Effects of Forest Stand Size on Species Diversity and Relative Abundance of Wintering Birds in Delaware County, Indiana

An Honors Thesis (HONORS 499)

by

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Abstract

I investigated the effect of forest stand size on the relative abundance and diversity of wintering birds. Surveys of wintering birds were conducted at three Ball State University woodlots of differing sizes. Species richness and relative abundance of wintering birds were calculated for each woodlot. Species richness was found to be greatest in the largest woodlot, while relative abundance of fifty percent of the species seen was greatest in the smallest woodlot. The greater species richness in the larger woodlot was attributed to the larger area requirements of many species. Birds which require large areas for feeding can not survive in small forest fragments. The greater relative abundance of most species observed in the smaller woodlot was attributed to a number of factors, including easier detection due to woodlot size, presence of birdfeeders, and increased edge habitat in smaller woodlots. Additional studies concerning the effect of forest woodlot size on wintering birds are needed.

Introduction

Much of Indiana's landscape is dominated by farm fields and interspersed with relatively small woodlots. Many studies have suggested that fragmentation of previously continuous forests has had a detrimental effect on bird populations, especially neo-tropical migrants (Ambuel and Temple 1983, Brittingham and Temple 1983, Galli et al. 1976, Whitcomb 1977). Wildlife biologists need to know the effects of fragmentation on birds so they can manage areas for the greatest amount of species. Many biologists have studied the effects of forest fragmentation on summer bird populations (Ambuel and Temple 1983, Forman et al. 1976, Galli et al. 1976, Lynch and Whigham 1984, Whitcomb 1977). Most of these studies found that species richness increased as the size of the forest patch increased. Results from these studies can be explained by the theory of island biogeography. MacArthur and Wilson (1967) established a strong relationship between increasing island size and increasing species richness.

The size of a forest fragment can also have an indirect effect on species richness. The fragmentation of Indiana's once continuous forests has greatly increased the amount of edge habitat in the state. The Brown-headed Cowbird, a brood parasite of many songbirds, is an edge species. The cowbird's numbers rose as eastern forests were logged, creating a patchy environment ideal for cowbirds (Brittingham and Temple 1983). Brown-headed Cowbirds have been documented as having detrimental

effects on songbird populations, especially neo-tropical migrants (Brittingham and Temple 1983).

Although many studies have investigated the effects of fragmentation on summer bird populations, relatively few studies have documented the effects of fragmentation on winter bird populations. The purpose of this study was to determine the effects of forest fragmentation on wintering bird species diversity and relative abundance in Delaware County, Indiana. My study compared the winter (January through March) bird populations of three different sized forest study areas. Species richness and abundance were measured in each study area.

Study Areas

Three forested study areas were selected in Delaware County, Indiana. Christy Woods (22 ha), the smallest study area, was located on the Ball State University campus and was surrounded by an urban environment. Cooper Woods (30 ha) was located 3.2 km west of Muncie and is surrounded by an early succesional meadow and a corn field. The north side of Cooper had a stream running through it (5 m in width). Approximately 15 ha of forest is located on the north side of the stream. Ginn Woods (59 ha) was located 32 km north of Muncie and was surrounded by corn fields on all sides.

Methods

All transects were located 50 m from the edge of the woods to ensure that species within the forest were observed. Due to its narrow width (100 m) only one transect running the length of the woods was established in Christy Woods. Two transects were located in both Cooper and Ginn Woods. Both transects in Cooper and Ginn Woods ran the length of the woods, and the distance between transects was 100 m in Cooper Woods and 150 m in Ginn Woods. Transects were located as far apart as possible to reduce the probability of counting the same bird twice.

Bird surveys were conducted using line transects. Point counts were not used due to the tendency of birds to forage in flocks in winter. By using line transects the chances of sighting a moving flock were increased.

The three study areas were surveyed eight times each. All transects were surveyed once a week, between 20 January 1995 and 26 March 1995. The order in which study areas were sampled was alternated each week. All surveys were conducted between 0800 and 1100 hours. Each week the three study areas were sampled within a three day period.

All Birds heard or seen during a survey were counted. Surveyors walked transects at a slow pace, stopping whenever birds were encountered. Distance of the birds from the transect was not measured. A bird was counted only if it was seen or heard in the woods. Birds flying above the study area canopy

were not counted.

