Confirming the Presence of the Southern Flying Squirrel, *Glaucomys volans* on Erie National Wildlife Refuge and Examination of Habitat Variables Affecting Nest Box Use

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Introduction:

The purpose of this project was to determine the presence and abundance of Northern (*Glaucomys sabrinus*) and Southern Flying Squirrels (*Glaucomys volans*) and to determine which habitat variables influence their choice of nest box on two sites where flying squirrels have been previously observed nesting on Erie National Wildlife Refuge. It is known that both species reside in this area of Pennsylvania (See Figure 1) (Burt 1976) though no one had yet determined which of the species is present on the refuge. Flying squirrels are known to make use of nest boxes on the refuge as well as in other areas when natural cavities are scarce (Stone et al.1996, Gilmore and Gates 1985, Hayward and Rosentreter 1994). Time constraints and inexperience in the wildlife management field on my part allowed only a investigation of the nest boxes, and not natural cavities. Also, because flying squirrels are nocturnal, trapping or other sorts of methods for estimating abundance of a species could not be done during daylight hours, as this project required.

Several variables have been found to be correlated with flying squirrel habitat choice in previous studies. I reviewed literature on both northern and southern flying squirrel behavior and habitat choice, but only the information relating to the southern species is mentioned here because none of the northern species were found on the sites that I surveyed.

One habitat variable which is cited in studies involving flying squirrel habitat choice is amount of understory cover. Bendel and Gates (1987) found that the habitats with the most flying squirrel activity had the highest percent total upper-understory cover. This cover is hypothesized to be favorable for the flying squirrels because it facilitates fairly easy gliding from tree to tree, a behavior especially advantageous when fleeing to a den to hide

from predators. The same study found that squirrels were most active in a habitat with higher percentages of lower-understory cover, yet kept their dens in the areas where there was the least percent total lower-understory cover. The authors suggest that this trend results from the advantage of increased cover provided by the lower-understory layer for foraging squirrels in the active areas. Therefore, the percent total lower-understory cover would not be such a strong factor in den habitat choice because the squirrels will not be seen around the den area as much by predators except for entering and leaving their dens.

The authors of the previous study also suggest that tree size and the heights that accompany them may be positively correlated with flying squirrel habitat use because larger trees allow them more surface area to land on when gliding from tree to tree and they may also be advantageous because the taller a tree is, the longer a flying squirrel can glide. Therefore, a very tall canopy with sparse upper-understory and dense lower-understory would be the most fit for a flying squirrel because the height of trees and sparseness of upper-strata would be most energy efficient, while the dense lower-strata would conceal movements form terrestrial predators.

The amount of brush cover has also been studied as a possible habitat variable. Again, Bendel and Gates studied this variable and found that the high-use areas by southern flying squirrels had the greater total shrub-layer stem density. They hypothesize that this correlation is seen because the density of plants near the ground can conceal the animals when they do forage on the ground or to conceal den entrances near or on the ground.

One variable which has been studied several times in relation to flying squirrel habitat is species of tree in the squirrels habitat. It has been found that southern flying

squirrels prefer to nest in areas with predominately hardwood vegetation. It has been noted that southern flying squirrels often rely on hickory and oak masts to feed on during the winter. In fact, many studies have found that these two species of tree are often abundant in the habitats of southern flying squirrels. In fact, it has been found that the northern boundary of *Glaucomys volans*' range coincides with the range of mast-producing tree species, especially hickories and oaks (Weigl 1978). Furthermore, other studies found that where mast-producing species were more prevalent, the squirrels home ranges tended to decrease in size (Fridell and Litvaitis 1991). Muul (1974) found southern flying squirrels in a variety of mixed-hardwood and mixed- hardwood and pine habitats in Pennsylvania. The species found included oak, maple, aspen, hickory, birch and pine, and Fridell and Litvaitis (1991) found that large hickories and birches were more prevalent in the squirrels' summer home ranges in New Hampshire than in unused sites.

One more variable which has been proven positively correlated with southern flying squirrel habitation is coarseness of the bark in their habitat. It is thought that the coarseness of the bark aids in landing when the squirrels jump from one tree to another because they are unable to grasp the tree with their claws unless there is some coarseness to the bark which they can dig their nails into and maintain their landing position (Stone et al.1996, Bendel and Gates 1987).

