BURNABY LAKE SQUIRREL PROJECT

To: Doug B. Ransome and Bob Gunn
From: Cameron Stooshnoff
Andrew Klassen

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Summary

Recently, the eastern grey squirrel (*Sciurus carolinensis*) population has been increasing in the lower Fraser Valley, as far east as Abbotsford. Few studies have examined the relationships between the native northern flying squirrels (*Glaucomys sabrinus*) and Douglas squirrels (*Tamiasciurus douglasii*), and the introduced eastern grey squirrels, in the Lower Mainland. Relative abundance and habitat preferences of these three sciurids were examined in mixed-deciduous and mixed-coniferous stands in Burnaby, British Columbia, Canada. Using live trapping methods we tested the hypothesis that native squirrels were being displaced by the introduced eastern grey squirrel. Populations were monitored in two mixed-deciduous stands and two mixed-coniferous stands from November 2003 to March 2003. Populations of northern flying squirrel and Douglas squirrel appeared unaffected by the presence of eastern grey squirrels in Burnaby Lake Regional Park. Eastern grey squirrels were more abundant in developed areas of the park than areas that had a more wilderness like setting. While Douglas squirrels and northern flying squirrels were more abundant in areas that had less development. Future monitoring is essential to help identify trends in squirrel populations in the Burnaby Lake area.

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1.0 Introduction

There has been a recent increase in abundance of eastern grey squirrels (*Sciurus carolinensis)* in Burnaby Lake Regional Park, British Columbia. The Douglas squirrel (*Tamiasciurus douglasii)* and northern flying squirrel (*Glaucomys sabrinus)* are suspected of being displaced from their natural habitat by eastern grey squirrels (Yeen Ten Hwang, 1997)

Little information is available on squirrel populations in Burnaby Lake Regional Park. Thus, the purpose of this project was to determine; if Douglas squirrels and northern flying squirrels were abundant in the Park; if they have been negatively influenced by the increase in abundance of eastern grey squirrels. In addition, habitat selection by each species of squirrel was examined.

Nest boxes were placed throughout Burnaby Lake Regional Park system to supply nesting habitat for wood ducks (*Aix sponsa)* and woodpeckers (Order Piciformes*)*. Through the program these nest boxes have been examined on a yearly basis. Recent nest box checks throughout Burnaby Lake Regional Park have found an increase in occupying rate by eastern grey squirrels (Bob Gunn per.comm., 2003). There is a concern that eastern grey squirrels are preying on native birds and squirrels that are using the nest boxes.

The eastern grey squirrel was introduced into the Lower Mainland of British Columbia in 1914 in Stanley Park (Merilees, 1986). Due to the lack of public knowledge and an increase in urban development, the squirrel population has increased (Merilees, 1985). Some people prefer the eastern grey squirrel to our native Douglas squirrel and northern flying squirrel because they are more visible in appearance then these two species. Currently, the distribution of eastern grey squirrels has expanded throughout the Lower Mainland, into the Fraser Valley, and as far east as Abbotsford (per. obs.). Although each of these squirrels has specific resource preferences that vary from the other species, they all are found in the same habitat. Competition may exist between Douglas squirrel and

northern flying squirrel for important food items such as truffles (Carey, 2004). It is unclear whether there is competition between the native squirrels and eastern grey squirrels, for important resources; however all three species of squirrels include similar food items in their diet (Carey, 2004) and use similar den structures. Potentially all three species of squirrels may compete with one another for important resources, such as food or nesting sites.

The northern flying squirrel and Douglas squirrel are important species which help maintain a healthy forest by spreading mycorrhizal fungi. These fungi attach to the roots of all tress in B.C. and expand their rooting system. These associations between the tree and mycorrhizae significantly enhance the uptake of water and nutrients increasing the productivity of all commercially important tree species. Mycorrhizal fungi reproduce by producing underground fruiting bodies called truffles, which are dispersed through excavation and consumption by small mammals. Once consumed the spores pass through the digestion tract of small mammals and are deposited on the ground, thus forming new mycorrhizal colonies which are important in the growth of trees. Without the mycorrhizal fungi, BC's forests would be considerably less productive. If the native squirrels were to be extirpated from their natural habitat it may have a negative impact on the forest ecosystem. Therefore it is important to determine whether the eastern grey squirrels are having a negative impact on native squirrel species from a biological, diversity, and forest health perspective.

The objectives of our study were to:

- Determine vegetation types throughout the Burnaby Lake Regional Park area,
- Determine relative abundance of the three squirrel species in two of the habitat types in Burnaby Lake Regional Park,
- Determine if eastern grey squirrels inhabit more developed or industrialized areas than native squirrels,
- Establish the methodology, study sites and baseline information for a multi-year study to monitor trends over time.

1.1 Douglas Squirrel

The Douglas squirrel, a tree dwelling squirrel inhabits areas in southwestern British Columbia south to southern California (Figure 1). The Douglas squirrel lives almost exclusively in coniferous forests (Eder & Pattie 2001). The squirrels' main sources of food include cones of Douglas fir (*Pseudotsuga menziesii),* lodgepole pine (*Pinus contorta),* Sitka spruce (*Picea sitchensis),* and western hemlock (*Tsuga heterophylla),* but they have also been known to consume maple (*Acer spp.),* red alder (*Alnus rubra)* and other seeds in deciduous forests. Douglas squirrels are territorial squirrels and will defend their territory from other squirrels and small mammals. These squirrels have a smaller build compared to that of the eastern grey squirrel, but are larger then the native northern flying squirrel. The average weight of Douglas squirrels ranges from 150-300 grams. Douglas squirrels are territorial and defend exclusive territories against other competitors (Gurnell et.al. 1984) and they center their territories around their cone middens (Smith 1968; cf. Steele 1999). Douglas squirrels are a diurnal species or active during the day (Carey, 2004).

