

1-1-1992

# Effects Of Forest Fragmentation On Neotropical Migrant Landbirds In East-Central Illinois

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EFFECTS OF FOREST FRAGMENTATION  
ON NEOTROPICAL MIGRANT LANDBIRDS  
IN EAST - CENTRAL ILLINOIS

LINDER

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Effects of Forest Fragmentation on Neotropical

Migrant Landbirds in East-central Illinois

(TITLE)

BY

Eric Thomas Linder

**THESIS**

**SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF**

Master of Science

**IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY  
CHARLESTON, ILLINOIS**

1992

YEAR

**I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING  
THIS PART OF THE GRADUATE DEGREE CITED ABOVE**

24 January 1992  
DATE

Eric K. Solley  
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24 January 1992  
DATE

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## TABLE OF CONTENTS

	<u>Page</u>
Table of Contents	i
Abstract	ii
Acknowledgements	iv
General Introduction	1
Chapter I	4
Introduction	4
Methods	6
Results	8
Discussion	9
Chapter II	15
Introduction	15
Methods	15
Results	17
Discussion	20
Chapter III	25
Introduction	25
Methods	25
Results	26
Discussion	33
Literature Cited	37
Appendix	46

## ABSTRACT

Neotropical migrant landbird populations continue to decline in eastern North America. Explanations for this decline include loss of both wintering and breeding habitats. Populations breeding within fragmented forests and species which are considered area-sensitive have been most severely affected. Although breeding habitat is available, much of it lies within fragmented forests where reproductive success is generally lower than in large contiguous forests. I studied various aspects of the breeding ecology of neotropical migrants in a 70-ha forest fragment in east-central Illinois during the spring and summer of 1991.

I examined some aspects of territory habitat selection by the Ovenbird (Seiurus aurocapillus). There were no statistical differences between areas of the forest that were utilized by Ovenbirds and those areas that were not used with respect to ground cover, canopy coverage, density of shrubs, or abundance of trees of various sizes. However, all eight Ovenbird territories were at least 150 m from the forest edge despite the lack of habitat differences. Only 21% of the woodlot area was  $\geq 150$  m from an edge. Two possible explanations for the apparent preference of the interior by Ovenbirds are the lower rates of brood parasitism and nest predation experienced there compared with birds that nest near the edge. Experiments with artificial ground nests showed significantly higher levels of predation among nests located near the

forest/field edge compared with nests located in the forest interior. In addition, domed nests (similar to those built by Ovenbirds) displayed higher survivorship than open-cup nests (the type constructed by most species of neotropical migrants).

The reproductive success of the avian community was estimated by comparing the ratio of adults to juveniles for neotropical migrants in 1991 with ratios provided by Robinson (1988) in 1985-86. Reproductive success appeared to have been markedly higher in 1991 when the adult:juvenile ratio was 1:1, than in 1985-86, when this ratio was greater than 7:1. Possible explanations for the improved reproductive success include the lower number of brood-parasitic Brown-headed Cowbirds (Molothrus ater) (3% of all captured in 1991 versus 11% in 1985-86) and avian nest predators, such as American Crows (Corvus brachyrhynchos) and Blue Jays (Cyanocitta cristata), found in the study area, lower interspecific and intraspecific competition for breeding habitat, or a combination of these factors. However, despite the apparently high reproductive success for neotropical migrants in 1991, their representation in the avian community has decreased significantly since 1985-86 in this forest fragment. Further studies need to focus on the long-term population trends of the avian community and the rates of predation and brood parasitism that occur within fragmented forests.

## ACKNOWLEDGMENTS

I would like to thank the Council for Faculty Research at Eastern Illinois University and the Champaign County Audobon Society for funding this research project. I would also like to thank the U. S. Army Corps of Engineers at Lake Shelbyville for allowing me access to the forests adjacent to Lake Shelbyville. Dr. Scott Robinson generously provided me with his unpublished data on the avifauna of the Boot and showed me his former study sites. I would also like to thank my committee members, Dr. Edward Moll, Dr. Clay Pierce, and extra thanks to Dr. Kipp Kruse whose statistical knowledge proved valuable, if not always significant. Figure preparation was done with the assistance of Dr. Charles Costa. Dr. John Ebingers' field knowledge of the local flora was useful (and needed). I am indebted to Yen-min Kuo and Roger Jansen for their extensive, and often exhaustive, field assistance throughout the summer. Hartke Gamefarm was kind enough to donate hundreds of quail eggs used in the study. Finally, I would like to thank my advisor, Dr. Eric Bollinger, not only for his aid throughout the entire project, but also for his encouragement and support.

This paper is dedicated to Tom and Margo Linder who have provided considerable support through the years. In addition, I would also like to thank Loren Woolson for introducing me to the world of birds.



## GENERAL INTRODUCTION

Many studies have documented the detrimental effects of forest fragmentation on the abundance and distribution of certain groups of birds breeding in North America (Robbins 1980, Whitcomb et al. 1981, Askins and Philbrick 1987, Robinson 1988, Robbins et al. 1989b). In particular, species that migrate to the Neotropics in the winter (often referred to as neotropical migrants) have been adversely affected. Many species of neotropical migrants nest primarily or exclusively in the interior of forested areas. These species are frequently absent from small forest fragments and are often considered "area-sensitive" (Askins et al. 1990, Robbins et al. 1989a). They continue to decline at rates greater than other neotropical migrants despite apparent increases in suitable habitat in some areas (Freemark and Merriam 1986). Long-term studies of fragmented forests in eastern North America have consistently documented the demise of neotropical migrants in these habitats (Terborgh 1989, Askins et al. 1990).

The two primary explanations for the decline of neotropical migrants are loss of suitable habitat on the wintering grounds and lower reproductive success on the breeding grounds (Terborgh 1989). This thesis focuses only on effects occurring on the breeding grounds. There are several characteristics of forest fragments which may limit reproductive success and lower species richness for "forest-interior" birds. First, small forests may exhibit inadequate food resources in the form of lowered insect

diversity and abundance (Faeth and Kane 1978), thus supporting lower densities and diversities of breeding birds which are primarily insectivorous. Second, island biogeography theory predicts lower immigration rates and also higher extinction rates for small, isolated woodlots compared to contiguous forests (MacArthur and Wilson 1967). Third, habitat heterogeneity is generally greater in larger forests allowing for habitat specialists to occur (Freemark and Merriam 1986). Conversely, smaller woodlots are more likely to lack the specific microhabitats that specialists require (Karr 1982). Thus, in smaller forests where habitat heterogeneity is low, generalists tend to occur at a disproportionately high rate compared to specialists (Blake 1983, Wilcove et al. 1986). Finally, increased levels of both brood parasitism by Brown-headed Cowbirds (Molothrus ater) and nest predation are found in smaller forests (Gates and Gysel 1978, Chasko and Gates 1982, Brittingham and Temple 1983, Wilcove 1985) due to a relative increase in edge and decrease in average distance from the forest interior to the ecotone. Mammalian predators, such as Eastern Chipmunk (Tamias striatus), Red Fox (Vulpes vulpes), Gray Fox (Urocyon cinereoargenteus), Raccoon (Procyon lotor), Opossum (Didelphis virginiana), Striped Skunk (Mephitis mephitis), feral house cats (Felis catus), and Domestic Dogs (Canis familiaris) frequently use the ecotone as a travel lane which results in increased levels of nest predation near habitat edges (Bider 1968, Chasko and Gates 1982). Avian predators, such as American

Crows (Corvus brachyrhynchos) and Blue Jays (Cyanocitta cristata), are more numerous along the ecotone as well (Johnston 1960, Norman and Robertson 1975, Gates and Gysel 1978, Brittingham and Temple 1983). Brown-headed Cowbirds parasitize nests near the edge at a disproportionately high rate compared with nests in the forest interior (Brittingham and Temple 1983, Robinson 1988, Robinson 1992). Thus, parasitism and predation levels tend to be higher and overall nest success lower in small forest fragments.

