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Research paper
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The effects of forest vegetation composition on avian abundance and diversity

ABSTRACT

We investigated the differences in the bird and plant communities between the AmeriFlux[1] tower and FASET[2] tower land plots at the University of Michigan Biological Station in Pellston, MI. We compared various relationships between the bird and vegetation communities located on the two plots including tree size, tree species, ground cover, number of birds, and bird species richness. We conducted an avian point count survey on 16 different transects amung the two plots. We also sampled the vegetation at 23 points along various transects by measuring diameter at breast height (DBH) and estimating the percentage of ground cover. We found that there was a significant relationship between the amount of ground cover and the bird species richness and abundance. There was also a marginally significant relationship between the number of trees and the number of birds. We also discovered that the basal area of the surrounding trees had an effect on the number of birds counted, and the species richness. Additionally, we determined that there was a significant difference in species richness between the two tower plots. In conclusion, we found that there were notable variations in the bird communities at different points along the transects within the two plots, as a result of the differences in vegetation structure.

[1] Forest carbon cycle research program
[2] Forest Accelerated Succession Experiment

INTRODUCTION

A wide variety of bird species depend on forest ecosystems to provide foraging sites, shelter, and breeding territories. The various tree species that make up a specific area of forest provide different environments for birds to forage, nest, and seek shelter (Lee & Rotenberry 2005). The compostion of the tree structure has also been shown to have an effect on the bird community in specific forested areas. Previous studies have shown that greater vegetative diversity and total habitat area also show a positive correlation with the number of species found in an area (Peak & Thompson 2006). Gabbe et al. (2002) demonstrated that foliage height, stem density, and location all have an influence on avian abundance and diversity. As the composition of the forest changes, various species of birds may appear, increase or decrease in abundance, or disappear as the habitat becomes more or less preferred for their needs. This is true not only because of a shift in vegetation but also a shift in the available interspecific avian interactions (Lee & Rotenberry 2005). Many birds have specialized foraging techniques in order to utilize one or two specific tree species. For example, it has been suggested that oak trees may supply more foraging opportunities for insectivorous birds than maples. (Rodewald & Abrams 2002). It has also been shown that many birds acquire territory in addition to the area they use for foraging. Many male birds will obtain supplemental territories in order to live and reproduce (Davis 2004). In addition, Lee and Rotenberry (2005) also showed that the physical structure of vegetation composition in an area has an affect on bird diversity. As has been shown in numerous studies, the vegetation composition of a forest often influences the make up of the avian community there (Block & Brennan 1993; Lee & Rotenberry 2005).

For the purposes of this project we measured forest diversity using four variables: tree species diversity, tree diameter at breast height (DBH), basal area of trees, and the amount of understory vegetation. We hypothesize that (1) bird species richness and bird number increases with tree species diversity, (2) cover has an impact on the number of birds and bird species richness, and that (3) tree size has an effect on the number of birds and bird species richness in the area, both in terms of basal area and DBH.

METHODS

We collected data at the AmeriFlux and FASET tower plots at the University of Michigan Biological Station in Pellston, Michigan (45˚N; 85˚W). These two plots have a similar arrangement. At the center of the circular AmeriFlux plot is the tower and emanating from the tower are nine, 1000 m transects, and two 500 m transects. There are markers placed every 100 m and blue paint on the trees between the markers to help distinguish each transect. The FASET tower site is similar, except the plot is a semicircle and there are seven transects, each 400 m in length.

We collected our data on bird species and abundance by performing point counts. We tried to complete our census before the end of the breeding season; at which point many birds become less active and more difficult to sample. We began sampling just after sunrise, approximately 5:30 – 6:00 am, and continued until roughly 11:00 am, three days a week between 4 July 2008 and 29 July 2008. To sample bird species and abundance, we followed each transect, stopped at markers 200 m apart, observed for 10 minutes, and noted every bird we saw and heard within a 50 m radius, and estimated their distance from us. We sampled every transect at least once, some points were sampled twice, in order to obtain a more accurate sample.