Figure 1. Distribution of Douglas squirrel in N. America

Figure 2. Douglas squirrel in Burnaby Lake Regional Park

1.2 Northern Flying Squirrel

The northern flying squirrel is an aboreal squirrel that has a unique characteristic in that it is able to glide from tree to tree and it can glide up to 100 m (Figure 3). This squirrel is the only nocturnal sciurid in BC. Coniferous forest is prime habitat for northern flying squirrels, but they are also found in aspen and cottonwood (*Populus ssp.)* forests (Eder & Pattie, 2001). Most of the squirrels' diet, consists of lichen and fungi, but also may contain berries, seeds and bird eggs. Average weight of these squirrels range from 75-180g; thus are lighter than Douglas squirrels. Northern flying squirrels are found throughout much of Canada and many of the northern United States (Figure 4). They use cavities as their main nesting sites, but also construct stick and twig nests (Carey, 2004). When northern flying squirrels nest, they can sometimes occur in large groups to keep warm over the winter (University of Michigan 2004). The northern flying squirrels do not appear territorial like Douglas squirrels.

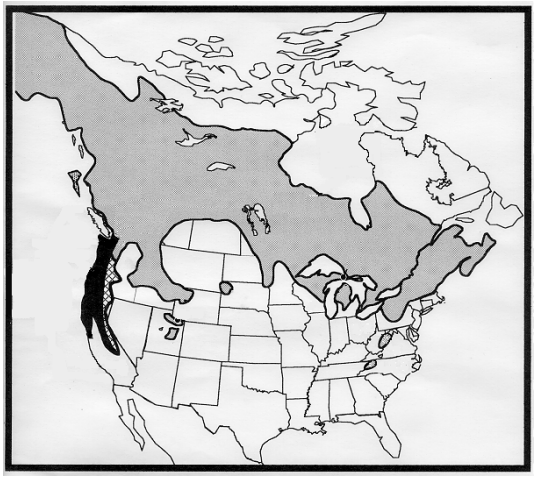

Figure 3. Distribution of the Northern flying squirrel.

Figure 4. Northern flying squirrel in North America.

1.3 Eastern Grey Squirrel

The eastern grey squirrel was introduced from eastern North America in 1914. This squirrel is a tree dwelling squirrel that is nearly twice the weight and size of native squirrels. These squirrels prefer mature deciduous or mixed forests with lots of nut-bearing trees (Eder & Pattie 2001). Eastern grey squirrels mainly consume seeds from oak (*Quercus ssp.*), maple and nuts from hazelnut (*Corylus ssp.)* trees. In spring and summer they eat buds and flowers and have been known to prey on nesting birds. Eastern grey squirrels create stick and branch nests and also inhabit existing tree cavities and in some cases may even use people's houses as nesting sites. Overlapping of home ranges is extensive; territoriality is not evidenced strongly in this species (Don 1983). The eastern grey squirrel is also a diurnal species meaning they are active during daylight hours.

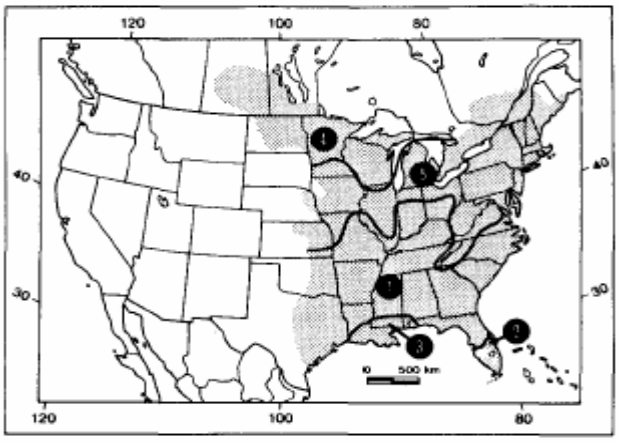

Figure 5. Distribution of the Eastern grey squirrel in North America.

Figure 6. Eastern grey squirrel

2.0 Methods

2.1 Study Area

2.1.1 Burnaby Lake Regional Park Study Area

Our project is located in Burnaby Lake Regional Park which is located in north east section of Burnaby (Figure 7). Burnaby Lake is located in the Coastal Western Hemlock, dry maritime CWHdm biogeoclimatic zone (Meidinger and Pojar 1991). The climate is characterised by mesothermal climate that is cool summers and mild winters. Mean annual temperature is 8 Celsius. Mean annual precipitation is 2228 mm, with less then 15% occurring as snow fall (Meidinger and Pojar 1991). Burnaby Lake Regional Park is bordered on all sides by major roads. South side of the lake is bordered by the Trans-Canada highway. On the west side of the lake there are a number of soccer fields and Kensington onramp to the highway. On the north side of the lake is Winston Avenue and a large industrial area. Finally on the east side of the lake is Gaglardi Way. All of these roads are subject to heavy traffic volumes every day of the year. The park is approximately 162 hectares in size, and is heavily used. The park has also been developed to host a number of events from soccer tournaments to interpretive walks to community runs. There are a large number of trails that braid throughout the park covering virtually all corners and sections of the park, leaving very small sections unaltered.

