

Analysis of Nighttime Movement and Home Range of Southern Flying Squirrels using Radio Telemetry at Brookhaven National Laboratory

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Abstract

Southern Flying Squirrels (*Glaucomys volans*), are small mammals that play a vital role in seed distribution and, therefore, forest health. Their nocturnal behavior leaves much to be discovered about this species. This study outlines the distribution and estimate the home range of individuals around the site. Sherman traps were used to capture the squirrels. Radio collars were secured to 9 individuals prior to release. Radio telemetry equipment was used to track the collars over several weeks. Each individual was located at least once daily. Triangulation methods were used at night to estimate the squirrels' locations. A Geographic Information System (GIS) was utilized to plot all the locations and movements. Each squirrel was located in order to complete a 24 hour period. The data was analyzed in the GIS and results were compared with previous published studies. Seven squirrels were successfully tracked for several weeks. The sample consisted of adult males, adult females and juvenile males. The home range of all the squirrels tracked in the summer of 2011 ranged from 0.08 hectares (ha) to 9.68 ha (average 4.57ha). The home range of squirrels successfully (more than a week) tracked ranged from 1.21 ha to 9.68 ha (average 5.59 ha). The largest movement made was 542.47 meters over two hours and the second largest movement was 245.36 meters in an hour. The average movement ranged from 46.6 meters to 131.11 meters. The average home range of males and females track was 6.00 ha and 4.56 ha, respectively. No correlation was seen between time tracked and home range size. Males have a larger home range than females. Research will continue in the following years and be compiled with previous studies on site to accumulate a comprehensive estimate. This completed study will then be compared with previous published studies from other regions to determine correlations in home range size.

Introduction

The Southern Flying Squirrel is a small, nocturnal mammals that spends a majority of its time in tree canopies and cavities. It glides or "flies" using a structure called a patagium, which consists of two layers of skin surrounding a thin layer of muscle that extend from forelimb to hind-limb. In one study, the maximum glide observed was 45 meters [4] . This species can be found from Maine to Florida and as far west as the Mississippi River [2]. It remains quite unknown to the public because of its nocturnal way of life. It spends most of its day sleeping and roosting. At night it forages for seeds, berries and fungi. It forages both in the trees and on the forest floor.

Observing the behavior of Southern Flying Squirrels is difficult because of their habitat and nocturnal lifestyle. They have been known to nest communally with many other individuals that are both male and female. It is unclear whether these individuals are related or unrelated. This plays a large role in winter survival. Because this species does not hibernate in the winter like many other squirrels, they survive using social thermoregulation. They spend the days huddled in a nest with other

individuals to keep their energy costs low [4]. Nesting has been seen with breeding females raising a brood and with all adult squirrel groups either for thermoregulation or breeding purposes. The Southern Flying Squirrel has two breeding periods, one in winter and one in late summer [5].

The presence of Southern Flying Squirrels in the Central Pine Barrens of New York was studied on site during the summer of 2009, and further studied in the summer of 2010 using radio telemetry. In 2011, radio telemetry studies were continued with nine different individuals from other areas around the site. The overall movements of each squirrel were analyzed to provide a home range and summary of each squirrels nesting and foraging habits. Research will continue in the following years and be compiled with previous studies on site to accumulate a comprehensive estimate. This completed study will then be compared with previous published studies from other regions to determine correlations in home range size.

Materials and Methods

During the summer of 2011, Sherman small mammal traps were set up in 10 different locations around the site over the course of 4 weeks. They were set up approximately 1.85 m from the base of oak and pine trees. Data was recorded for each trap location, including height, facing, width of trunk, overstory and understory. Each trap was baited with a mixture of peanut butter and oats and provided with nesting material. The traps were opened in the late afternoon and checked early the following morning. If a squirrel was present in the trap, it was taken back to the road for easier handling. Once there, the trap was placed in a container charged with the anesthetic isoflurane. The squirrel was sealed in this container for 1.5-3 minutes, to ensure sufficient sedation to make handling easier and less stressful for the animal. Once sedation was observed the squirrel was removed from the trap, weighed and sexed. Measurements of body length, tail length and hind foot length were recorded. An ear tag was attached and any markings or evidence of breeding were noted.