Diameter of nest entrance is also a variable extensively studied in choice of natural cavities, especially woodpecker cavities by southern flying squirrels. Glaucomys volans often utilizes old woodpecker cavities because they often co-inhabit the same habitats, and the cavities are usually readily available. The entrances that woodpeckers make are fairly small too, which adds to the cavities' appeal because they are small enough for the small

southern flying squirrel to fit through, but not its competitors like the larger grey squirrel, or predators. Entrance diameter has been found to be correlated with both nest box and natural cavity use in several studies (Stone et al. 1996, Loeb 1993).

Distance to the nearest tree from the squirrel's nest was also found to be related to habitat choice in a study by Loeb (1993). She found that the distance to the nearest tree was negatively correlated with use of dens in only one year of her three year study. She suggests that this finding may be due to the fact that other squirrels would not be able to gain access to the southern flying squirrel's den if the closest entry point is far away. I cannot help but wonder if there would be a positive correlation in other areas because it seems that the closer a tree is to a squirrel's den, the better chance they have to escape from predators by gliding quickly to that tree. But maybe if the tree is relatively far away, the squirrel will have a better chance at escaping because it be able to get farther away with the same amount of effort.

One more variable which was not discussed in any literature I read, but which I was interested in evaluating to see if it had any effect was distance from a water source.

Methods:

Part 1: Determination of Flying Squirrel Species and Distribution

Weekly observations of nest boxes erected for wood duck use in the Pool 9 Outlet and Muddy Creek areas on Erie National Wildlife Refuge were made from March 20 to April 27, 1998. The first check involved prying out the nails keeping the boxes shut so I was able to see inside and look for squirrels. I soon realized that the squirrels would be rather startled as soon as they heard noise outside of their box,and would quickly jump out and

try to escape. So, after I had established which boxes the squirrels were nesting in (I rechecked each box over several weeks to establish that none of them had changed nest boxes), I simply hit the outside of the box a few times with my hand to make them jump out while placing a mesh net over the entrance. I found if I used a cloth bag, the squirrels would not jump out, but instead find another way to squeeze out and avoid being caught. Yet with the mesh, they were unable to discern the net from the rest of the environment, and jumped right into it. I then removed the squirrel from the net, while wearing leather gloves, to examine the fur on the squirrel's stomach. This was the only way to tell the southern and northern species apart without much deliberation. Southern flying squirrels have completely white hair on their stomachs while the northern species' fur is ash-colored near the base (Burt 1976). It was often difficult to discern for certain whether the fur was colored due to the movement of the squirrel each time I made an attempt to touch its stomach. I spent a lot of time trying to catch the squirrels to see what species they were and looking in additional sites where squirrels might inhabit the nest boxes, that I had much less time remaining for the second aspect of this project than I had hoped for.

Part 2: Habitat Variable Evaluation

Measurements of several habitat variables were then made around inhabited nest boxes as well as the boxes surrounding them that the squirrels did not inhabit. These habitat variables were measured because they have shown correlations with flying squirrel habitat choice in previous studies. I wanted to do a very accurate evaluation of the habitats in order to make a comparison between those of the inhabited and uninhabited boxes, yet as stated earlier, time constraints made that impossible. I referred to the U.S. Department

of the Interior's publication Estimating Wildlife Habitat Variables (Hays et al. 1981) in order to know how I should accurately estimate the variables I wanted to measure. Yet again, time constraints a low manpower prevented me from carrying out most of those evaluations in the way they suggest. Instead I compared the nest box habitats to each other when explaining density of canopy and brush, some variables were simply measured in inches of feet with a tape measure. The density of and type of trees were taken within a 30 foot radius of the nest box. I was unable to do the evaluation of tree species like I had hoped due to the fact that I have had little experience in tree identification, and because the leaves of the trees were not out yet. This made if very difficult to distinguish one tree from another. Instead, I counted the number of hardwoods and conifers within the 30 foot radius.

Data:

See Figures 2 through 4.

Notes on Fig. 2:

The squirrel in box #4048 was "undetermined" species because he never returned to the box after the first day observed nesting there, so I never got to get catch him.

Also, for box #4052, although there were three squirrels in there during most observation times, I was only able to classify the species of one at a time. Therefore I do not know for sure whether they were all southern, but I am supposing that they are since they were nesting together and also for purposes of data analysis . I am supposing the squirrel that was in box #4048 was also southern for purposes of data analysis also.

Results/Conclusions:

It is difficult to draw any solid conclusions from the data because the method of collecting the data was not extremely accurate and because the data set is so small. There was way too much room for confounding variables and experimenter bias to draw any strong conclusions from this data set, although they do show some small trends. Only surveying the five nest boxes with squirrels nesting in them does not allow for any solid conclusions on correlations between habitat variables and choice of nest box because the sample size is so small.