This thesis examines some of the effects of fragmentation on neotropical migrant landbirds in a 70-ha fragmented forest in east-central Illinois. It is organized into three chapters; the first examines some aspects of habitat selection by one area-sensitive species of neotropical migrant, the Ovenbird (Seiurus aurocapillus). The second chapter examines both the effects of distance from a forest/field ecotone and nest-type on predation of artificial ground nests. In the final chapter, estimates of the reproductive success, based on results from mist-netting, of birds breeding in the same forest fragment in 1991 are compared with data collected in 1985-86.

## **Chapter I: Analysis of Ovenbird (Seiurus aurocapillus)**

### **Territory Selection in east-central Illinois**

#### **INTRODUCTION**

The Ovenbird (Seiurus aurocapillus) is typically found in larger forest tracts and is uncommon or absent in smaller, isolated woodlots (Blake and Karr 1984). This species is usually considered an "area-sensitive" species (Robbins 1980, Robinson 1988) which breeds in the forest interior of mature woodlots in eastern North America. Despite apparent increases in favorable habitat for the Ovenbird in some regions in eastern North America, abundance of this species declined between 1953 and 1985 (Askins and Philbrick 1987). This chapter examines some aspects of territorial habitat selection by Ovenbirds in a fragmented forest.

#### **STUDY AREA**

This study was conducted in a 70-ha forest fragment adjacent to the east shore of Lake Shelbyville in Shelby County, Illinois (39°N 88°W) during the spring and summer of 1991 (Fig. 1). This is the largest forest fragment bordering the lake and is often referred to as the "Boot" (see also Robinson 1992). Dominant vegetation types consisted of a mixture of mature oak/hickory forest and old pastures undergoing succession bordered on the east side by agricultural fields (soybean and corn) and on the west side by the lake. The forest is transected by numerous steep ravines. The forest has been selectively logged as

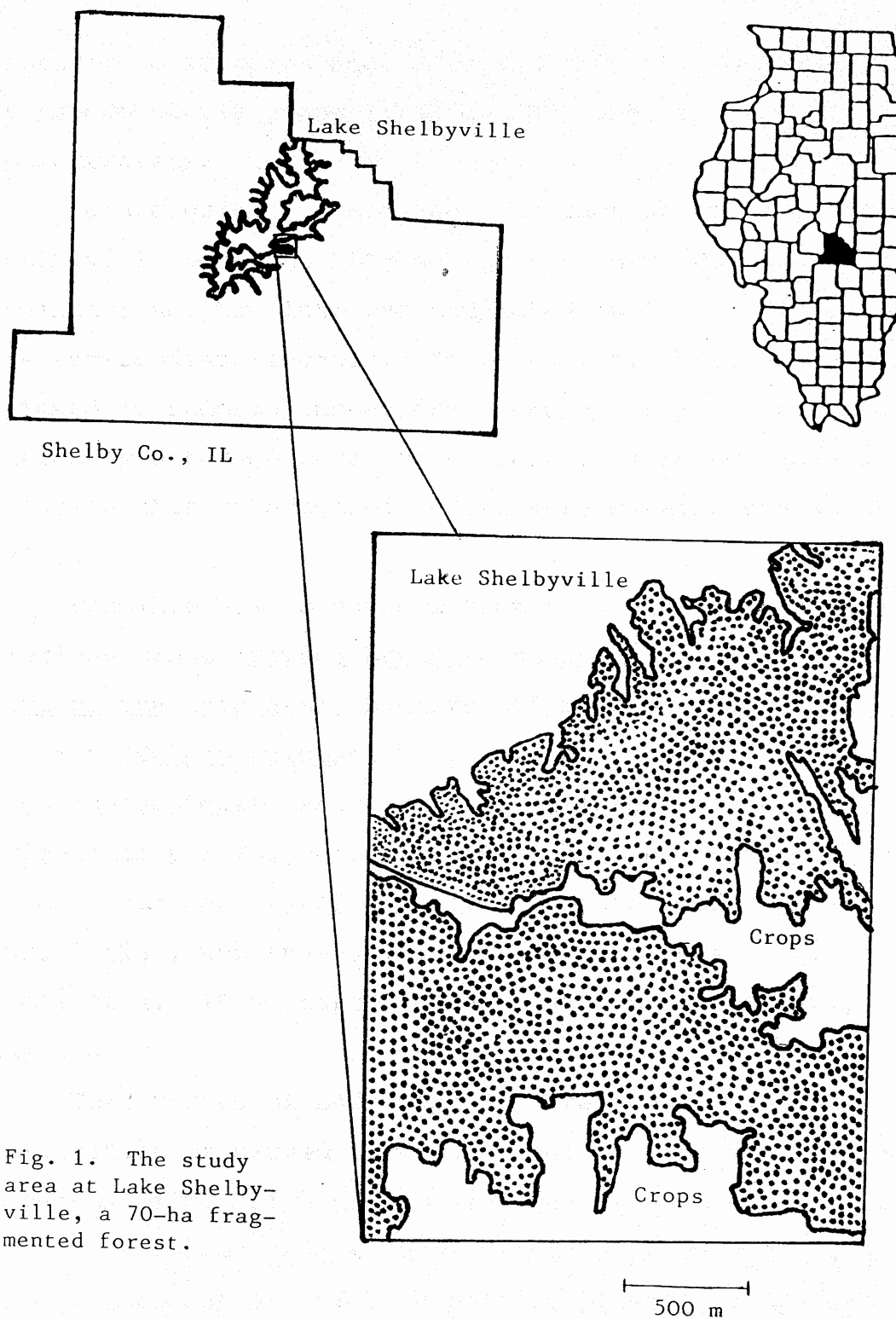


Fig. 1. The study area at Lake Shelbyville, a 70-ha fragmented forest.

recently as 30 years ago. Consequently, the stand consists of predominantly young (< 30 cm DBH) oak, maple, and hickory trees.

Land acquisition for the construction of Lake Shelbyville began in 1960 by the U.S. Army Corps of Engineers and the lake was completed in 1970. Since 1960 the surrounding floodplain has been left undisturbed and allowed to undergo succession. The habitat in this area is extremely heterogeneous and currently is being managed to maintain this heterogeneity (for more details see Robinson 1992).

