Food supplementation leads to increases in large mammal diversity and abundance, but no carry over effect in small mammals

Sana Zabihi-Seissan
5990458

BIO4009 – Honours Project

Supervisors:

Julie Morand-Ferron
Gabriel Blouin-Demers

April 2014

Department of Biology

University of Ottawa

II. ABSTRACT:

The feeding of wild birds is common in many countries. Apart from impacting birds, food supplementation sometimes impacts small mammal abundance and diversity. In this study, we looked at the carry-over effects of food supplementation on small mammal abundance and diversity, and the effects of direct food supplementation on large mammal abundance and diversity in Gatineau Park, Québec, Canada. Three supplemented sites were compared to three control sites of similar habitat structure. We estimated small mammal abundance and diversity via live trapping, whereas we used camera traps for large mammals. We found no significant carry-over effect of food supplementation on small mammal abundance and diversity, but we found a significant positive effect of food supplementation on large mammal abundance and a marginally non-significant effect on large mammal diversity. It is possible that food supplementation affects small mammal abundance and diversity, but that the effect disappears when supplementation ceases. Increase in resources could lower intra-specific competition and allow more large mammals to coexist.

III. ACKNOWLEDGEMENTS:

Many thanks go to my supervisors, Dr. Julie Morand-Ferron and Dr. Gabriel Blouin-Demers for helping make this project possible. I would like to also thank Dr. Maxime Cauchoix, William Halliday and the rest of the lab team for their help in the field.

IV. CONTENTS:

V. LIST OF FIGURES:

VI. LIST OF TABLES:

VII. INTRODUCTION:

Feeding wildlife, most often birds but sometimes deer, is common in North America. Several studies have been conducted to determine the impacts of food supplementation on birds in urban landscapes (Fuller *et al.* 2008; Jones 2011; Robb *et al*. 2008). In birds, it seems that an increase in available food increases the overall abundance (Fuller *et al*. 2008). Although food supplementation is often done for birds, its impacts can be extended to other species, such as mammals (Koekemoer *et al.* 2000). The presence of extra food seems to affect the taxa in different ways. In birds, it seems that an increase in available food increases the abundance of currently existing species independent of seasonality or weather conditions and does not seem to increase overall species richness (Fuller *et al.* 2008). Studies have shown that small mammal abundance increases when food is provided but seasonal population fluctuation (e.g. winter mortalities) was maintained (Akbar and Gorman 1993; Doonan and Slade 1995). In one instance, supplementation was ceased after a year and a slight drop in abundance was seen (Doonan and Slade 1995). As for small mammal diversity, the added resources cause a change in behaviour where the more dominant opportunistic species take advantage and claim the resources causing a drop in species richness (Koekemoer *et al.* 2000). However, most of the experiments looking at the effect of supplemental feeding on mammals were done in locations with poor quality habitat (urban or newly restored areas) and habitat quality seems to be a limiting factor for most species of small mammals and birds (Akbar and Gorman 1993; Evans *et al.* 2009; Koekemoer *et al.* 2000; Shochat *et al.* 2010). To better document the impact of food supplementation on animal abundance and community composition, studies should control for habitat quality. As studies have been done observing direct impacts of supplementation on small mammals, this study will focus on the potential carry-over effects of previous years of food supplementation on small mammal diversity and abundance.

To our knowledge, there are no studies examining the direct impacts of food supplementation on larger mammal species richness and abundance (e.g. larger than the eastern gray squirrel (*Sciurus carolinensis*)). Changes in the large mammal community (be it abundance or diversity), could cause several types of repercussions. A higher level of predation on ground nests (e.g wild turkeys) by raccoons (*Procyon lotor*) and striped skunks (*Mephitis mephitis*) due to supplementation has been shown in previous studies, indicating a potential effect of supplementation on large mammal abundance levels (Cooper and Ginnett 2000). Furthermore, certain species such as racoons are considered pest and the potential attraction of such species may cause issues for humans (e.g. property damage, noise and odors) and also be a vector for diseases, putting humans and domestic animals at risk (CIU Carnivores 2004). As raccoons and these other species (e.g. striped skunks) are attracted to feeders (Cooper and Ginnett 2000), there is a need for studies examining the impacts of food supplementation on large mammals.

In this study, we tested the hypothesis that food supplementation affects mammal abundance and community composition, though the directionality of the impact may differ depending on the species studied. We predicted that the abundance of most aggressive small mammal species will increase with food supplementation and cause a decline in species richness in small mammals (Akbar and Gorman 1993; Doonan and Slade 1995; Koekemoer *et al.* 2000). For large mammals, species richness will likely rise due to the attracting effect of food presence. However large mammals tend to have larger territories than small mammals (Blair 1940; Blair 1942; Koehler and Pierce 2003; Tierson *et al*. 1985) and therefore the abundance for most of the large mammals should be similar at supplemented and control sites and we would see no significant effect of supplementation on abundance.

