Bachman's Sparrow Habitat in the Lower Flint River Basin, Georgia

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Abstract: Bachman's sparrow *(Aimophila aestivalis)* populations are generally declining throughout much of the Southeast, and habitat loss is suspected as the principal force driving declines. Therefore, we assessed the potential effects of current land use practices on Bachman's sparrows (BACS) within the lower Flint River Basin (LFRB). We then used a previously developed habitat model to quantify current available BACS habitat and used common landscape metrics to describe fragmentation of remaining habitat. Prior to major land use changes associated with European settlement, approximately 86% of the LFRB was suitable for BACS. Of this once suitable habitat, 3.8% is now urban, 42.4% is now in agriculture, and 48.2% is now in forests unsuitable for BACS. We estimated that only 3.3% of the original upland forests within the basin remain suitable for BACS. Today, 97.4% of suitable habitat occurs in patches <30 ha with 17.9% of patches fragmented by >1000 m. Small patch size and increased distance between patches combine to yield low proximity indices. Pine plantation management emphasizing prescribed fire and thinning may increase overall habitat availability for BACS while reducing habitat fragmentation. The recent interest in longleaf pine *(Pinus palustris)* restoration may similarly benefit BACS.

Key Words: Aimophila aestivalis, Bachman's sparrow, fragmentation, Georgia, habitat model

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Bachman's sparrows *(Aimophila aestivalis)* inhabit open mature pine forests and early successional habitats of the southeastern United States (Dunning and Watts 1990, Dunning 1993, Engstrom 1993). The sparrow nests and forages in dense herbaceous ground vegetation, which is maintained by frequent fires and habitat disturbance (Dunning 1993). Sparrow numbers and distribution have been negatively affected by loss and fragmentation of the longleaf pine *(Pinus palustrus)* ecosystem (Dunning and Watts 1990), which now occupies <3% of its historical range (Ware et al. 1993).

Bachman's sparrow (BACS) is considered uncommon throughout its range and a species of priority and concern (Dunning 1993). Breeding Bird Survey (BBS) data indicated a 2.8% annual population decline from 1966–2000 (Sauer et al. 2001), which has been attributed to habitat loss (Dunning and Watts 1990, Dunning 1993). To determine the current distribution on BACS habitat within the lower Flint River

Basin (LFRB), Georgia, we assessed BACS habitat loss as a result of land use change and quantified the current amount and distribution of BACS habitat in the LFRB, Georgia.

Study Area

Our study encompassed the LFRB (1.48 million ha) in southwestern Georgia (Fig. 1). Before European settlement, all upland habitats within the basin were thought to be mostly mature longleaf pine-wiregrass *(Aristida beyrichiana)* forests (Frost 1993). Since European settlement, land use within the basin has changed drastically, with much of the basin being used for food and fiber production. The original longleaf pine-wiregrass forest currently exists in remnant patches throughout the basin.

Methods

We assumed that prior to European settlement, upland habitats within the LFRB were predominantly covered with longleaf pine forests (Frost 1993) and thus represented suitable BACS habitat. Therefore, we estimated the availability of BACS habitat as the area of the LFRB minus any wetland and riparian areas as identified in the National Wetlands Inventory (U.S. Fish and Wildlife Service 1989). We used this estimate of habitat availability and the spatial distribution of this habitat as a baseline depiction of BACS habitat prior to European settlement. We developed a baseline habitat coverage (i.e., thematic map) using ArcInfo (ESRI 2001) for further spatial analysis. We acknowledge that our historic estimate is a very liberal estimate of BACS habitat because unsuitable BACS habitat likely existed in these upland sites as a result of catastrophes (e.g., tornados, forest-replacing fires, etc.), or other ecological phenomena (e.g., establishment of hardwood areas within the longleaf pine matrix due to long-term lack of fire).

We quantified current land use within the LFRB using a combination of supervised and unsupervised classification algorithms (Lillisand and Kiefer 1994). Ultimately, we reclassified all land cover types into three broad categories (forest, agriculture, and urban) as a generalization of land use within the basin. We classified land use in IMAGINE (ERDAS 2001) and subsequently converted to an ArcInfo (ESRI 2001) coverage.