Possible nest predators that occur in the Boot include American Crows (Corvus brachyrhynchos), Blue Jays (Cyanocitta cristata), Eastern Chipmunk (Tamias striatus), Red Fox (Vulpes vulpes), Gray Fox (Urocyon cinereoargenteus), Raccoon (Procyon lotor), Opossum (Didelphis virginiana), Striped Skunk (Mephitis mephitis), feral house cats (Felis catus), Domestic Dogs (Canis familiaris), and snakes (Liberg 1984, Wilcove et al. 1986, Soulé et al. 1988, Langen et al. 1991, pers. observ.).

#### METHODS

Territories of male Ovenbirds were determined by observation of marked birds and their responses to tape playback of Ovenbird song during the breeding season of 1991. Ovenbirds caught in mist-nets were marked with unique combinations of both colored plastic leg bands and U. S. Fish and Wildlife Service aluminum bands. In addition, tails were painted with a unique combination of

red, yellow, blue, and white stripes.

To determine if Ovenbirds were preferentially selecting locations in the interior of the forest, I compared the frequency with which territory centers were located  $> 150$  m from either the agricultural edge or lake edge with that expected by chance. Using an aerial photograph of the Boot and a computer digitizer, the areas both greater than and less than 150 m from these edges were calculated.

To determine if differences existed in the vegetational composition between territories and non-territorial area, I used a slight modification of James and Shugart's (1970) sampling methods. Straight-line transects from the nearest agriculture field edge to the lake edge which bisected each territory were determined. Two 0.04-ha circular plots, one on each side of the transect, were sampled at the following four locations: 15 m and 75 m from the agricultural field edge, within the territory, and 15 m from the lake edge. Sample sites within a territory were determined by random selection of compass coordinates and distance from the center of the territory. Within each circular plot the following data were recorded: % canopy coverage, % ground coverage of green vegetation, slope, species and number of shrubs ( $< 7.5$  cm (DBH) and  $> 40$  cm height) and trees (three size classes: DBH 7.5 - 15.2 cm, DBH 15.3 - 22.9 cm, and DBH  $> 22.9$  cm). These habitat components are thought to be structural cues used by Ovenbirds in territory selection (Dawson 1984, Smith and

Shugart 1987). Shrubs were counted and identified along two perpendicular transects (N to S and W to E) nested within the circle (James and Shugart 1970). Each tree that was within (totally or partially) each 0.04-ha plot was identified and its DBH was recorded. I determined canopy and ground coverage using an ocular tube (James and Shugart 1970). Twenty point-samples were taken for both canopy and ground coverage in each sample plot. Slope was estimated visually.

For all statistical analyses, a mean for each habitat variable was calculated for each pair of samples at each location. A randomized complete-block, one-way ANOVA was used to compare these means among the four locations (15 m, 75 m, within the territory, and 15 m from the lake) for the five habitat components: % canopy coverage, % ground coverage, slope, tree abundance, and shrub density. The data were blocked by transects. When data were expressed as a percent, an arc-sine transformation was performed before statistical analyses were computed (Scheffler 1979).

## RESULTS

Eight Ovenbird territories were mapped in the Boot in 1991. All were located at least 150 m from any edge despite the fact that the interior ( $\geq 150$  m) comprised only 21% of the forest area. This is unlikely to have occurred by chance as only 1-2 ( $0.21 \times 8 = 1.7$ ) territories would be expected to be found in the interior if territories were located randomly within the woodlot. Vegetational analyses indicated essentially no differences between Ovenbird



territories and non-territorial habitats located at 15 m and 75 m from the forest/field ecotone and 15 m from the lake edge (Table 1). For example, there were no significant differences among the four locations sampled for any of the three size classes of trees (Table 1). Furthermore, the number of shrubs found in the four areas did not differ significantly. Canopy coverage was also similar at my sample locations along the transects (Table 1). Similarly, ground coverage by green foliage did not differ among the four areas selected (Table 1). There was, however, a decreasing trend in ground coverage as distance from the edge increased. The amount of leaf litter was inversely proportional to the amount of ground coverage by green foliage. The only statistically significant difference found among the four areas occurred with respect to slope. Slope was significantly greater near the lake compared to the other three locations sampled, which were statistically indistinguishable from one another (Tukey's pairwise comparison test,  $p > 0.05$ ).

#### DISCUSSION

Ovenbirds appear to select interior areas ( $> 150$  m from the edge) of this woodlot for territory establishment due primarily to their distance from the edge rather than any differences in habitat composition. All eight Ovenbird territories were found in the interior despite the overall lack of differences in vegetational composition between occupied areas in the interior and unoccupied areas closer to the edge.

Table 1. Habitat characteristics of selected locations within a 70-ha forest fragment adjacent to Lake Shelbyville, IL (the Boot). Data are from 0.04-ha circular plots (James and Shugart, 1970) taken within eight ovenbird territories, 15 m and 75 m from the agricultural field edge, and 15 m from the lake edge (Lake). Mean is above the standard error and the range is in parenthesis.

Territory	15 m	75 m	Lake	F	P
% Canopy Coverage					
81.56 2.41 (70-90)	78.75 4.56 (58-93)	79.69 3.32 (70-100)	84.06 2.36 (70-90)	0.49	0.6944 <sup>a</sup>
% Ground Coverage					
21.25 4.01 (16-38)	38.13 3.46 (32-46)	29.38 5.32 (21-49)	37.50 10.65 (16-74)	1.33	0.2912 <sup>a</sup>
Slope Aspect Ratio					
1.82 1.35 (0-11)	5.00 3.69 (0-30)	10.94 4.49 (0-33)	24.69 6.71 (0-45)	4.20	0.0170 <sup>a</sup>
Shrub Density					
33.06 3.60 (17-44)	39.25 2.38 (27-48)	34.31 4.24 (16-46)	33.81 3.61 (26-57)	0.49	0.0694
Large Trees (DBH >22.9 cm)					
3.50 0.91 (0-7)	3.75 1.00 (1-9)	4.75 0.90 (1-8)	3.00 0.57 (0-7)	0.72	0.5515
Medium Trees (DBH 15.3 - 22.9 cm)					
1.88 0.48 (0-4)	4.13 0.95 (1-8)	2.38 0.71 (1-7)	2.13 0.67 (0-6)	1.85	0.1688

Table 1., continued.

Territory	15 m	75 m	Lake	F	P
Small Trees (DBH 7.5 - 15.2 cm)					
4.13	8.00	4.88	5.63	2.01	0.1431
1.13	1.34	1.08	0.86		
(1-10)	(3-14)	(1-9)	(2-9)		

<sup>a</sup> Statistical tests performed using arc-sine transformation

Selection of the forest interior may be attributed to the fact that birds which nest near or in edge habitat often experience decreased reproductive success. One cause of lower reproductive success may be that large number of nest predators are found near forest edges (Gates and Gysel 1978, Wilcove 1985, Yahner and Cypher 1987, Yahner and Scott 1988). Robinson (1988) calculated that over the entire nesting cycle (approximately 25 days), open cup nests in the Boot would suffer at least 80% mortality from predation. In addition to increased predation, brood parasitism rates by Brown-headed Cowbirds (Molothrus ater) are usually higher near forest edges than they are in the forest interior (Mayfield 1977, Chasko and Gates 1982, Brittingham and Temple 1983). However, whereas some species of birds that typically nest on the edge have evolved defenses to combat Brown-headed Cowbirds (e.g., rejection of parasitic egg), most "forest-interior" birds do not have the behavioral defenses to do so and are consequently very susceptible hosts (Mayfield 1965, Rothstein 1975).