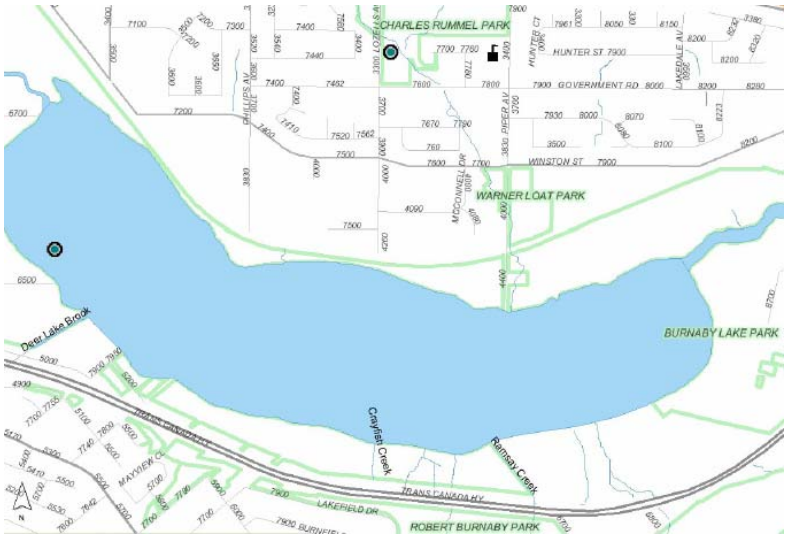

Figure 7: Location of Burnaby Lake Regional Park.

The park is shared by many different users, especially runners. There are a number of trails that run through the park and may contribute to the fragmentation of squirrel habitat. Runners may also cause some disturbances to the animals. The park is also used extensively by equestrians. Trails used by this group are localized to the eastern portion of the park. Finally, dog walkers and their dogs probably have the most effect on the squirrels. The park specifies that dogs must be on leash at all times but this restriction is not heavily enforced and many people do not follow these rules. Off leash dogs chase the squirrels and may cause undue stress to the squirrel.

Burnaby Lake is composed of two main forest types; mixed-deciduous and mixed-coniferous forest (Figure 8). We examined squirrel populations in these two forest types.

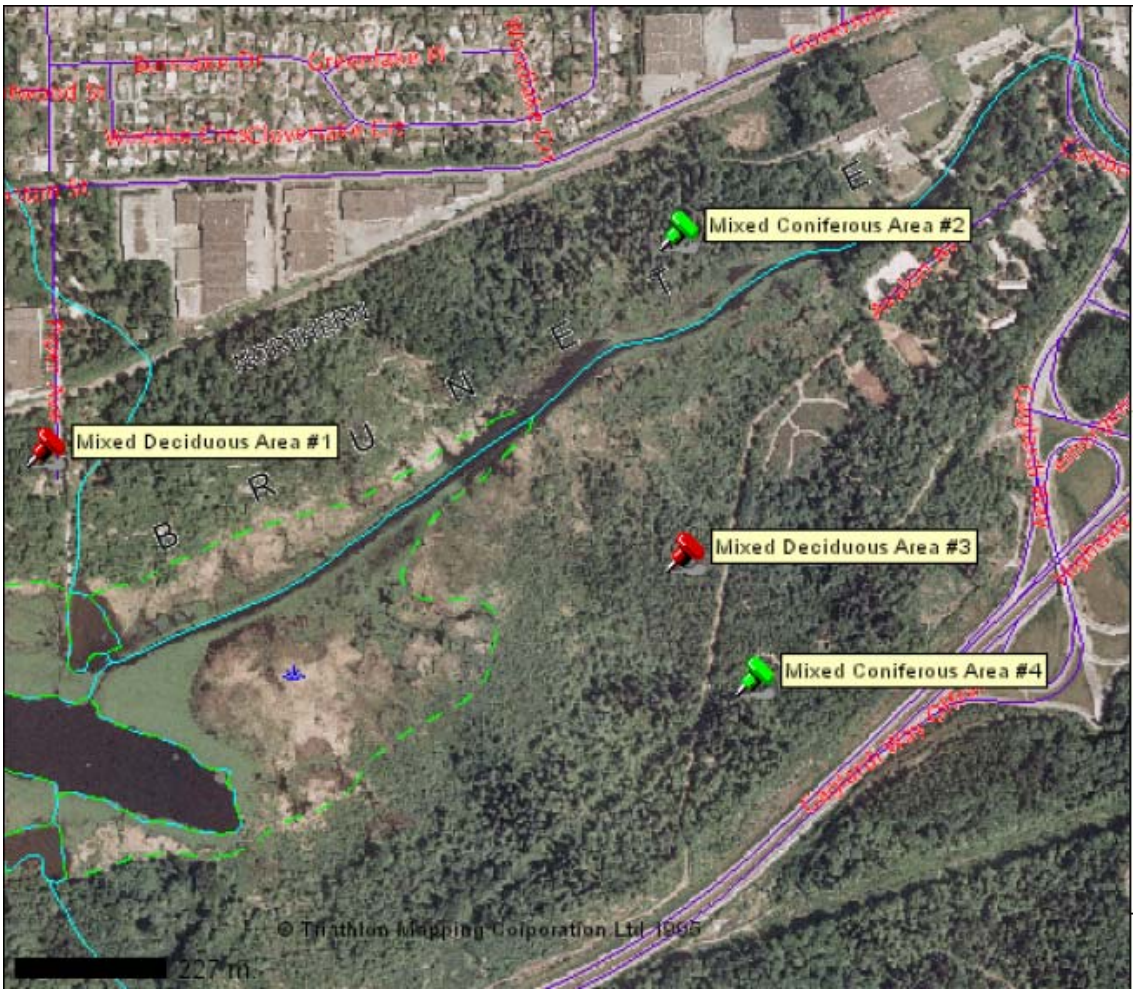

Figure 8: Location of mixed-deciduous and mixed-coniferous stands.