We identified BACS habitat within the LFRB using a model developed and described by Conner (2002). This model was developed by selecting 60 sites where BACS were known to exist (Clark et al. 1993). Reflectance values of 1999 SPOT multispectral (MS) scenes (SPOT Images Corporation, Chantilly, Virginia) were used as predictor variables. The model was tested and found sufficient for identifying potential BACS habitat within the LFRB ($\chi^2_1 = 8.33$, $P < 0.01$) (Conner 2002). The model identified 14% of the total pine and shrub-scrub habitat in the LFRB to represent suitable BACS habitat. Areas identified by the habitat model were assumed to be BACS habitat with all remaining forested area unsuitable for BACS. For a complete

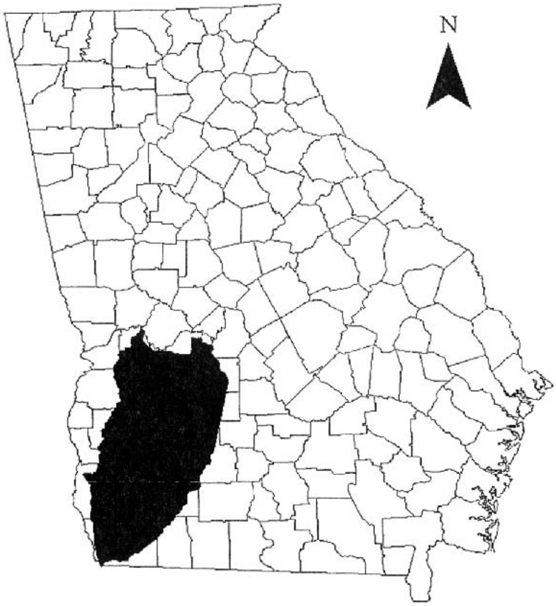

Figure 1. Black area indicates lower Flint River Basin, Georgia, USA.

description of model development and testing, readers are encouraged to refer to Conner (2002).

Because habitat occupancy is related to patch size and distance between patches (MacArthur and Wilson 1967, Martin 1980, Blake and Karr 1987), we used frequency distributions of patch size and nearest neighbor metrics as an assessment of current habitat conditions for BACS in the LFRB. We used FRAGSTATS (McGarigal and Marks 1995) to generate all landscape metrics. Habitat patches identified as suitable by the model were restricted to ≥2.5 ha because this level represents the minimum territory size of BACS (Dunning 1993). The nearest neighbor metrics used for analysis were the Euclidean distance to the nearest suitable habitat patch, and mean proximity index (mpi ≥0), which provided an index of the amount and size of suitable patches within a specified radius of an individual suitable patch (McGarigal and Marks 1995). An index value of zero indicates that no patches were within the search radius, and the index value increases with the number and size of suitable patches within the search radius.

Results

We estimated that 86% (1,278,584 ha) of the LFRB was suitable BACS habitat prior to European settlement. Of the suitable habitat available to BACS prior to European settlement, 3.8% is now in urban areas, 42.4% in agriculture, and 48.2% in unsuitable forest. Our model indicated that only 3.3% (patch size ≥2.5 ha) of historically available BACS habitat remains suitable. Remaining suitable habitat (42,485 ha)

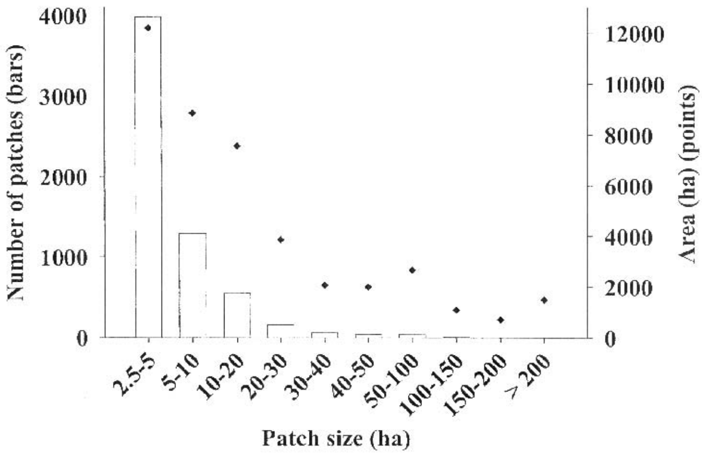

Figure 2. Number of suitable Bachman's sparrow habitat patches and area of habitat according to patch size class in the lower Flint River Basin, Georgia.