The interior of forest fragments may closely resemble the extensive forest tracts in which Ovenbirds presumably bred in the past. Loss of suitable breeding habitat or the saturation of the highest quality habitat may have forced Ovenbirds to select areas which may otherwise be deemed undesirable.

In addition, habitat variability may account for territory selection in Ovenbirds (Dawson 1984, Smith and

Shugart 1987). In an attempt to determine if structural habitat characteristics are the proximate factor determining Ovenbird territory size, Smith and Shugart (1987) found that habitat selection is correlated with prey abundance. They determined that habitat structure accounted for 73% of the variation in prey abundance in territories. Thus, variation in habitat structure may be the principle component in Ovenbird territory selection. My findings are inconsistent with other results of Smith and Shugart (1987) who found Ovenbird territories had more trees in all three size classes and a higher percentage of canopy coverage than were found in unoccupied areas. I found no significant differences between Ovenbird territories and the unoccupied areas that are located closer to the edges with respect to tree abundance. Additionally, Smith and Shugart (1987) found that territories contained significantly less ground coverage by green foliage and lower shrub density than unoccupied areas. I did not detect significant differences in these variables suggesting that at least much of the area nearer the edge was suitable habitat for Ovenbirds with respect to vegetation structure.

My results are consistent with those of Wales (1972) and Ranney et al. (1977) who found that major vegetational changes caused by the edge typically extend only 10-30 m inside the forest. Similarly Ambuel and Temple (1982) found "no area-related changes in vegetation structure and composition" in woodlots ranging from 3 to > 500 ha which

might affect birds. However, some non-significant trends in my data were consistent with previous findings (e.g., ground coverage) (see Dawson 1984, Smith and Shugart 1987), and the lack of differences found in this study may be due to the small sample size ( $n=8$ ) of Ovenbird territories. In addition, the significantly greater slope near the lake edge may have made these areas unsuitable for Ovenbirds who selected the more level ridge tops in my study area (see also Robinson 1988). Thus, although it appears that habitat differences did not account for the selection of interior areas for territories by Ovenbirds in the Boot, differences may still exist which were unmeasured or undetected by this study. Overall, however, I feel that my results indicate that Ovenbirds are selecting the interior of forests primarily for reasons other than habitat differences (see also Ambuel and Temple 1982). One explanation may be the increased reproductive success experienced by those birds that nest in the forest interior due to lower levels of nest predation and brood parasitism relative to birds nesting nearer the forest edge.

## **Chapter II: Effects of Distance From Edge and Nest-type on Predation of Artificial Ground Nests.**

### **INTRODUCTION**

Artificial nests have proven to be an effective way to study various patterns of nest predation (Yahner and Voytko 1989). For example, predation rates on artificial arboreal nests (Yahner and Voytko 1989) and ground nests (Bowman and Harris 1980) have been recorded as well as predation rates in chaparral forests (Langen et al. 1991), marshes, meadows, and upland thickets (Picman 1988). In particular, artificial nests have been a useful tool for better understanding the role of nest predators in the decline of neotropical migrant landbird populations (Yahner and Voytko 1989). Artificial nests allow one to experimentally manipulate factors thought to affect predation rates and to rigorously test hypotheses. This chapter will focus on predation rates of artificial ground nests (both open-cup and domed-nests) in a fragmented, deciduous forest.

### **STUDY AREA**

This study was conducted at Lake Shelbyville in a 70-ha forest fragment known as the "Boot" (for a more detailed description, see chap. 1) during May-August of 1991.

### **METHODS**

I constructed artificial "open-cup" nests from plastic cups (90 mm in diameter and 45 mm in depth) painted with flat black paint. Nesting material consisted of woven dry grasses placed in each cup. Infertile Northern Bobwhite

(Colinus virginianus) eggs, acquired from a local gamefarm, were used. Artificial cup nests were placed on leaf litter depressions (virtually no plastic was visible) near or under vegetation (Yahner and Wright 1985). I also constructed artificial "domed" nests, which were similar, but given a leaf litter dome to mimic the nest of the Ovenbird (Seiurus aurocapillus). All nests were located near shrubs, logs, or trees and were  $\geq 25$  m from one another; nests of a similar type were  $\geq 50$  m apart. Seven nests of each type were placed 20 m, 200 m, and 400 m from the forest/agricultural field (ecotone) edge. Nests 400 m from this ecotone were 100-200 m from the edge of Lake Shelbyville.

To simulate a natural egg-laying cycle, eggs were added one-per-day to create the appearance of an active nest in an attempt to elicit brood parasitism as in Lowther (1979). Four trials were conducted between 16 June and 20 July 1991. A single trial consisted of four consecutive days of egg placement. Eggs were deposited daily between 1000 and 1200 hours in each nest for four consecutive days. Nest fate was recorded at each visit; a nest was considered depredated if the egg(s) was(were) broken or missing (Yahner and Scott 1988). Egg fragments, if present, were removed daily. Nest location was changed ( $> 20$  m) for each trial. Rubber boots were worn to minimize scent trails.

Survival rates were estimated by calculating "egg-days of survival" and "predation-free days." For each nest, I determined the number of egg-days of survival by summing



the number of days each egg remained in the nest undisturbed. Each nest could achieve a maximum of ten egg-days of survival (four days for the first egg, three egg-days for the second, two egg-days for the third, and one egg-day for the fourth). Predation-free days were also determined to minimize the potential bias resulting from eggs that remained in the nest for consecutive days. Predation-free days are defined as the total number of days in which the nest was undisturbed. Each nest received a score between 0 and 4 predation-free days.

Data for both predation-free days and egg-days of survival were analyzed with a three-way ANOVA; main effects were nest type (two levels: domed and open-cup), distance from the forest/field edge (three levels: 20 m, 200 m, and 400 m), and date (four levels: trials 1, 2, 3, and 4).

## RESULTS

During this study, 172 of the 189 (91%) nests were disturbed at least one time. Whether using predation-free days or egg-days of survival, nest fate was dependent on distance from the edge, date, and nest type. However, no interactions were significant (see Table 2). There were no nests in which brood parasitism was recorded.

Nests located 20 m from the edge exhibited significantly lower survivorship ( $\bar{x} = 1.61$  egg-days/nest) than those nests at 200 m or 400 m ( $\bar{x} = 2.63$  and  $\bar{x} = 2.89$  egg-days/nest, respectively), which were statistically indistinguishable (Fig. 2). Nest fate was also associated with nest type. Survival was significantly lower for open

Table 2. Results of a study of nest predation on artificial ground nests placed in 70-ha woodlot adjacent to Lake Shelbyville, IL. Three factors were studied; nest type (N), distance from field (D), and time of trial (T). Nest type was either open-cup or domed. Nests were placed at distances of 20 m, 200 m, and 400 m from the agricultural edge. A three-way ANOVA test (completely randomized blocks) was used.

Table 2a. Survival in egg-days.

