Bird Project Paper
Ecology 381
Professor Cathy Bach
University of Michigan
Biological Station

Effects of Tree Species, Number of Trees, Basal Area and Understory Vegetation on the Abundance and Diversity of Avian Species

Katie Brown

ABSTRACT

We investigated the relationships between bird species diversity and vegetation abundance, size, and groundcover of a forest ecosystem. We measured three variables: tree species diversity, tree diameter at breast height (DBH), and the amount of understory vegetation. We collected data at the AmeriFlux[1] and FASET[2] tower plots at the University of Michigan Biological Station property, Pellston, Michigan. The number of birds and number of bird species significantly increased with an increase in groundcover. The number of birds and bird species decreased with an increase in number of trees. Also, the number of birds and bird species decreased with an increase in basal area (tree size). These observations indicate the number of birds and bird species decreased with an increase in number of trees and tree basal area and increased with an increase in groundcover; all indicators of bird species diversity varying because of differences in vegetation abundance, structure, size, and amount of understory vegetation.

[1] Forest Carbon Cycle Research Program (UMBS-Flux)
[2] Forest Accelerated Succession Experiment

INTRODUCTION

Vegetation structure in different bird habitats often affects the distribution, abundance, richness, and diversity of bird communities (Block & Brennan 1993, Augenfeld *et al.* 2008). Vegetation type, vertical stratification, and canopy complexity provide essential foraging, roosting, and nesting requirements for rearing offspring (Augenfeld *et al.* 2008). Many avian species depend on these types of forest ecosystems for survival. Different tree species allow for different opportunities for foraging, nesting, and shelter (Lee and Rotteberry 2005). On a larger scale, different forest ecosystems offer widely varying habitats, because of differing tree species. For example, it has been suggested that oak trees may supply more foraging opportunities for insectivorous birds than maples (Abrams and Rodewald 2002).

Other studies have shown that the ratio of edge of habitat to interior habitat and patch size can also have a strong influence on avian diversity (Davis 2004). In the United States, housing density and human populations have substantially increased in and near forests, both on fringes of cities and in rural areas, which effect the development and biodiversity of birds (Pidgeon *et al.* 2007). Forest composition strongly affects the bird community because many birds depend on the foraging qualities of a specific species of a tree. However, it has also been shown that many bird species require more territory than what is needed for just foraging. Many males, in addition to their territory, will acquire supplementary patches of land to live and reproduce (Davis 2004).

In all of the habitats, variables such as foliage height, connectivity, heterogeneity, and vegetation cover can all have an influence on avian abundance and diversity (Gabbe *et al.* 2002, Goetz *et al.* 2007). We anticipated a high diversity of forest habitats within

the AmeriFlux and FASET tower sites on University of Michigan Biological Station property. We measured forest diversity using three variables: tree species diversity, tree diameter at breast height (DBH), and the amount of understory vegetation. We hypothesized (1) bird species diversity and the number of birds would increase linearly with tree species diversity, that (2) bird species diversity and number of birds would increase with tree diameter up to a point, then decrease, and that (3) bird species diversity and number of birds would increase linearly with an increase in the ground cover of understory vegetation.

METHODS

Site Descriptions

We collected data at the AmeriFlux (45.55996˚N; -84.72094˚W) and FASET (45.560496˚N; -84.693904˚W) tower plots at the University of Michigan Biological Station, Pellston, Michigan (Fig. 1). The two plots were set up similarly. At the center of the circular AmeriFlux plot was the tower and emanating from the tower were nine 1000 m transects, and two 500 m transects. There were markers spaced every 100 m and blue paint on the trees between the markers help to distinguish each transect. The FASET tower site is a semicircle with seven transects, each 400 m in length.

Bird Surveys

We conducted a bird census on bird species and abundance. This was done before the end of the breeding season, at which point many birds become less active and more difficult to sample. We sampled after sunrise, approximately 5:30 –6:00 am, when the birds were most active, and continued until roughly 11:00 am. To sample bird species and abundance, we followed each transect, stopping at markers 200 m apart, listening and noting every bird we saw and heard within a 50 m radius (personal

communication Tom Dietsch) and estimating their distance from us. We sampled each transect at least once, and often twice, to ensure an accurate sampling.