consisted of 6,156 individual patches, of which 76.4% of the area was in patches <30 ha and 97.4% of the total number of patches were <30 ha (Fig. 2). Further, 28.7% of the total BACS habitat area was in patches 2.5–5 ha and 64.7% of the total number of patches was 2.5–5 ha. We found that 17.9% of the patches were >1,000 m from the next closest patch, 37.1% were >500 m, and 75.9% were >200 m (Fig. 3). For all patch size classes, we found the mean proximity index to be 2.33 ± 0.55 (mean ± SE) for a 200 m search radius, 4.74 ± 0.65 for 500 m search radius, 5.33 ± 0.65 for 1,000 m search radius, 6.11 ± 0.66 for 6,000 m search radius, and the average for all search radii to be 4.63 ± 0.63 (Fig. 4).

Discussion

Within the LFRB, much of the suitable BACS habitat occurs as small (<30 ha) patches. Although many suitable patches were relatively close to other suitable patches (i.e., 24% of suitable patches were ≤200 m from the next closest patch), these nearest patches were often small. Mean proximity index values further support the contention that remaining BACS habitat patches are highly isolated. The average index value for all five size classes and four search radii was 4.63, indicating that little suitable habitat existed in proximity of any other suitable patch. To place this index value in context using a hypothetical landscape, a 1,000-m radius around a 10-ha patch with 50% of the area containing 20 10-ha patches in a checkerboard pattern throughout would have an index value of 31.

Bachman's sparrows can use small suitable habitat patches in non-suitable landscapes (Dunning 1993) but isolated suitable patches have lower population densities or can be unoccupied (Dunning 1993, Dunning et al. 1995). Threshold isolation dis-

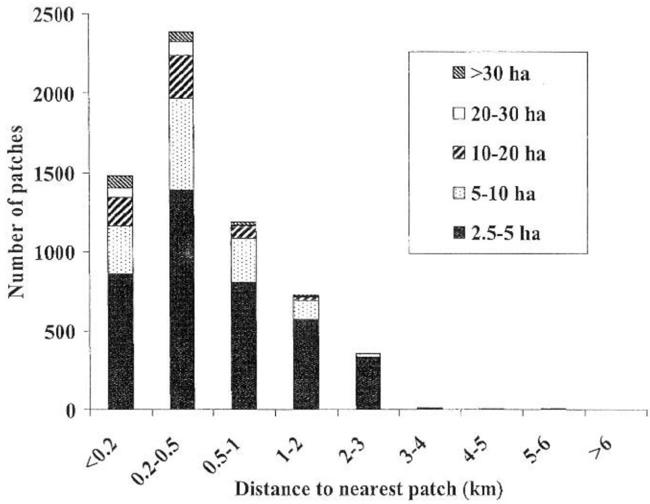

Figure 3. Number of suitable Bachman's sparrow habitat patches in relation to distance from individual suitable habitat patches to nearest suitable patch according to patch size class in the lower Flint River Basin, Georgia.

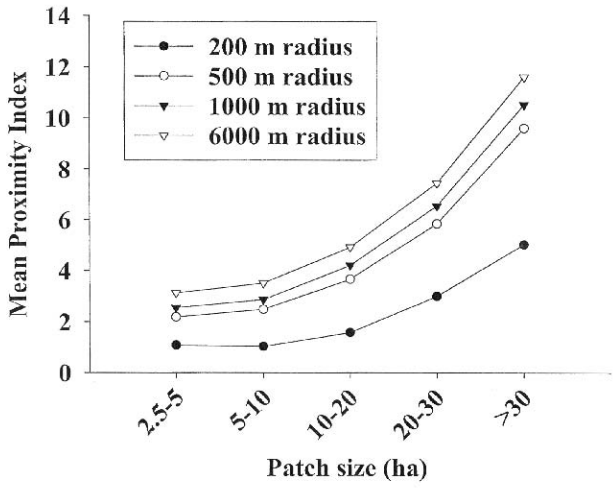

Figure 4. Mean proximity indices of of suitable Bachman's sparrow habitat patches within specified search radii according to patch size class in the lower Flint River Basin, Georgia.