We examined the impact of supplemental feeding on community composition and abundance of mammals in Gatineau Park, a well-established protected area of suitable habitat. In addition to having plenty of natural habitats, Gatineau Park is ideal for this study due to long-term feeding supplementation program provided by the staff of the park.

VIII. METHODS AND MATERIALS:

8.1. Study Sites:

The work took place in Gatineau Park from September 2013 to December 2013. We selected three experimental sites within the park that have had an operational feeding station for at least the past 5 years. The tree experimental sites were each compared to a control site in a paired design. Control sites had a similar vegetation type (mature forest dominated by deciduous trees, bordered by open fields and less than 100 m from a small dirt path) and were at a minimum distance (2 km) from the experimental site and from any human establishments. The experimental sites were chosen roughly 100 m from the original supplemented area. This was requested by the park staff as they did not want to have the feeders visible to the public. There were potentially 6 different feeder stations available in Gatineau Park, however 3 out of 6 of the feeders were within 1 km from each other and therefore only three feeders were selected to ensure that there was minimal movement of individuals between sites. During previous years, experimental sites were supplied with black oil sunflower seeds starting 15 November and ending in April. The park staff kept the feeders full by restocking them every week or two depending on the extent of their use by the animals. The main purpose of these feeders was to attract bird species for the enjoyment of the park visitors. This same procedure was repeated this year by members of our research group to restock the feeders. The control sites had a similar feeder this year, but lacked the actual food except for short bouts of supplementation necessary for data collection in regards to other studies taking place using the feeders during the same season. We limited the total amount of food given to 3 kg per control site over the winter (Desrochers *et al.* 1989).

8.2. Small Mammals:

For small mammals, a simple system of capture-mark-recapture was put into place using small Tomahawk live traps. Marking was done to detect potential “trap happy” individuals that would inflate abundance values due to a higher rate of capture (Pollock 1980). The marking consisted of fur clipping using scissors at various spots along the back of the animals, which allowed identifying recaptures and new captures (Gurnell and Flowerdew 2006). Trapping was undertaken in October 2013 (Pre-feeder trapping), giving a total of 1 trapping period for each site. This gave us a chance to look at the carry-over effect of supplementation since the last supplementation at these sites took place the previous year (November 2012-March 2013). Trapping periods consisted of three consecutive days and two nights. Trapping for paired experimental and control sites was done simultaneously. Prebaiting was done for two days to allow the animals to familiarise themselves with the traps (Gurnell and Flowerdew 2006). Prebaiting consisted of placing the traps opened at the site without being set which gives a chance for the animals to explore and familiarise themselves with the traps and not perceive them as threats. A trapping grid consisting of 7x7 points (distance of 4 m); for experimental sites this was placed roughly 100 m from the original supplementation area. One Tomahawk trap was placed at each of the points on the grid giving a total of 49 traps per site. The bait used for the traps consisted of black oil sunflower seed and a small amount of peanut butter which was used as an attractant. A piece of fresh apple was also added to serve as a source of moisture for the animal. To minimise the probability of mortalities, non-absorbent cotton wool was given as bedding and an ample amount of food was placed within the traps and replenished when needed (Gurnell and Flowerdew 2006). Traps were checked twice daily, once at sunrise and once at sunset. Species were identified by morphological features using the book *Mammals of Canada* (Eder and Kennedy 2011). Deer mice (*Peromyscus maniculatus*) and white-footed mice (*Peromyscus leucopus*) data were pooled into a genus category (*Permyscus spp.*) since it is difficult to differentiate between the two species.

8.3. Large Mammals:

Discreet motion-activated infrared cameras (Bushnell X-8) were placed at the sites to observe infrequent visits by larger mammals. These cameras were placed during the small mammal trapping periods starting in October 2013, rotating cameras from paired sites every 7-11 days. The pattern was maintained past the small mammal trapping sessions until the end of December 2013. Three periods were thus created: pre-supplementation during small mammal trapping (October), regular pre-supplementation (November), and supplementation (Late November to December). The difference between pre-supplementation during and post small mammal trapping is the presence of traps and related bait (e.g. minor amount of peanut butter). The species targeted by this section consisted of any mammal species too large for the Tomahawk traps. Cameras were fastened to a tree using nylon straps and positioned at proximately 40 cm from the ground to maximise species detection. They were positioned to have the feeder in view as well as a portion of the surrounding area. An individual was counted when a specimen is photographed at a minimum 30 minute interval (Jenks 2011). The data were compiled to reach relative abundance indices (RAI; Jenks 2011; O'Brien *et al*. 2003) for each of the species during each of the three periods at each site. To reach the RAI (Relative abundance indices) for each species, all sightings were pooled by species, divided by the number of camera trapping days and multiplied by 100.