	<u>D.F.</u>	<u>F Ratio</u>	<u>Significance</u>
Nest type (N)	1	12.47	0.0005
Distance (D)	2	5.98	0.0032
Time (T)	3	9.35	< 0.0001
N x D	2	0.47	0.6286
N x T	3	1.94	0.1257
D x T	6	1.20	0.3102
N x D x T	6	0.35	0.9103

Table 2b. Predation-free days

	<u>D.F.</u>	<u>F Ratio</u>	<u>Significance</u>
Nest type (N)	1	15.61	0.0001
Distance (D)	2	9.28	0.0002
Time (T)	3	9.78	< 0.0001
N x D	2	0.14	0.8676
N x T	3	1.05	0.3735
D x T	6	1.19	0.3175
N x D x T	6	0.46	0.8382

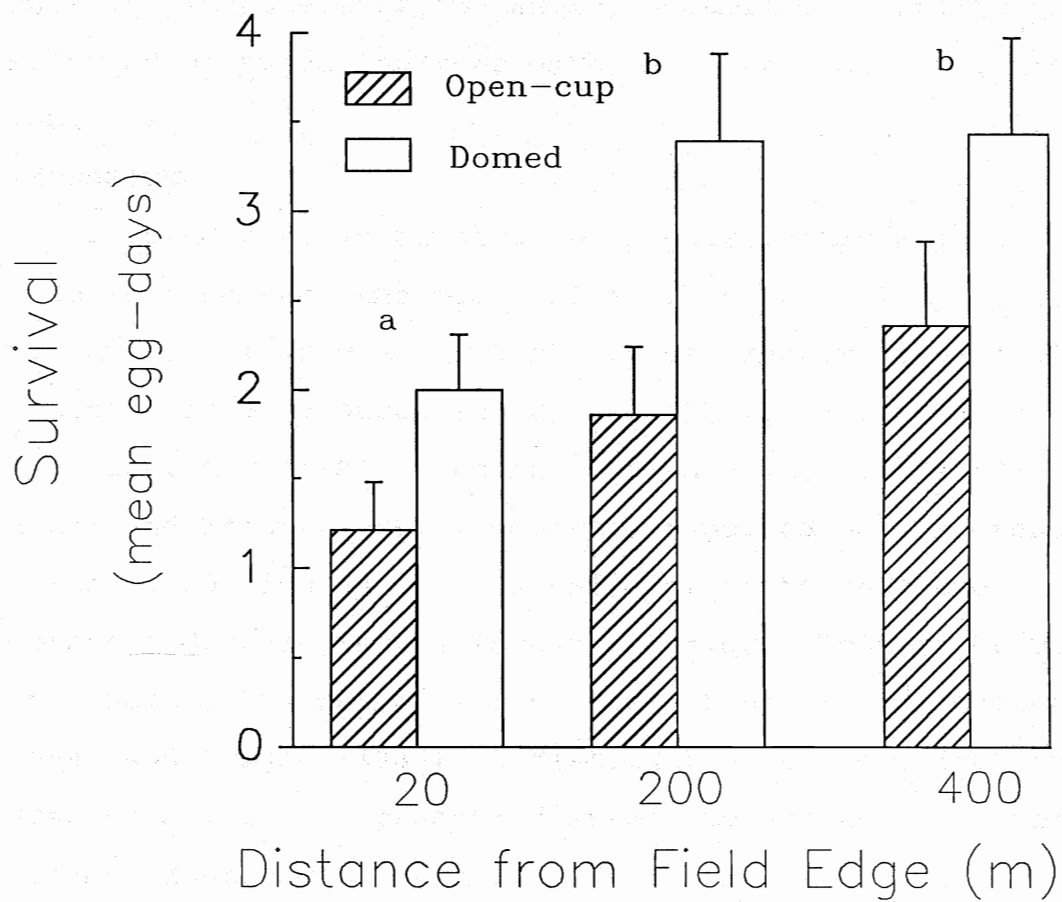


Fig. 2. Egg-days of survival of artificial ground-nests in a 70-ha fragmented forest near Lake Shelbyville, IL. Different letters (above bars) denote significant differences among the distance categories ( $p < 0.01$ , Tukey's pairwise comparisons). Significant differences were also found between nest types ( $p < 0.001$ , 3-way ANOVA).

cup nests ( $\bar{x} = 1.81$  egg-days) than domed nests ( $\bar{x} = 2.94$  egg-days) and this pattern was consistent at all three distances from the field (Fig. 2). Nests from the first trial displayed a significant higher survivorship than succeeding trials, which were statistically indistinguishable from one another (Table 2). Analyses performed on predation-free days exhibited identical trends (Table 2).

#### DISCUSSION

I found nest survival to be significantly less in nests located near the edge (20 m) than those located in the interior (200 m and 400 m). These results are similar to those found by Gates and Gysel (1978), Wilcove (1985), Wilcove et al. (1986), and Andren and Angelstram (1988). Yahner and Wright (1985), however, reported no difference between predation rates of artificial nests near the ecotone and those in the forest interior. This might be explained by the relatively short distance (50 m) chosen by Yahner and Wright (1985) to distinguish the edge from the interior. I used a greater distance to define the interior (minimum distance = 200 m).

My results also indicate a difference in predation rates for different nest types. Domed nests, such as those built by Ovenbirds, had a significantly higher survival rate than did open-cup nests which are typical of many neotropical migrants (Robinson 1988). This effect was seen regardless of the distance from the edge or the trial period. This can most likely be attributed to the design

of an Ovenbird nest; the small "bump" in the leaf litter of the forest floor might be difficult to locate. Although I found significantly higher egg survival in artificial Ovenbird nests, Robinson (1992) found that this species did not have significantly higher nest survival than species that build open-cup nests in the Boot. However, Robinson (1992) did find that Ovenbirds had lower rates of brood parasitism by Brown-headed Cowbirds, providing evidence that domed nests offer some defense against nest disturbance.

Similar studies of artificial nests have found that ground-nesting birds suffer higher mortality rates than arboreal-nesting species by nonavian predators (Yahner and Scott 1988) and that predation rates are greater for higher arboreal nests than lower arboreal nests (Yahner and Cypher 1987). In addition, Picman (1988) found that ground-nesting birds in an upland thicket experienced lower survival rates than similar species nesting in wet meadows or marshes. Wilcove (1985) reported significantly lower predation rates for cavity nests (0%) compared to open-cup nests (95%).

Survival was significantly higher during the first trial period, but no differences existed between the three subsequent trials. Decreased nesting success later in the breeding season has been reported in several studies (Zimmerman 1971, Dolbeer 1976, Caccamise 1977, Best and Stauffer 1980) and is often attributed to an increase in nest predation. This increase may occur because predators

developed a search image and/or there was an increase in the density of nest predators throughout the summer.

It is unclear what significance avian nest predators had during this study. It appeared that abundance of these predators had decreased in recent years (see chap. 3). In addition, very few eggshells were found near nests. Fragments of eggshells have been attributed to avian predators in previous studies (Picozzi 1975, Wray et al. 1982, Yahner and Wright 1985). However, I used Northern Bobwhite eggs which are considerably smaller than chicken eggs, which were used in the studies noted previously. The increased size of the chicken eggs may force avian predators to consume the egg(s) at the nest rather than transport the egg(s) to a different area. However, the Boot also contains numerous other predators which may have affected the nest success of this study. The Boot appears to be high-quality habitat for mammalian predators (especially raccoons, Procyon lotor) and provides both abundant water (streams and Lake Shelbyville) and food (corn, berries, and invertebrates) for many species (Rollfinke et al. 1990).