After we completed our bird census we sampled the vegetation at 23 points located throughout the two tower plots; 16 points at the AmeriFlux tower and 7 points at the FASET tower. We assumed that the vegetation did not significantly change from the time we were collecting the bird data to the time we collected the vegetation data. To collect the vegetation data we set up a circle with a radius of 10 m around each marker in which we noted the species and DBH of each tree. Only trees with a diameter greater than 5 cm were sampled as trees. We also sampled the understory, estimating the total cover in three separate, randomly placed 1-m^2 plots throughout the 10 m^2 vegetation circles. We estimated the ground cover and assigned it to one of 10 categories that we created, 0-10%, 10-20%, 20-30%, 30-40%, 40-50%, 50-60%, 60-70%, 70-80%, 80-90%, and 90-100%. Unlike the birds, we only sampled the vegetation once since the vegetation was not variable between visits.

DATA ANALYSIS

We preformed regression analyses to test our hypotheses. We compared the affects of cover on the bird species richness and the number of birds at each site. We also looked at how the number of trees affected the bird species richness and the number of birds at each site. Lastly, we examined how the basal area of the trees had and affect on the bird species richness and the total number of birds at each point. We also graphed the regression analyses to visualize the relationship between dependent and independent variables; using the number of birds, and bird species richness as the dependent variables, and cover, number of trees, and basal area of trees as the independent variables.

RESULTS

Ground Cover

We examined the hypothesis that ground cover has an affect on the number of birds and bird species richness in the two tower plots. Conducting a regression analysis showed a positive correlation between the percentage of ground cover at a point and the number of birds at that same location (R^2=0.373, df=22, p=0.002; Figure 1). Bird species richness also increased positively with an increase in percentage of ground cover (R^2=0.244, df=22, p=0.014; Figure 2).

Number of Trees

We also conducted a test examining the relationship between the number of trees in an area its effect on the bird community at each point. We also conducted a regression analysis for this data and found that the number of trees located at a point has a marginally significant correlation with the number of birds (R^2=0.13, df=22, p=0.084; Figure 3). Also, we found a marginally significant correlation between the number of trees and the bird species richness at each point (R^2=0.114, df=22, p=0.106; Figure 4).

Basal Area of Trees

We examined the hypothesis that the basal area of the trees at each point had an affect on the bird community. We performed a linear regression model and found a negative correlation between the basal area of the surrounding trees and the bird species richness (R^2=0.163, df=22, p=0.051; Figure 5). We also found a marginally significant negative correlation between the basal area and the number of birds at each point (R^2=0.153, df=22, p=0.059; Figure 6).

DISCUSSION

We found many significant correlations between the vegetative and the avian communities at the AmeriFlux tower and the FASET tower plots. Our data show that there is a strong positive correlation between the amount of ground cover at each site and the number of birds and bird species richness. One possible explanation for this correlation is that a significant proportion of our birds were Ovenbirds (*Seiurus aurocapillus*) which are ground nesters (Ehlrich et al. 1988). We noticed as we were conducting the bird census that the points with noticeably more ground cover had more bird species and more birds in general. Another possible explanation for the increased number of birds in areas with a high percentage of ground cover is that ground cover could harbor more insects on which the birds consume.

We also identified a marginally significant negative relationship between the number of trees at each point and the number of birds and bird species richness. There are numerous possibilities as to why there were more birds in a plot with less trees. Perhaps where there are more trees there is also more of a variety and the birds prefer a more homogeneous mixture of trees to make foraging and nesting easier. If a bird specializes its nesting and foraging techniques on a certain type of tree it may tend to be found in an area where that tree is most abundant. We also noticed that in the areas where we were recording less trees, they had much larger DBH measurements; and the areas where we recorded more trees they had smaller DBH measurements. It has been previously shown that bird species diversity increases directly with the foliage height in a forest (MacArthur & MacArthur 1961). Typically, a larger DBH measurement translates into a taller, more usable forest (Sharma & Zhang 2004).