8.4. Statistical Analyses:

Species richness was calculated as α-diversity (number of species present in a locality). The effect of the experimental treatment on species richness was assessed with a paired t-test. Abundance was compared among experimental treatments in generalized linear models (GLMs) using a Poisson distribution (Consul and Jain 1973). A Poisson distribution was used since most of the data points were of low value and could not fit a normal distribution. For small mammals, the model included treatment, species and study site, while the model for large mammals also included the time period (pre-supplementation during small mammal trapping, regular pre-supplementation or supplementation). In both cases we fitted the interaction between species and treatment but removed it if the p-value was smaller than 0.1 (Littell *et al.* 2002). We tested for overdispersion in the data by comparing the distribution of the results with a poisson model and a quasipoisson model (Bolker *et al.* 2009), and present results using the poisson model when results were qualitatively similar, or the quasipoisson model if that was not the case.

All analyses were conducted in R version 3.0.2 (R Core Team 2013)

IX. RESULTS:

9.1. Small mammals:

We trapped a total of 97 individuals from 8 different species (Table 1) in three trapping sessions (total number of days = 9).

Table 1. List of small mammal species observed at each site during small mammal trapping in Gatineau Park (October 2013).

Species	Supplemented	Control
Deer mouse (*Peromyscus spp.*)	Renaud, Huron, Healy	Renaud, Huron, Healy
Meadow vole (*Microtus pensylvanicus*)	Renaud, Healy	.
Southern red-backed vole (*Myodes gapperi*)	.	Renaud, Healy
Eastern chipmunk (*Tamias stratus*)	Renaud, Huron	Renaud
American red squirrel (*Tamiasciurus hudsonicus*)	Healy	Renaud
Northern flying squirrel (*Glaucomys sabrinus*)	Healy	Healy
Masked shrew (*Sorex cinereus*)	Renaud, Healy	Renaud, Huron
Northern short-tailed shrew (*Blarina brevicauda)*	Renaud, Huron	Renaud

9.1.1. Small Mammal Diversity:

There were 3 species from the Sciuridae family, 2 species from the Soricidae family and 3 species from the Cricetidae family (Table 1). The total number of species found at supplemented and control sites was 7 with a difference of one species missing from each treatment group (the Red-backed vole in supplemented sites and the Meadow vole in control sites).

