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The Effects of Habitat Fragmentation and Factors Influencing Nest Box Use on the Southern Flying Squirrel (Glaucomys volans) in Southern Illinois

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The Effects of Habitat Fragmentation and Factors Influencing Nest Box Use on the Southern Flying Squirrel (*Glaucomys volans*) in Southern Illinois

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BY

Catherine J. Woodworth

THESIS

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for Alice and Dale

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Chapter I

THE EFFECTS OF HABITAT FRAGMENTATION ON THE SOUTHERN FLYING SQUIRREL (*Glaucomys volans*) IN SOUTHERN ILLINOIS

ABSTRACT

I studied the effects of habitat fragmentation on the southern flying squirrel (*Glaucomys volans*) in 30 forest fragments in southern Illinois. The fragments ranged in size from 6 ha to 5264 ha, and had varying degrees of isolation. I placed 10 nest boxes in each habitat fragment and checked them monthly. I captured southern flying squirrels in 24 of the 30 fragments, and found evidence of squirrels (i.e., nests and feeding stations) in 4 additional fragments. Thus, only 2 fragments did not show any evidence of squirrel use suggesting that the southern flying squirrel may not be particularly sensitive to the negative impacts of habitat fragmentation, in a primarily forested landscape like southern Illinois. However, the 2 fragments apparently lacking squirrels were small and isolated.

INTRODUCTION

Habitat fragmentation has been defined as a process in which one large, continuous tract of habitat is divided into smaller, more isolated tracts (Wilcove et al., 1986). More recently, Lord and Norton (1990) have defined habitat fragmentation as simply the "disruption of continuity." Typically, fragmentation results in habitat patches which are reduced in overall size, and generally surrounded by less suitable habitat. In addition, habitat fragmentation leads to an increase in the relative amount of habitat edge which has been associated with a plethora of changes to the physical and biotic environment. These changes, often called "edge effects," can have both negative and positive effects on wildlife populations (Yahner, 1988). The increase in habitat edge is beneficial to species which prefer edge such as the indigo bunting (*Passerina cyanea*), raccoon (*Procyon lotor*), and opossum (*Didelphis virginianus*). The creation of edge can also be deleterious because it produces changes in the microclimate which can alter radiation fluxes, as well as cause changes in wind, soil moisture, and air temperature (Saunders et al., 1991). Many species are extremely sensitive to edge effects. The increased edge may lead to heightened predation by omnivorous predators, whose densities are higher in edge habitat, and increased interspecific competition for nesting sites from edge species. Habitat fragmentation has been hypothesized to be a leading cause of the decline of neotropical migrant songbirds, due to an increase in the populations of parasitic brown-headed cowbirds (*Molothrus ater*) and nest predators (Robinson et al., 1995).

Spatially, populations are affected by fragmentation because movement between patches may be restricted, creating difficulties for dispersing animals (Merriam, 1995). Responses to habitat fragmentation vary by how the fragmentation is perceived by the individual, and is related to both the scale of the fragmentation (Lord and Norton, 1990) and the life history of the animal. For example, it should be much easier for a large animal, such as the white-tailed deer (*Odocoileus virginianus*), and habitat generalists such as raccoons and opossums to move between habitat patches after fragmentation. These species prefer fragmented landscapes because they can find food and cover in forest fragments and agricultural fields. They are not tied to a particular habitat type and can move easily across agricultural fields. Species which are habitat specialists should find it much more difficult to move great distances between sites through heterogeneous habitats. For example, many birds and mammals will not move small distances between forest fragments. Wegner and Merriam (1979) found that white-footed mice (*Peromyscus leucopus*) and chipmunks (*Tamias striatus*) rarely moved from wooded areas into adjacent grassy fields. Similarly, they found that birds rarely flew directly across open fields.

Clearly, fragmentation may cause significant barriers to dispersing animals, and there has been increased interest in determining how landscape level characteristics affect the population dynamics and interpatch movements of mammals (Geuse et al., 1985; Diffendorfer et al., 1995; Shepherd and Swihart, 1995). The concept of the metapopulation has become a popular way to describe how populations develop as a shifting mosaic of temporary subpopulations which are isolated from each other (as a result of fragmentation), while maintaining some level of dispersal between isolated patches. The original metapopulation model (Levins, 1970) assumed that the habitat patches were of equal size, identical in quality, and evenly spaced within the environment. In addition, this model assumes an equal degree of movement between habitat patches. Because few, if any, fragmented landscapes fit this model, the term metapopulation has evolved from a rigid model with many assumptions into a concept with loose definitions (McCullough, 1996). Certainly, an important component of metapopulation studies has been to investigate the underlying causes of local extinctions, including the degeneration of the environment, demographic and environmental stochasticity, and genetic effects (Verboom et al., 1993).

The overall size of habitat patches as well as the isolation of patches are important factors which must be considered when determining what effects habitat fragmentation may have on a species (Goodman, 1987). Several recent studies have focused on what effects area and isolation of habitat fragments have on the species composition, as well as the patterns of occupancy, of birds and mammals (Opdam et al., 1985; Blake and Karr, 1987; Van Dorp and Opdam, 1987; Verboom and van Apeldoorn, 1990; van Apeldoorn et al., 1992; Celada et al., 1994). Van Dorp and Opdam (1987), using logistic regression, found that the size of woodlots was the most important predictor of whether or not a bird species would occur in a woodlot. Studies of red squirrels (*Sciurus vulgaris*) in the Netherlands and in Italy found that woodlot size and isolation (distance to nearest 'source area') were factors which influence presence or absence of this species in habitat fragments (Verboom and van Apeldoorn, 1990; Celada et al., 1994).

The purpose of this study was to determine how the area of forest fragments and isolation of fragments affects the southern flying squirrel (*Glaucomys volans*), a forest-obligate mammal, in the fragmented landscape of southern Illinois. Agricultural practices and increased urbanization have decreased the forested area in Illinois from 38.2% in 1820 to approximately 12% in 1985 (Figure 1) (Iverson et al., 1989). The southern flying squirrel is a species which is nearly always found in association with hardwood trees (Weigl, 1978). These squirrels are secondary-cavity nesters, usually making their nests in woodpecker holes and other cavities (Mull, 1968). The majority of their diet consists of hard mast, especially acorns (Harlow and Doyle, 1990). Their primary means of locomotion over long distances is by gliding from tree to tree in a descending fashion (Giacalone-Madden, 1976). The combination of these life history traits make the southern flying squirrel an organism which could be susceptible to the negative impacts of forest fragmentation. This study examines how the size and isolation of forest fragments affects the patterns of occupancy and reproductive success of the southern flying squirrel in southern Illinois.

METHODS

Study sites. Thirty habitat fragments were selected in and around the Shawnee National Forest in Jackson, Johnson, Union, and Williamson counties in southern Illinois (Appendix A). Of the 30 sites, 7 were classified as "very small" sites (6-10 ha), 7 were classified as "small" (26-81 ha) sites, 7 were classified as "medium" (100-223 ha) sites, and 9 were classified as "large" (645-5264 ha) sites (Table 1). The smallest sites selected were no less than 6 ha, as this area would probably encompass the home ranges of several squirrels. Home ranges have been reported to be anywhere from 0.4 to 3.8 ha for females (Madden, 1974; Stone et al., 1997) and 0.5 ha to 9.9 for males (Madden, 1974; Fridell and Litvaitis, 1991). United States Geological Survey (USGS) maps (photo revised 1990) were used to identify and locate forest fragments. Sigma Scan™ (Jandel Scientific, Corte Madera, CA) was used to measure areas from the USGS maps. Isolation was defined as the distance a forest fragment was from the next nearest fragment of at least 5 ha. Distances were measured on the USGS maps.

Nest boxes. Nest boxes were the primary tool used to determine if flying squirrels were present in the 30 forest fragments. The nest box design was modified from Henderson (1992) with a 3.3 cm diameter hole. Each of the 30 habitat fragments had 10 nest boxes placed in it, 50 meters apart on a roughly square grid. The boxes were placed approximately 2.2 m off the ground on the south side of the tree.

I installed the nest boxes between March and June 1996. The nest boxes were checked monthly after installation with the exception of July and August when each box was only checked once due to decreased use of the boxes by squirrels in the warmer summer months (Heidt, 1977). The first complete check of all 30 sites occurred in July/August 1996. A final check occurred in June 1997. Squirrels captured in the boxes were sexed, weighed, and marked with an individually numbered metal ear tag. I also noted the reproductive condition of each squirrel. Body weight was used to distinguish age classes (Raymond and Layne, 1988). Squirrels > 50 g were classified as adults, subadults were 25-50 g, and nestlings were < 25 g.

Vegetation. I attempted to select fragments which were uniform in vegetation. All sites were upland oak-hickory forests. In addition, I sampled vegetative characteristics at each site using 700-m^2 circular plots centered around each of the 300 nest box trees. The species, height, bark texture (rated from 1-4 [smooth to very rough] as in Boardman, 1991), and diameter at breast height (DBH) of each nest box tree were recorded. Within the circular plots, all trees ≥ 8 cm DBH were measured and identified to genus. Snags and logs were recorded and classified according to Thomas et al. (1979). Additionally, canopy cover was estimated with a densiometer, and ground cover was visually estimated using 1-m^2 circular hoops. Four estimates of canopy cover and ground cover were taken at each nest box tree at cardinal directions. Habitat variables selected for statistical analysis were modified from Stone et al. (1996) and Gilmore and Gates (1985) (Appendix B).

Statistical analysis. Spearman rank correlations (ρ) were used to determine if there were any significant associations between flying squirrel abundance and forest fragment size or isolation (Minitab, Inc., 1989). Chi-square (χ^2) goodness-of-fit tests were used to determine if sex ratios were different from 1:1, and if sex ratios differed among the 4 size classes of the forest fragments. A Pearson product-moment correlation coefficient was used to determine if vegetative characteristics were related to fragment size using Statistical Analysis Systems (SAS; SAS Institute, 1990). Forward stepwise logistic regression (SAS; SAS Institute, 1990) was used to model factors which explained box usage by squirrels.

RESULTS

Patterns of occupancy. Flying squirrels were present in 28 of 30 fragments in southern Illinois. I captured flying squirrels in 24 of the 30 forest fragments and noted definitive evidence of squirrel presence (*i.e.*, nests and feeding stations in nest boxes) in 4 additional fragments. Squirrels were absent from the 2 most isolated sites. The isolation of fragments inversely affected the likelihood of capturing a squirrel at a given nest box, and was the first variable entered into the logistic regression model. The remaining variables entered into the model all pertained to habitat characteristics. These variables were diameter at breast height of nest box tree, relative density of hard mast trees, and the number of fallen logs (see Chapter II for model).

Overall, 75% of the 300 nest boxes were used by flying squirrels at some point during this study. No relationship existed between the percentage of nest boxes used in a fragment and area ($\rho = 0.126$, $P > 0.50$) or isolation ($\rho = -0.307$, $P > 0.10$) (Figure 2, Table 2). In addition, the total number of squirrels captured was not correlated with area ($\rho = 0.110$, $P > 0.50$) or isolation ($\rho = -0.252$, $P > 0.10$) (Figure 3). Similarly, there was no relationship between the number of recaptures per fragment and area ($\rho = 0.141$, $P > 0.20$) or isolation ($\rho = -0.321$, $P > 0.10$) (Figure 4). Finally, the number of individual squirrels (captures- recaptures) captured per woodlot was not significantly correlated with area ($\rho = 0.093$, $P > 0.50$) or isolation ($\rho = -0.221$, $P > 0.20$) (Figure 5). Sufficient sample sizes were not available to calculate densities for more than 2 of the woodlots sampled, negating any possible comparisons of flying squirrel density among fragments.

Reproduction. Only 10 litters were found, and there was no relationship between number of litters found and area (ρ = -0.077, $P > 0.50$) or isolation (ρ = 0.341, $P > 0.05$) (Figure 6). In addition, litter size was not significantly correlated with either area (ρ = -0.103, $P > 0.50$) or isolation (ρ = 0.368, $P > 0.05$) of fragments. Litters ranged in size from 2 to 4 with a mean litter size of 2.4 young. There was also no relationship between the number of subadults captured and area (ρ = -0.233, $P > 0.20$) or isolation (ρ = 0.169, $P > 0.20$).

Sex Ratios. There was not a significant relationship between male captures and area (ρ = 0.023, $P > 0.50$) or isolation (ρ = -0.165, $P > 0.20$) of fragments. Female captures were not significantly related to area (ρ = 0.018, $P > 0.50$) or isolation (ρ = -0.201, $P > 0.20$) either. Sex ratios were calculated for comparison among area size classes (Figure 7). The sex ratio of squirrels in the very small sites was 1.5 males to 1 female. The sex ratio of small and medium sites were 2.1:1 and 1.5:1, respectively. Finally, the sex ratio of large sites was 0.74:1. Sex ratios did not differ from 1:1 except in the small sites ($\chi^2 = 6.23$, df = 1, $P < 0.01$), however, there were more females captured than males in the large sites.

Vegetation. Pearson correlation coefficients revealed no significant relationships among habitat variables and area (all $r < 0.344$, all $P > 0.05$) (Table 3). Therefore vegetative characteristics were relatively uniform among fragments of different sizes. Habitat variables included in this analysis were % canopy cover, % ground cover, relative density of trees, relative density of hard mast trees, number of snags per sample plot, and number of logs per sample plot (Appendix B). Variables associated with each nest box tree including height, DBH, distance to closest tree, and bark texture, also were tested to determine whether they correlated with fragment size. These variables were not affected by fragment size (all $r < 0.348$, all $P > 0.05$). Since no relationships were found between fragment size and habitat characteristics, I assumed that the habitat was similar among forest fragments.