2.1.2 Mixed-deciduous Stand

Mixed-deciduous stands (Figure 9A+B, 10A+B) were primarily comprised of black cottonwood (*Populus balsamifera ssp trichocarpa),* paper birch (*Betula papyrifera),* red alder, and cascara *(Rhamnus purshiani).* Most common shrub species were, salmonberry *(Rubus spectabilus),* lady fern *(Athyrium filix-femina),* spiny wood fern *(Dryopteris expansa),* and red elderberry *(Sambucus racemosa).* Two trapping areas were located in this forest type.

Figure 9A+B: Mixed deciduous stand number one

Figure 10A+B: Mixed deciduous stand number two

2.1.3 Mixed-coniferous Stand

Mixed-coniferous stand were primarily comprised of western hemlock, western red cedar, and Sitka spruce. Most common shrub species were red huckleberry *(Vaccinium parvifolium),* salmonberry, and false azalea *(Menziesia ferruginea).* Two trapping areas were located in this forest type (Figures 11A+B, 12A+B).

Figure 11A+B: Mixed coniferous stand number one.

Figure 12A+B: Mixed coniferous Stand number two.

2.2 Vegetation Plots

In each study area five vegetation plots were placed on 250-m transects with plots every 50 m. Some of the areas were small and fragmented by trails so transect were not straight in all cases. Three levels of inventory were done at each plot:

- 1-m^2 radial plot for herbs and moss
- 9-m^2 radial plot for shrubs
- 25-m^2 radial plot for trees

In all plots, species composition and percent cover was determined using visual estimates.

2.3 Live Trapping

Each study area contained a 300-m live trapping transect with stations every 30 m for a total of ten traps per transect. At each station we placed one Tomahawk (model 201, Tomahawk Live Trap Co., Tomahawk Wisc.) equipped with a nest box (1-litre plastic jar equipped coarse brown cotton), covered with a 45cm by 45cm ploy-sheet (Figure 13A+B).

Figures 13A+B: Tomahawk Live Trap model 201.

Traps were set four times between November 2003 and March 2004. Traps were pre-baited for two weeks before the first trapping session. Sunflower seeds (*Helianthus annuus)* were used as bait and were placed in trays under nest boxes. Traps were then set on the first day and checked the following morning. Traps were then locked shut until next trapping session. Pre-baiting was only done when the delay between trap sessions exceeded four weeks.

All squirrels captured were identified with individually numbered ear tags. For each capture the tag number, trap number, and species were recorded.

2.4 Analysis

We determined relative abundance of three species of squirrels in two different habitat types located in Burnaby Lake Regional Park. Species abundance was calculated using captures per trap night. Captures per trap night is the total number of squirrels caught by species divided by total number of trap nights per area. Species abundance is the total number of individuals captured per species. Species richness was also calculated and is the total number of species in each area. The Shannon Wiener function, and Simpson's Index of Diversity were calculated for all species**.** The Shannon-Wiener function is a good measurement for species diversity, because it is large when the species diversity is large is small when the species diversity is small. Simpson's index is the probability that two individuals picked at random will belong to the same species. The index is based on a scale with 0 being low diversity and 1 being high diversity. Species abundance was calculated using percent cover for each vegetation species. Species richness was calculated and represents the total number of species. The Shannon Wiener function, and the Simpson's Index of Diversity were used to estimate diversity of vegetation.

3.0 Results

We captured 27 different squirrels 35 times over 160 trap nights. There was twice as many Douglas squirrels captured in the mixed coniferous stands than in mixed deciduous stands as reflected in captures per trap night (Table 1). Northern flying squirrels were captured more often in mixed deciduous stands then in mixed coniferous stands. Four out of six flying squirrels were captured in mixed deciduous stand number two. Eastern grey squirrels were more often captured in mixed deciduous stand number one compared to other stands. Shannon Wiener function is higher in mixed deciduous stands indicating higher diversity than mixed coniferous stands. Mixed deciduous stand number two had the highest Simpson's Index of Diversity, and highest diversity.

Table 1: Species richness, Captures per trap night, Shannon Wiener function, and Simpson's Index of Diversity for Douglas Squirrel, Northern Flying Squirrel, and Eastern Grey Squirrel in mixed deciduous and mixed coniferous stands.

	MD1*	MD2	MC1**	MC2
Species Richness	3	2	2	2
Captures per 100 trap nights				
Douglas Squirrel	5	10	20	15
Northern Flying Squirrel	2.52	10	0	2.52
Eastern Grey Squirrel	20	0	2.52	0
Shannon Wiener	0.92	0.98	0.66	0.81
Simpson's	0.34	0.49	0.28	0.38

*MD: Mixed Deciduous
*MC: Mixed Coniferous

The results clearly show the preferences of each squirrels species to a particular vegetation type (Figure 14).