Species richness was determined by counting the number of species seen per effort, an effort being defined as a day in which all transects within a given study area were surveyed. Abundance measurements of birds were determined by calculating the mean number of birds per effort.

Relative abundance estimates of birds in each of the study areas were determined using the following formula, in which X was solved for.

$$\frac{\text{mean number of birds}}{\text{length of transects}} = \frac{X}{300 \text{ m}}$$

Mean number of birds was determined by dividing the total number of birds of a given species seen during the eight week period at a given study area by eight. Length of transect was determined by summing the lengths of all transects in a given study area. The Christy Woods transect was 427 m, two Cooper Woods transects were a total of 532 m, and two Ginn Woods transects were a total of 1287 m. The mean number of birds per 300 meters of transect was determined for each species at each study area.

Results

Species richness was greatest in Ginn Woods. A mean of

7.5 species per effort at Ginn Woods (See Fig. 2) was documented. A mean of 6 species observed per effort was documented at Christy Woods. The lowest species richness was observed in Cooper Woods, where a mean of 5 species seen per effort was observed.

The most frequently observed species (abundance greater than 0.40 birds per 300 m) found in Christy Woods were Carolina Chickadees, Tufted Titmice, Downey Woodpeckers, Red-bellied Woodpeckers, Mourning Doves, and Northern Cardinals (Fig. 1). The most frequently observed species in Cooper Woods were Carolina Chickadees, Blue Jays, White-breasted Nuthatches, Downey Woodpeckers, Red-bellied Woodpeckers, and Northern Cardinals. The most frequently observed species in Ginn Woods were Carolina Chickadees, Tufted Titmice, Downey Woodpeckers, Red-bellied Woodpeckers, White-breasted Nuthatches, Northern Cardinals, and Blue Jays.

The highest relative abundances of Carolina Chickadees, Tufted Titmice, Northern Cardinals, and White-breasted Nuthatches were observed in Christy Woods (See Table 1). The relative abundance of Blue Jays was highest in Cooper Woods, and no Blue Jays were detected in Christy Woods. The highest relative abundance of Red-bellied Woodpeckers was observed in Ginn Woods, and lowest in Christy Woods.

Eight species were encountered in Ginn Woods that were not observed in the other study areas, including Pileated Woodpeckers, Red-tailed Hawks, Barred Owls, Wood Ducks, Canada Geese, Great Blue Herons, Common Grackles, and American Crows. Pileated Woodpeckers were observed on five separate efforts,

and Red-tailed Hawks were observed on two separate efforts in Ginn Woods. Other species sighted only in Ginn Woods were observed once each.

Four species were observed only in either Christy or Cooper Woods. A pair of Mallards and an Eastern Bluebird were spotted in Cooper Woods only, and an Eastern Phoebe and three American Robins were sighted only in Christy Woods. These species were observed on only one occasion each.

Discussion

Species richness was greatest in Ginn Woods, the largest study area, while the largest relative abundance estimates were observed in Christy Woods, the smallest study area. However, there is a great deal of overlap in number of species seen per effort between the three study areas (Fig. 2). Forman et al. (1976) also found greater species richness in larger study areas and greater abundance of more common species in smaller study areas in New Jersey. The authors suggested that the greater species richness was due to the space requirements of certain species, although they warn that there probably was no single mechanism for explaining greater species richness. Birds which require more space for feeding could not survive without a minimum area requirement. This could explain the occurrence of Pileated Woodpeckers and Barred Owls in only Ginn Woods, the largest of the study areas. The size of Ginn Woods could also explain the greater abundance of Red-bellied Woodpeckers

found there. Other species observed only in Ginn Woods such as Wood Ducks, Canada Geese and a Great Blue Heron can be better explained by Ginn Woods' poor drainage than by its size.

Though size requirements can explain the greater number of species observed in Ginn Woods, it can not explain the higher abundance of White-breasted Nuthatches in Christy Woods. Galli et al. (1976) argued that species such as the White-breasted Nuthatch should be more abundant in larger stands, because larger stands should contain more standing dead snags, thus holding more possible nesting sites. However, it is possible that Christy Woods could hold more dead snags if it was older than Ginn Woods. Lynch and Whigham (1984) argue that vegetation characteristics of a forest fragment are more important than forest size for certain species. Christy Woods could hold more nesting sites than Ginn Woods, explaining the higher abundance.