DISCUSSION

I found that southern flying squirrels were common in southern Illinois woodlots, occurring in 93% of the forest fragments I studied. Patch size did not appear to be a factor excluding squirrels from small sites, assuming that habitat quality was good and isolation was not too extreme. Squirrels were present in 6 of 7 woodlots that were between 6 and 10 ha, leading me to conclude that the area of the habitat fragment may not be the most important factor in predicting squirrel occupancy in a woodlot. These results support Nupp and Swihart's (1997) report that southern flying squirrels in west-central Indiana were present only in continuous tracts of forest and woodlots > 6 ha which are in proximity to other woodlots. All of the forest fragments I sampled were > 6 ha, however not all occupied fragments, were in proximity to other fragments.

Southern flying squirrels were not present in the 2 most isolated woodlots. Populations in these woodlots may have become locally extinct, with recolonization unlikely due to the distance which must be crossed for successful dispersal. Another problem which may have inhibited squirrels from occupying the two most isolated fragments may have been increased competition for food and nesting sites from fox squirrels (*Sciurus niger*) and gray squirrels (*S. carolinensis*) in these sites.

Fahrig and Merriam (1985) designed a model of patch dynamics in white-footed mice in order to determine how population survival is affected by isolation. Their model predicted that mouse populations in isolated areas were more likely to have reduced growth rates, and a greater probability of extinction. Field data on this species supported the model. This model may hold true for southern flying squirrel populations as well, as I found southern flying squirrels were not present in woodlots that were isolated by more than 0.5 km.

Southern Illinois is a primarily forested landscape compared to northern and central Illinois. In areas where the distances between patches are relatively small (*i.e.* < 500 m) the probability of interpatch dispersal by flying squirrels may be high. Unfortunately, this study was not designed to address dispersal movements. Landscape connectivity is often associated with the persistence of species in fragmented landscapes (Fahrig and Merriam, 1985). Many species rely upon at least some level of connectivity in order for dispersal to take place. For species such as chipmunks (*Tamias striatus*) and white-footed mice, vegetated fencerows play an important role in connecting populations between woodlots (Wegner and Merriam, 1979; Henderson et al., 1985). Even though box use by southern flying squirrels was not significantly correlated with either area or isolation, squirrels were more likely to occur in areas with higher levels of connectivity such as large, contiguous forests > 645 ha, and forests which had shorter distances between patches. However, I was not able to document movement between patches, or the use of habitat corridors.

If young males are the dispersers in this species, it would seem that they should occur more often in smaller, more isolated woodlots. Although not statistically significant, there did tend to be a female biased sex ratio in larger fragments. This trend toward more females in the largest sites could possibly lead to greater reproductive success in these larger sites. Also, the only fragments with sex ratios different from a 1:1

were small. However, not enough litters were found to make any predictions in this area, highlighting the importance of longer studies.

While the southern flying squirrel appears to be an abundant species in southern Illinois forest fragments, this study does support the idea of a flying squirrel metapopulation with local extinctions possible in areas which are extremely isolated. However, flying squirrels were still common even in my smallest sites. Further work is necessary to determine dispersal patterns in this species, as well as to what extent habitat corridors are used. Additionally, long term studies on the survival of flying squirrels in fragmented landscapes are needed.

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Table 1. The site abbreviations, areas, size classifications, and isolation distances (distance to nearest fragment > 5 ha) of 30 habitat fragments located in southern Illinois.

Site	Area (ha)	Size Class*	Isolation**
SU	6.4	VS	146
CE	6.6	VS	439.2
BU	7.2	VS	122
HC	8.4	VS	73.2
TW	8.4	VS	634.4
CP	10	VS	73.2
FA	10.4	VS	390.4
RL	26.4	S	366
HF	29	S	195.2
BK	34.8	S	195.2
WA	40.6	S	536.8
VT	56	S	97.6
HA	64	S	73.2
DN	81.2	S	73.2
RY	100.7	M	73.2
RT	102	M	73.2
WO	160.8	M	73.2
RO	186.2	M	73.2
BB	188.4	M	219.6
TR	212	M	122
CL	223.1	M	146.4
DR	645.2	L	0
GC	658.2	L	0
IM	772.8	L	0
PA	908.8	L	0
DK	1061.6	L	0
TT	1623.6	L	0
HH	2568	L	0
LG	2613.4	L	0
PI	5264	L	0

*VS = Very Small, S = Small, M = Medium, L = Large

**Large size classes were assigned an isolation of 0 because their size meant that they inevitably were < 0.5 km from another fragment.

Table 2. Spearman rank correlations between various measures of southern flying squirrel abundance and both area and isolation for 30 forest fragments in southern Illinois.

Variable	Area	Isolation
Number of Captures	0.110 ($P > 0.50$)	-0.252 ($P > 0.10$)
Number of Recaptures	0.141 ($P > 0.20$)	-0.321 ($P > 0.10$)
Number of Individuals	0.093 ($P > 0.50$)	-0.221 ($P > 0.20$)
Number of Male Captures	0.023 ($P > 0.50$)	-0.165 ($P > 0.20$)
Number of Female Captures	0.018 ($P > 0.50$)	-0.201 ($P > 0.20$)
Number of Subadult Captures	-0.233 ($P > 0.20$)	0.169 ($P > 0.20$)
Number of Litters	-0.077 ($P > 0.50$)	0.341 ($P > 0.05$)
Mean Litter Size	-0.103 ($P > 0.50$)	0.368 ($P > 0.05$)
% Nest Boxes Used	0.126 ($P > 0.50$)	-0.307 ($P > 0.10$)

Table 3. Correlations of mean habitat variables associated with southern flying squirrel nest boxes placed in 30 habitat fragments in southern Illinois and the area of the fragment.

Variable	Pearson r	P-value
Distance to Closest Tree	-0.146	0.442
Diameter at Breast Height of Nest Box Tree	0.347	0.061
Height of Nest Box Tree	0.244	0.193
Bark Texture of Nest Box Tree	-0.288	0.123
% Canopy Cover	0.120	0.527
% Ground Cover	-0.343	0.063
Relative Density Trees	-0.178	0.346
Relative Density Hard Mast Trees	-0.098	0.608
# of Snags	-0.177	0.350
# of Logs	0.204	0.279

Figure 1. The forest cover in Illinois in 1820 (A), and 1975 (B) (modified from Hoffmeister, 1989).

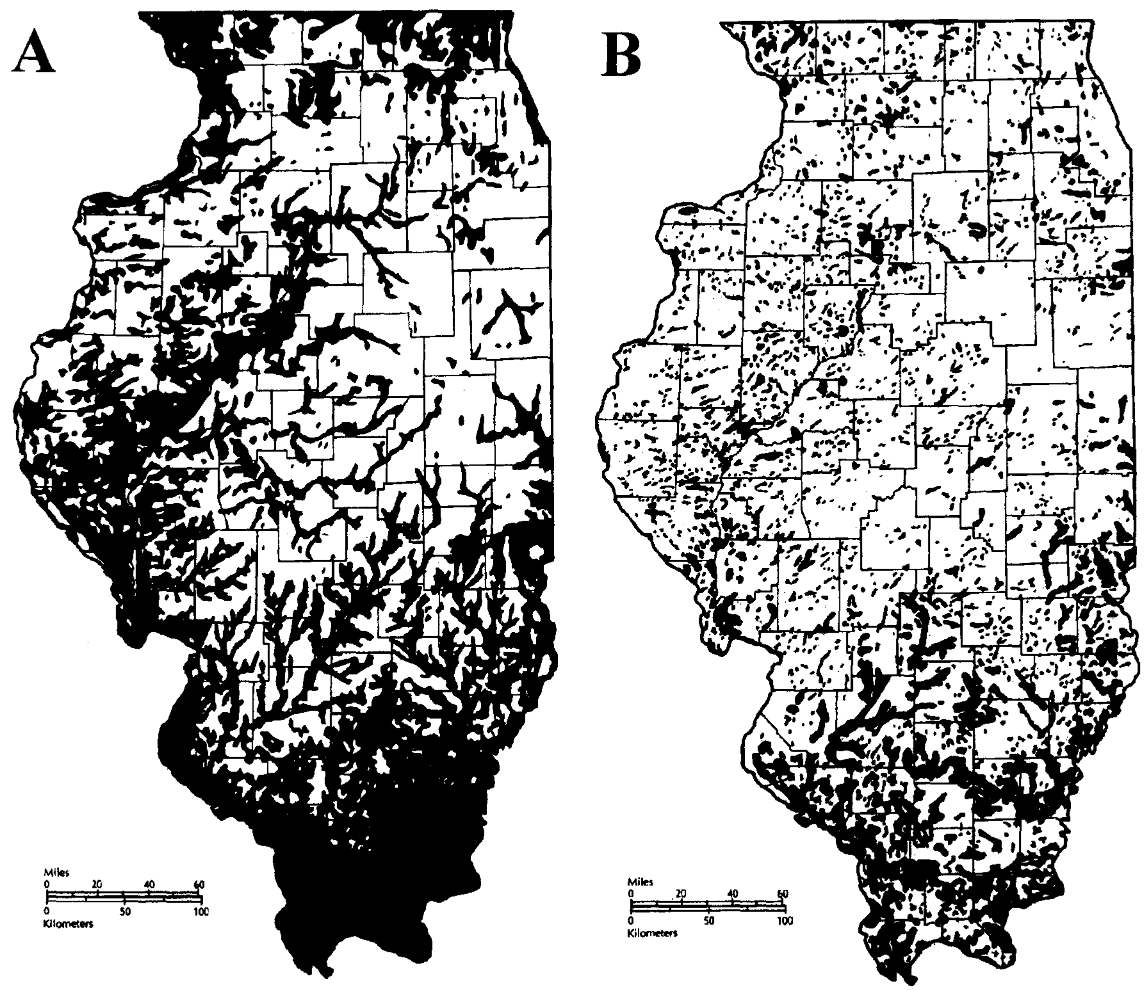
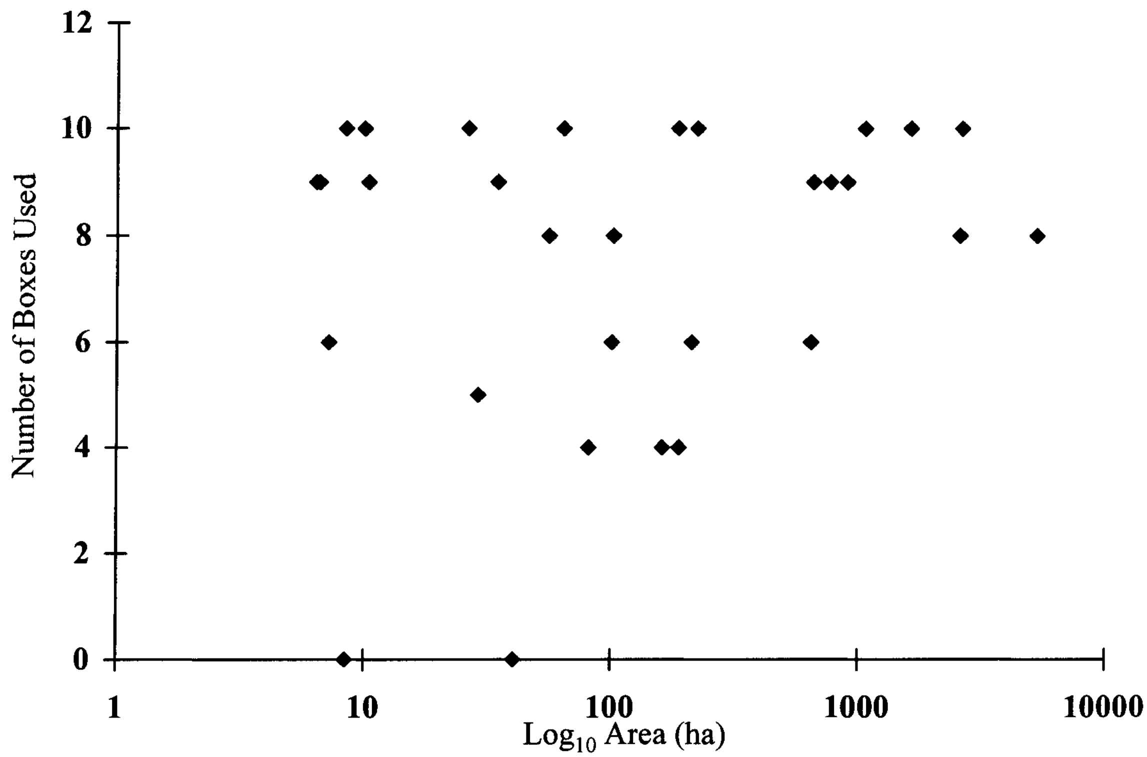
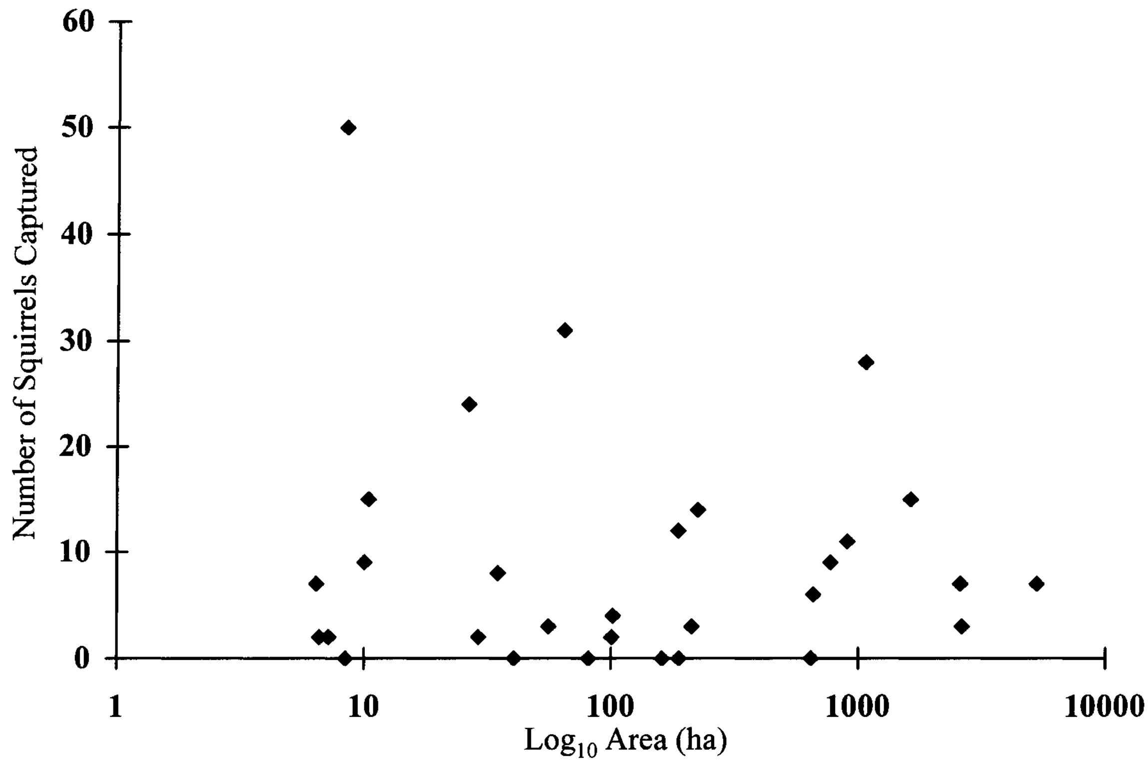