Vegetation Surveys

We sampled 23 plots total, 16 plots at the AmeriFlux tower and 7 plots at the FASET site for vegetation cover. We assumed the vegetation would not significantly change in the time between the bird data collection and the vegetation data collection. We set up non-overlapping circles with a radius of 10 m around each marker and recorded the species and DBH (diameter at breast height) of each tree within each circle. We only sampled trees with a DBH greater than five centimeters and ferns, trees and shrubs below 1 meter from the ground were considered understory. We randomly made 3 one meter squared quadrats to estimate the amount of understory groundcover in each ten-meter-radius plot and assigned it to one of ten categories, 0-10%, 11-20%, 21-30%, 31-40%, 41-50%, 51-60%, 61-70%, 71-80%, 81-90%, 91-100% (standard). It was only necessary to sample the vegetation at each marker once, as the vegetation should not be variable.

Data Analyses

We performed regression analyses independently between the number of birds and bird species and tree species, number of trees, basal area (size of tree), and groundcover to determine the effect of these independent variables on bird diversity.

To visualize the results, these regression data sets and analyses were graphed as dependant variable vs. independent variable with bird species and number of birds as the dependant variables and the tree species, number of trees, size of tree, and groundcover as the independent variables.

RESULTS

Groundcover Relative to Number of Birds and Bird Species

The number of birds increased with an increase in groundcover (R^2=0.373, p=0.002, d.f.=22, Fig 2). The number of bird species increased with an increase in groundcover (R^2=0.244, p=0.014, d.f.=22, Fig. 3).

Number of Trees Relative to Number of Birds and Bird Species

No significant difference was found between bird species and tree species. However, we found a negative correlation between the number of birds and number of trees (R^2=0.130, marginally significant, p=0.084, d.f.=22, Fig. 4). Also, we found a negative correlation in the number of bird species and number of trees in a plot (R^2=0.114, marginally significant, p=0.106, d.f.=22, Fig. 5). Therefore, an increase in number of trees caused a decrease in number of birds and bird species at both the AmeriFlux and FASET towers.

Basal Area Relative to Number of Birds and Bird Species

The number of birds decreased with an increase basal area (size of tree) (R^2=0.153, marginally significant, p=0.059, d.f.=22, Fig. 6). Also, the number of bird species decreased with an increase in basal area (size of tree) (R^2=0.163, marginally significant, p=0.051, d.f.=22, Fig. 7).

DISCUSSION

Groundcover Relative to Number of Birds and Bird Species

The number of birds and bird species increased with an increase in groundcover. This result fits our hypothesis that the number of birds and bird species diversity would increase linearly with an increase in groundcover vegetation. Other studies found similar

results; the most important variable determining forest bird species richness was the amount of forest cover (Pidgeon *et al.* 2007). Also, Ovenbirds were one of the main birds identified in our bird census and these birds forage and build their nests on the ground in understory vegetation. Further, more insects and grubs live in understory vegetation which increases foraging opportunities which may increase the number of birds and bird species. One study indicated that food availability is considered one of the most important factors limiting bird populations (Strong and Sherry 2000). However, bird species which are ground foragers or ground nesters including Ovenbirds, Veery, and Ruffed Grouse may have greater predation risk because of the increased visual obstruction (Fernandez-Juricic 2002).

Number of Trees Relative to Number of Birds and Bird Species

An increase in the number of trees decreased the number of birds and bird species at the AmeriFlux and FASET tower plots. It is possible that the reason for the decrease in number of birds and bird species with an increase in number of trees is because birds have to expend more energy flying around and through trees to get to their nests. Also, an increase in number of trees does not mean these are species of trees in which certain bird species like to make nests. Specific bird species may roost and forage in specific tree species and will live where these tree species are most abundant, most likely a more homogenous forest. For example, Black-throated Green Warblers cluster their territories where conifers reach their highest density, and tend to avoid areas where conifers are rare or absent (Robichaud and Villard 1999). Also, it is likely when there are more trees there is more heterogeneity in tree species; therefore birds will spend more energy foraging because the tree species they prefer is less abundant. Further, in multiple plots with the

bird and vegetation surveys, many big-tooth aspen, trembling aspen, and american beech trees were being girdled and in the next few years will be dead and decomposing on the ground. Therefore, the number of trees will be declining in the future, and in alignment with our results, the number of birds and bird species may increase. One study concluded logging at Land Between the Lakes, Kentucky and Tennessee, affected forest structure, breeding composition, diversity of some guilds, and densities of priority species decreased 12 years after logging (Augenfeld *et al.* 2008). On the other hand, in another study, research suggests that increases in housing density and associated development such as roads and power lines are accompanied by habitat loss degradation for native species (Pidgeon *et al.* 2007). The AmeriFlux and FASET towers are divided by Bryant Road and power lines following the road and are located near Douglas Lake, Pellston, Michigan with a community of homes on the lakeshore. All of these factors, and development in the future, may drastically reduce the number of trees in the area which may decrease the number of birds and bird species.