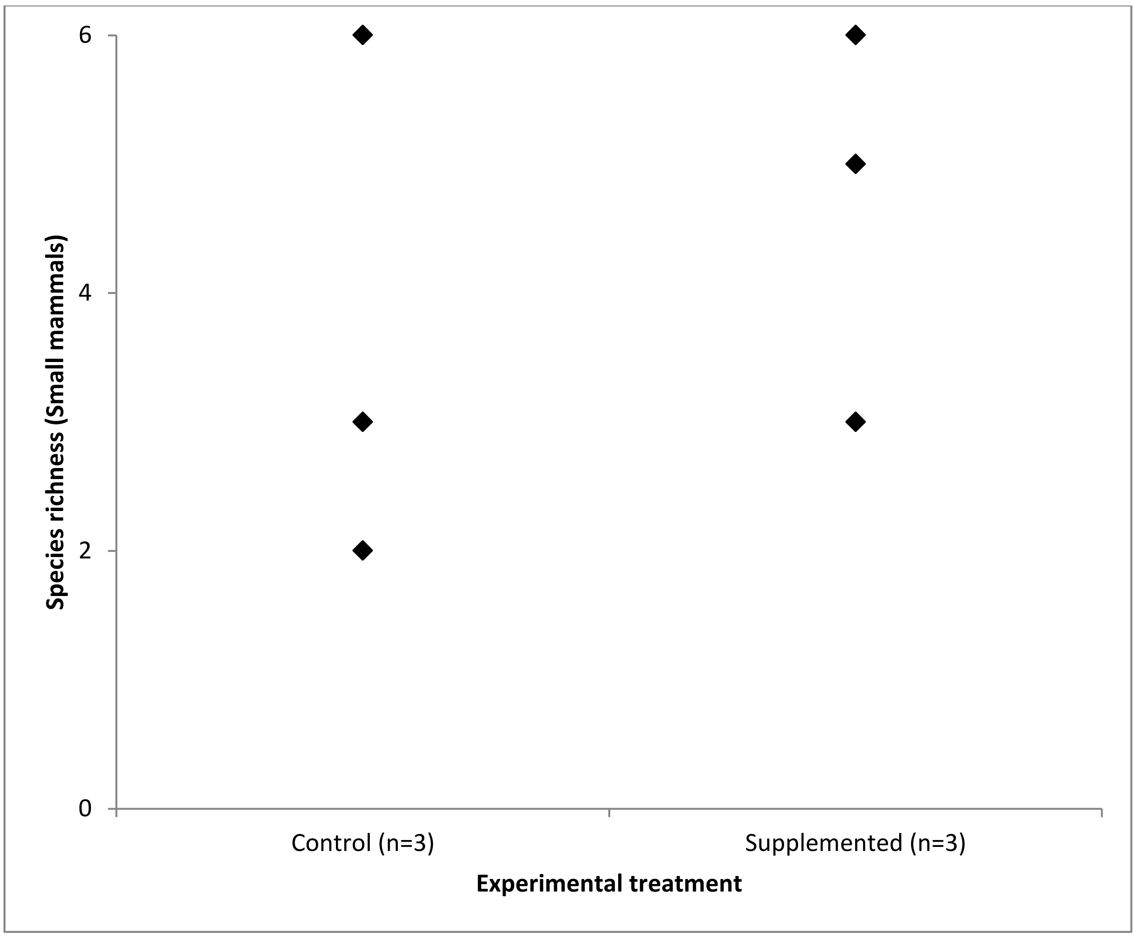

Fig. 1 Species richness (α-diversity) of small mammals found at supplemented experimental sites and non-supplemented control sites in Gatineau Park (October 2013).

Using a paired t-test, we found no significant treatment effect on small mammal species diversity (Fig. 1; $t=0.866$, d.f.=2, $p=0.478$).

9.1.2. Small Mammal Abundance:

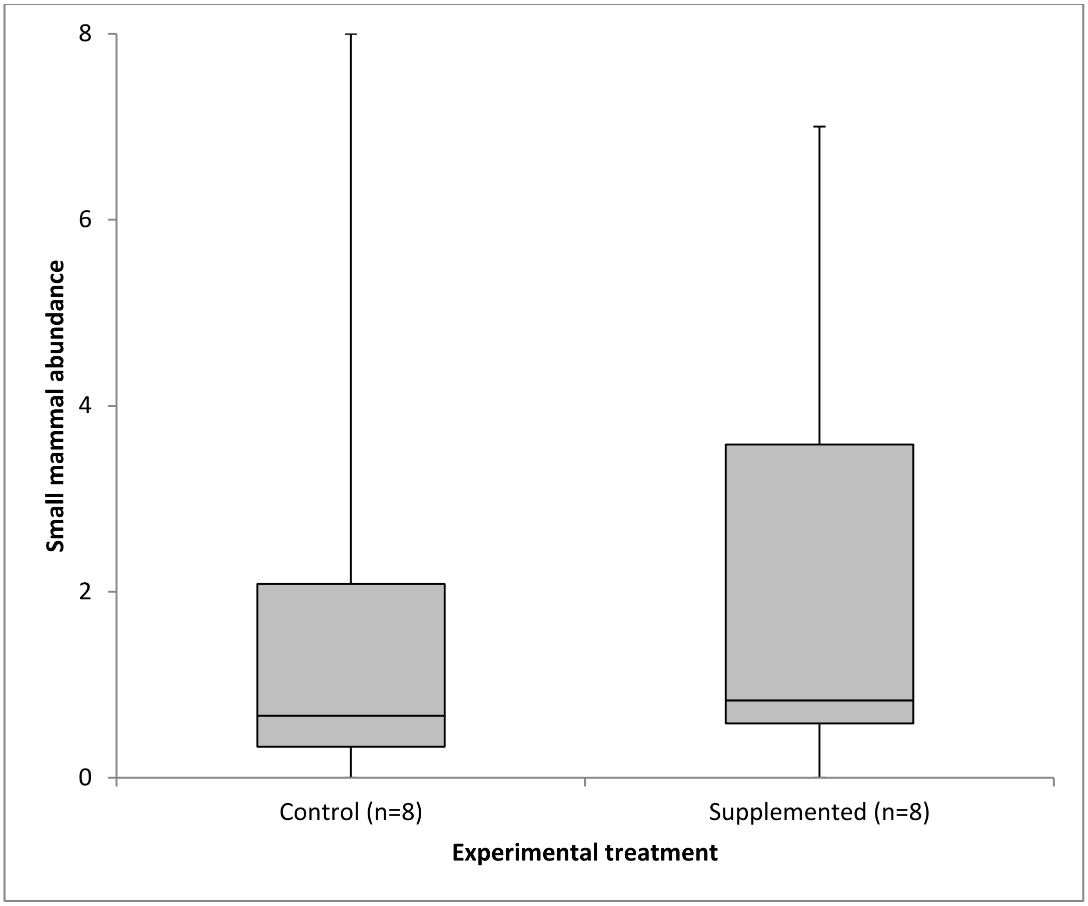

Fig. 2 Boxplot of observed abundance (total number of individuals) of small mammal species found at supplemented experimental and non-supplemented control sites in Gatineau Park (October 2013)

Supplementation treatment had no significant impact on abundance levels of small mammal species (Figure 2; GLM with quasipoisson distribution: treatment: $X^2 = 0.272$, d.f. = 1, $p = 0.602$; species: $X^2 = 57.1$, d.f. = 7, $p < 0.001$; site: $X^2 = 19.4$, d.f. = 2, $p < 0.001$).