A
B
Miles
0 20 40 60
0 50 100
Kilometers
Miles
0 20 40 60
0 50 100
Kilometers

Figure 2. The number of southern flying squirrel nest boxes used (out of 10) in each of 30 habitat fragments in southern Illinois plotted against the $\log_{10}$ area (ha) of the fragment.



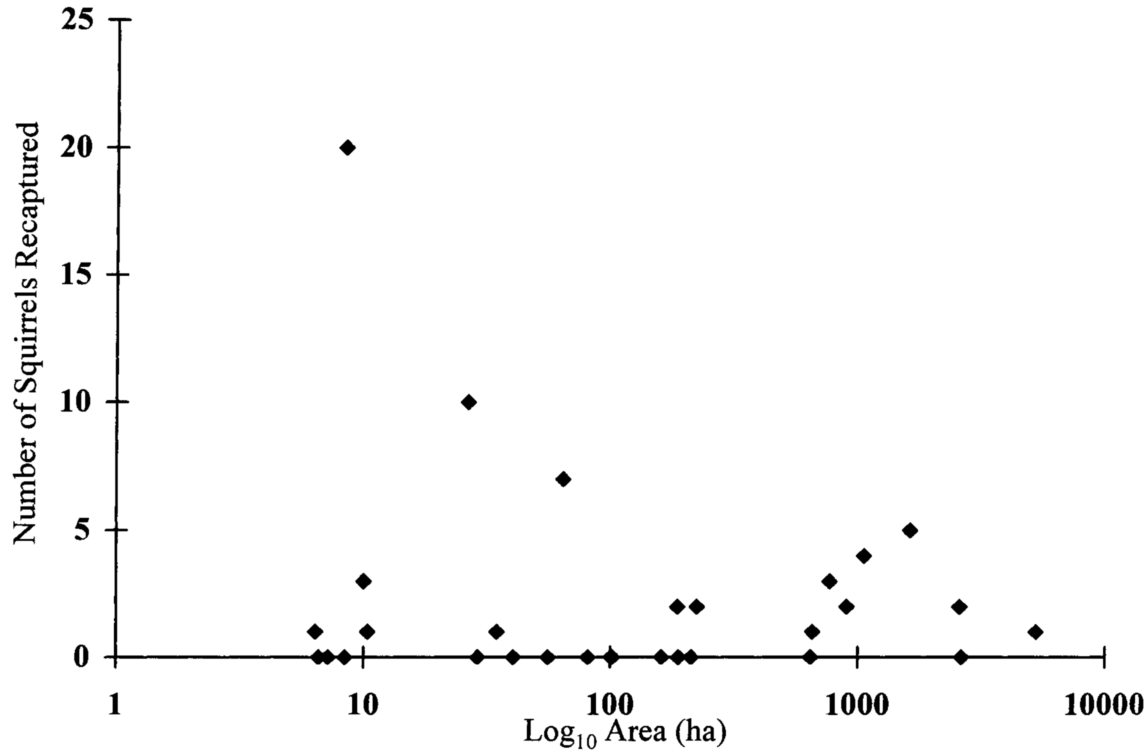
12
10
8
6
4
2
0
Number of Boxes Used
1
10
100
1000
10000
Log10 Area (ha)

Figure 3. The number of southern flying squirrels captured from nest boxes placed in 30 habitat fragments in southern Illinois plotted against the log_{10} area of the fragments.



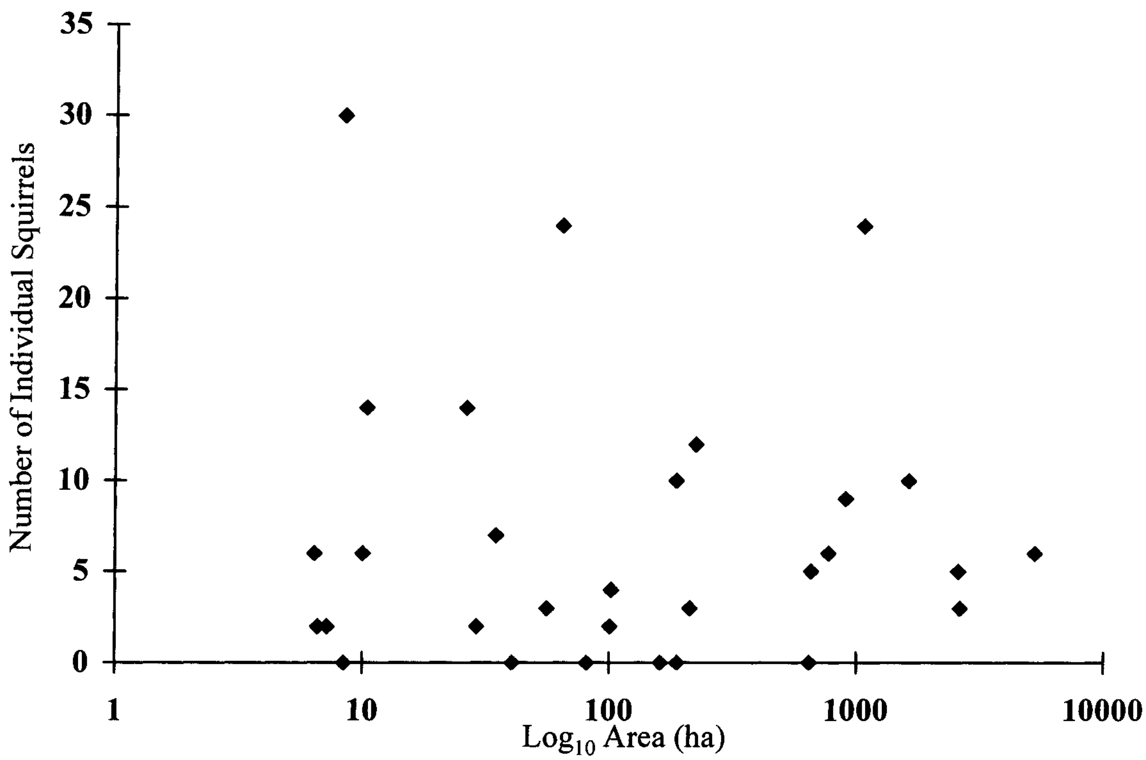
60
50
40
30
20
10
0
Number of Squirrels Captured
1
10
100
1000
10000
Log10 Area (ha)

Figure 4. The number of southern flying squirrels recaptured from nest boxes placed in 30 habitat fragments in southern Illinois plotted against the $\log_{10}$ area of the fragments.



25
20
15
10
5
0
Number of Squirrels Recaptured
1
10
100
1000
10000
Log10 Area (ha)

Figure 5. The number of different individual (captures - recaptures) southern flying squirrels captured from nest boxes placed in 30 habitat fragments in southern Illinois plotted against the $\log_{10}$ area of the fragments.



35
30
25
20
15
10
5
0
Number of Individual Squirrels
1
10
100
1000
10000
Log10 Area (ha)

Figure 6. The percentage of fragments with southern flying squirrel litters found in area size classes of habitat fragments in southern Illinois. "Very small" fragments ranged in size from 6-10 ha (N=7). "Small" fragments ranged in size from 26-81 ha (N=7). "Medium" fragments ranged in size from 100-223 ha (N=7), and "large" fragments ranged in size from 645-5264 ha (N=9).

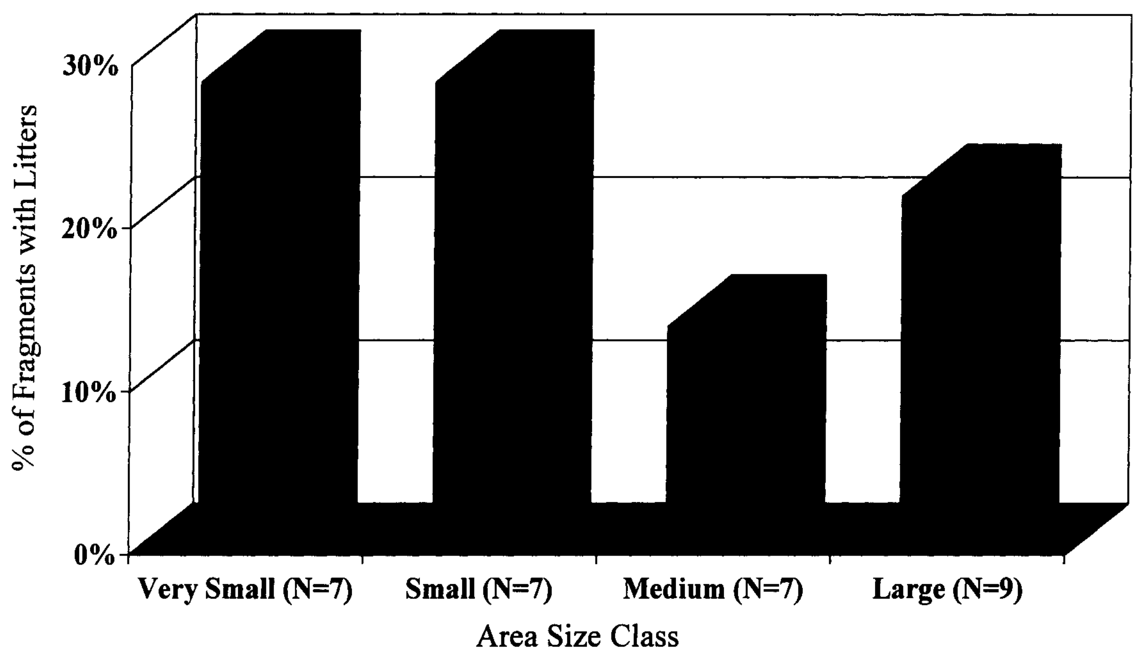
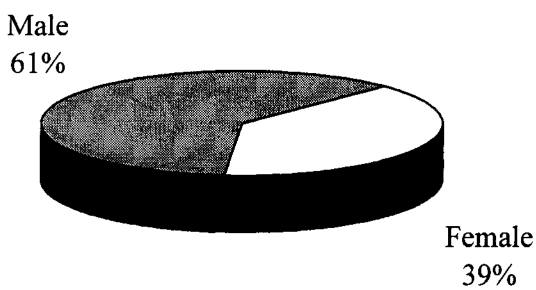
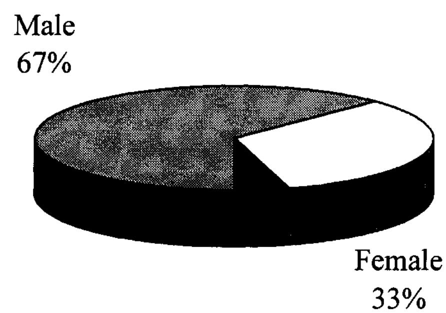

30%
20%
10%
0%
% of Fragments with Litters
Very Small (N=7)
Small (N=7)
Medium (N=7)
Large (N=9)
Area Size Class

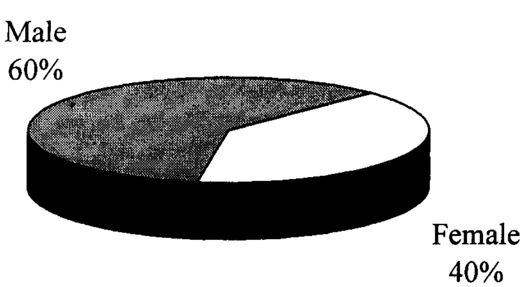
Figure 7. The sex ratios (expressed as a percentage) of southern flying squirrels in 4 area size classes of habitat fragments in southern Illinois. "Very small" fragments ranged in size from 6-10 ha (N=7). "Small" fragments ranged in size from 26-81 ha (N=7). "Medium" fragments ranged in size from 100-223 ha (N=7), and "large" fragments ranged in size from 645-5264 ha (N=9).