Predation at all three locations in the woodlot was very high indicating that a distance of 400 m from the edge may not be great enough to markedly depress nest predation in this highly fragmented forest (see also Robinson 1992). Increased rates of nest predation near forest edges may extend as far as 300-600 m into the forest-interior (Wilcove et al. 1986). The vegetational transitional zone

from agriculture field to mature forest at the Boot is extremely small ( $< 20$  m) in most areas (see also chap. 1). The result is a forest with an open understory with few shrubs or grasses in most locations. It has been shown that greater vegetational diversity and density reduce predator foraging efficiency (Bowman and Harris 1980, Sudgen and Beyersbergen 1986, Yahner and Cypher 1987). The lack of heterogeneity in the Boot (chap. 1) may result in elevated predation rates throughout the entire forest.

The predation rate (91% in five days) determined in my study was higher than those found in similar studies. Yahner and Wright (1985) reported an 83% loss for ground nests exposed for six days whereas Yahner and Morrell (1991) determined nest loss to be 81% in an irrigated woodlot. Other examples of predation rates of artificial ground nests include 55% for a six-day period (Yahner and Scott 1988), 32% in five days (Yahner et al. 1989), and  $< 60\%$  for nests near a forest/field ecotone during eight days of exposure (Andren and Angelstam 1988). Elevated predation rates in this study may have resulted from the increased disturbance, resulting from daily egg deposition, in the study area.

In conclusion, it appears that nest predation in the Boot is very high and almost certainly has a strong influence on the avian community. For example, the increased nest predation rates at the ecotone may be an explanation for the apparent preference by Ovenbirds for interior areas in the Boot (chap. 1). These results also

indicate that the traditional "edge-effect," denoting increased local diversity and higher populations of certain game species in ecotones (Leopold 1933), needs to be modified to include the detrimental effects of increased nest predation, brood parasitism, and the reduction of microhabitats available for habitat-interior specialists (Robinson 1988). Further studies should attempt to isolate and quantify factors limiting reproductive success of neotropical migrants in fragmented forests, such as the rates of actual nest loss and brood parasitism, and identification and population estimates of the primary nest predators.



### **Chapter III: Reproductive Success of Neotropical Migrant Landbirds in a Fragmented Forest in east-central Illinois.**

#### **INTRODUCTION**

The population declines of neotropical migrant landbirds in fragmented forests of eastern North America (e.g., Askins et al. 1990) are also occurring in east-central Illinois (Robinson 1992). Whereas agricultural abandonment in the east has increased the amount of suitable habitat for birds which breed in the forest interior (Freemark and Merriam 1986), land in the midwest continues to be used for agricultural purposes and breeding habitat continues to diminish (Iverson et al. 1989, Robinson 1990). This chapter reports on the reproductive success of an avian community in a forest fragment of east-central Illinois.

#### **STUDY AREA**

This study was conducted in a 70-ha forest fragment adjacent to Lake Shelbyville referred to as the "Boot" (for a more detailed description, see chap. 1).

#### **METHODS**

Mist-nets were used to estimate reproductive success for birds nesting in the Boot during the spring and summer of 1991. Between 15 and 25 mist-nets were strung end-to-end across the interior of the Boot (Fig. 1). Nets were opened for three consecutive days from 0600 to 1200 hours beginning after the primary breeding season for most forest-nesting passerines and ending before fall migration

(20 June to 20 July). These methods were essentially identical to those of Robinson (1992, pers. comm.) who studied this same woodlot in 1985-86. After a section of the study area had been sampled, the mist-nets were moved to the next adjacent area. It took approximately two weeks to sample the entire net-line. The study area was sampled twice, 20 June-5 July and 6-20 July. By netting for two separate three-day periods in each area, rather than a single six-day block, I maximized the chance of capturing both early and late fledglings. All birds that were captured were banded with U. S. Fish and Wildlife Service aluminum bands, aged as in Pyle et al. (1987), morphological measurements were taken, and the birds were released. Permanent and short-distance migrants are referred to collectively as "local species."

I compared my data with those collected in the same forest fragment (along the same net-line) by Robinson (1988, 1992). Data reported in this thesis for birds captured in 1985-86 come from Robinsons' raw data and may not be the same as in Robinson (1988) and Robinson (1992). Only data from the same study area and similar mist-netting dates are used. Some neotropical migrants, such as the Northern Oriole (Icterus galbula) and the Indigo Bunting (Passerina cyanea), that do not nest in the forest interior were excluded from the results.

## RESULTS

I captured a total of 165 birds during the summer of 1991 (see Table 3 for summary of birds captured). Birds

Table 3. Birds caught in mist-nets in a 70-ha forest fragment adjacent to Lake Shelbyville, IL (the Boot) for 1991. Only neotropical migrant species which nest in the forest interior are reported.\*

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**NEOTROPICAL MIGRANTS**

SPECIES**	ADULTS	JUVENILES
Scarlet Tanager	7	1
Red-eyed Vireo	3	5
Kentucky Warbler	3	0
Ovenbird	1	2
Acadian Flycatcher	3	0
Wood Thrush	0	5
Worm-eating Warbler	1	1
Summer Tanager	2	0
Great Crested Flycatcher	4	4
Eastern Wood-Pewee	1	3
Louisiana Waterthrush	0	1
Yellow-billed Cuckoo	1	0
TOTALS	26	22

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AHY:HY ratio; 26:22 = 1.18:1

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**PERMANENT RESIDENTS and SHORT-DISTANCE MIGRANTS**

SPECIES	ADULTS	JUVENILES
Northern Cardinal	5	3
Tufted Titmouse	11	34
Blue Jay	8	6

Table 3., continued.

American Goldfinch	2	0
Downy Woodpecker	16	2
Hairy Woodpecker	4	0
Red-bellied Woodpecker	3	0
Northern Flicker	1	0
Black-capped Chickadee	2	0
Brown-headed Cowbird	1	4
Carolina Wren	4	6
Eastern Bluebird	0	3
White-breasted Nuthatch	2	0
TOTALS	59	58

AHY:HY ratio; 59:58 = 1.02:1

\* Only "interior" and "interior/edge" species are included (e.g., Whitcomb et al. 1981). One adult Indigo Bunting was excluded.

\*\* Scientific names are found in Appendix 1.

that typically nest in the forest interior (both local species and neotropical migrants) appeared to have relative high reproductive success in 1991. A ratio of after-hatching-year (AHY) to hatching-year (HY) adults was used to estimate reproductive success. Both local species and neotropical migrants had AHY:HY ratios very close to 1:1 (Table 3) in 1991. In 1985-86, HY birds only represented 13.6% (14/103) of all neotropical migrants netted (Fig. 4) whereas in 1991 this age-class represented 45.8% (22/48) ( $\chi^2_{\text{cal}} = 22.29$ ,  $DF = 1$ ,  $p = 0.0001$ ). This resulted in an increase in the AHY:HY ratio from greater than 7:1 (Table 4) in 1985-86 to a ratio of 1:1 in 1991 (Table 3). Higher reproductive success was also evident for local species in 1991. Whereas HY birds accounted for 31.2% (54/173) in 1985-86, their proportion significantly increased to 49.6% (58/117) (Fig. 3) in 1991 ( $\chi^2_{\text{cal}} = 10.85$ ,  $DF = 1$ ,  $p = 0.0010$ ). Thus, the AHY:HY ratio changed from greater than 2:1 in 1985-86 (Table 4) to approximately 1:1 in 1991 (Table 3). In 1991, the community composition had changed and contained a significantly higher proportion of local species than had been found in 1985-86 ( $\chi^2_{\text{cal}} = 4.86$ ,  $DF = 1$ ,  $p = 0.0274$ ). Neotropical migrants represented 40.3% (117/290) of the avian community in 1985-86. However, by 1991 they only represented 29.1% (48/165) of the avian community (Fig. 3).