9.2. Large Mammals:

Monitoring for large mammals took place from October 2013 – December 2013 with a total of 57 days of camera trapping distributed between the 3 pairs of sites. A total of 6 large mammal species were observed (Table 2). Sizes of the animals ranged from Eastern gray squirrels (*Sciurus carolinensis*) to American black bears (*Ursus americanus*).

Table 2. List of large mammal species observed with camera traps at each site in Gatineau Park (October 2013- December 2013)

Species	Supplemented	Control
Eastern gray squirrel (*Sciurus carolinensis*)	Huron	Renaud
Eastern cottontail (*Sylvilagus floridanus*)	Renaud	.
Snowshoe hare (*Lepus americanus*)	Renaud, Huron, Healy	.
White-tailed deer (*Odocoileus virginianus*)	Huron	Huron
Raccoon (*Procyon lotor*)	Renaud, Huron	Renaud
American black bear (*Ursus americanus*)	Healy	.

9.2.1. Large Mammal Diversity:

Out of the 6 large mammal species observed at the study sites, all were seen at experimental (supplemented) sites while only three were seen at control sites (Eastern gray squirrel, White-tailed deer and Raccoon) (Table 2).

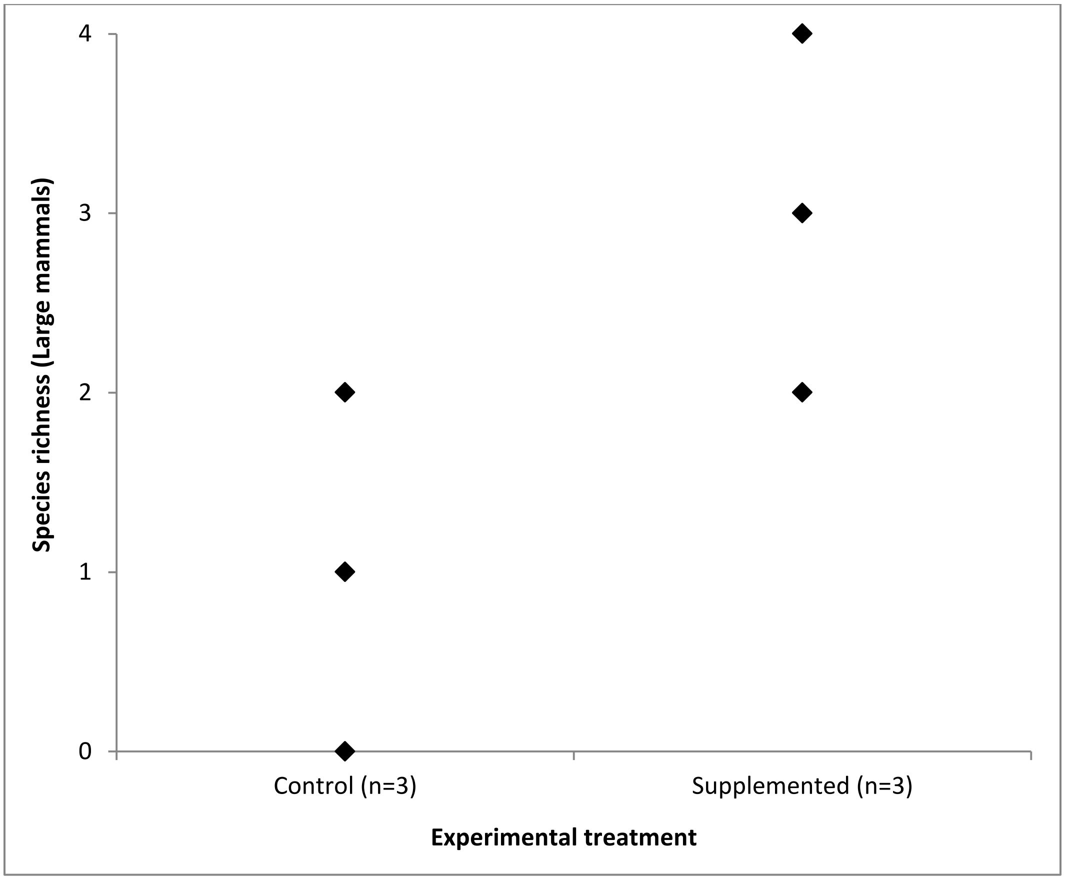

Fig. 3 Species richness (α-diversity) of large mammals found at supplemented experimental sites and non-supplemented control sites in Gatineau Park (October-December 2013).