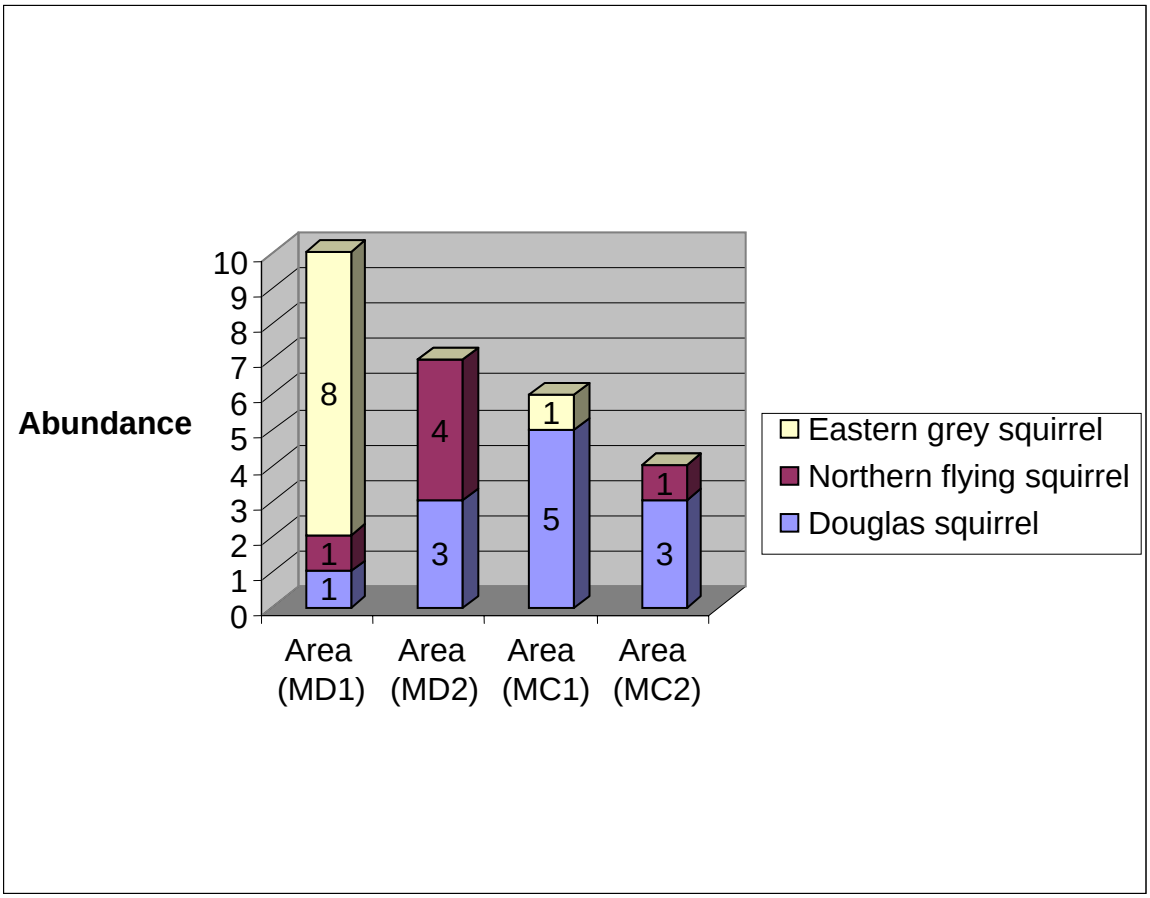

Figure 14: Total number of Eastern grey, Northern flying, and Douglas squirrels captured in two mixed deciduous stands (MD1, MD2) and in two mixed coniferous stands (MC1, MC2). Squirrels were captured from November 2003 to February 2004 in Burnaby Lake Regional Park.

Percent cover of each plant species was averaged from the five vegetation plots for each of the study areas (Table 2). Mixed deciduous forest types had higher shrub species richness, while mixed coniferous forest types had higher tree species richness. Mixed deciduous forest types also had higher amounts of shrub cover, which was represented by the species abundance.

Table 2: Species richness, Shannon Wiener and Simpson's Index of Diversity for vegetation layers in four stand types located in Burnaby Lake Regional Park. Abundance is total percent cover sum for all species within a layer. Percent cover for each species was averaged across five vegetation plots in each study area.

Vegetation Layers	**MD1**	**MD2**	**MC1**	**MC2**
Herbs				
Species Richness	5	4	9	7
Species Abundance*	0.092	0.18	0.402	0.406
Shannon Wiener	1.81	1.57	2.50	2.15
Simpson's	0.64	0.57	0.79	0.70
Shrubs				
Species Richness	14	15	15	10
Species Abundance*	1.335	1.324	0.822	1.012
Shannon Wiener	3.06	2.03	2.92	2.54
Simpson's	0.86	0.63	0.83	0.79
Trees				
Species Richness	3	6	6	7
Species Abundance*	0.38	0.47	0.536	0.76
Shannon Wiener	1.55	1.48	1.73	1.93
Simpson's	0.65	0.63	0.63	0.64

* Total for layer, see appendix A for individual species.

It is clear that each area has different amounts of each vegetation layer. The tree layer was divided into deciduous layers and coniferous layers based on percentage of cover (Figure 15).