Ambuel and Temple (1983) found the abundance of edge and farmland bird species to increase as forest area decreased. This may explain the higher abundance of edge species in Christy Woods. Christy Woods was the smallest study area, measuring 8 ha less than Cooper Woods and 37 ha less than Ginn Woods.

The dimensions of Christy Woods can also explain the higher abundance of edge species in Christy Woods. Because of its small width (approximately 100 m x 427 m) the interior of Christy Woods is closer to the edge than the interiors of the other study areas, thus Christy Woods can be considered better edge habitat. Cooper and Ginn Woods are much wider, measuring 200 m x 532 m and 250 m x 643 m respectively.

Not only could the dimensions of Christy Woods result in edge habitat, but the dimensions and location of Christy Woods could also have made birds easier to detect. The narrow width of Christy Woods allows most of the birds in the woods to be detected. Cooper and Ginn Woods are much wider, thus transects at Cooper and Ginn Woods, while covering the entire length of each woods, could not cover the entire width. In addition, the presence of three bird feeders in Christy Woods and several feeders in the surrounding neighborhood could have made birds easier to detect, although the feeders were at least 60 m from the transect.

Cooper Woods contained a lower relative abundance of eleven species, yet was very similar in size to Christy Woods (a difference of only 8 ha). Cooper Woods was surrounded on one side by a meadow in an early stage of succession, containing many small trees and shrubs interspersed with patches of grass. If the meadow provided better habitat or more food, then birds would be expected to spend more time in the meadow than nearby Cooper Woods, perhaps explaining the lower abundance. The greater abundance of eleven species at Christy Woods could also be explained by the presence of three bird feeders in the woods, and the presence of feeders in surrounding neighborhoods. Finally, the narrow width of Christy Woods could have made it easier to detect birds, resulting in a large relative abundance estimate.

Conclusion

Forest stand size affects species richness (Forman et al. 1976, Galli et al. 1976). Species richness was greater in Ginn Woods, the largest study area, and the relative abundance of edge species was greatest in Christy Woods, the smallest study area. The results of this study are applicable throughout many areas of Indiana. The results of this study suggest that the sizes of remnant forest woodlots in Indiana should be enlarged to manage for the greatest number species. However, remnant forest woodlots should by further fragmented if edge species are to be managed for.

However, study area size is not the only factor affecting species abundance and richness. Further study of Christy, Cooper, and Ginn Woods is needed using larger sample sizes and analyzing vegetation characteristics to determine if differences in species richness and relative abundance were due to forest characteristics other than study area size. Considering the lack of research in this area, studies using larger sample sizes could further determine the effects of forest stand size on wintering birds.