Experimental treatment had a marginally non-significant effect on large mammal diversity ($t=3.46$, d.f.=2, $p=0.074$). Species richness tended to be higher in sites where supplementation took place compared to the control sites, but the difference did not reach significance.

9.2.2. Large Mammal Abundance:

The American black bear was omitted in the abundance calculations due to the high probability of having only one individual reappearing multiple times at one site. We pooled the abundance data of the Snowshoe hare and Eastern cottontail due to uncertain species-level identification in some cases (30.8%).

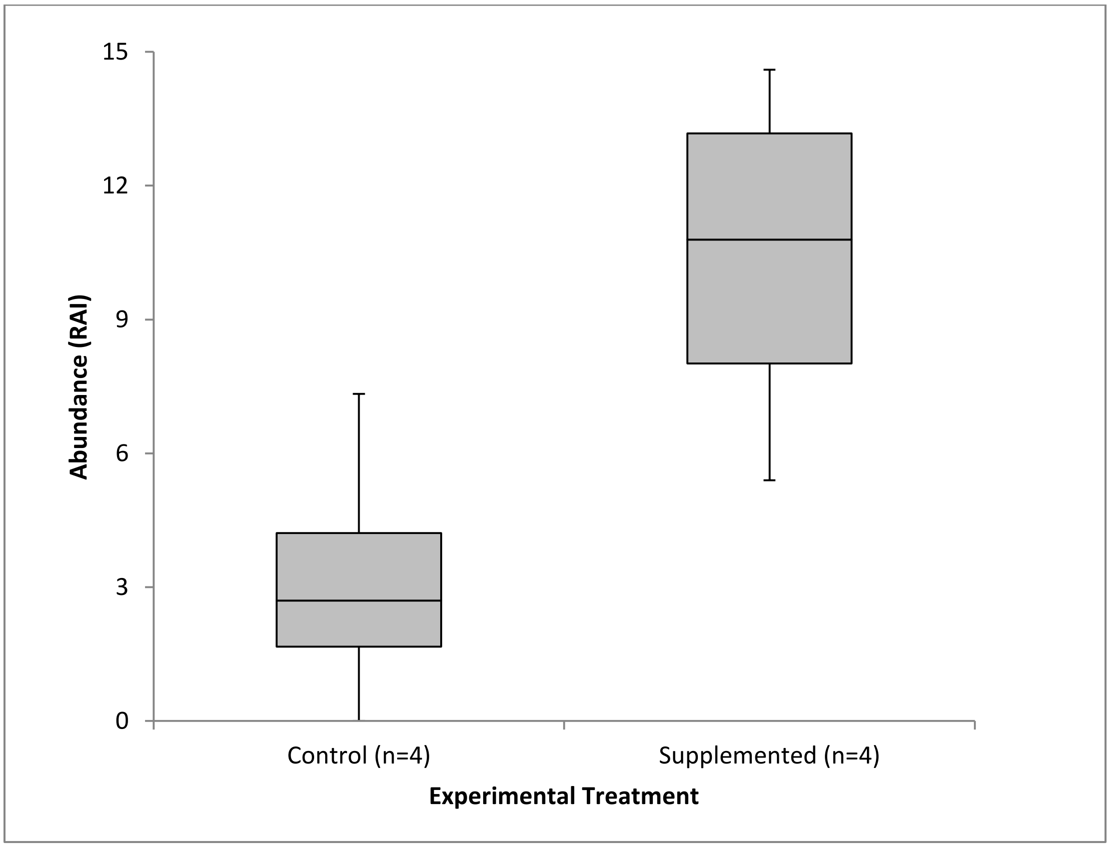

Fig. 4 Boxplot of observed abundance (RAI) of large mammal species found at supplemented experimental and non-supplemented control sites in Gatineau Park (October-December 2013)

Large mammal abundance was significantly higher at experimental sites than at control sites, however all other effects were not significant (Figure 5; GLM with quasipoisson distribution: treatment: $X^2 = 4.58$, d.f. = 1, p = 0.032; species: $X^2 = 0.281$, d.f. = 3, p = 0.964; site: $X^2 = 2.54$, d.f. = 2, p = 0.281; period: $X^2 = 3.8$, d.f. = 2, p = 0.149).

X. DISCUSSION:

This experiment yielded results that show no significant effect of food supplementation on small mammal diversity and abundance levels. There was, however, a significant effect of site and species on abundance of small mammals. There was a marginally non-significant effect of supplementation on large mammal diversity and a positive significant effect of supplementation on large mammal abundance.

The initial prediction for small mammal diversity consisted in finding lower species richness in supplemented sites compared to control sites. This would have been in part due to the fact that certain small mammal species are more aggressive and would take hold of the excess resources, thereby raising their abundance level and driving away other less dominant species from the area (Koekemoer *et al.* 2000). However the analysis on species richness demonstrated no significant difference between the two treatments. Experimental and control sites had the same number of species in total, and the species present at experimental and control sites did not differ greatly indicating that an exclusion effect by more aggressive and dominant species may not have been occurring in this experiment.