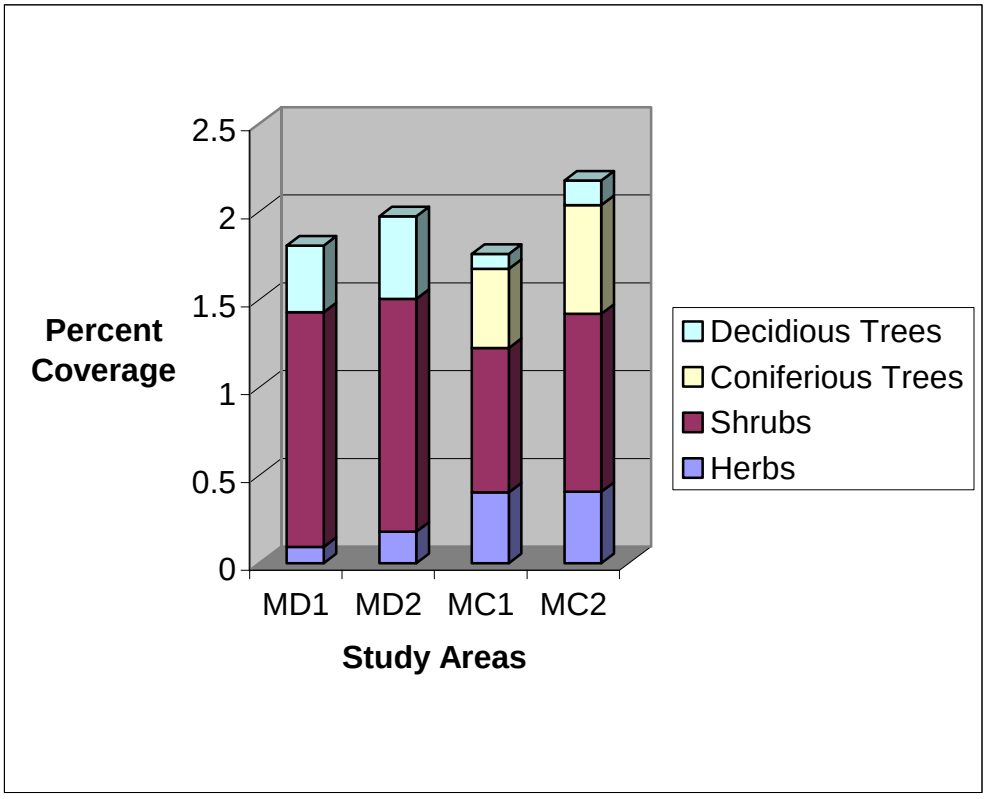

Figure 15: Total percent cover of each vegetation type in each mixed deciduous stand (MD1, MD2) and mixed coniferous stands (MC1, MC2). Vegetations plots were done in October 2003, using $1m^2$, $9m^2$, and $25m^2$

4.0 Discussion

Previous studies examining habitat preference of these sciurids have found different results. For instance in our study the trends indicate that Douglas squirrels were more likely to be in coniferous stands, which is similar to findings of Ingles (1965). Previous studies on northern flying squirrels have indicated that they are more likely to frequent coniferous forests (Cooney, in lit.) than deciduous forests. We found that flying squirrels were more likely to frequent deciduous stands than what has been indicated by other reports. Eastern grey squirrels were more abundant in developed areas like mixed deciduous stand one and mixed coniferous stand one than in areas less developed such as mixed deciduous stand two or mixed coniferous stand two.

Eastern grey squirrels appeared more abundant in mixed deciduous stands than mixed coniferous stands. Potentially mixed deciduous stands had more preferred food items for the squirrels. Our vegetation data shows that there is more shrub cover in the mixed deciduous areas; this may provide more preferred food. There was a greater abundance of eastern grey squirrels in the first mixed deciduous stand compared to that of the second mixed deciduous stand. The first stand had more urban development and is used more by humans. This may provide more food for eastern grey squirrels which are food generalists (Campbell and Hoban 1999).

Abundance of Douglas squirrels was higher in mixed coniferous stands then in mixed deciduous stands. Douglas squirrels main food source is coniferous cones (Flyger and Gates 1982), which they require a supply of coniferous cones for their over-winter survival. Our mixed coniferous stand had Western red cedar, western hemlock, vine maple, and Sitka spruce, while these species were considerably less abundant in mixed deciduous stand. “They prefer coniferous trees over deciduous trees as they have difficulty in climbing the smooth bark of the latter.”(Cooney in lit.). Since these trees provide an important food source for the Douglas squirrel the higher abundance of Douglas squirrel in these stands was expected. Our results are consistent with past reports

The abundance of flying squirrels was higher in mixed deciduous stands than mixed coniferous stands. Our results vary from other studies. Previous studies on northern flying squirrels have suggested that they are more likely to frequent coniferous forests (Cooney in lit.). In our study we noticed that there was more flying squirrels captured in mixed deciduous stand two than in mixed deciduous stand one, it may be because this is a less disturbed area. It may also be due to the lack of eastern grey squirrels in that area. This suggests that eastern grey squirrels do in-fact cause northern flying squirrels to be displaced out of their native habitat. Captures per trap night may have been higher if the individuals were not lost to predation while in traps. Mixed deciduous stand one had more development, and was frequented by people more often because of the visitor center and housing. This may affect the northing flying squirrels shy behaviour. The lack of flying squirrels in mixed deciduous stand number one may also be because of the abundance of eastern grey squirrels in that area. Flying squirrels may prefer deciduous forests because under story vegetation is well developed, especially salmonberry, licorice fern, and hazelnut. There seems to be more diversity of vegetation, which may aid in the squirrel selection of food. Introduced plant species, which can supply an additional food source, may be one of the reasons why there is a high abundance of flying squirrels in the deciduous forests.