Reproductive success of birds which breed in the forest interior may be negatively affected by increased rates of nest predation and brood parasitism. In 1985-86,

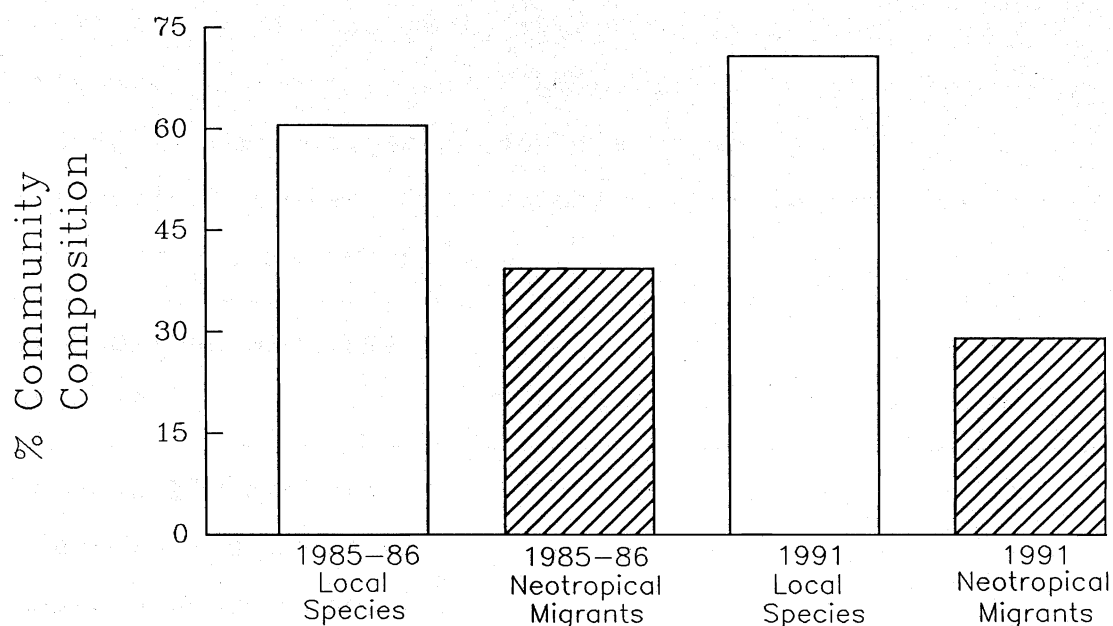


Fig. 3. Birds caught in a 70-ha fragmented forest at Lake Shelbyville, IL. Neotropical migrants decreased significantly from 1985-86 to 1991 ( $p=0.0374$ , Chi-square test).

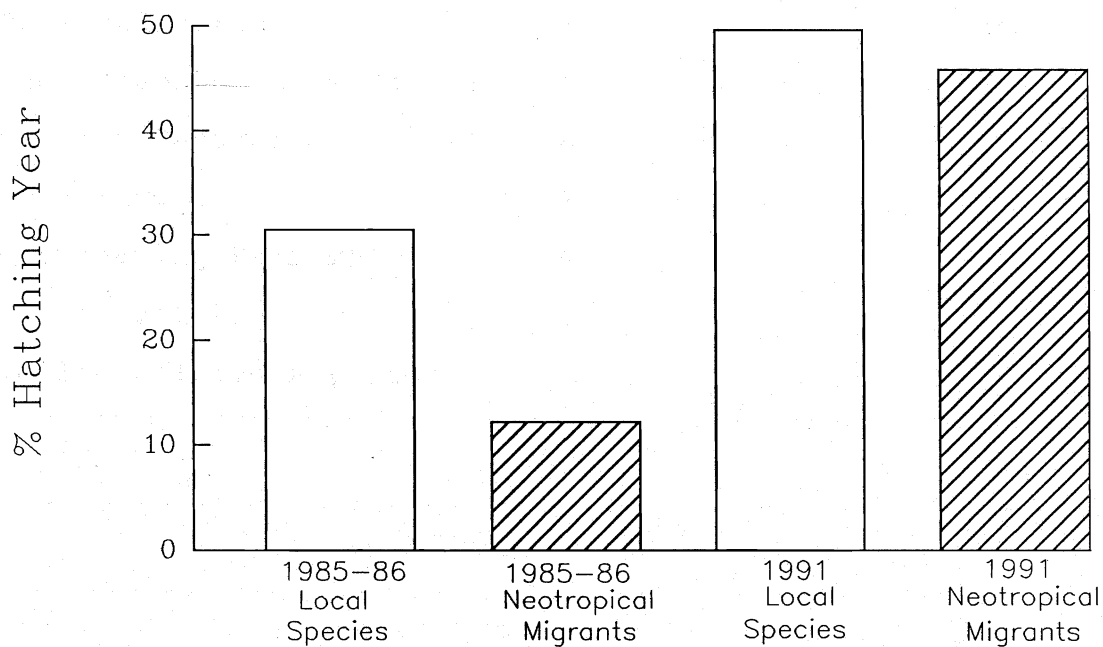


Fig. 4. Birds caught in a 70-ha fragmented forest at Lake Shelbyville, IL. The proportion of hatching-year birds was significantly greater for both groups in 1991 than in 1985-86 ( $p=0.0010$  and  $p=0.0001$ , Chi-square test).

Table 4. Birds caught in mist-nets in a 70-ha forest fragment adjacent to Lake Shelbyville, IL (the Boot) for 1985-86 (from Robinson, unpublished data). Only neotropical migrant species which nest in the forest interior are reported.\*

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**NEOTROPICAL MIGRANTS**

SPECIES**	ADULTS	JUVENILES
Acadian Flycatcher	7	0
Blue-gray Gnatcatcher	3	1
Eastern Wood-Pewee	4	3
Great Crested Flycatcher	17	1
Kentucky Warbler	8	2
Louisiana Waterthrush	0	1
Ovenbird	16	2
Red-eyed Vireo	2	0
Ruby-throated Hummingbird	1	0
Scarlet Tanager	6	0
Wood Thrush	32	3
Worm-eating Warbler	4	0
Yellow-billed Cuckoo	2	1
Yellow-bellied Flycatcher	1	0
TOTALS	103	14

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AHY:HY ratio; 103:14 = 7.36:1

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Table 4., continued.