Carry-over effect of supplementation seemed to have no significant impact on small mammal abundance in contrast to the initial prediction where total small mammal abundance would rise due to more individuals from dominant species. The combination of these non-significant results for carry-over effect and previous studies (Akbar and Gorman 1993; Doonan and Slade 1995; Koekemoer *et al.* 2000) showing the opposite during supplementation could suggest that supplementation effects diminish in magnitude as time goes on since supplementation took place. The variation in abundance levels between sites during this study could be attributed to habitat quality as the variable "site" was significant for abundance. The original prediction would have led to results showing higher total abundance levels for small mammals. Further studies could be done in that direction and in looking into the impact of supplementation through time over a full year, keeping in mind seasonal changes.

While we found no carry-over effect of supplementation on small mammal abundance and diversity, there could have been a more short term impact on small mammal diversity as suggested in the literature (Akbar and Gorman 1993). It has been shown in a white-footed mouse

(*Peromyscus leucopus*) population that food supplementation had no significant effect on reproduction rates and that this would be attributed to other factors (Wolff 1985). We could therefore assume that population fluctuation could attributed to individuals moving from and to the sites. A higher level of winter mortality could however be the cause as well. Further studies would need to take place to see the pattern and amplitude of this impact on a chronological scale, determining when supplementation would cease having an effect.

Several factors could have impacted the small mammal results, as a carry-over effect may be harder to detect. Furthermore, the distance at which the trapping grids were placed from the original supplementation sites could have reduced the probability of detecting changes in abundance. Alternatively, it may be possible that the variance in abundance was due to unmeasured characteristics of sites as suggested by the significant effect of "site" in the analysis of small mammal abundance.

Though large mammal diversity results proved marginally non-significant, they pointed in the same direction as our initial prediction where we stated that large mammal diversity would be higher in areas of supplementation. This would be due to supplementation acting as an attractant. Though some species were found at both sites in two areas (Huron and Renaud), it was demonstrated that there was still a marginal difference between the supplemented and control sites. Very few large mammal species were seen at control sites (e.g. Healy having no sightings). We however know the cameras were still functional as many pictures were taken at the sites due to wind induced tree movement. We can in conclusion state that food supplementation has a marginally non-significant effect on large mammal diversity causing a rise in the number of species present at the sites. Very few studies have looked at the impact of food supplementation on large mammal diversity and there is thus much more work to be done in this direction. Looking at various types of supplementation (ex: deer baiting vs bird feeding) may prove useful as different resources may attract these species differently. Studies extending on larger time periods and using more sites and cameras may also prove effective to see the long term and carry-over effect of supplementation on large mammal diversity. It could be possible that biodiversity would benefit from food supplementation as our results hinted in possibilities that it may raise biodiversity levels in certain areas. However it may attract certain nuisance species. Therefore it would be wise to monitor species presence in various habitats when supplementation is taking place, be it for human recreational or conservation purposes.

The initial predictions suggested that there would be no significant difference of overall large mammal abundance between supplemented and control sites. This would have been the result of large mammals having larger territories than small mammals and therefore we would not expect to see more individuals of one species in a given area regardless of treatment. However the results show that there is a significant difference between the two treatments, where supplemented sites have a higher overall large mammal abundance. More studies would have to take place to look into possible mechanisms behind these results. One of these may be that the higher availability of resources due to supplementation would lower intra-specific competition which would in turn allow for more individuals of the same species to coexist at one site. The significant effect on large mammal abundance could also be due to inflated visit rates by repeated individuals. This was attempted to be addressed by counting individuals appearing at a minimum of 30 minutes intervals (Jenks 2011). Unless there are unique markings on the large mammals differentiating the individuals (O'Brien *et al*. 2003), it would prove difficult to control for individuals revisiting the sites.

In conclusion, results from this study demonstrate that there seems to be no significant carry-over impact of food supplementation on small mammal diversity or abundance in an area of pristine habitat. Further studies would be needed to confirm this, but it may be that food supplementation has a short term effect on these species and therefore the effect tends to diminish after it has ceased, until supplementation no longer seems to have an effect. This could be due to individuals leaving the supplemented site for more naturally productive areas. It could also be due to higher mortality rates due to low resource availability post-supplementation (at experimental sites) needed to sustain the small mammal population or higher levels of predation at experimental sites. Further studies would need to be done to test for these hypotheses but could have important implications related to the use or ceasing of food supplementation in parks.

As for the large mammals, it has been shown that both the diversity (marginally significant) and the abundance (significant) had increased with the presence of food supplementation. This new information as to the repercussions of supplementation on non-target species has implications in conservation. The use of bird feeders in a park may attract unwanted wildlife which may disturb the natural ecosystem. This adds one more consideration to take when wanting to install feeders in an area reserved for ecosystem preservation and conservation.