The squirrel was fitted with an ATS model M1420 radio collar, secured with fishing line. The

fishing line was fed through plastic tubing coated in a plasti dip and cayenne pepper mixture. The purpose of the cayenne is to deter the animal from chewing the collar off. An additional layer of plasti dip was applied to decrease skin irritation from the cayenne. The collar was secured tightly enough that it would not slip off and the animal would not get entangled in it, but loose enough that it would not impede eating or breathing. It was able to move but not slip over the ears or rotated around the neck easily. A Yagi antenna and an R-1000 Telemetry receiver (Communication Specialist, Inc) were used to test the effectiveness of each collar prior to deployment.

Trapping continued for several weeks until all eight collars were deployed. A total of nine squirrels were collared over the course of five weeks and seven were tracked successfully. Each collar had its own frequency, which allowed each squirrel to be found individually (149.461, 149.760, 149.610, 149.730, 149.671, 149.700, 149.580, and 149.790). Each squirrel was found at a different hour everyday to increase the likelihood of filling a 24 hour clock of tracking for each individual (Figure 1). During daytime hours, telemetry equipment was used to track the collar to the exact location of each squirrel at least once daily. Because of safety precautions and to decrease interference with squirrel movements, triangulation methods were used to estimate the squirrels' location during nighttime hours. A compass was used to find a heading for the strongest signal at each of the three points for squirrel in a 20 minute set of time. An exact GPS location was recorded using a Trimble Geo XT 2008 series with ArcPad 8.0 and point identification data was plugged in for each point. ArcGIS ArcInfo 9.2 was used to plot and analyze all locations and movements.

Daytime points were joined with nighttime point after triangulation headings were extended and a new nighttime point location was estimated. The points were organized for each frequency by date and time in order to provide a concise calendar of daily and hourly movements. The Hawth's tools extension in ArcInfo 9.2 was used to create paths between each location by date and time for each squirrel separately. A Minimum Convex Polygon was formed to estimate a home range and show distribution of every squirrel around the site (Figure 2 and 3). Analysis on home range size, average

movement, largest movement overall and largest movement in a single night was conducted. These results were used to compare each squirrel by general location, gender, age and vegetation type, as well as compared to results of previous studies.

Results

The average home range for all the squirrels collared in 2011 was 4.57 ha and ranged from 0.08ha- 9.68 ha (Figure 4). The average home range for the males was 5.02 ha and 3.68 ha for females. The average home range for all the squirrels successfully tracked for more than a week was 5.59 ha. The average home ranges of males and females successfully tracked were 6.00 ha and 4.56 ha, respectively.

On the west side of the property, Squirrel 461 was an adult female tracked for 5 weeks She had a home range of 6.12 ha near well seven extending westward toward the William Floyd Parkway. She had an average movement of 79.67 meters and a maximum movement was 260.06 m over the course of 3 days (~80 hrs). Her largest movement in one night was 152.18 m in 35 minutes. Collar 461 was recovered after recapture. Squirrel 760 was an adult male tracked for 5 weeks He had a home range of 8.32 ha near well seven extending to Woods Rd. His average movement was 74.01 m and had a maximum movement of 370.48 m over the course of the same 3 days (~80 hrs) as 461. His largest movement in the shortest time was 279.78 m in 2 hours. Collar 760 was not retrieved. Squirrel 580 was a very active juvenile male tracked for 4 weeks near the White Pine Forest extending from Upton Rd to West 4th to White Pine Rd. His home range was 7.68 ha and his average movement was 131.12 m. His maximum movement was 301.5 m over 6.5 hours after two other large movements were tracked. His largest movement in the shortest time was 150.35 m in 39 minutes. Collar 580 was retrieved after recapture.