PERMANENT RESIDENTS and SHORT-DISTANCE MIGRANTS		
SPECIES	ADULTS	JUVENILES
American Goldfinch	3	0
Black-capped Chickadee	13	1
Blue Jay	11	7
Brown-headed Cowhead	21	10
Common Grackle	18	1
Downy Woodpecker	15	7
Gray Catbird	3	0
Hairy Woodpecker	2	1
Northern Cardinal	5	6
Northern Flicker	5	3
Red-bellied Woodpecker	1	0
Red-headed Woodpecker	5	3
Rufous-sided Towhee	1	0
Tufted Titmouse	11	15
Whip-poor-will	1	0
White-breasted Nuthatch	4	0
TOTALS	119	54

AHY:HY ratio; 119:54 = 2.20:1

\* Only "interior" and "interior/edge" species are included (e.g., Whitcomb et al. 1981). Northern Orioles (4 AHY, 8 HY), Indigo Buntings (1 AHY, 1 HY), and Rose-breasted Grosbeaks (1 AHY, 2 HY) were excluded.

\*\* Scientific names are found in Appendix 1.



Brown-headed Cowbirds (Molothrus ater) were the most common species caught in mist-nets and comprised 10.7% (31/290) of all birds captured. In 1991 that proportion decreased significantly to only 3.0% (5/165) of all species netted ( $\chi^2_{\text{cal}} = 5.96$ , DF= 1,  $p = 0.0146$ ). Similarly, potential nest predators, such as the Common Grackle (Quiscalus quiscula) and the Blue Jay (Cyanocitta cristata), constituted a smaller proportion of captured birds in 1991 than in 1985-86. These two avian nest predators comprised a greater proportion 21.4% (37/173) of local species captured in 1985-86 (Table 4) compared with only 12.0% (14/117) captured in 1991 (Table 3). However, this result was only marginally significant ( $\chi^2_{\text{cal}} = 2.86$ , DF= 1,  $p = 0.0903$ ).

#### DISCUSSION

Mist-netting results indicated that reproductive success, as estimated by AHY:HY ratios (Robinson 1988), was higher for both neotropical migrants and local species in 1991 than in 1985-86. This apparent increase in reproductive success in 1991 could be attributed to a lack of competition for limited resources, abundant resources, decreased numbers of predators, fewer Brown-headed Cowbirds in the area, or a combination of these factors. Whereas mammalian predator population densities were not known, it appears that some avian nest predators (e.g., Blue Jays and Common Grackles) were less numerous in 1991 than 1985-86. This may have led to the improved reproductive success recorded in 1991. However, predation rates on artificial nests in this woodlot were extremely high (see chap. 2)

indicating that populations of mammalian predators may still have been high. Brown-headed Cowbirds comprised a much smaller proportion of the avian community in 1991 when compared to 1985-86 and this reduced number of brood parasites could explain the apparent higher reproductive success in 1991. I did not collect data on resource abundance.

From 1985-86 to 1991 the proportion of neotropical migrants in the avian community declined (Fig. 3) despite the fact that the reproductive success of neotropical migrants was similar to that of local species in 1991. However, this could be the result of the asymmetry in reproductive success that has occurred between the two groups of birds in previous years (Robinson 1992). For example, in 1985-86 neotropical migrants produced an AHY:HY ratio of greater than 7:1 compared to the more successful ratio of 2:1 for local species. Several consecutive years of this asymmetry could be responsible for the fact that neotropical migrants' representation in the avian community decreased by 11%. This decrease is very alarming because the proportion of neotropical migrants in 1985-86 was already low (40%). In most large, extensive tracts of mature deciduous forests, neotropical migrants typically comprise > 60% of the entire avian community (Wilcove et al. 1986, Terborgh 1989, Askins et al. 1990). The declining proportion of neotropical migrants could also be due to lower survival on the wintering grounds as a result of forest clearing in the tropics (Askins et al. 1990).

Area-sensitive species, such as the Ovenbird (Seiurus aurocapillus) and Kentucky Warbler (Oporornis formosus) (Robbins 1980), have experienced a dramatic decline in numbers from 1985-86 to 1991 in the Boot. During this period the number of territorial males observed decreased by over 50% for each of these species (Robinson 1992). Consequently, whereas the total proportion of neotropical migrants has decreased, the number of area-sensitive species appears to be declining at an even greater rate.

Despite these population declines, reproductive success by neotropical migrants appeared to be high in 1991. It seems possible that a density-dependent relationship may exist such that small populations of neotropical migrants may lead to reduced numbers of Brown-headed Cowbirds, which in turn could result in higher reproductive success for both hosts and parasites.

Robinson (1988, pp. 153) describes the Boot as "a sink that attracts young dispersing birds, which fail to reproduce successfully." The data from 1985-86 and 1991 suggest that neotropical migrants may fluctuate between periods of high and low reproductive success. Thus, when population size, numbers of cowbirds, and competition are low, high reproductive success may allow populations to at least partially recover to their former numbers. I speculate that the avian community in the Boot, and avian communities in other forest fragments, are most likely maintained by a combination of both immigration and

periodic years of high reproductive success. However, long term population studies in forest fragments such as the Boot that are designed to ascertain reproductive success and dispersal movements of breeding adults and their young are essential.

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Appendix I. Scientific names of birds (in alphabetical order) mentioned in this thesis.

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Acadian Flycatcher (Empidonax virescens)  
American Crow (Corvus brachyrhynchos)  
American Goldfinch (Carduelis tristis)  
Black-capped Chickadee (Parus atricapillus)  
Blue-gray Gnatcatcher (Polioptila caerulea)  
Blue Jay (Cyanocitta cristata)  
Brown-headed Cowbird (Molothrus ater)  
Carolina Wren (Thryothorus ludovicianus)  
Common Grackle (Quiscalus quiscula)  
Downy Woodpecker (Picoides pubescens)  
Eastern Bluebird (Sialia sialis)  
Eastern Wood-Pewee (Contopus virens)  
Gray Catbird (Dumetella carolinensis)  
Great Crested Flycatcher (Myiarchus crinitus)  
Hairy Woodpecker (Picoides villosus)  
Indigo Bunting (Passerina cyanea)  
Kentucky Warbler (Oporornis formosus)  
Louisiana Waterthrush (Seiurus motacilla)  
Northern Cardinal (Cardinalis cardinalis)  
Northern Flicker (Colaptes auratus)  
Northern Oriole (Icterus galbula)  
Ovenbird (Seiurus aurocapillus)  
Red-bellied Woodpecker (Melanerpes carolinus)  
Red-eyed Vireo (Vireo olivaceus)  
Red-headed Woodpecker (Melanerpes erythrocephalus)

Appendix I., continued.

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Rose-breasted Grosbeak (Pheucticus ludovicianus)  
Ruby-throated Hummingbird (Archilochus colubris)  
Rufous-sided Towhee (Pipilo erythrophthalmus)  
Scarlet Tanager (Piranga olivacea)  
Summer Tanager (Piranga rubra)  
Tufted Titmouse (Parus bicolor)  
Whip-poor-will (Caprimulgus vociferus)  
White-breasted Nuthatch (Sitta carolinensis)  
Wood Thrush (Hylocichla mustelina)  
Worm-eating Warbler (Helmitheros vermivorus)  
Yellow-billed Cuckoo (Coccyzus americanus)  
Yellow-bellied Flycatcher (Empidonax flaviventris)

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