XI. REFERENCES:

Akbar, Z., & Gorman, M. L. (1993). The effect of supplementary feeding upon the demography of a population of woodmice Apodemus sylvaticus, living on a system of maritime sand-dunes. *Journal of Zoology*, *230*(4), 609-617.

Blair, W. F. (1940). Notes on home ranges and populations of the short-tailed shrew. *Ecology*, *21*(2), 284-288.

Blair, W. F. (1942). Size of home range and notes on the life history of the woodland deer-mouse and eastern chipmunk in northern Michigan. *Journal of Mammalogy*, *23*(1), 27-36.

Bolker, B. M., Brooks, M. E., Clark, C. J., Geange, S. W., Poulsen, J. R., Stevens, M. H. H., & White, J. S. S. (2009). Generalized linear mixed models: a practical guide for ecology and evolution. *Trends in ecology & evolution*, *24*(3), 127-135.

Carnivores, C. I. U. (2004). Ecology and management of striped skunks, raccoons, and coyotes in urban landscapes. *People and predators: From conflict to coexistence*, 81.

Consul, P. C., & Jain, G. C. (1973). A generalization of the Poisson distribution.*Technometrics*, *15*(4), 791-799.

Cooper, S. M., & Ginnett, T. F. (2000). Potential effects of supplemental feeding of deer on nest predation. *Wildlife Society Bulletin*, 660-666.

Doonan, T. J., & Slade, N. A. (1995). Effects of supplemental food on population dynamics of cotton rats, Sigmodon hispidus. *Ecology*, 814-826.

Desrochers, A. (1989). Sex, dominance, and microhabitat use in wintering black-capped chickadees: a field experiment. *Ecology*, *70*(3), 636-645.

Eder, Tamara and Kennedy, Gregory. (2011). Mammals of Canada. *Lone Pine Publishing*, 446.

Evans, K. L., Newson, S. E., & Gaston, K. J. (2009). Habitat influences on urban avian assemblages. *Ibis*, *151*(1), 19-39.

Fuller, R. A., Warren, P. H., Armsworth, P. R., Barbosa, O., & Gaston, K. J. (2008). Garden bird feeding predicts the structure of urban avian assemblages.*Diversity and Distributions*, *14*(1), 131-137.

Gurnell, J. and Flowerdew, J.R. (2006). “Live trapping Small Mammals : A Practical Guide” . *The Mammal Society*, 48.

Jenks, K. E., Chanteap, P., Damrongchainarong, K., Cutter, P., Cutter, P., Redford, T., ... & Leimgruber, P. (2011). Using relative abundance indices from camera-trapping to test wildlife conservation hypotheses--an example from Khao Yai National Park, Thailand. *Tropical Conservation Science*, *4*(2).

Jones, D. (2011). An appetite for connection: why we need to understand the effect and value of feeding wild birds. *Emu*, *111*(2), i-vii.

Koehler, G. M., & Pierce, D. J. (2003). Black bear home-range sizes in Washington: climatic, vegetative, and social influences. *Journal of Mammalogy*,*84*(1), 81-91.

Koekemoer, A. C., & Van Aarde, R. J. (2000). The influence of food supplementation on a coastal dune rodent community. *African Journal of Ecology*, *38*(4), 343-351.

Littell, R., Stroup, W., & Freund, R. J. (2002). *SAS for linear models*. SAS Institute.

O'Brien, T. G., Kinnaird, M. F., & Wibisono, H. T. (2003). Crouching tigers, hidden prey: Sumatran tiger and prey populations in a tropical forest landscape. *Animal Conservation, 6*(2), 131-139.

Pollock, K. H. (1980). *Capture-recapture models: a review of current methods, assumptions and experimental design*. Raleigh, NC: North Carolina State University.

R Core Team. (2013). *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing.

Robb, G. N., McDonald, R. A., Chamberlain, D. E., & Bearhop, S. (2008). Food for thought: supplementary feeding as a driver of ecological change in avian populations. *Frontiers in Ecology and the Environment*, *6*(9), 476-484.

Shochat, E., Lerman, S. B., Anderies, J. M., Warren, P. S., Faeth, S. H., & Nilon, C. H. (2010). Invasion, competition, and biodiversity loss in urban ecosystems. *BioScience*, *60*(3), 199-208.

Tierson, W. C., Mattfeld, G. F., Sage, R. W., & Behrend, D. F. (1985). Seasonal movements and home ranges of white-tailed deer in the Adirondacks. *Journal of wildlife management, 49*(3), 760-769.

Wolff, J. O. (1985). The effects of density, food, and interspecific interference on home range size in Peromyscus leucopus and Peromyscus maniculatus. *Canadian Journal of Zoology, 63*(11), 2657-2662.