There appears to be no significant difference in total density of trees surrounding the inhabited and uninhabited boxes. There were 47 trees in the uninhabited sites and 51 in the inhabited sites. However, the density of trees between different box sites varied considerably. This may be due to the fact that a squirrel may not be choosing the nest box for the immediate tree population around it. They may instead base their decision more on the forest community/area as a whole.

There may be an effect on nest box choice brought about by the type of tree. There were 36 hardwood trees and 15 conifers total on inhabited sites while there was almost an equal amount of both on uninhabited sites (26 hardwood, 23 conifer). This suggests that southern flying squirrels may have a preference for hardwoods in their surroundings. This could be due to the possibilities mentioned earlier including food sources, or that hardwoods serve as better sites for their cavities since the squirrels are rarely found nesting in conifers.

The coarseness of the bark appears to show no correlation with nest box use. There were 8 smooth-bark trees out of 47 for the uninhabited sites and one out of 51 for

the inhabited sites. This may be because the squirrels are able to stay fairly safe from predators being in the nest box. The predators cannot reach the nest boxes as easily as cavities in trees, therefore making it unnecessary for a flying squirrel to flee the den and glide to another so often. Yet, it is important for the squirrel to have coarse bark on the surrounding trees if escape is needed, as was demonstrated to me first hand via the squirrel in Box 4043 who glided toward a tree with smooth bark when I startled him. He hit the tree with his feet and struggled to keep his hold of the tree trunk. Try as he must, he failed to stay on the tree, and slid down to the bottom.He then scurried away and jumped onto another tree with coarse bark.

The distance to the closest tree from the nest box did not appear to differ significantly. In fact, the distance to the closest tree for almost every uninhabited and inhabited pair of nest boxes was equal except for the 4050-4052 boxes. Here the distance for the uninhabited box was half as much as the distance for one inhabited site, yet more than three times as high for the other site. Interestingly, the site that had the most squirrels in it also had the smallest distance to the closest tree. Maybe the closer the tree to the box, the easier it is for squirrels to locate the boxes.

Trunk circumference (size of tree) did not appear to differ significantly between inhabited and uninhabited sites. There were four trees with a circumference greater than 30 inches on inhabited sites compared to three on uninhabited sites. There was variation in the moderate size trees (greater than 30"). It is likely, though, that this variation is due to experimental error since many of the circumferences were estimated for the a few trees on each site which appeared to be to be of equal size. Alternatively, these data could show a trend that moderate sized trees are favored for southern flying squirrel habitat.

Maybe it could have something to do with the most favored food sources, natural cavities or lower-understory density. Smaller tree counts were about even. For those trees with a circumference less than 20", there were 33 in inhabited sites versus 31 in uninhabited sites.

The data on brush density did not seem to show any trends, however this could be because all of the nest boxes were placed near the shore of a water source, where there is usually very little brush compared to sites deep in the woods.

The data on understory density seems very counter-intuitive because the site where most squirrels were found (Box #4052) was the one with the highest upper-understory cover and most sparse lower-understory cover. According to the findings mentioned in the introduction, we should expect the opposite. All other data sets for these variables are very similar between inhabited and uninhabited sites, or again counter-intuitive to the previous explanation for the understory density variation. I am fairly inexperienced in judging where the different sections of the canopy divide, so it is possible that I measured these variables incorrectly. It could also be possible that there is some other factor at work in this area that causes the understory density data to look very unlike previous results.

Entrance diameter did not vary much, so there was no comparison to make between sites for this variable.

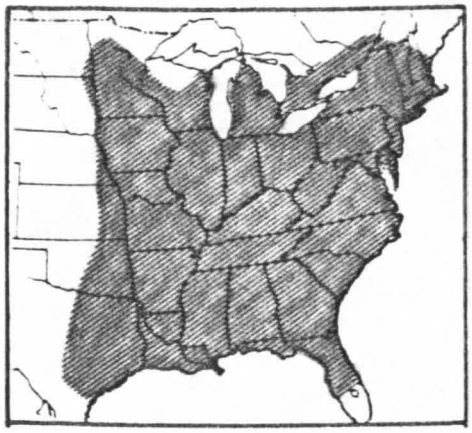
Distance from water did vary, however each box was placed so near a bank that the distance only differed by at most 20 feet, and therefore this small difference should have a negligible effect on habitat choice. There appear to be no trends between inhabited and uninhabited areas for distance from water. It could be that distance from water would have little influence on Glaucomys volans habitat choice for winter nesting anyway because they

receive a lot of their water from their food during the winter, and many water sources may be frozen.