Squirrel 730 was an adult male tracked for 3 weeks before his collar was found intact removed due to predation. He had the largest home range tracked during the summer of 2011. His home range

was 9.68 ha and extended from the East Fire Break over East Margin Path into the Gamma Forest and continued south across Forest Path. His average movement was 114.30 m and his largest movement in the shortest time was 542.48 m within 2 hours and 5 minutes. This was also his largest movement in a single night. Squirrel 610 was a juvenile male tracked for 2 weeks before the collar was found chewed off. His home range overlapped that of 730 within the Gamma Forest. His home range was 3.13 ha and his maximum movement was 77.51 m. His largest movement in the shortest time was 139.40 m in 53 minutes.

On the east side of the property two squirrels were captured along Treatment Plant Rd and collared. Squirrel 700 was a juvenile male tracked for 5 weeks. His home range was 1.21 ha and his average movement was 46.59 m. His maximum movement was also his largest movement in one night and was 245.36 m in 1 hour. Squirrel 671, in the same area, was an adult female tracked for 5 weeks as well. She had a home range of 2.99 ha and an average movement on 74.7 m. Her maximum movement was 222.71 m over 33 hours. Her largest movement in the shortest time was 129.77 m in 48 minutes. Collar 671 and 700 were unable to be retrieved after recapture did not occur.

The first squirrel captured was squirrel 759, which had had collar 760 on before it chewed it off, therefore the collar was used again for another individual and this squirrel was renamed. Squirrel 759 was an adult male tracked for 4 days on the northern part of the East Fire Break. His home range was 0.08 ha and his average movement was 79.06 m. His maximum movement seen before he was lost was 162.91 m in a 24 hour period. The other squirrel in which tracking was not successful was Squirrel 790. Squirrel 790 was an adult female with a 1.93 ha home range extending from First Ave to Crescent Path. Her average movement was 121.34 m and her maximum movement was 190.99 m over 3 hours. She was tracked for a few days before the signal was lost. The collar was found only 1 week after deployment about 800 m from her home range. The collar was assumed to be removed due to predation.

Discussion

The size of the home ranges of squirrels found onsite fell within the range 2.45 ha for males and 1.95 ha for females to 16.03 ha for males and 5.88 ha for females reported in previous published studies [1, 3]. Variability of geography, climate and food supply add to the disparity of these results.

Throughout the course of our research, we collared nine squirrels, but only successfully tracked seven individuals. The first squirrel we collared was equipped with collar 149.760, but within four days the collar was found. It had been chewed off and the tubing was badly shredded. This could have been a result of insufficient amounts of cayenne to deter chewing. Because the collar was not deployed for long, we were able to salvage it and used it again, with better tubing. The first squirrel was then referred to as 149.759, since the original collar was to be used again. Squirrel 790 was tracked for a few days before its frequency went missing. It was later found about 800 meters from the squirrel's original home range, completely intact. This could be a result of predation. By the end of our research, two collars were chewed off, two were recovered after predation, two were recovered at recapture and three were unable to be recovered.

On the west side of the property, Squirrel 580 inhabited the White Pine area of the laboratory. He was a juvenile male with a large home range (7.68 ha). We would assume that his home range would be large because of the scarcity of food in the white pine, but since he remained within that vegetation type that doesn't seem to be a factor. Also, his home range was similar to the home ranges of other squirrels in different vegetation types. It is always possible that with a juvenile, he is venturing away from his brood nest and trying to find new territory as well. Squirrel 461 was an adult female that was observed in a nest with at least three or four other individuals. She was seen staying within the nest for about a week before moving east to a new nest where she resided for a few more days before leaving again. This could be a result of her leaving a previous brood and finding an area with less competition. Compared to the adult female on the east side of the property (671), 461 has a home range of 6.12 ha,

compared to 2.99 ha. Squirrel 760 was captured in the same area as 461 and their home ranges overlapped nicely, although they both extended away from each other. 760 had a large home range of 8.32 ha throughout different vegetation types.