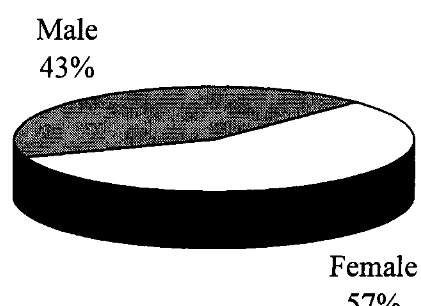
VERY SMALL



SMALL



MEDIUM



LARGE

Chapter II

FACTORS INFLUENCING NEST BOX USE BY THE SOUTHERN FLYING SQUIRREL (*Glaucomys volans*) IN SOUTHERN ILLINOIS

ABSTRACT

I examined factors which influence the use of nest boxes by southern flying squirrels (*Glaucomys volans*) in southern Illinois. I placed 300 nest boxes in 30 oak-hickory forest fragments in southern Illinois. Nest boxes were checked monthly between August 1996 and June 1997. Habitat variables that I measured described the nest box tree, the microhabitat surrounding the nest box tree, and the landscape level characteristics of the fragment's isolation and area. Flying squirrels used boxes in 28 of the 30 sites. Overall, 75% of the nest boxes were used; 22% as nests, 15% as feeding stations, 5% as defecatoria, and 33% as a combination of these. Stepwise logistic regression indicated that flying squirrels were more likely to use boxes that were in less isolated woodlots, on trees with a smaller DBH, which had a greater number of hard mast trees surrounding them, and in areas which had few fallen logs.

INTRODUCTION

The southern flying squirrel (*Glaucomys volans*) is a nocturnal sciurid (Burt and Grossenheider, 1980) that was relatively unstudied (but see Sollberger, 1940, Jordan, 1948) until artificial nest boxes were implemented as a research tool (Mull, 1968; Sonenshine et al., 1973; Heidt, 1977). The use of artificial nest boxes has revolutionized the study of the southern flying squirrel, and increased our knowledge of its reproductive ecology (Raymond and Layne, 1988), behaviors (Giacalone-Madden, 1976), and home range (Stone, 1993). The squirrels are often found denned up in the boxes during the day, making them easily accessible to researchers. In addition, capturing these animals with live-traps can be tedious and ineffective during certain times of the year (J. Scheibe, pers. comm.). Nest boxes on the other hand provide access to squirrels year-round with the exception of a few months in the summer when usage is reduced due to increased temperatures (Heidt, 1977).

Microhabitat variables which may influence the use of cavities and nest boxes by southern flying squirrels have been studied in Arkansas (Stojeba, 1978; Stone et al., 1996), Louisiana (Goertz et al., 1975), Maryland (Gilmore and Gates, 1985; Bendel and Gates, 1987), Missouri (Boardman, 1991), and Virginia (Sonenshine and Levy, 1981), with varying results. In addition, Mull (1968) gives an overview of habitats in which southern flying squirrel nests have been found. He suggested that southern flying squirrels are not restricted to a certain forest or tree type. He further noted that the choice of tree and cavity height followed that of woodpeckers (*Dendrocopos villosus* and *D. pubescens*) in the area, as flying squirrels do not excavate their own cavities.

Stojeba (1978) studied habitat factors relating to box use in summer and winter across 5 forest types. He found that factors associated with the tree that the box was placed on were the most important for predicting whether or not a nest box would be utilized. These factors included: nest box tree height, height of the nest box on the tree, and diameter at breast height of the tree. Goertz et al. (1975) correlated nest box use with the habitat surrounding the boxes. They found the greatest box use in cutover pine-hardwoods and the least amount of use in mature hardwood forests.

Sonenshine and Levy (1981) studied which specific vegetative variables were required by southern flying squirrels. They determined that the shrub and understory strata are important factors to flying squirrels. In particular, they suggested that a dense shrub layer is important to reduce the risk of predation to squirrels when they forage on the ground.

Gilmore and Gates (1985) explored why some nest boxes were used while others were not, although all were placed in apparently suitable habitat. They found that the number of medium sized (> 15.2-22.9 cm DBH), unbroken snags was less around boxes that were used. Additionally, used boxes had a greater number of stumps (> 38.1 cm DBH) in the surrounding area than unused boxes. Bendel and Gates (1987) studied microhabitat partitioning and their results were similar to those of Sonenshine and Levy (1981), in that more intensively used habitats had a greater total shrub-layer stem density. In addition, they found that higher-use habitats had a lower percent total upper-understory cover (> 10-15 m), and more tree cavities (Bendel and Gates, 1987). In contrast, Boardman (1991) found that flying squirrels showed a preference for nest sites which had less cover near the ground, possibly due to a more complex canopy structure in those areas.

The most recent study of microhabitat variables which influence nest box use was completed by Stone et al. (1996). Of 13 variables examined, they found that feeding stations were more likely to be on hardwood trees instead of pine. Other variables were not significant over the three years of their study (Stone et al., 1996).

Clearly, these studies have shown different microhabitat factors to be important to southern flying squirrels. The differences could be due to geographic variation in habitat preferences or different methods of data collection, emphasizing the importance of multiple studies over the geographic range of a species. No recent studies have been completed on southern flying squirrels in Illinois, nor have previous studies addressed broader landscape-level variables which may influence the use of nest boxes. The present study examines microhabitat, as well as landscape level variables, which may influence nest box use by southern flying squirrels in southern Illinois. Additionally, I report on the natural history of this species in this region.

METHODS

Study Sites. As part of a larger study to assess the effects of habitat fragmentation on the southern flying squirrel (Woodworth, 1997), 30 habitat fragments were selected in and around the Shawnee National Forest in Jackson, Johnson, Union, and Williamson counties in southern Illinois (Appendix A). The sites ranged in size from 6 to 5264 ha, and were primarily oak-hickory forests. They were selected to be as similar as possible in forest type, age, and topography, and to be suitable habitat for flying squirrels.

Nest boxes. Ten nest boxes were placed 50 m apart on a roughly square grid in each of the 30 sites. Nest box design was modified from Henderson (1992) with a 3.3 cm diameter hole. The boxes were placed approximately 2.2 m up on the south side of the tree between March and June 1996. After installation, boxes were checked approximately every four weeks. A total of 3870 box checks were made between April 1996 and June 1997. Box use was classified as: (1) nest site, (2) feeding station (3), defecatoria, (4) combination usage, or (5) no use. A nest box was considered a nest site if it contained nesting material characteristically used by southern flying squirrels such as shredded bark and/or leaves. A feeding station was a box which contained acorns, hickory nuts, and other food items. The hard mast was visually examined for gnawings made by southern flying squirrels. A box was considered a defecatoria if it had feces of flying squirrels in it. Combination usage was any combination of the previously mentioned classifications. Most often, a combination box was a nest site which was later converted to a feeding station or defecatoria. Box use categories are after Heidt (1977) with the exception of defecatoria (Mull, 1968).

Captured squirrels were weighed, sexed, and marked with a numbered metal ear tag before being released at the base of the tree. In addition, I noted their reproductive condition. Occasionally, squirrels were placed back into the nest box (*e.g.*, during extremely cold weather, or mother with young). Age classes were determined by body weight according to Raymond and Layne (1988). Squirrels > 50 g were classified as adults, subadults were 25-50 g, and nestlings were < 25 g.

Habitat sampling. Vegetation associated with each nest box tree was sampled in June and July 1996. Within 700-m^2 circular plots, all trees ≥ 8 cm diameter at breast height (DBH) were measured and identified to genus. The overstory trees were then placed into size classes (based on DBH) of 8-10 cm, > 10-20 cm, > 20-30 cm, > 30-40 cm, and > 40 cm. All trees and snags were classified into one of 9 stages representing a continuum from a living tree (1) to a stump (9) (Thomas et al., 1979). Additionally, logs (> 8 cm) were assigned a decomposition classification ranging from newly fallen (1) to nearly complete decomposition (5) (Maser et al., 1979).

The species, height, bark texture (rated from 1-4 [smooth to very rough] as in Boardman, 1991), and diameter at breast height of each nest box tree were also recorded. Additionally, canopy cover was estimated with a densiometer, and ground cover was visually estimated using 1-m^2 circular quadrats. Four estimates of canopy cover and ground cover were taken at 5 m from each nest box tree in each of the 4 cardinal directions. The habitat variables selected for statistical analysis were modified from Gilmore and Gates (1985), Boardman (1991) and Stone et al. (1996) (Appendix B).

Statistical Analysis. I used forward stepwise logistic regression to model factors which influence nest box use by southern flying squirrels (SAS Institute, 1989). A nest box was considered used if it had a nest, defecatoria, or feeding station in it. A total of 47 habitat variables were initially considered. These potential independent variables were first correlated with each other to avoid using variables which were highly autocorrelated. For example, the relative density of hard mast trees was highly correlated with the basal area of hard mast trees ($r = 0.9556$). Thus, only the relative density of hard mast trees was retained as a candidate independent variable. Where variables were autocorrelated, the variable most commonly used in other studies was selected for comparison. In 2 cases I combined 2 variables to create single, new variables. For example, I combined trees in the 2 largest diameter classes. I again searched for autocorrelations among the remaining variables, and found no significant correlations existed among the 14 variables I eventually used as candidate independent variables (Table 1). The cutoff for variables to be entered into the model was at the $P < 0.05$ level. Pearson product moment correlation coefficients were used to correlate the predictor variables with box use. Finally, Student's t-tests were used for univariate comparisons of the habitat variables at used and unused boxes.

RESULTS

Captures and use of boxes. The number of captures varied by month with a peak in October (Figure 1). The mean aggregation size of squirrels in used boxes also varied monthly, but was highest in November (3.4), December (2.8), and January (3.3) (Figure 2). The largest aggregation was 9 squirrels found in one box in November. Of the 300 boxes, 226 (75%) were used. At some point during the study, nests were found in 148 of the boxes. Feeding stations were found in 126 of the boxes, and 59 of the boxes were used as defecatoria. Squirrels were captured in 98 of the boxes. The remaining 74 boxes did not have any signs of use. According to my classification scheme, 74 were classified as "nest only" boxes, 44 were "feeding station only" boxes, 16 were "defecatoria only" boxes, and 100 of the boxes were "combination usage" (Figure 3).

The sex ratio of captured squirrels was significantly male biased with 1.3 males per 1 female ($\chi^2 = 3.88$, *d.f.* = 1, $P < 0.05$). The mean weight of adult males was 67 g, whereas the mean weight of adult females was slightly higher at 73 g. As flying squirrels are known to have litters in both the spring and the fall, the data are divided by season. A total of 5 litters were found in the spring. All 5 of these litters had 2 young each. In the fall of 1996, 5 litters were found. These litters ranged in size from 2-4 with a mean of 3.2 young per litter. The mean litter size was 2.4 for both seasons combined.

Factors influencing nest box use. Stepwise logistic regression techniques identified 4 variables that influenced whether or not a nest box was used. The following equation depicts the coefficients and the independent variables:

$$P[x] = p(d = \frac{1}{x}) = \frac{1}{1 + e^{(2.9641 - 0.00454(DCW) - 0.0234(DBHNBT) + 0.0553(RDNT) - 0.0948(NL))}}$$

where d = used/unused nest boxes, DCW = distance closest woodlot, DBHNBT = DBH of nest box tree, RDNT = relative density nut trees, and NL = no. of logs.

The first variable entered into the model was distance to closest woodlot or isolation which had a negative relationship with box use (P = 0.0001). The second variable entered was diameter at breast height of the nest box tree which also had a negative relationship (P = 0.0126). There was a positive relationship between the relative density of hard mast trees and whether or not a box was used (P = 0.0079), and finally there was a negative relationship with the number of fallen logs in the area (P = 0.0051). The model was concordant 75.3% of the time, meaning that about 75% of the time it correctly predicted a box would be used when if fact it was used. SAS uses a series of rank correlations to assess the predictive ability of the model (SAS, 1990). These are Somers' D (maximum value = 1.0), Goodman-Kruskal Gamma (maximum value = 1.0), Kendall's Tau-a (maximum value = 0.5), and the c indices (maximum value = 1.0). The predictive ability of the model was not extremely high (Somers' D = 0.509; Goodman-Kruskal Gamma = 0.510; Kendall's Tau-a = 0.191; c = 0.754). The habitat variables that were significantly different between used and unused boxes were: DBH of nest box tree (t = 2.430, P = 0.001), % canopy cover (t = -0.598, P < 0.001), area of sites (t = -3.319, P = 0.002), and isolation (t = 4.990, P < 0.001).