To eliminate survey bias we placed an equal number of traps in each stand and trapped each area equally in terms of trap nights. Animals were tagged to prevent capturing individuals more than once, which would overestimate the population size. We found that Douglas squirrels preferred mixed coniferous stands to mixed deciduous stands. Eastern grey squirrels and northern flying squirrels were more likely to occur in mixed deciduous areas than mixed coniferous areas, but can be found in lower abundance in other forest types. It appeared that eastern grey squirrels had little influence on Douglas squirrels, and northern flying squirrels. The number of eastern grey squirrels is comparable to the number of Douglas squirrels and northern flying squirrels. The eastern grey squirrel prefers developed or industrialized areas over areas of less development. In mixed deciduous area one there was interpretative center, and local residents near by. Also more people frequent this area then other regions of the park. This may have an influence on

squirrel numbers. In localized areas around development it appears that eastern grey squirrels might be pushing native squirrels out. In the surrounding ecosystem the native species seem to be doing quite well.

5.0 Recommendations

We recommend that this project be continued on in the future to determine population trends of these three squirrel species in Burnaby Lake Regional Park. The vegetation should be monitored and noted for changes such as introductions of non-native species. We also suggest that a nest box program specifically for the northern flying squirrel and Douglas squirrel be implemented. These boxes should be eastern grey squirrel proof to reduce the competition of eastern grey squirrels.

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Appendix A:

Vegetation Plots

Percent cover of vegetation by species for each of 5 vegetation plots in mixed deciduous forest in Burnaby Lake Regional Park for herbs, shrubs, and trees, were estimated in $1m^2$, $9m^2$, and $25m^2$, respectively. Percent cover for each species was averaged across all vegetation plots (n=5)

Area # 1 Mixed-Deciduous Forest

	Plot # 1	**Plot # 2**	**Plot # 3**	**Plot # 4**	**Plot # 5**	
Herb Layer 1 M^2						**Average**
Oregon Beaked Moss	0.05					0.01
False Lily of the Valley	0.05	0.2				0.05
Slender Beaked Moss					0.1	0.02
Wavy Leafed Cotton Moss			0.02			0.004
Lanky Moss			0.04			0.008
Shrub Layer 9 M^2						
Salmonberry	0.25	0.3	0.1	0.4	0.1	0.23
Lady Fern	0.35	0.15	0.2			0.14
Spiny Wood Fern		0.15	0.35	0.05	0.1	0.13
Red Elderberry		0.25				0.05
Licorice Fern		0.01				0.002
Vine Maple	0.35		0.7		0.05	0.22
Skunk Cabbage	0.02					0.004
Red Huckleberry			0.15		0.06	0.042
Trailing Blackberry				0.005	0.7	0.141
Sword Fern				0.05		0.01
Indian Plum				0.03		0.006
Bracken Fern					0.2	0.04
Cascara					0.1	0.02
Hazelnut					0.3	0.3
Tree Layer 25 M^2						
Birch				0.3	0.15	0.09
Red Alder	0.3	0.1	0.2	0.1	0.05	0.15
Big Leaf Maple				0.7		0.14

Percent cover of vegetation by species for each of 5 vegetation plots in mixed coniferous forest in Burnaby Lake Regional Park for herbs, shrubs, and trees, were estimated in $1m^2$, $9m^2$, and $25m^2$, respectively. Percent cover for each species was averaged across all vegetation plots (n=5)

Area #2 Mixed-Coniferous Forest

	Plot 16	Plot 17	Plot 18	Plot 19	Plot 20	
Herb Layer 1 M^2						**Average**
Oregon Beaked Moss		0.01				0.002
False Lily of the Valley				0.05		0.01
Slender Beaked Moss			0.05		0.2	0.05
Wavy Leafed Cotton Moss	0.15	0.1				0.05
Lanky Moss				0.03		0.006
Badge Moss	0.05			0.4	0.2	0.13
Large Leaved Avens				0.4		0.08
Broom Moss	0.02					0.004
Three Leaved Foam Flower	0.05		0.3			0.07
Shrub Layer 9 M^2						
Salmonberry	0.7		0.2	0.4	0.1	0.28
Morning Glory				0.01		0.002
Lady Fern			0.2	0.35	0.4	0.19
False Azalia		0.15				0.03
Red Elderberry			0.05		0.05	0.02
Western Red Cedar		0.25				0.05
Introduced Holly		0.05				0.01
Vine Maple		0.03	0.05	0.5		0..116
Sword Fern			0.05			0.01
Licorice Fern			0.03			0.006
Red Huckleberry		0.02				0.004
Skunk Cabbage		0.02				0.004
Hard Hack		0.4				0.08
Spiny Wood fern	0.2		0.2	0.2		0.12
Introduced Ash	0.05	0.03				0.016
Tree Layer 25 M^2						
Cascara			0.03			0.006
Red Alder				0.15		0.03
Introduced Oak	0.05					0.01
Western Hemlock	0.3	0.65	0.2	0.15		0.26
Vine Maple	0.05			0.15		0.04
Western Red Cedar		0.1	0.4	0.15	0.3	0.19

Percent cover of vegetation by species for each of 5 vegetation plots in mixed deciduous forest in Burnaby Lake Regional Park for herbs, shrubs, and trees, were estimated in $1m^2$, $9m^2$, and $25m^2$, respectively. Percent cover for each species was averaged across all vegetation plots (n=5)