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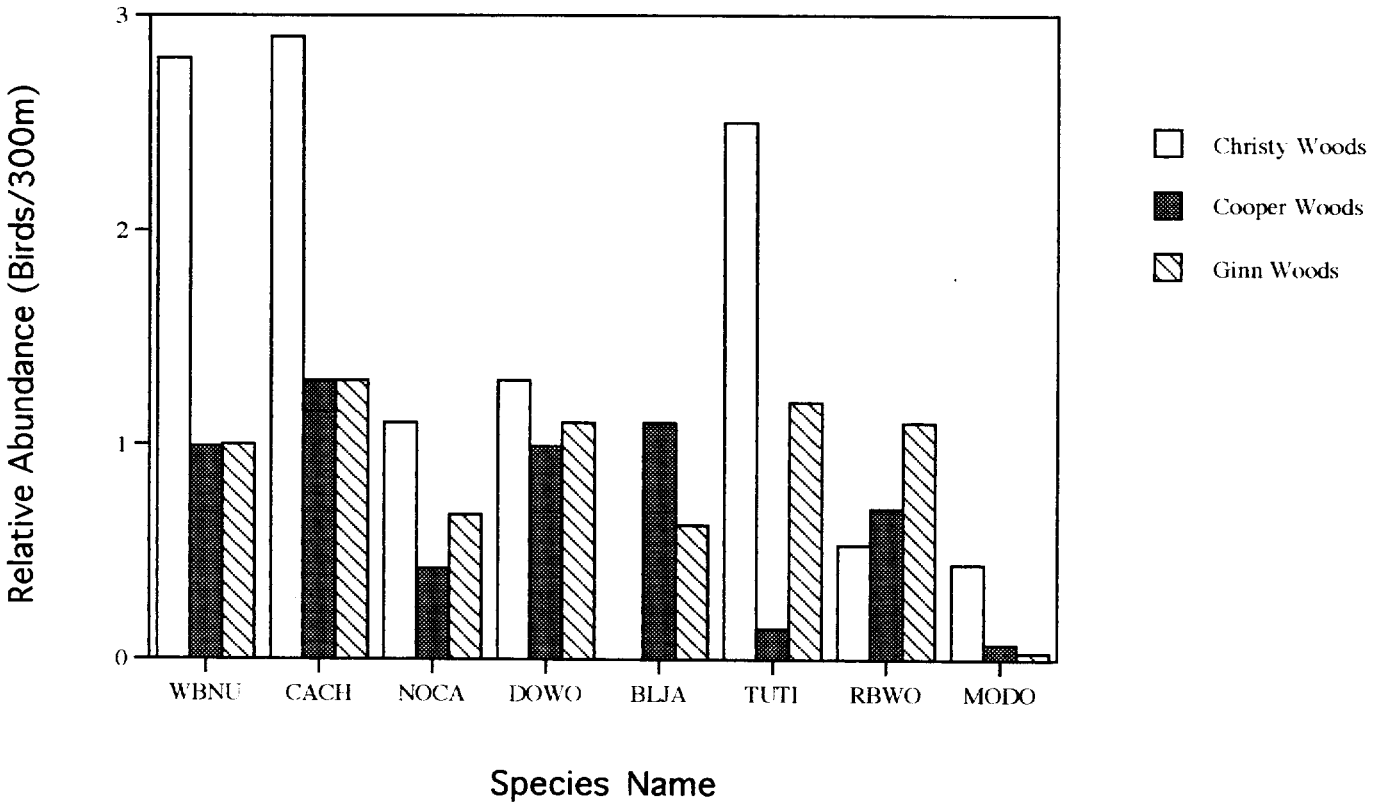
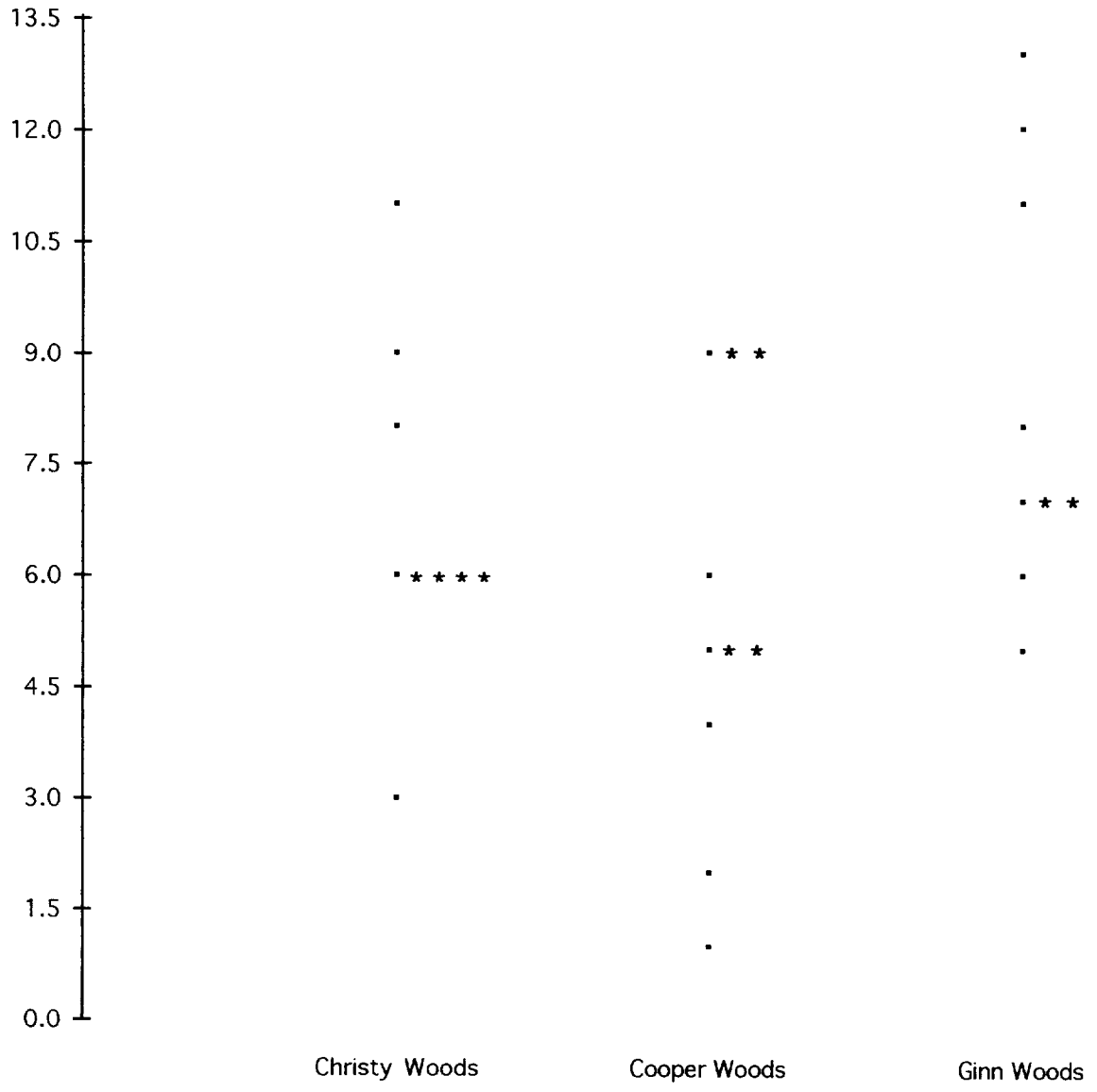
Figure 1.
Relative abundance estimates of selected bird species in three study areas in Delaware County, Indiana between 20 January and 26 March 1995.