Basal Area Relative to Number of Birds and Bird Species

The number of birds and bird species decreased with increase in basal area (size of tree). This disagreed with our hypothesis that the number of birds and bird species would increase linearly with increase in basal area. However, in conjunction with our results of number of birds and bird species decreasing with an increase in number of trees, both of these results go hand in hand. Increasing the number of trees and increasing the basal area (size of tree) decrease the number of birds and bird species in the area. The AmeriFlux and FASET towers plots contain forests with high number of trees and trees with large basal area that can cause birds to spend more energy flying around and through

the trees therefore decreasing their energy. This is a reason for this forest ecosystem having less birds and less bird species. Also, the forest plots sampled at the AmeriFlux and FASET towers are next to Douglas Lake, Pellston, Michigan and would be considered a narrow forested-riparian area. Studies have indicated that the wider the forested-riparian area, the larger the patch and the more likely the forest is to vary in habitat structure (Peak and Thompson 2006). Our habitat sampled may not have a large diversity in habitat structure and tree species compared to a wider-forested riparian area which could support more birds and more bird species diversity.

We concluded at the AmeriFlux and FASET towers there were differences in bird species diversity based on the abundance of vegetation, size of vegetation, and amount of groundcover in these forest ecosystems. We found the number of birds and number of bird species increased with an increase in groundcover. Further, we found the number of birds and bird species decreased with an increase in the number of trees and an increase in basal area (size of tree). These results indicate more bird species prefer habitats with more groundcover but fewer trees and smaller trees, all conditions that can affect bird species diversity in a given forest ecosystem.

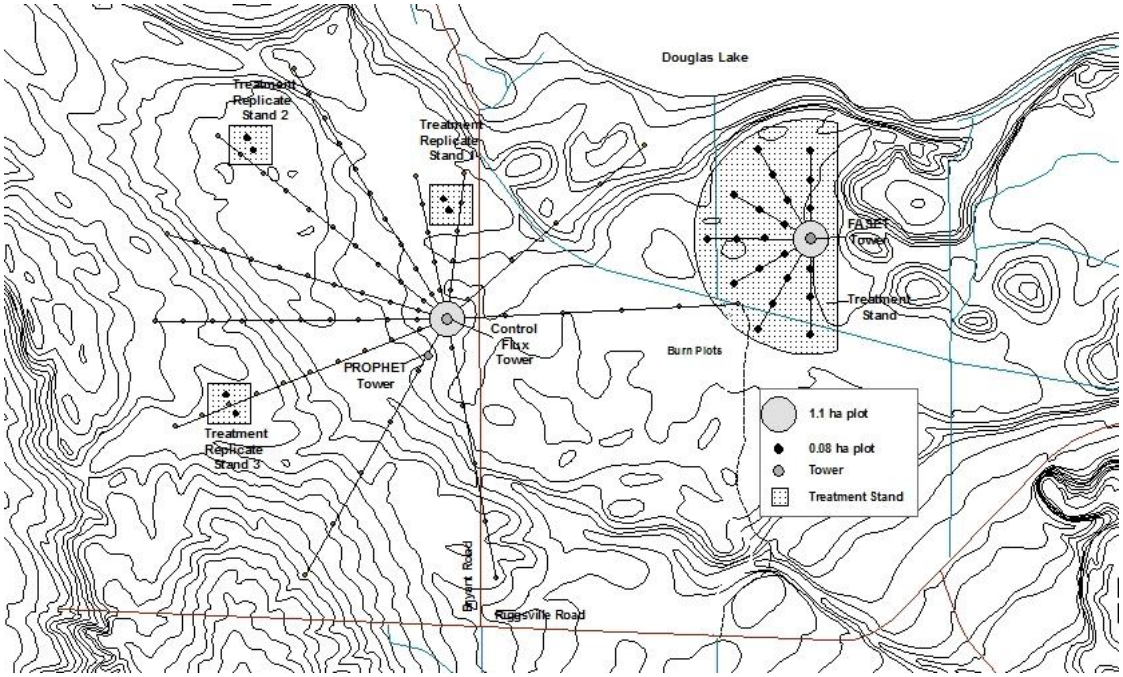

Fig. 1: Diagram of the AMERIFLUX tower (left) and FASET tower (right) on the University of Michigan Biological Station property in Pellston, Michigan.