Squirrel 730 was tracked for three weeks before he fell prey to what we assume to be an owl. His collar was found placed neatly on a fallen tree. Although we were only able to track him for three weeks, he exhibited the largest home range of all the squirrels we tracked (9.68 ha) before he was lost. He crossed into three different areas of woods crossing two dirt roads which shows that the roads are not barriers to flying squirrels. The individuals on the west side of the property also had no issue crossing roads, but squirrel 700 and 671 on the east side of the property seemed not to cross the road they foraged near. Unlike 580, the other juvenile male we tracked (700) has a small home range and wasn't seen leaving his area. He had a home range of 1.21 ha over five weeks. We would assume to see him venturing away from his nest area to find new territory and avoid competition, but this was not observed. He might be staying in that area because his parent did not have another brood this summer to push him out of the nest, or he has not quite left the nest yet and will be venturing out in the weeks to come.

It can be assumed that the longer an animal is tracked the bigger its home range will get, but this was not observed. Squirrel 610 which was a juvenile male tracked for about two weeks had a home range of 3.13 ha which is larger than squirrel 700's home range tracked after five weeks. This suggests that there may not be a correlation between time tracked and home range size. There was also no correlation seen between availability of water and movement. Although numerous squirrels were captured along the Peconic River onsite, the squirrels we tracked do not seem to be inclined to move toward or inhabit areas where water is readily available. This could be a result of the squirrels' lack of need of water since it receives a majority of its water intake from its food sources.

The results we observed during 2011 research period are not sufficient enough to make a clear estimate of home range sizes of Southern Flying Squirrels at Brookhaven National Laboratory.

Research will continue in the following years and be compiled with previous studies on site to accumulate a comprehensive estimate. This completed study will then be compared with previous published studies from other regions to determine if there is a difference between home range sizes of Southern Flying Squirrels on Long Island than squirrels on the mainland.

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Time	Frequency 730	Frequency 610	Frequency 700	Frequency 671	Frequency 790	Frequency 760	Frequency 461	Frequency 580
0:00		***	***	***	*	***	**	**
1:00	**	**	*****	*****	*	***	****	****
2:00		***	****	***	*	***	**	**
3:00		*	**	**		*	*	*
4:00	*	*	**	**		**	**	*
5:00			*	**		**	**	*
6:00		**	*	*		*		
7:00	*		**	**		**	*	*
8:00						**	*****	***
9:00		*	**	*		***		
10:00	*		*	**			*	*
11:00	*					*		
12:00						*	**	
13:00	*						*	
14:00			**	**		*		
15:00	**	**	**	**		***	***	**
16:00		*	*	*	*	*	*	*
17:00	*		**	*				*
18:00	**		*	*	*			
19:00	*			*				
20:00	**	*	***	***		****	*****	****
21:00	***	**	*****	*****	*	*****	*****	*****
22:00	*	*	*****	*****	*	*****	****	****
23:00		*	*	*	*		*	**