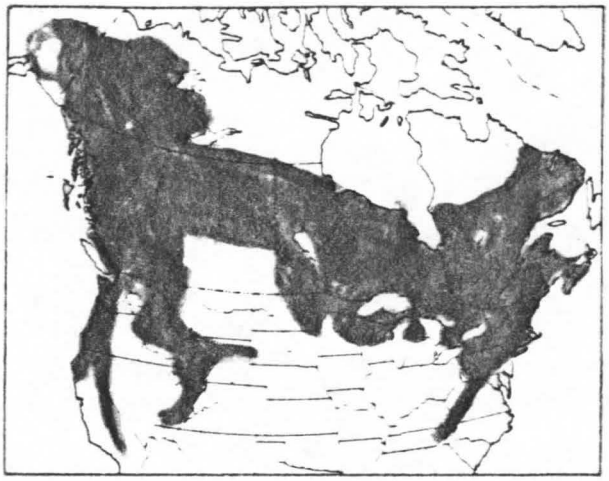
Overall there are no data that suggest any strong correlation between habitat choice and habitat variables, however the data that might suggest something could lead to future research on southern flying squirrel habitat choice.

Several new projects that would be worthwhile doing would be to redo the exact same study I attempted to complete, this time attempting to avoid the problems I ran into. The main problem with my study was that I was very inexperienced in the ecology and wildlife management fields, and had to complete the project within the best of my capabilities. However, someone more familiar with methods of estimating habitat variables could get some more reliable data, and maybe actually find some significant correlation for habitat choice by southern flying squirrels on the Erie National Wildlife refuge. Individual studies of all these variables can be done also to help separate the variables, and make sure all the possible confounding variables are known. More interspecific studies can also be done to see how the habitat choice and behavior of one species affects the other, like the study on gray squirrels and southern flying squirrels (Loeb 1993), or on woodpeckers (Stone et al 1996).

Figure 1.



Range of the Southern Flying Squirrel (*Glaucomys volans*) in North America



Range of the Northern Flying Squirrel (*Glaucomys sabrinus*) in North America

Figure 2. **Distribution and Species of Flying Squirrels in Nest Boxes in Pool 9 Outlet and Muddy Creek Sites**

	Box#	# Squirrels	Species
Pool 9 Outlet:	4043	1	southern
	4048	1	undetermined
	4051	1	southern
	4052	3	southern (at least 1)
Muddy Creek:	1003	1	southern

Figure 3. **Summary of Habitat Variables from Pool 9 Outlet Nest Boxes**

	#Squirrels	Distance from H2O (ft)	Closest Tree (ft)	Kinds of Tree	Bark	Upper Story Cover	~~Upper~~ Under Lower UnderStory Cover	Trunk Circumference	Entrance Diam (in.)	Brush
4043	1	20	8	3 conifer, 8 hardwood	10/11 coarse	moderate	low	two >50", nine < 10"	3 x 4	very sparse
4044	0	5	8	15 hardwood	14/15 coarse	moderate	low	two >50", six >20", eight at 10"	3x4	sparse
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4048	1	25	10	5 conifer, 3 hardwood	7/8 coarse	dense	dense	two >20", six <20"	4x4	sparse
4049	0	15	10	15 conifer, 2 hardwood	17/17 coarse	very dense	very dense	ten >20", seven at 10"	3x4	sparse
00000000										
4051	1	15	20	5 conifer	5/5 coarse	very sparse	very sparse	one >20", four <20"	3x4	sparse
4052	3	15	3	2 conifer, 15 hardwood	17/17 coarse	very dense	sparse	three > 20", fourteen < 20"	3x4	moderate
4050	0	10	10	6 conifer, 3 hardwood	3/9 smooth	most dense	most dense	nine at ~ 20"	3x4	very sparse

Figure 4. **Summary of Habitat Variables from Muddy Creek Nest Boxes**

	#Squirrels	Distance from H2O (ft)	Closest Tree (ft)	Kinds of Tree	Bark	Upper Story Cover	Upper UnderStory Cover	Trunk Circumference	Entrance Diam (in.)	Brush
1003	1	1	10	10 hardwood	10/10 coarse	very sparse	very sparse	two > 30", eight <30"	3x4	moderate
1001	0	5	10	6 hardwood	4/6 smooth	none	none	one > 50", five < 20"	3x4	moderate

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