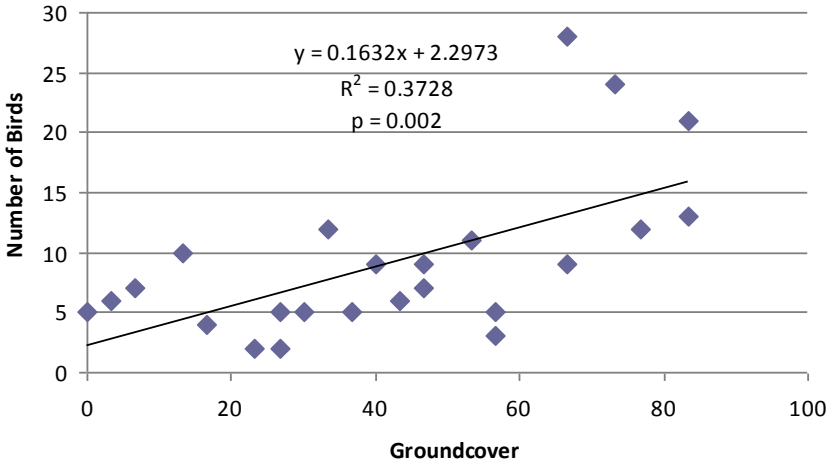

Fig. 2: Regression analyses: Best fit line showing the number of birds increased with an increase in groundcover at the AmeriFlux and FASET towers. Data was collected from July 4, 2008 to August 4, 2008.

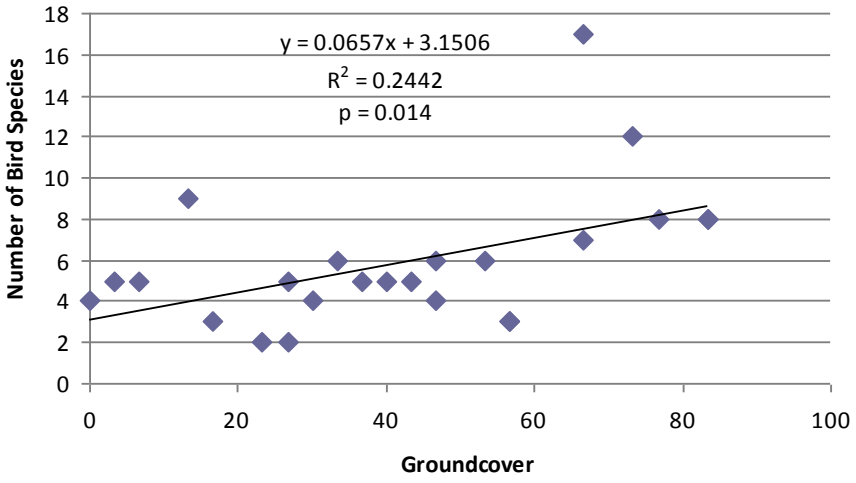

Fig. 3: Regression analyses: Best fit line showing the number of bird species increased with an increase in groundcover at the AmeriFlux and FASET towers. Data was collected from July 4, 2008 to August 4, 2008.

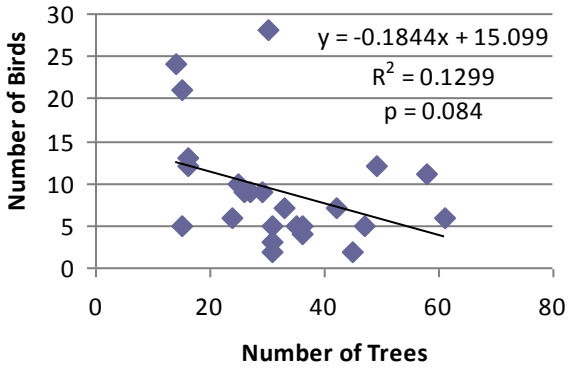

Fig. 4: Regression analyses: Best fit line showing the number of birds decreased with an increase in number of trees at the AmeriFlux and FASET towers. Data was collected from July 4, 2008 to August 4, 2008.

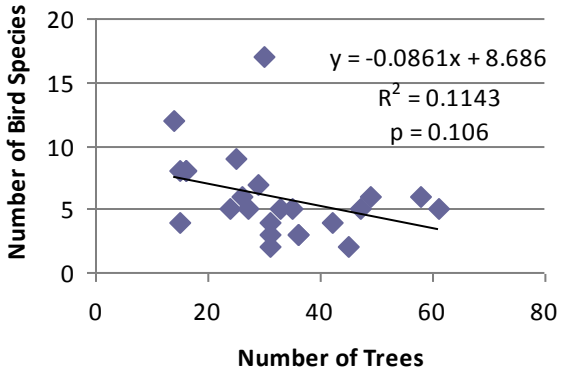

Fig. 5: Regression analyses: Best fit line showing the number of bird species decreased with an increase in number of trees at the AmeriFlux and FASET towers. Data was collected from July 4, 2008 to August 4, 2008.