DISCUSSION

I found the southern flying squirrel to be a relatively common species in southern Illinois, as it used boxes in 28 of the 30 sites. In fact, 75% of the 300 boxes were classified as "used." Southern flying squirrels formed the largest aggregations in November, December, and January, suggesting that these form primarily for thermoregulatory purposes (Mull, 1968; Stapp et al., 1991). These findings agree with other reports that aggregations increase during the coldest part of the year (Goertz et al., 1975; Sonenshine et al., 1979; Gilmore and Gates, 1985; Sawyer and Rose, 1985; Stapp et al., 1991; Layne and Raymond, 1994). Previously reported sex ratios have been male biased (Heidt, 1977; Gilmore and Gates, 1985; Sawyer and Rose, 1985; Layne and Raymond, 1994) as was the sex ratio in this study.

The last report on litter size of southern flying squirrels in Illinois came from Jordan (1956). He sacrificed 6 females from central Illinois to examine embryos in March. He found a mean of 3.3 embryos with a range of 2-5. The litter size of spring litters I found in southern Illinois was not as large as what Jordan (1956) found ($N = 5$, $\bar{x} = 2$). However, the 5 litters I found in the fall were closer to his results with a mean of 3.2. In addition, I did not find any litters of 5. My results are possibly lower due to infant mortality and/or reabsorption of fetuses.

Southern flying squirrels were more likely to use boxes that were in less isolated woodlots, and boxes which were placed on trees with a smaller DBH (within the range of 32 - 60 cm). In addition, squirrels tended to use boxes which were in areas that had a greater number of hard mast trees, and areas which had lower numbers of fallen logs.

It is not surprising that the distance to the closest woodlot was the first variable entered into the model, as the 2 most isolated woodlots did not have any box use (and thus accounted for 20 of the 74 unused boxes). This may be in part due to decreased levels of dispersal to areas which are extremely isolated (> 0.5 km). It was surprising that the diameter at breast height of nest box trees was negatively related to nest box use. However, none of the nest boxes were placed on trees with a diameter less than 32 cm. Perhaps boxes on the largest trees were less likely to be used because they were more likely to contain natural cavities. When Stojeba (1978), used discriminant function analysis to determine variables important to box use by flying squirrels, he also found the DBH of the nest box tree to be an important factor. However, he did not state whether there was a positive or negative relationship between DBH and nest box use.

Squirrels were more likely to use boxes in areas where there was a greater density of hard mast-producing trees such as oaks (*Quercus* sp.), and hickories (*Carya* sp.). It seems likely that this is because these tree species' fruits represent a large part of the squirrels' diet (Weigl, 1969; Harlow and Doyle, 1990). This finding agrees with Stojeba (1978) whose analysis included total food trees, "other" species of food trees, and total black oaks as important factors explaining nest box use by southern flying squirrels in Arkansas.

The southern flying squirrel is known to use subterranean areas such as under root systems and trees as secondary nests and retreats (Mull, 1968). I found that southern flying squirrels were more likely to use boxes in areas which had fewer logs. The nest boxes may be used as a supplement because there is a lack of subterranean retreats and nesting sites in these areas.

My model had a level of concordance of 75.3%. The other measures of predicted probabilities were not extremely high either. For example, the Kendall's Tau-a was 0.191 with 0.50 being the maximum value. Therefore, I conclude that there may be better predictors of nest box use by southern flying squirrels than the variables I measured. However, I designed my study specifically to test landscape level differences, not microhabitat differences. Thus, all of my boxes were placed in apparently suitable habitat for squirrels. Clearly, my level of prediction would have been higher if I had placed boxes in less suitable habitat as well.

Regardless, of which habitat variables predict box usage the fact still remains that some boxes are used while others are not. Perhaps if my study was longer I would see other variables were important over certain years. Over a 3-year study of nest box usage, Stone et al. (1996) found that most variables were not significant consistently over all 3 years. It is possible that I may not have put the most important predictor variables into my model. In addition, my study sites were selected to be as uniform in vegetation type as possible in order to assure that "area effects" were not due to differences in other habitat variables. The differences found in the various studies of southern flying squirrel nest box use and habitat selection may be due to the different geographic locations where the studies were conducted. Alternately, they may be due to slight differences in sampling methods or simply that within relatively suitable habitat southern flying squirrels may be habitat generalists.

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Table 1. The 14 variables used as candidate independent variables in the logistic regression model of nest box use by southern flying squirrels in southern Illinois, and t-test results comparing unused and used boxes. Variables in bold were entered into the logistic regression model at the $P < 0.05$ significance level.

Variable	t-value*	P-value
Distance to Closest Tree	-1.560	0.120
Height of Nest Box Tree	-0.273	0.785
DBH Nest Box Tree	2.430	0.017
Bark Texture	0.091	0.927
% Canopy Cover	-0.598	0.551
% Ground Cover	2.950	0.004
No. Large Trees (> 35 cm DBH)	-1.804	0.072
Relative Density Trees	-1.775	0.770
Relative Density Hard Mast Trees	-3.601	0.000
No. Stage 2 and 3 Snags	0.267	0.789
No. Total Snags	0.786	0.432
No. Logs	2.748	0.006
Area	-3.319	0.001
Isolation	4.990	0.000

*Negative values associated with a higher mean for used boxes.

Figure 1. The number of southern flying squirrels captured per month from 300 nest boxes placed in 30 sites in southern Illinois. (*July and August (J/A) checks were combined.)

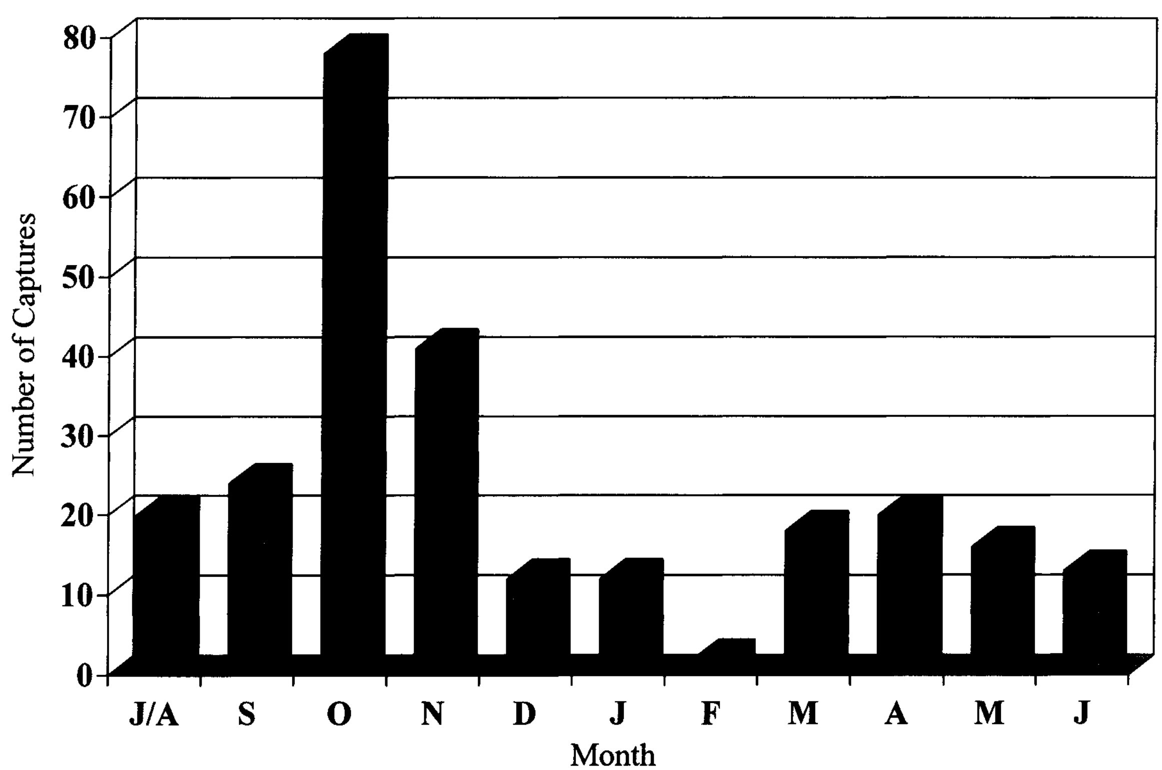

80
70
60
50
40
30
20
10
0
Number of Captures
J/A
S
O
N
D
J
F
M
A
M
J
Month

Figure 2. The mean aggregation size of southern flying squirrels captured from nest boxes in southern Illinois. February was not reported due to a low sample size. (*July and August (J/A) checks were combined.)

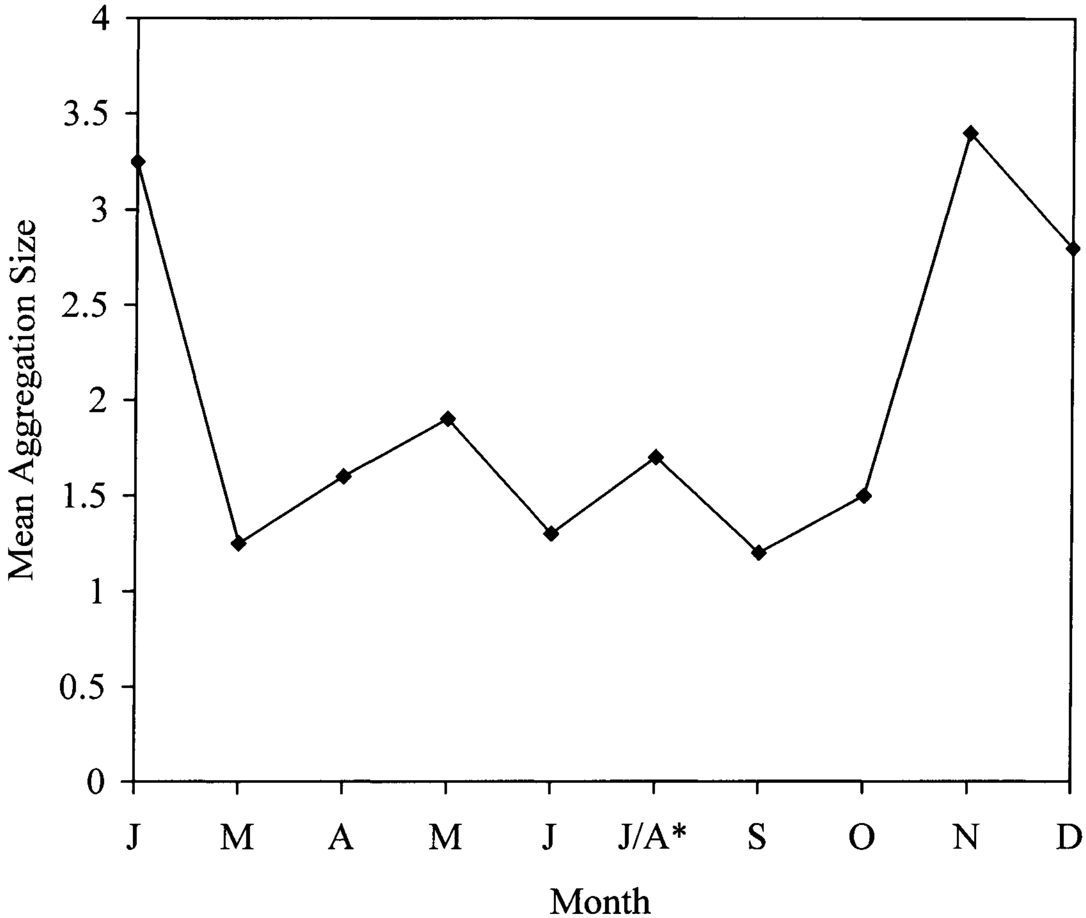
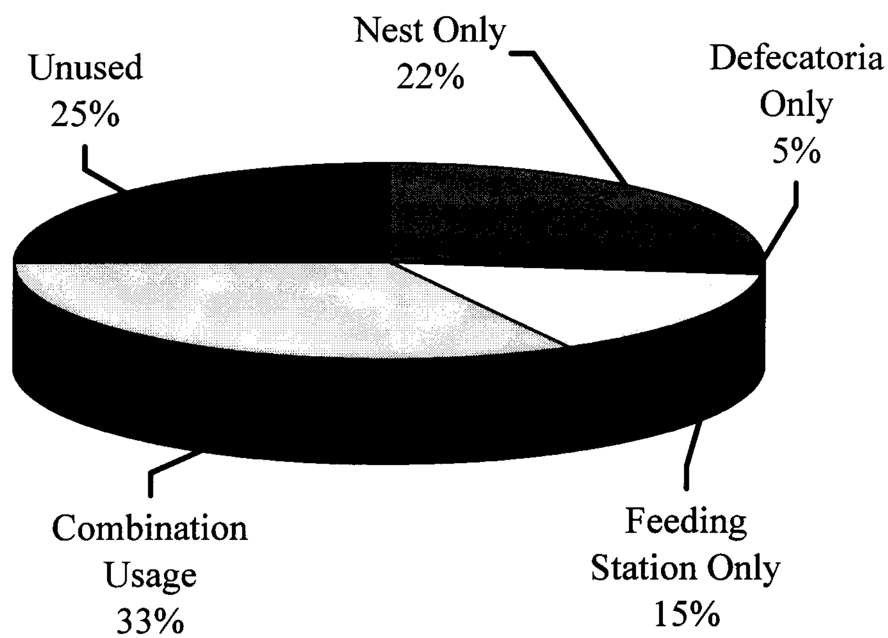
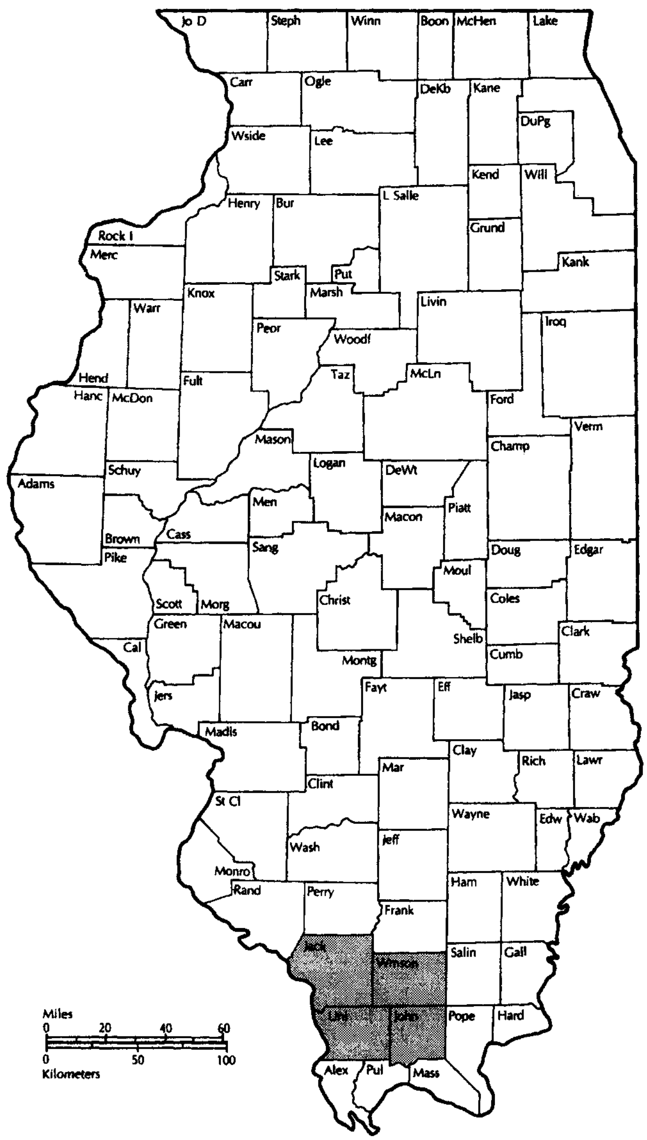