We also found that there was a significant positive relationship between the basal area of trees and the number of birds and number of bird species found there. The basal area is the amount of land that would be covered, in each 10 m^2 diameter circle, by the cross-sectional area at the base of the tree. There are various reasons as to why a higher basal area would support a more diverse and larger bird community. It is possible that the more basal area simply means that there is more tree area available for use, and more stem density; if there is more area to use, more organisms can inhabit the area. A tree with a larger basal area most likely will have more canopy area for birds to utilize than a small tree with a minimal basal area.

Although it was not statistically analyzed, we also discovered that there were fewer bird species located at the FASET tower plot than at the AmeriFlux tower plot. However, there is a simple explanation for this noticeable difference. We began sampling the AmeriFlux tower plot 3 weeks prior to the census at the FASET tower plot. As the summer progresses, many of the bird species end their mating season, and because of this, the males stop singing. Because we were conducting a point count survey, audibility of the bird species was important. By the time we began surveying the FASET site the breeding season was coming to an end, and many of the birds we heard singing in the AmeriFlux tower plot were not audible in the FASET tower plot.

We also tested many other relationships between the number of birds and bird species richness in correlation with various vegetation trends. We compared both independent variables with the number of snags and basal area of snags; however we found no significant relationship between the two. We also found no significant correlation between the number of tree species and the number of birds and bird species. We noticed, that our tree diversity was severely limited, we only had a range of 4 to 8 species of trees in each plot, which could have been an explanation as to why we found no significant relationship.

It has been shown that the influence of the coarse forest measurements such as tree species often only show a significant relationship with bird species diversity on a larger biogeographical scale; on a smaller scale, floristic features tend to be of larger significance to the avian community (Lee & Rotenberry 2005). Because we worked with a limited research area, it may have helped if we had concentrated more on the fine grained aspects of the forest such as ground cover species and height, as opposed to tree species and tree DBH.

The low numbers of individual birds recorded at each point made a univariate analysis difficult. It would have been more helpful to analyze the data using a principal response curve (PRC) which has been used in previous studies to analyze bird communities with relatively low abundance and richness (Hanowski et al. 2005). In addition to above ground vegetation analysis, we also could have recorded data about abiotic factors throughout the two plots; soil moisture and light levels may have had an effect on the bird communities between the two tower plots as previously shown by

Simons et al. (2006). Also, trees with a DBH less than 5 cm were completely disregarded, these trees are a major component of the structure of the understory.

Sampling bias also could have contributed to some of the non-significant results, observer experience varied between the three bird census recorders. Also, estimating distances may have been skewed between various forest sites. Previous studies have shown that there is a reduced detection probability in primary forests, possibly because of the taller, more dense shrub forest layer which could have an affect on the observers ability to hear distant birds clearly (Simons et al. 2006).

We did find that the vegetative construction of the AmeriFlux and FASET tower plots had an affect on the avian communities in each area. However, the correlation was not as strong as we had originally predicted. Ground cover and basal area of the trees had the greatest affect on avian abundance and diversity. We did find that the vegetative structure has an affect on avian abundance and species richness between various habitat structures.

FIGURES AND TABLES

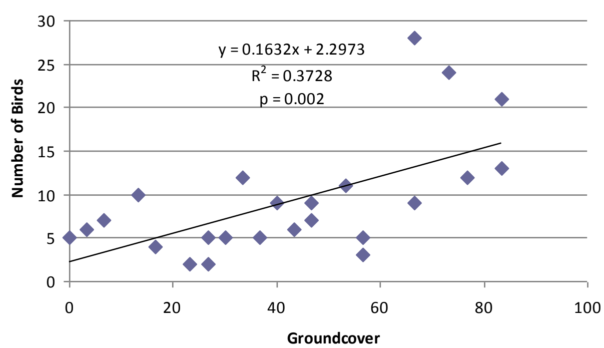

Figure 1. Shows the positive correlation between the percentage of ground cover and the number of birds at each sampled site (p=0.002).