Area # 3 Mixed-Deciduous Forest

	Plot 26	Plot 27	Plot 28	Plot 29	Plot 30	
Herb Layer 1 M^2						**Average**
Slender Beaked Moss		0.05			0.05	0.02
Lanky Moss		0.05	0.5			0.11
Fan Moss				0.15		0.03
Oregon Beaked			0.05	0.05		0.02
Shrub Layer 9 M^2						
Spiny Wood Fern			0.01	0.2	0.2	0.082
Salmonberry	1	0.4	0.85	0.85	0.65	0.75
Cascara	0.06	0.5	0.5	0.15	0.1	0.262
Introduced Holly	0.01					0.002
Licorice Fern	0.01					0.002
Deer Fern	0.01					0.002
Hardhack		0.1				0.02
Trailing Blackberry		0.1				0.02
Introduced Ivy		0.6				0.12
Brachen Fern		0.05				0.01
Hybrid Blackberry		0.05				0.01
Vine Maple		0.1				0.02
Sword Fern			0.01			0.002
Red Elderberry			0.1			0.02
Dogwood			0.01			0.002
Tree Layer 25 M^2						
Birch	0.2	0.45	0.05	0.15	0.05	0.18
Cascara	0.2	0.25	0.2	0.2	0.2	0.21
Poplar			0.4			0.08

Percent cover of vegetation by species for each of 5 vegetation plots in mixed coniferous forest in Burnaby Lake Regional Park for herbs, shrubs, and trees, were estimated in $1m^2$, $9m^2$, and $25m^2$, respectively. Percent cover for each species was averaged across all vegetation plots (n=5)

Area #4 Mixed-Coniferous Forest

	Plot 21	Plot 22	Plot 23	Plot 24	Plot 25	
Herb Layer 1 M^2						**Average**
Flat Moss	0.1		0.02			0.024
Badge		0.1	0.01		0.05	0.032
Slender Beaked Moss		0.02		0.1		0.024
Lanky Moss			0.5			0.1
False Lily Of The Valley			0.05	0.1		0.03
Fan Moss				0.03		0.006
Step Moss					0.95	0.19
Shrub Layer 9 M^2						
Spiny Wood Fern	0.2	0.6	0.5		0.15	0.29
Salmonberry	0.25	0.15		0.08	0.1	0.116
Cascara	0.2	0.2	0.01			0.082
Introduced Ash	0.02		0.02		0.01	0.01
Vine Maple	0.01	0.3	0.05	0.4	0.2	0.192
Lady Fern			0.7	0.6		0.26
E.G. Blackberry			0.01			0.002
Skunk Cabbage				0.05	0.05	0.02
Red Elderberry				0.15		0.03
False Azalia					0.05	0.01
Tree Layer 25 M^2						
Western Hemlock	0.8	0.25	0.4	0.2	0.4	0.41
Cascara	0.15					0.03
Sitka Spruce		0.2				0.04
Western Red Cedar		0.4	0.05		0.4	0.17
Red Alder				0.4		0.08
Vine Maple				0.1		0.02
Hazelnut				0.05		0.01

Appendix B

Trap results

Trap session by date, includes area species was caught, forest cover type, trap number, tag number, and species of squirrel caught.

23-Nov-03

Area	Trap #	Tag #	Species
1-Mixed-deciduous	1	228	SCCA(grey)
1-Mixed-deciduous	2	229	SCCA(black)
1-Mixed-deciduous	5	-	SCCA(black)
2-Mixed-coniferous	12	230	TADO
2-Mixed-coniferous	14	231	TADO
2-Mixed-coniferous	15	232	SCCA(Grey)*
3-Mixed-deciduous	21	241	GLSA**
3-Mixed-deciduous	23	244	TADO***
3-Mixed-deciduous	26	-	GLSA(DOA)****
4-Mixed-coniferous	34	233	TADO
4-Mixed-coniferous	35	234	TADO
4-Mixed-coniferous	38	-	RANO*****

* SCCA: Eastern grey squirrel
**GLSA: Northern flying squirrel
***TADO: Douglas squirrel
**** (DOA): Dead on Arrival
*****RANO: Norway rat

12-Dec-03

Area	Trap #	Tag #	Species
1-Mixed-deciduous	5	-	SCCA(grey)
2-Mixed-coniferous	14	238	TADO
2-Mixed-coniferous	15	231(rc)	TADO
3-Mixed-deciduous	21	233(rc)	TADO
3-Mixed-deciduous	22	245	GLSA
3-Mixed-deciduous	24	-	GLSA(DOA)
4-Mixed-coniferous	32	239	TADO
4-Mixed-coniferous	38	-	RANO
4-Mixed-coniferous	40	234(rc)	TADO

TADO (rc): Douglas squirrel recapture

Trap session by date, includes area species was caught, forest cover type, trap number, tag number, and species of squirrel caught.

04-Feb-04

Area	Trap #	Tag #	Species
1-Mixed-deciduous	1	237	SCCA(black)
1-Mixed-deciduous	2	247	SCCA(black)
1-Mixed-deciduous	8	249	TADO
1-Mixed-deciduous	10	242	GLSA
2-Mixed-coniferous	11	230(rc)	TADO
2-Mixed-coniferous	16	246	TADO
3-Mixed-deciduous	26	224	TADO
4-Mixed-coniferous	34	234?	TADO(DOA)
4-Mixed-coniferous	39	225(239)	TADO(rc)
4-Mixed-coniferous	40	299	GLSA

29-Feb-04

Area	Trap #	Tag #	Species
1-Mixed-deciduous	2	223	SCCA(black)
1-Mixed-deciduous	3	222	SCCA(black)
1-Mixed-deciduous	8	249(rc)	TADO
2-Mixed-coniferous	16	231(rc)	TADO
2-Mixed-coniferous	18	221	TADO
3-Mixed-deciduous	21	219	TADO