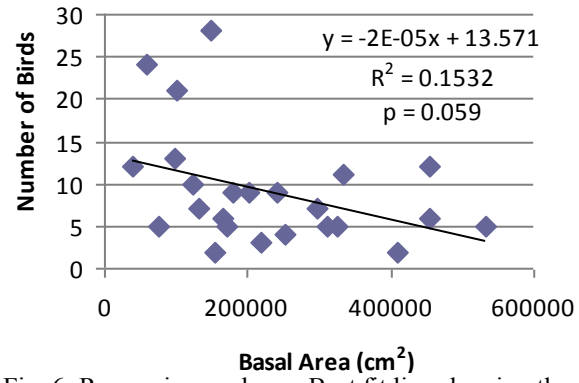

Fig. 6: Regression analyses: Best fit line showing the number of birds decreased with an increase in basal area (cm^2)(the size of the tree) at the AmeriFlux and FASET towers. Data was collected from July 4, 2008 to August 4, 2008.

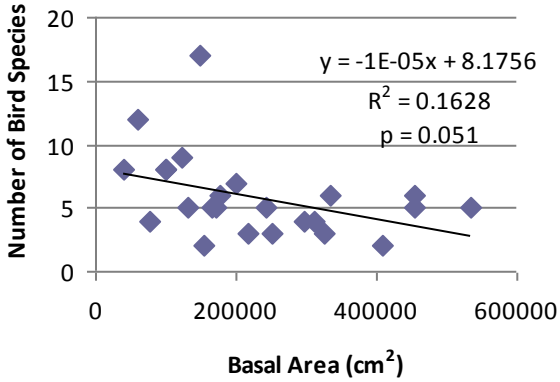

Fig. 7: Regression analyses: Best fit line showing the number of bird species decreased with an increase in basal area (cm^2)(the size of the tree) at the AmeriFlux and FASET towers. Data was collected from July 4, 2008 to August 4, 2008.

LITERATURE CITED

Abrams, M.D. and A.D. Rodewald. 2002. Floristics and avian community structure: implications for regional changes in eastern forest composition. Forest Science 48: 267-272.

Augenfeld, K.H., S.B. Franklin and D.H. Snyder. 2008. Breeding bird communities of upland hardwood forest 12 years after shelterwood logging. Forest Ecology and Management 225: 1271-1282.

Block, W.M. and L.A. Brennan. 1993. The habitat concept in ornithology. Current Ornithology 11: 35-91.

Davis, S.J. 2004. Area sensitivity in grassland passerines: effects of patch size, patch shape, and vegetation structure on bird abundance and occurrence in southern Saskatchewan. The Auk 121: 1130-1145.

Fernandez-Juricic E., M.D. Jimenez and E. Lucas. 2002. Factors affecting intra- and inter-specific variations in the difference between alert distances and flight distances for birds in forested habitats. Canadian Journal of Zoology 80: 1212-1220.

Gabbe, A.P., S.K. Robinson, and J.D. Brawn. 2002. Tree-species preferences of foraging insectivorous birds: implications for floodplain forest restoration. Conservation Biology 16: 462-470.

Goetz, S., D. Steinberg, R. Dubayah and B. Blair. 2007. Laser remote sensing of canopy habitat heterogeneity as a predictor of bird species richness in an eastern temperate forest, USA. Remote Sensing of Environment 108: 254-263.

Lee, P.-Yi and J.T. Rottenberry. 2005. Relationships between bird species and trees species assemblages in forested habitats of eastern North America. Journal of Biogeography 32: 1139-1150.

Peak R.G. and F.R. Thompson 2006. Factors affecting avian species richness and density in riparian areas. Journal of Wildlife Management 70: 173-179.

Pidgeon A.M., V.C. Radeloff, C.H. Flather, C.A. Lepczyk, M.K. Clayton, T.J. Hawbaker and R.B. Hammer 2007. Associations of Forest Bird Species Richness with Housing and Landscape Patterns across the USA. Ecological Applications 17: 1989-2010.

Robichaud I. and M.A. Villard 1999. Do Black-throated Green Warblers prefer conifers? Meso- and microhabitat use in a mixedwood forest. CONDOR 101: 262-271.

Strong A.M. and T.W. Sherry 2000. Habitat-specific effects of food abundance on the condition of ovenbirds wintering in Jamaica. Journal of Animal Ecology 69: 883-895.