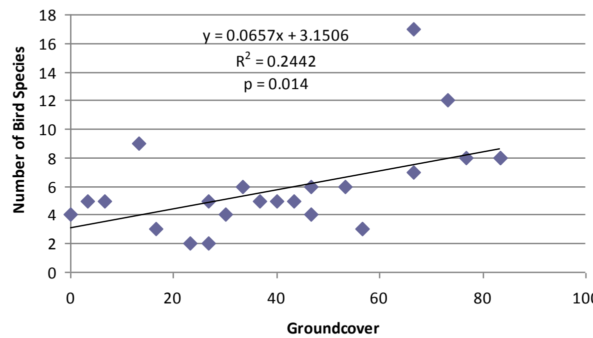

Figure 2. Shows the positive correlation between the number of bird species and the amount of ground cover at each sampled site (p=0.014).

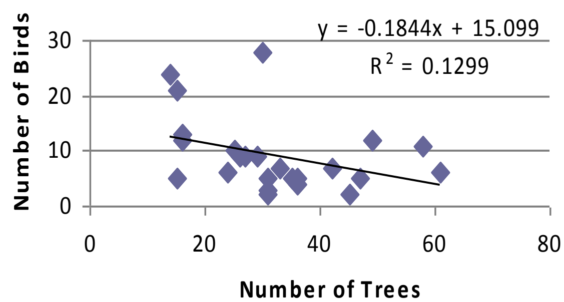

Figure 3. Shows the negative correlation between the percentage of ground cover and the number of bird species at each sampled site. This relationship was marginally significant (p=0.084).

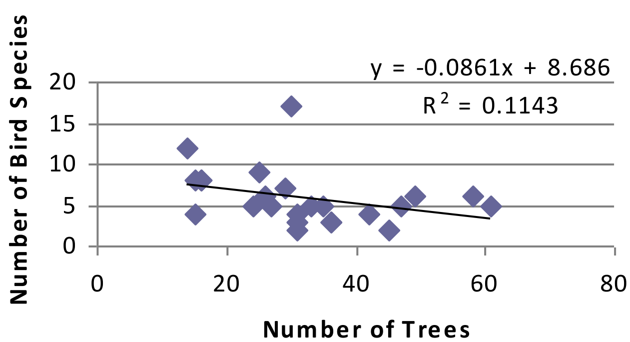

Figure 4. Shows the negative correlation between the number of bird species and number of trees at each sampled point. This relationship was marginally significant (p=0.106).

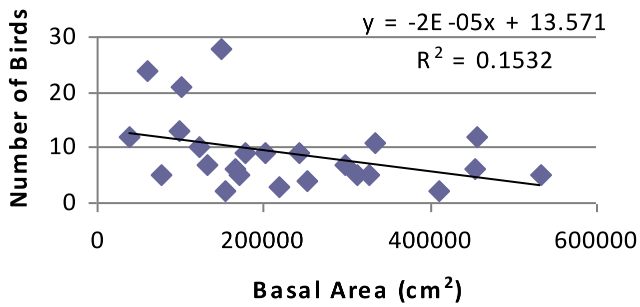

Figure 5. Shows the negative correlation between number of birds and basal area of trees at each sampled point (p=0.051).

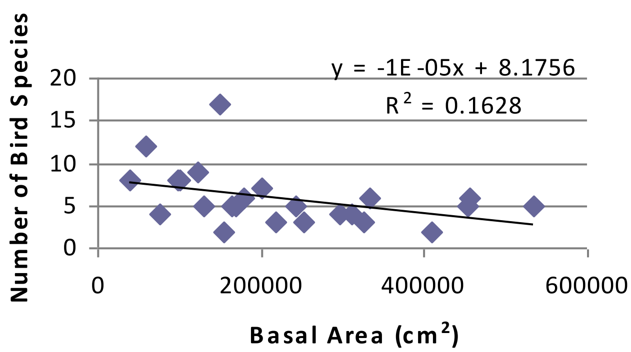

Figure 6. Shows the negative correlation between the number of bird species and the basal area of trees at each sampled site (p=0.059).

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