WBNU: White-breasted Nuthatch
CACH: Carolina Chickadee
NOCA: Northern Cardinal
DOWO: Downey Woodpecker
BLJA: Blue Jay
TUTI: Tufted Titmouse
RBWO: Red-bellied Woodpecker
MODO: Mourning Dove

Figure 2.
The number of species seen per effort at three study areas in Delaware County, Indiana between 20 January and 26 March 1995.



** = This number of species was observed during two different efforts.

**** = This number of species was observed during four different efforts.

Appendix of Scientific Names

Common Name	Scientific Name
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Carduelis pinus*
American Robin	*Turdus migratorius*
Barred Owl	*Strix varia*
Blue Jay	*Cyanocitta cristata*
Brown Creeper	*Certhia familiaris*
Brown-Headed Cowbird	*Molothrus ater*
Canada Goose	*Branta canadensis*
Carolina Chickadee	*Parus carolinensis*
Common Flicker	*Colaptes auratus*
Common Grackle	*Quiscalus quicula*
Dark-eyed Junco	*Junco hyemalis*
Downey Woodpecker	*Picoides pubescens*
Eastern Bluebird	*Sialia sialis*
European Starling	*Sturnus vulgaris*
Great Blue Heron	*Ardea herodias*
Hairy Woodpecker	*Picoides villosus*
Mallard	*Anas platyrhynchos*
Mourning Dove	*Zenaida macroura*
Northern Cardinal	*Cardinalis cardinalis*
Pileated Woodpecker	*Dryocopus pileatus*
Eastern Phoebe	*Sayornis phoebe*
Red-bellied Woodpecker	*Melanerpes carolinus*
Red-tailed Hawk	*Buteo jamaicensis*
Tufted Titmouse	*Parus bicolor*
White-breasted Nuthatch	*Sitta canadensis*
Wood Duck	*Aix sponsa*
Yellow-bellied Sapsucker	*Sphyrapicus varius*