Mean Aggregation Size
4
3.5
3
2.5
2
1.5
1
0.5
0
J
M
A
M
J
J/A*
S
O
N
D
Month

Figure 3. The classification of nest boxes, expressed as a percentage of 300 boxes placed in 30 sites in southern Illinois.


Nest Only
22%
Unused
25%
Defecatoria
Only
5%
Combination
Usage
33%
Feeding
Station Only
15%

Appendix A. The counties where this study occurred (highlighted in gray): Jackson, Johnson, Union, and Williamson counties.


Jo D
Steph
Winn
Boon
McHen
Lake
Carr
Ogle
DeKb
Kane
DuPg
Wside
Lee
Kend
Will
Henry
Bur
L Salle
Grund
Rock I
Merc
Stark
Put
Kank
Knox
Marsh
Livin
Warr
Peor
Woodf
Iroq
Hend
Hanc
McDon
Fult
Taz
McLn
Ford
Verm
Mason
Champ
Schuy
Logan
DeWt
Adams
Men
Piatt
Macon
Brown
Cass
Pike
Sang
Doug
Edgar
Moul
Scott
Morg
Christ
Coles
Green
Macou
Shelb
Clark
Cal
Montg
Cumb
Jers
Fayt
Eff
Jasp
Craw
Madis
Bond
Clay
Rich
Lawr
Mar
Clint
St Cl
Wayne
Edw
Wab
Wash
Jeff
Monro
Rand
Perry
Ham
White
Frank
Jack
Salin
Gall
Wmson
Miles
0
20
40
60
0
50
100
Kilometers
Uni
John
Pope
Hard
Alex
Pul
Mass

Appendix B. Abbreviations and descriptions of habitat variables measured in 700 m^2 circular plots centered at southern flying squirrel (*Glaucomys volans*) nest boxes in southern Illinois. Variables in bold were used as candidate independent variables in the logistic regression model described in Chapters 1 and 2. (*Variables were significant ($P < 0.05$), and were entered in the model as predictors of box use by southern flying squirrels.)

Variable	Description of variable and method of collection
Area	Area of study site (ha). Measured with Sigma Scan™ from U.S.G.S. maps (photo revised 1990).
Bark Texture Nest Box Tree	Bark texture of nest box tree: smooth (1), medium (2), rough (3), very rough (4) (as in Boardman, 1991).
Basal Area	The basal area of all trees in the plot measured at DBH.
% Canopy Cover	Canopy cover estimated 4 times at each plot to the north, south, east, and west of the nest box tree with a densiometer.
DBH Nest Box Tree*	Diameter (cm) at breast height (1.4 m) of nest box tree.
Distance Closest Tree	Distance to the closest tree (m) from the nest box tree that was ≥ 8 cm DBH.

Appendix B, continued:

% Ground Cover	Ground cover (%) visually estimated 4 times to the north, south, east, and west of each nest box tree with a 1-m^2 circular hoop.
Height Nest Box Tree	Height (m) of the nest box tree measured with a clinometer.
Isolation*	Distance to closest woodlot (m) ≥ 5 ha.
No. Large Trees	The number of trees (≥ 35 cm DBH) in plot.
No. Logs*	Number of logs in plot.
No. Snags	The number of snags in plot.
Relative Density	Number of trees in plot ≥ 8 cm DBH
Relative Density Hard Mast Trees*	Number of hard mast producing trees (oaks, hickories, walnuts) ≥ 8 cm DBH in plot.
Size Class	Area size class of woodlot (ha) divided into 4 classes. Very Small: 6-10 ha (N=7) Small: 26-81 ha (N=7) Medium: 100-223 ha (N=7) Large: 645-5264 ha (N=9)
Snags Grouped	The number of snags classified as snag stage 2 or 3 in plot.
Tree Species	Tree species of nest box tree.

Appendix C. The means of selected habitat variables collected at 30 sites in southern Illinois.

Site	Area (ha)	Size Class	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Hard Mast Trees	# Snags	# Logs
BB	188.4	M	94	19	20.1	9.5	3.0	6.3
BK	34.8	S	94	37	26.7	10.0	1.8	9.2
BU	7.2	VS	97	30	29.8	9.9	6.1	4.2
CE	6.6	VS	91	35	22.6	3.3	6.5	5.6
CL	223.1	M	95	31	27.3	14.9	5.3	3.8
CP	10	VS	93	30	23.1	10.6	5.0	6.5
DK	1061.6	L	96	13	32.3	11.7	2.3	6.4
DN	81.2	M	94	52	24.2	4.3	9.2	9.1
DR	645.2	L	93	35	23.8	11.5	3.4	6.0
FA	10.4	VS	97	27	35.2	24.6	2.4	6.0
GC	658.2	L	92	21	28.5	18.0	5.4	9.1
HA	64	M	93	18	37.9	18.2	4.3	7.1
HC	8.4	VS	94	20	32.0	14.5	2.7	1.5
HF	29	S	98	12	33.3	6.1	6.1	5.5
HH	2568	L	96	21	25.8	15.4	5.5	6.3
IM	772.8	L	95	19	24.7	8.4	4.2	6.3
LG	2613.4	L	93	9	26.0	6.6	6.8	10.1
PA	908.8	L	98	16	19.9	11.6	2.2	2.9
PI	5264	L	95	17	23.8	6.2	3.4	7.1
RL	26.4	S	84	50	25.7	3.8	7.8	3.3
RO	186.2	M	95	15	32.6	15.8	12.2	4.2
RT	102	M	95	23	24.6	5.2	6.6	7.4
RY	100.7	M	94	18	28.6	19.3	7.1	7.6
SU	6.4	VS	96	11	21.4	6.9	3.5	5.6
TR	212	M	88	24	32.8	17.3	5.5	8.0
TT	1623.6	L	94	11	30.3	9.8	3.8	6.0
TW	8.4	VS	89	51	26.7	5.4	6.3	7.9
VT	56	M	96	14	35.7	14.2	7.0	4.4
WA	40.6	S	96	47	24.3	5.9	9.0	6.8
WO	160.8	M	97	37	25.2	3.8	3.4	7.2

Appendix D. Southern flying squirrel data collected from nest boxes at 30 sites in southern Illinois.

Site	Area (ha)	Size Class	Isolation (m)	# Captures	# Recaptures	# Individuals	# Male Captures	# Female Captures
BB	188.4	M	219.6	0	0	0	0	0
BK	34.8	S	195.2	2	0	2	0	2
BU	7.2	VS	122	2	0	2	1	1
CE	6.6	VS	439.2	2	0	2	1	1
CL	223.1	M	146.4	14	2	12	5	9
CP	10	VS	73.2	9	3	6	3	6
DK	1061.6	L	0	28	4	24	7	15
DN	81.2	M	73.2	0	0	0	0	0
DR	645.2	L	0	0	0	0	0	0
FA	10.4	VS	390.4	15	1	14	8	7
GC	658.2	L	0	6	1	5	2	4
HA	64	M	73.2	31	7	24	21	10
HC	8.4	VS	73.2	49	20	29	29	20
HF	29	S	195.2	2	0	2	0	2
HH	2568	L	0	7	2	5	5	2
IM	772.8	L	0	9	3	6	7	2
LG	2613.4	L	0	3	0	3	0	3
PA	908.8	L	0	11	2	9	4	4
PI	5264	L	0	7	1	6	1	1
RL	26.4	S	366	24	10	14	14	10
RO	186.2	M	73.2	12	2	10	9	2
RT	102	M	73.2	4	0	4	3	1
RY	100.7	M	73.2	2	0	2	1	1
SU	6.4	VS	146	7	1	6	2	5
TR	212	M	122	3	0	3	2	1
TT	1623.6	L	0	15	5	10	4	11
TW	8.4	VS	634.4	0	0	0	0	0
VT	56	M	97.6	3	0	3	2	1
WA	40.6	S	536.8	0	0	0	0	0
WO	160.8	M	73.2	0	0	0	0	0

Appendix E. Habitat variables associated with each nest box tree and the number of southern flying squirrels (*Glaucomys volans*) captured at that box from a study of the southern flying squirrel in southern Illinois. (*Box Use: U = Ununsed, N = Nest, D = Defecatoria, FS = Feeding Station.)

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
BB	1	U	0	0.01	56.8	27.15	2	96%	2%	18	4	360	3	3
BB	2	D	0	1.5	41.3	26.05	3	91%	24%	25	16	499	4	2
BB	3	U	0	1.2	35.4	20.65	4	98%	9%	21	5	387	2	6
BB	4	U	0	2	32.1	19.05	3	94%	28%	15	4	317	2	2
BB	5	U	0	0.6	28.6	15.15	3	83%	24%	34	17	530	11	18
BB	6	D	0	4.7	39.2	27.95	2	88%	21%	19	17	451	1	1
BB	7	U	0	2.2	51.4	20.95	3	99%	28%	14	4	378	1	7
BB	8	N,FS	0	4.1	27.5	21.85	3	99%	15%	26	14	466	1	6
BB	9	U	0	1.8	31.5	33.05	2	95%	15%	18	11	450	1	3
BB	10	U	0	2.3	45	27.45	3	100%	25%	11	3	251	4	15
BK	1	N	0	2.75	30	29.45	3	96%	8%	31	5	715	1	3
BK	2	N	1	2.8	30.1	21.8	4	94%	70%	27	4	499	4	17
BK	3	N,FS	0	1.5	38.2	22.85	2	89%	75%	24	9	514	2	14
BK	4	N,FS	3	1.8	34.6	22.6	3	97%	39%	28	19	654	2	5
BK	5	N	0	2.08	28.7	25.1	4	94%	9%	33	9	671	3	9
BK	6	N,FS	1	2.5	34.3	26.85	4	96%	58%	36	15	820	0	2
BK	7	N	3	4.9	40.6	27.05	2	97%	12%	18	13	568	0	5
BK	8	U	0	2.9	44	18.95	2	98%	18%	29	8	617	1	23
BK	9	N,FS	0	1.85	39.3	27.35	2	92%	48%	19	9	463	3	8
BK	10	FS	0	1.7	43.2	32.45	2	88%	35%	22	9	486	2	6
BU	1	U	0	0.3	55	26	2	95%	33%	21	3	407	5	6
BU	2	U	0	5.1	55	31.2	3	98%	10%	15	5	409	5	6
BU	3	D	0	0.15	35.5	22.65	2	95%	14%	35	7	745	4	7
BU	4	D	0	1.7	25.9	21	3	99%	58%	35	22	865	10	1
BU	5	FS	0	4.4	31.7	24.25	3	97%	9%	26	8	594	2	8
BU	6	N	1	2.1	34.3	20.9	2	96%	18%	33	1	779	9	1
BU	7	D	0	0.5	41.5	24.8	2	99%	71%	27	18	599	9	2
BU	8	N	1	2	38.2	34.25	2	97%	3%	54	18	1118	7	7

