs to be more work done at the geographic scale because evidence shows that the spatial distribution of habitats across the landscape is a crucial feature of connecting migratory birds from wintering grounds to breeding grounds.

Discussion

It is apparent that there is no broad, general solution for the restoration of the bottomland hardwood forest. Restorations must be site specific and pay attention to several factors, with hydrology having a major impact on species composition. It will de difficult to address the issues of hydrology, especially in the Mississippi Alluvial Plain, at the site scale. Dealing with the drainage and levee system that farmers have created would be more appropriate for a large scale regional program, than mass planting trees with no regard for site conditions.

Another regional goal of restoration programs could be the identification of sites along known migration routes, where restorations would be most effective in providing adequate stopover habitat for migrating birds. After potential sites have been identified, it will be restorationists', ecologists', and land managers' jobs to understand the site and develop a successful plan. While it is still important to protect large areas of quality habitat, especially at hot spots adjacent to ecological barriers, it is also just as important to provide a patchwork of habitats across the landscape in order to provide options for migrating birds that are dealing with multiple variables along the journey.

The size of these patches could be linked to known habitat requirements for priority birds identified in the Twedt, et al. (1999) study. There are also ways to continue foresting for profit while providing quality habitat for generalist neotropicals. Cottonwood plantations have become more popular because of their fast growth and use as pulpwood. Careful management could maximize habitat for migratory birds. However, it is equally important to protect lands for current bird populations and for ecological education. Because of their complexity, restoration of the bottomland hardwood forests will be an ongoing, sometimes trial and error, process that will involve the knowledge and resources of several disciplines: hydrologists, ecologists, forest managers, etc. While neotropical bird populations and diversity may be the indicator of success, it is the interaction of humans and the complex environments they inhabit that will be the true reward for attempting to restore the bottomland hardwood forest.

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