EAST

WEST

Figure 1. Frequency Tracked Time Chart

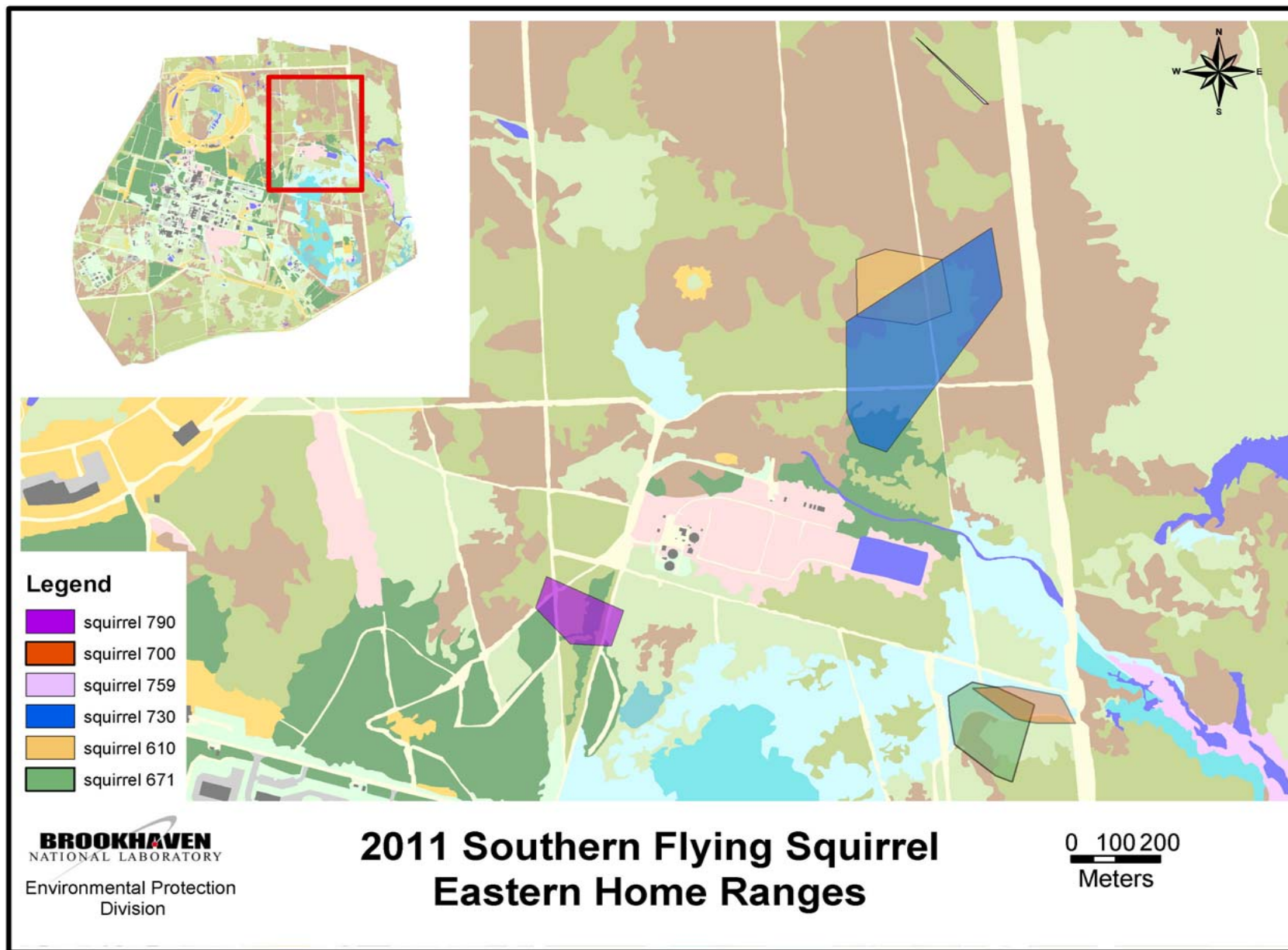


Figure 2. Map of Home Ranges of Collared Squirrels on East Side of Property

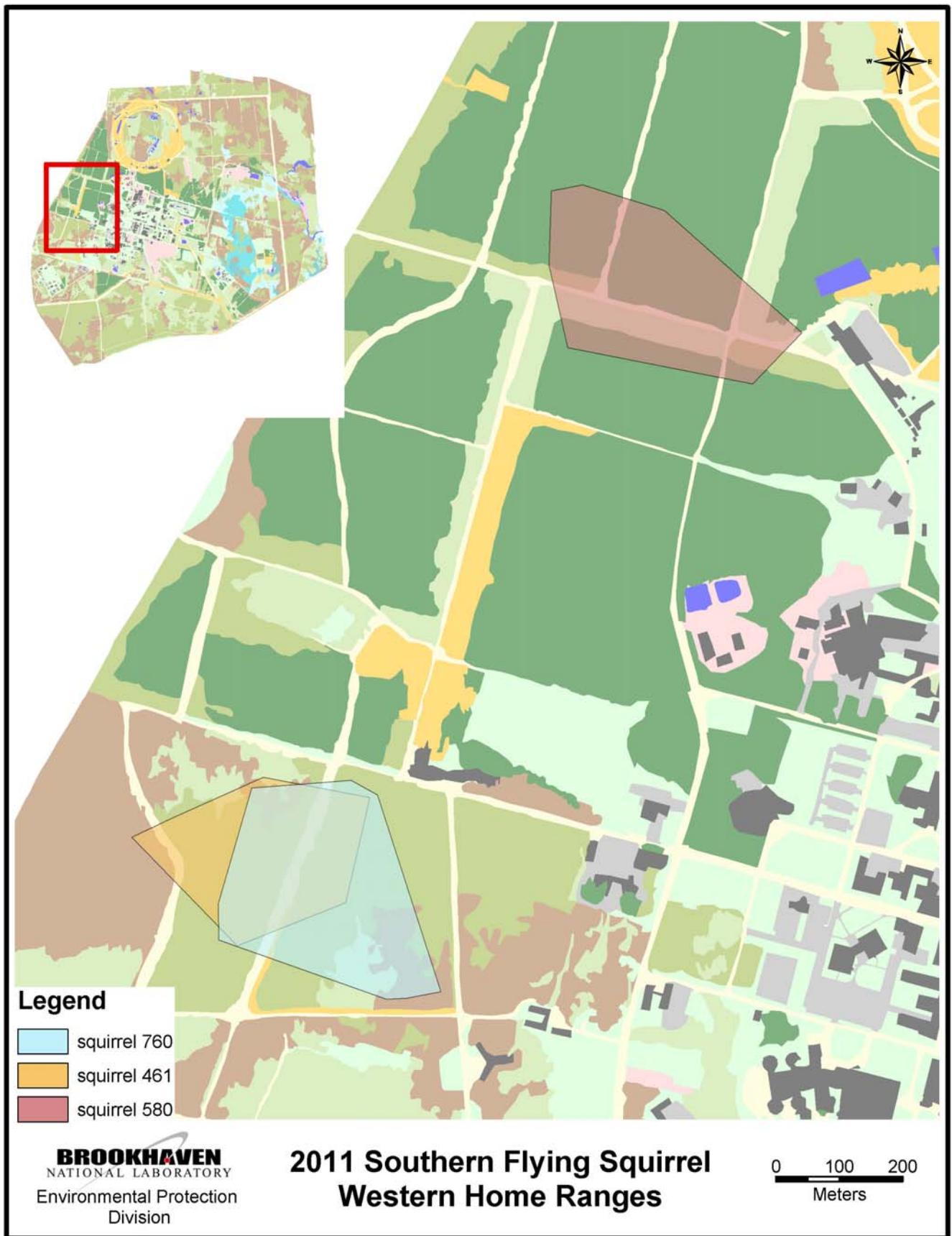


Figure 3. Map of Home Ranges of Collared Squirrels on West Side of Property

	461	760	580	700	671	730	610	790	759
Gender	Adult Female	Adult Male	Juvenile Male	Juvenile Male	Adult Female	Adult Male	Juvenile Male	Adult Female	Adult Male
Home Range from Minimum Convex Polygon (hectares)	6.12	8.32	7.68	1.21	2.99	9.68	3.13	1.93	0.08
Time Tracked (days)	~5 weeks	~5 weeks	~4 weeks	~5 weeks	~5 weeks	~3 weeks	~2 weeks	~ 1 week	4 days
Average Movement (meters)	79.67	74.01	131.11	46.59	74.7	114.3	77.51	121.34	79.06
Maximum Movement (meters)	260.06	370.48	301.5	245.36	222.71	542.48	139.4	190.99	162.91
Time Elapse of Largest Movement	3 days	3 days	6 hrs 13 min	1 hr	33 hrs	2hrs 05 min	17 hrs 45 min	3 hrs	24 hours
Largest Movement in a Night	152.18	279.78	150.35	245.36	129.77	542.48	135.48	190.99	162.91
Time Elapse of Largest Movement	35 min	2 hrs 06 min	39 min	1 hr	48 min	2hrs 05 min	53 min	3 hrs	24 hours

Figure 4. Individual Statistics of Each Collared Squirrel