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
BU	9	U	0	1.75	25.7	19.85	4	94%	34%	26	16	510	3	4
BU	10	U	0	4.3	30	23.65	2	98%	49%	26	1	644	7	0
CE	1	FS	0	3.3	48.1	31.2	4	55%	69%	20	4	328	14	2
CE	2	N,FS	1	3.45	27.2	14.55	1	91%	4%	36	2	592	9	9
CE	3	U	0	2.8	64.5	35.9	1	97%	17%	16	0	258	4	5
CE	4	N,FS	0	3.1	26.9	26.9	3	97%	19%	17	3	311	6	7
CE	5	FS	0	4.5	36.3	23.75	3	98%	4%	21	5	411	7	5
CE	6	N,FS	0	5.1	47.2	29.25	4	98%	43%	28	3	530	3	3
CE	7	N,FS	0	3.6	25.1	13.45	3	92%	58%	24	11	520	5	8
CE	8	N,FS	1	1.02	25.2	30.9	2	96%	29%	19	1	433	5	4
CE	9	N,D	0	1.3	45.9	21.65	3	96%	39%	23	4	433	7	11
CE	10	D,FS	0	1	48	28.25	2	88%	66%	22	0	496	5	2
CL	3	N	3	1.7	36.6	27.35	3	95%	34%	22	14	450	4	2
CL	4	N,FS	2	0.15	31.6	25.8	2	95%	6%	29	13	487	10	5
CL	5	FS	0	1.3	39.6	24	2	96%	11%	25	12	579	2	6
CL	6	FS	0	2.5	28.8	29.05	2	96%	30%	31	14	591	3	2
CL	7	FS	0	0.4	36.4	22.85	2	96%	40%	22	15	588	4	3
CL	9	N,FS	3	5.4	37.2	26.85	2	96%	9%	27	15	551	3	2
CL	10	FS	0	0.55	17.5	25.1	4	95%	46%	23	20	569	4	6
CL	11	N,D	0	5.4	30.8	22.1	3	95%	22%	33	25	803	3	3
CL	12	N,FS	8	1.7	29.5	24.15	2	94%	54%	33	6	563	13	3
CL	13	N,FS	1	2.7	71.6	32.2	2	93%	56%	28	15	566	7	6
CP	1	FS	2	6	41.3	22.05	3	93%	49%	22	16	584	5	12
CP	2	FS	5	3.7	41.1	14.55	3	88%	4%	24	20	372	1	2
CP	3	D,FS	1	3.1	76	21.35	4	89%	80%	21	5	401	6	11
CP	4	N,FS	0	2.8	36.2	19.2	2	98%	6%	18	2	328	5	4
CP	5	U	0	0.52	45.6	21.95	2	99%	4%	15	4	271	10	14
CP	6	FS	0	4.2	89.8	31.9	2	94%	43%	16	6	384	8	5
CP	7	N,FS	0	3	63.2	28.65	2	97%	40%	32	8	690	3	8
CP	8	U	3	3.5	29.5	21.15	4	92%	16%	26	15	604	3	4
CP	9	U	1	2.7	42	20.25	4	95%	23%	31	18	631	6	3
CP	10	D,FS	0	5	66.5	36.55	2	88%	31%	26	12	386	3	2

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
DK	1	N,FS	4	1.6	45.6	33.85	3	98%	2%	37	27	899	4	2
DK	2	N,FS	1	2.9	33	22.8	2	98%	14%	28	13	712	0	6
DK	3	N,FS	1	3.3	58.7	42.75	4	98%	1%	28	13	538	4	9
DK	4	N	5	0.7	43	28.4	3	98%	14%	42	0	992	8	13
DK	5	N	3	0.5	21.6	17.2	2	97%	27%	29	9	631	1	4
DK	6	N,D	0	1.1	43.2	29.2	2	98%	4%	37	26	801	0	3
DK	7	N	1	4.4	29.6	32.05	2	96%	4%	33	8	687	2	11
DK	8	N	1		47.7	26.3	2	98%	21%	26	10	604	0	4
DK	9	N	0	1.1	58.6	40.75	2	97%	7%	29	10	575	2	9
DK	10	D,FS	9	1.8	51.7	31.5	3	86%	36%	34	1	848	2	3
DN	1	N,FS	0	0.8	58.1	23.5	2	89%	65%	37	5	705	15	11
DN	2	U	0	2.23	67.9	32.5	2	94%	60%	21	12	549	6	16
DN	3	N,FS	0	0.15	42.3	26.95	3	97%	56%	20	13	418	1	1
DN	4	U	0	0.3	31	20.9	3	94%	66%	25	1	523	5	14
DN	5	U	0	0.8	89.1	19.9	3	91%	63%	23	0	501	10	5
DN	6	U	0	3.4	49.7	22.8	4	94%	56%	23	2	629	8	3
DN	7	U	0	0.85	30	15.95	2	88%	45%	17	6	409	13	7
DN	8	N	0	0.4	33.1	18.95	4	97%	44%	22	0	456	12	7
DN	9	N,D	0	4.9	61.1	32.65	2	94%	34%	22	3	460	6	7
DN	10	U	0	0.7	27	23.35	3	98%	33%	32	1	610	16	20
DR	1	FS	0	2.2	68.3	29.15	3	97%	26%	27	14	503	1	8
DR	2	N	0	0.225	31.8	30.3	3	90%	3%	32	18	594	3	5
DR	3	U	0	0.1	54.7	27.85	3	97%	43%	22	10	512	4	9
DR	4	N	0	1.9	35.6	34.75	2	90%	54%	18	7	482	3	1
DR	5	N	0	2.7	30.6	34	3	88%	40%	14	9	342	1	2
DR	6	N	0	1.7	20.5	27.35	4	91%	25%	32	21	634	4	3
DR	7	FS	0	1.6	41.6	24.35	3	94%	44%	26	14	368	5	12
DR	8	U	0	1.7	50.4	23.75	3	97%	46%	18	10	410	4	9
DR	9	U	0	2.3	42.7	32.65	3	93%	35%	25	6	597	4	2
DR	10	U	0	2.3	80.2	33.15	3	96%	36%	24	6	518	5	9
FA	1	FS	0	2.1	46.3	36.6	4	94%	48%	48	22	896	5	16
FA	2	N,D	3	2.65	30.9	29.1	2	99%	0%	38	23	736	3	4

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
FA	3	N	4	4.85	72.3	26.35	3	98%	30%	37	28	845	1	2
FA	4	N	3	2.55	46.2	29.95	2	98%	19%	35	17	671	2	9
FA	5	N,D	0	0.6	64.8	36.3	2	97%	44%	26	21	526	3	3
FA	6	N,D	1	1.85	38.9	24.3	4	97%	4%	48	37	946	2	4
FA	7	N	6	1.85	37.8	29.7	2	97%	53%	28	25	586	4	5
FA	8	N,FS	1	1.9	53	30.05	2	96%	59%	21	14	455	3	1
FA	9	U	0	2.8	44.1	16.85	2	97%	4%	25	22	371	0	6
FA	10	N	0	4.1	44.4	29.9	2	97%	9%	46	37	958	1	10
GC	1	N,D,FS	1	4.1	45.6	25.5	3	88%	4%	25	12	599	4	8
GC	2	U	0	2.6	36.6	26.35	2	91%	30%	19	17	353	4	8
GC	3	D,FS	0	4.6	40.2	22.85	3	92%	4%	23	17	525	5	12
GC	4	D,FS	1	1.2	47.6	21.9	2	94%	18%	37	16	699	6	10
GC	5	D,FS	0	2.2	36.8	26.25	2	96%	15%	30	24	658	2	5
GC	6	D,FS	0	2.7	39.2	27.15	3	95%	34%	26	18	482	8	10
GC	7	N,D,FS	1	3.3	37.3	23.2	2	85%	33%	34	17	646	8	17
GC	8	D	0	0.97	46.5	21	2	89%	29%	25	19	535	10	9
GC	9	N,D	3	1.3	46.8	23.1	2	90%	20%	33	20	681	3	7
GC	10	D,FS	0	0.3	42.5	23.65	2	96%	18%	33	20	755	4	5
HA	2	N	3	6.1	35.2	32.45	3	89%	8%	32	15	766	6	6
HA	3	N,D,FS	1	1.9	29.6	31.15	3	98%	11%	49	22	1097	9	13
HA	5	N,FS	0	1	43.7	26.75	3	97%	45%	38	22	888	3	9
HA	6	N	2	1.1	31.2	21.55	3	88%	3%	32	27	822	1	6
HA	7	N,D	0	2.7	37	23.85	3	98%	16%	48	25	1082	3	5
HA	11	D	0	1	54.1	11.45	2	90%	13%	40	13	770	5	5
HA	12	N,D	2	5.9	36.4	20.15	3	98%	33%	38	4	730	5	4
HA	13	N,FS	16	0.15	30.5	27.25	4	89%	31%	46	30	850	2	9
HA	14	N,D	7	3	30.4	21.05	1	84%	14%	28	5	596	5	3
HA	15	N,D,FS	1	1.7	47.5	27.05	2	98%	3%	28	19	784	4	11
HC	1	FS	1	2.3	23.3	10.7	4	96%	21%	37	3	589	1	0
HC	2	N	17	2.8	34.9	23.2	3	95%	65%	32	15	626	2	0
HC	3	N,FS	0	1.1	56.5	30.95	2	98%	9%	40	17	862	2	1
HC	4	N,D,FS	5	1.2	87.7	24.35	2	96%	36%	30	15	552	1	6

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
HC	5	N	3	0.48	41	22.65	2	97%	24%	34	17	672	5	1
HC	6	N	6	0.2	34.4	20.05	2	75%	10%	27	3	521	4	1
HC	7	FS	0	2.2	69.3	36.5	2	97%	2%	19	17	409	6	2
HC	8	N,FS	11	1.6	46.1	23.3	4	95%	6%	30	10	600	2	1
HC	9	N	6	2.9	34.9	27.85	3	97%	19%	34	29	760	0	1
HC	10	N	1	3.55	51.1	23.3	4	96%	11%	37	19	673	4	2
HF	1	U	0	1.2	107.6	35.45	2	98%	5%	41	10	819	2	1
HF	2	D	0	1.6	36.6	29.85	2	97%	3%	45	5	797	5	4
HF	3	FS	0	2	39.1	21.5	3	97%	14%	34	0	728	16	3
HF	4	N,FS	0	0.4	38.9	32.05	2	97%	28%	25	0	515	2	3
HF	5	D	0	2.5	40.6	27.8	3	99%	1%	31	13	697	4	9
HF	6	U	0	3.55	45.1	33.25	4	98%	8%	26	3	614	8	7
HF	7	U	0	2.4	74.7	27.9	3	98%	31%	29	14	731	0	10
HF	8	U	0	1.8	53.6	25.6	3	99%	9%	41	10	695	11	7
HF	9	U	0	2.75	39.7	22.35	3	99%	8%	29	4	601	7	6
HF	10	N	6	2.3	27.9	22.9	3	98%	12%	32	2	606	6	5
HH	6	FS	0	1.25	20.5	22.05	2	97%	35%	16	12	354	5	5
HH	7	FS	0	2.6	57.4	25.8	3	94%	3%	14	5	292	4	1
HH	8	N	0	1.9	35.6	23.95	3	97%	23%	24	13	500	4	11
HH	9	N	5	1.43	34.8	22.6	2	88%	35%	29	9	621	7	6
HH	10	N	5	0.35	30.9	20.75	2	97%	36%	38	25	726	4	9
HH	11	N,FS	0	1	53.2	50.6	2	95%	20%	32	25	726	8	11
HH	12	FS	0	0.9	49.1	23.85	2	98%	28%	35	28	787	5	6
HH	13	N,FS	0	1.4	21.6	22.15	2	98%	18%	28	14	732	5	2
HH	14	FS	0	2.6	66.1	31.1	2	95%	3%	24	15	498	7	7
HH	15	N	0	1.95	34.1	26.55	3	99%	9%	18	8	362	6	5
IM	5	N	5	2.4	46.4	24.15	4	97%	31%	27	19	573	1	8
IM	6	U	0	1.6	36.6	33.45	2	92%	9%	15	3	389	4	4
IM	7	FS	0	2.6	43	21.35	3	99%	21%	20	10	482	11	10
IM	8	N	3	2	25.8	27.35	3	87%	9%	17	5	407	3	1
IM	9	D	0	0.01	58.3	37.95	2	100%	31%	26	2	600	11	13
IM	10	N,FS	0	2.4	46.6	27.05	2	97%	11%	28	6	550	3	4