tances depend on individual patch size and size of adjacent patches. The distance at which isolation negatively affects colonization and dispersal is not well defined (Dunning 1993). Isolation distances that negatively affected BACS density were >0.2 km (Dunning et al. 1995), >0.5 km (Pulliam et al. 1995), and >1 km (Dunning 1993). A study at Savannah River Site, South Carolina, demonstrated that 8.9–45.7 ha patches were unoccupied if >3 km from source patches, and 4–27.2 ha patches were unoccupied if >6 km from source patches (Dunning et al. 1995). However, suitable habitat corridors can improve BACS dispersal (Dunning et al. 1995).

Temporarily suitable habitat can increase the fragmentation of already spatially isolated habitats. Bachman's sparrow has strict breeding habitat requirements of open mature pine forests or one- to seven-year-old clear cuts (Dunning 1993). However, suitability of these clear cuts decreases with habitat succession (Dunning 1993), and within 5 years after planting of pines, clear cuts become unsuitable for BACS (Dunning and Watts 1990). The temporal nature of suitable habitat could negatively affect dispersal and increase the probability of regional extinction in unsuitable landscapes (Dunning and Watts 1990). Such dispersal, shown by Pulliam et al. (1992) using a simulation model, can be important in maintaining BACS populations on a landscape scale.

Within unsuitable landscapes, BACS population persistence may be negatively affected with increased temporal or spatial isolation (Dunning and Watts 1990). Conversely, ephemeral habitat suitability may temporarily decrease fragmentation of habitat by providing temporary suitable habitat, which serves as a corridor between other suitable patches.

Management Recommendations

Bachman's sparrow habitat suitability and availability is dependent on habitat management (Dunning and Watts 1990, Dunning 1993). Important habitats are open mature (>80 years old) pine forests with herbaceous understories and other open grassy habitats such as clear cuts and right-of-ways (Dunning and Watts 1990, Dunning 1993). Moreover, longleaf pine flatwoods may serve as BACS population source habitats for adjacent dry prarie sink habitats (Perkins et al. 2003).

To maintain open pine woods for BACS, prescribed fire should be on a one- to five-year rotation (Plentovich et al. 1998, Provencher et al. 2002). Unsuitable BACS habitat will result with fire suppression (Dunning 1993, Plentovich et al. 1998). Thus, the trend associated with reduced use of prescribed fire within the South's pine forests (Frost 1993) may be detrimental to BACS. Dunning (1993) stated that forest stands managed with a majority of age classes between 15–70 years will result in unsuitable habitat. However, thinning and burning 50- to 80-year-old pine stands (Liu et al. 1995) and burning 17- to 28-year-old pine plantations (Tucker et al. 1998) can produce suitable BACS habitat in middle-aged pine habitats.

In regions comprised mostly of unsuitable land cover types such as the LFRB, management and maintenance of small remaining suitable patches are warranted to prevent increased spatial and temporal isolation. In this region, most of the land cover types are unsuitable in the form of urban, agriculture, closed-canopy deciduous forests, and industrial pine plantations in unsuitable age classes. Much of the original BACS habitat in the basin is currently in industrial forests. Incorporating active habitat management for BACS, such as prescribed fire and thinning, into pine plantation management plans, represents an opportunity to decrease fragmentation within the LFRB. Moreover, there has been much recent interest in longleaf pine restoration throughout much of the lower Coastal Plain. Such restoration efforts if accompanied by proper forest management, such as judicious use of prescribed fire, would likely benefit BACS. Management actions taken to maintain and increase suitable habitats within the LFRB at local levels may slow the advance of regional fragmentation and allow for regional BACS population persistence.

Future BACS research should investigate effects of suitable habitat corridors on juvenile dispersal ability, and metapopulation dynamics. In addition, the relationship between patch size and isolation and their effect on BACS presence and density needs further exploration.

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