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
IM	11	N,D,FS	0	0.2	36.7	24.75	3	100%	33%	24	6	482	6	2
IM	12	FS	0	2.2	38.1	29.75	2	91%	25%	31	15	605	2	3
IM	13	N,FS	1	1.7	31.3	32.35	3	94%	12%	24	12	478	0	13
IM	14	N,FS	0	0.13	36.2	25.95	3	95%	5%	35	6	723	1	5
LG	1	FS	0	0.9	58.4	27.95	2	90%	3%	14	4	304	7	1
LG	2	FS	0	1.1	47.7	25.55	4	97%	4%	47	9	849	8	8
LG	3	N,FS	0	0.795	59.3	29.65	2	97%	2%	39	9	823	10	18
LG	4	FS	0	1.17	53.3	27.85	2	96%	5%	17	10	473	7	17
LG	5	N,FS	3	2.1	66.8	26.5	3	97%	20%	17	6	385	5	17
LG	6	N,FS	0	2.532	36.5	33.85	3	88%	2%	28	12	632	2	10
LG	7	D,FS	0	1.004	37.1	20.35	4	88%	9%	38	4	690	8	9
LG	8	FS	0	1.83	57.1	33.25	3	88%	2%	23	4	411	9	5
LG	9	D,FS	0	1.085	25.3	25.25	2	97%	40%	13	3	303	8	12
LG	10	FS	0	1.78	85.3	34.25	2	90%	7%	24	5	556	4	4
PA	1	N,FS	0	1.65	54.7	29.55	2	98%	34%	17	4	493	0	0
PA	2	FS	0	6	35.5	25.7	3	99%	6%	17	7	519	3	7
PA	3	N,FS	2	1.4	41.9	31	3	99%	5%	20	16	566	4	2
PA	4	N	1	4.5	42.3	31.1	3	95%	12%	17	14	447	5	2
PA	5	FS	0	3.6	52	34.35	2	98%	25%	12	8	390	3	1
PA	6	N,D,FS	0	2.2	36.5	26.9	3	98%	8%	24	15	520	3	5
PA	7	N,FS	0	1.75	41.3	26.35	2	99%	18%	26	19	536	1	6
PA	8	U	0	0.8	31.6	24.8	3	98%	29%	30	8	552	3	2
PA	9	N	2	6.2	43.3	28.05	2	98%	24%	17	10	521	0	1
PA	10	N	6	1.1	31.8	21.75	2	98%	7%	19	15	543	0	3
PI	1	FS	1	2	50	29.1	2	99%	7%	25	8	509	6	15
PI	2	FS	0	2.38	76.8	35.35	3	98%	13%	31	6	593	1	5
PI	3	U	0	1.14	73.1	24.9	3	92%	9%	22	6	518	2	7
PI	4	N	0	4.85	61.8	35.9	3	91%	30%	21	2	633	1	4
PI	5	N	2	2.6	31.8	23.75	2	98%	25%	18	2	488	4	6
PI	6	U	0	5.4	89.4	31.65	2	97%	11%	23	11	633	1	7
PI	7	N,FS	0	1.3	50.4	25.65	2	98%	24%	20	2	442	3	8
PI	8	FS	0	2.1	34	28.1	2	89%	15%	18	6	438	4	8

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
PI	9	D	2	1.4	41.5	25.4	2	91%	19%	34	10	704	11	3
PI	10	N	2	2.1	39.6	23.9	2	99%	20%	26	9	628	1	8
RL	1	N	2	0.65	39	24.05	2	98%	38%	23	8	525	9	4
RL	2	N,FS	4	1.45	10	23.45	3	54%	92%	25	3	421	13	0
RL	3	N,D,FS	0	1.9	36.3	27.95	3	96%	48%	25	1	475	3	0
RL	4	N,D,FS	2	3.9	30.6	20.85	3	94%	59%	13	2	275	13	6
RL	5	N	1	1.3	38.7	26	1	41%	26%	42	3	840	16	9
RL	6	N,FS	0	2.6	31.5	19.1	2	91%	40%	19	4	515	0	4
RL	7	N,FS	0	2	32.3	25.45	2	85%	45%	45	3	1069	4	5
RL	8	N	6	1.1	24.3	19.65	2	95%	22%	10	0	200	11	4
RL	9	N,FS	0	3.5	36	21.2	2	92%	78%	20	4	368	1	0
RL	10	N	10	2.25	45.7	22.8	2	97%	50%	35	10	753	8	1
RO	4	N	1	1.8	40.7	26.45	2	88%	8%	30	11	670	13	5
RO	5	FS	0	0.3	42	26.6	3	97%	11%	38	19	634	5	2
RO	6	FS	0	0.9	44.2	22.25	2	87%	22%	45	2	701	22	0
RO	7	N	3	3.25	28.8	24.4	2	98%	10%	26	14	558	3	1
RO	8	FS	0	2.9	47.7	28.5	2	98%	5%	27	15	559	2	1
RO	9	N,FS	0	2.1	31.4	16.65	2	96%	25%	35	32	893	6	11
RO	10	N,D	6	2.1	30.8	30.85	2	90%	20%	34	28	820	4	10
RO	11	N,D,FS	3	2.1	50	24.8	2	98%	27%	18	11	368	19	0
RO	12	N	2	1	31.2	17.75	2	96%	13%	28	16	540	14	5
RO	15	N	0	3.7	33.3	23.15	4	98%	10%	45	10	731	34	7
RT	3	FS	0	0.1	41.8	24.25	2	95%	35%	32	0	478	20	0
RT	4	U	0	1.2	26.4	24.4	2	98%	4%	42	3	744	14	11
RT	5	FS	1	3.1	44.1	28.05	3	94%	8%	15	9	363	2	8
RT	8	U	0	2.1	28.6	23.3	2	84%	30%	16	6	320	6	7
RT	9	D	0	3.65	45.2	32.8	3	97%	15%	23	9	607	2	13
RT	10	N,D,FS	1	2.7	36	25.8	2	95%	23%	23	7	609	5	5
RT	13	D,FS	0	0.6	40	32.95	4	95%	49%	18	5	474	5	3
RT	14	N,D,FS	0	1.3	35.3	33.7	2	96%	6%	26	5	602	3	6
RT	16	N,D,FS	0	3.1	68.5	40.75	2	98%	13%	19	6	503	2	17
RT	17	N,FS	2	2.34	37.4	29.15	2	95%	45%	32	2	732	7	4

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
RY	1	U	0	2.2	38.7	19.85	3	90%	40%	27	22	617	4	11
RY	2	D	0	4.2	42.6	44.9	2	97%	9%	30	16	726	1	2
RY	3	N	1	2.3	43.4	23.65	2	96%	16%	33	22	685	8	13
RY	4	D	0	1.7	70.3	23.75	3	97%	46%	38	24	794	8	6
RY	5	D	1	1.8	42.7	21.75	2	83%	31%	22	8	582	13	6
RY	6	D	0	1.25	41.4	26.7	2	96%	12%	22	11	420	19	8
RY	7	U	0	3.4	45	28.65	2	90%	3%	24	13	520	7	7
RY	8	U	0	2.6	25.3	21.35	2	97%	14%	40	34	948	2	8
RY	9	D	0	1.7	46.3	19.85	2	93%	5%	18	14	494	3	6
RY	10	U	0	1.7	38.9	24.9	3	96%	5%	32	29	862	6	9
SU	1	U	0	0.85	36.9	23.5	3	92%	13%	21	7	575	4	7
SU	2	N	0	3.31	48.5	26.05	4	95%	13%	24	8	686	3	2
SU	3	N	0	1.05	44.4	28.4	3	97%	1%	19	3	519	4	12
SU	4	N	1	2.25	27.6	25.85	4	97%	23%	24	6	642	4	5
SU	5	N,FS	0	2.9	49.2	50.6	2	98%	13%	26	5	718	1	5
SU	6	N	1	0.15	34.1	22.9	4	95%	4%	22	13	508	3	4
SU	7	N	1	2.25	33.4	22.15	4	96%	13%	18	4	468	7	7
SU	8	N	0	3.65	46.3	30.65	3	95%	27%	22	7	574	1	3
SU	9	N	5	1.75	42.2	23.3	2	95%	3%	19	10	639	4	5
SU	10	N	0	2.2	47.1	24.8	4	96%	3%	19	6	523	4	6
TR	4	N,FS	0	0.8	36.4	24.3	2	99%	63%	19	3	367	4	6
TR	5	U	0	0.6	67.6	33.05	2	98%	5%	22	10	486	5	8
TR	6	U	0	0.3	37.9	36.4	2	97%	20%	21	9	433	2	5
TR	7	N	0	2.7	35.4	26.45	4	96%	16%	10	3	340	1	4
TR	10	U	0	2.65	54.8	37.65	2	94%	25%	50	29	1098	2	4
TR	11	U	1	0.9	30.5	30.6	2	94%	50%	67	30	1321	11	14
TR	12	U	0	1.95	48.7	19.55	2	23%	21%	47	38	875	4	11
TR	13	N,FS	0	2.65	32.2	29.9	3	88%	31%	37	17	817	10	12
TR	14	N	1	3.1	31.9	24.85	3	98%	8%	26	18	568	10	10
TR	15	N	0	2.5	42.1	30.1	2	97%	2%	29	16	685	6	6
TT	1	FS	1	1.75	60.4	23.75	2	99%	15%	36	16	734	4	9
TT	2	N,FS	0	2	43.6	33.3	2	98%	2%	37	13	727	0	4

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
TT	3	N	6	1.7	53.2	29.05	3	80%	1%	30	8	702	8	8
TT	4	FS	0	3.45	72.5	20.05	2	97%	8%	29	20	551	2	6
TT	5	N,FS	0	3.6	90.8	26.8	3	99%	3%	32	3	600	5	5
TT	6	N,FS	3	0.9	30	22.85	2	90%	18%	23	5	413	7	2
TT	7	N,D,FS	3	0.486	33.7	31	2	98%	7%	29	2	649	6	4
TT	8	N,D,FS	0	1.6	70.5	22.25	3	97%	18%	25	5	443	3	10
TT	9	N,D,FS	3	1.8	60.7	37.25	2	88%	4%	26	6	548	2	4
TT	10	N,FS	0	2.3	57.2	27.65	2	90%	34%	36	20	698	1	8
TW	1	U	0	1	37.2	21.55	2	88%	86%	23	8	497	6	5
TW	2	U	0	1.95	91.4	38	2	86%	40%	31	4	627	2	9
TW	3	U	0	0.7	77.3	30.25	3	98%	78%	35	10	727	6	3
TW	4	U	0	0.95	81.2	31.75	3	96%	29%	28	10	638	11	9
TW	5	U	0	3.7	30.2	24.95	2	97%	8%	35	4	729	5	1
TW	6	U	0	7.2	82.3	34.5	2	74%	48%	16	1	360	7	10
TW	7	U	0	2.5	67	20.15	2	84%	64%	21	8	453	9	17
TW	8	U	0	0.9	43.1	26.2	2	85%	13%	31	2	659	5	10
TW	9	U	0	0.03	55.7	27.75	4	98%	56%	29	4	667	6	13
TW	10	U	0	3.7	31.6	20.4	2	81%	86%	18	3	414	6	2
VT	1	N,FS	0	3.1	33	25	4	97%	1%	38	29	866	3	3
VT	2	N	1	3.3	34	32.2	2	97%	1%	19	14	485	7	3
VT	3	FS	0	3.5	54	22.15	2	95%	12%	25	19	623	1	4
VT	4	N	1	6.2	42.2	29.35	3	90%	12%	18	13	414	3	6
VT	5	N	1	5.5	40.2	51	3	96%	27%	33	30	825	6	11
VT	6	D	0	3	72.8	43.3	3	99%	16%	36	10	820	6	1
VT	7	U	0	2.1	53.7	27.3	3	95%	1%	33	12	645	15	6
VT	8	U	0	1.75	46.7	43.8	2	97%	48%	50	4	780	7	5
VT	9	FS	0	1.7	69.7	41	3	97%	14%	59	11	927	17	0
VT	10	U	0	1.75	37.3	18.75	4	95%	3%	46	0	944	5	5
WA	1	U	0	2.2	41.2	24.7	2	95%	93%	17	2	465	7	14
WA	2	U	0	1.6	37.7	23.55	2	95%	35%	33	13	695	9	5
WA	3	U	0	2.06	68.3	27.3	4	98%	30%	18	5	386	5	6
WA	4	U	0	1.8	28	21.83	2	91%	84%	32	8	708	10	6

Site	Box #	Box Use*	# Captures	Distance to Closest Tree (m)	DBH (cm)	Height (m)	Bark Texture	% Canopy Cover	% Ground Cover	Relative Density Trees	Relative Density Nut Trees	Basal Area Trees	# Snags	# Logs
WA	5	U	0	0.2	58.7	22.1	4	96%	31%	21	5	391	13	11
WA	6	U	0	0.7	30.4	22.45	2	97%	35%	27	4	429	5	12
WA	7	U	0	1.17	29.7	26	3	96%	74%	25	9	467	7	1
WA	8	U	0	3.8	54.33	32.25	2	97%	20%	15	3	243	10	4
WA	9	U	0	2.05	39.1	25.1	2	98%	31%	32	8	578	17	8
WA	10	U	0	1.45	40	18.95	4	96%	38%	23	2	425	7	1
WO	3	FS	0	3.8	47.5	25.8	2	100%	11%	33	0	789	2	5
WO	5	U	0	0.5	37.4	19.15	3	99%	39%	31	2	691	2	9
WO	6	N	0	0.78	66.8	28.9	2	95%	70%	29	9	587	8	12
WO	7	U	0	0.76	52.9	31.65	3	90%	40%	25	1	661	3	9
WO	8	U	0	2	46.7	28.55	2	94%	38%	22	4	546	3	9
WO	9	N	0	3.8	75.2	36.2	2	100%	33%	17	4	489	2	8
WO	10	N	0	2.1	30.2	20.35	3	99%	18%	30	8	492	5	5
WO	11	U	0	2.5	57.8	31.85	2	98%	43%	20	6	508	3	6
WO	12	U	0	0.8	35.1	29.95	3	96%	46%	26	2	470	5	6
WO	13	U	0	3.5	31.9	26.95	2	98%	33%	19	2	477	1	3