How to humanely protect your garden beds: Evaluating the effectiveness of humane wildlife deterrents

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Abstract

Urbanization has resulted in an increase in human-wildlife conflicts (Schell et al., 2020). With this, it is important to identify means of mitigating such conflicts in a way that promotes co-existence between humans and urban wildlife. A common human-wildlife conflict within urban landscapes is the damaging of garden beds from animal foraging. In this study I aimed to identify the most effective and humane way to mitigate this conflict by evaluating the effectiveness of several humane wildlife deterrents. To do so, unique feeding stations were placed around the yard of a suburban home in Vancouver, British Columbia, each protected by and testing a deterrent. The deterrents tested were garlic powder, coffee grounds, noise makers, dog hair and bird mesh. I predicted that bird mesh would be most effective at preventing wildlife from taking food from the stations and that the amount of food taken from stations would differ according to which deterrent it was protected by. However, across all six trials performed only one piece of food was taken from a station. With this, we could not statistically support the notion that any of the deterrents were more effective than the others. Some possible underlying causes for the lack of feeding observed are discussed, the most likely being that local fauna had no need to seek out additional food sources and that the feeding stationed induced a neophobic response in the animals.

Introduction

Over the last several decades urban landscapes across the world have undergone significant expansion. In Canada alone, total urban land area expanded by 9.7% between 1996 and 2006, a short time span of only 10 years (“Table 3.4”, 2009). As cities continue to grow, human-wildlife interactions and human-wildlife conflicts are becoming increasingly common (Schell et al., 2020). The majority of such conflicts, such as physical altercations between pets and wildlife, and those that result in property damage, most often negatively impact both the wildlife and humans involved (Mekonen, 2020; Schell et al., 2020). An example of such conflict is one experienced by many gardeners. During the Spring and Summer, it is common for urban wildlife to steal food from and/ or damage backyard gardens (Schell et al., 2020; MacNeil, 2010). Finding such behaviour a nuisance, people often resort to ineffective and/ or harmful strategies to protect their gardens, including the use of lethal traps and translocation (Schell et al., 2020). Although wildlife interactions can be negative, they are just as often beneficial. For example, interacting with wildlife is known to provide many health benefits to humans (Soulsbury & White, 2015). By taking this knowledge and current evidence of the harm that certain mitigation strategies can cause into consideration, the need for effective and humane wildlife strategies becomes evident. The implementation of these sorts of strategies to protect backyard gardens would not only reduce the harm brought to fauna but would promote greater co-existence between humans and urbanized wildlife moving into the future.

The objective of this study was to develop a more comprehensive understanding of the efficacy of previously known humane wildlife deterrents, with overall goal of using the acquired knowledge to advocate for their use in garden protection. The tested deterrents included three scent/ taste repellents: garlic powder, coffee grounds and dog hair which acted as a predator scent, noise makers which functioned as auditory deterrent and bird mesh, a physical deterrent/ barrier. All deterrents that were tested are known humane and non-lethal mitigations techniques (MacNeil, 2010; Schell et al., 2020). With this, I wanted to determine which humane wildlife deterrent, out of those being tested is most effective. The effectiveness of the deterrents was quantified by using each deterrent to protect one of six feeding stations set-up around a suburban yard and by measuring how much feeding took place at each station. I hypothesized that the various deterrents would prevent animals from feeding at the stations with varying efficacy, so that the amount of produce taken from the feeding station would be affected by the wildlife deterrent chosen to protect it. Furthermore, I predicted that the least amount of produce would be taken from the station protected with bird mesh, since the mesh should function as a physical barrier restricting the animals from accessing the food. The use of nets to prevent feeding has shown to be very effective against birds, indicating a likely effectiveness against other urban wildlife as well (Schell et al., 2020).

Methods

Experimental Procedure

To assess the effectiveness of the five chosen deterrents, six unique feeding stations were placed around the yard of a suburban home in Vancouver, British Columbia, Canada. Each of the five deterrents being tested were used to protect one of the six stations and one station was left unprotected as a control. The amount of produce left in each station at the end of trials was used to assess how well each deterrent prevented fauna from feeding at the station. Each station consisted of the bottom half of a small *Sterilite* two-layer handle box, its respective deterrent and four shallow plastic cups filled with produce. Six trials were performed in total using the following methods.

First the produce was chopped into small pieces. The produce used, including butternut squash, strawberries, zucchini and broccoli were chosen for being both suitable garden produce and produce that squirrels, the animal most abundant animal in the yard where the experiment was conducted, are known to enjoy (Meager, 2021; “What do”, 2019). All produce was cut into cubes/ pieces with edges approximately 0.5 – 1.5 cm in length. The produce was kept separate and refrigerated prior to use. Directly before each trial, 5 tablespoons of garlic powder were added into one of the stations and 5 tablespoons of coffee grounds was added to another. A dog hair filled nylon pouch was then placed along each of the four edges of another station. These pouches were made by cutting out four squares of nylon around 12X12 cm in size, adding five tablespoons of dog hair (West Highland Terrier) to each and by tying them closed with yarn. Twenty pieces of each produce type was then placed in six cups so that twenty-four cups in total were filled with food. Using a food scale, the contents of each cup were measured to the closest gram to minimize the amount of size variation in food pieces between stations and trials. The weight range maintained for strawberries, zucchini, broccoli and squash were respectively, 31-34g, 35-38g, 13-16g and 32-36g. Once weighed, one cup of each food type was placed in a corner of each station. All stations were then placed in one of the set six station locations around the yard. The set locations were at least 5 metres apart to minimize the degree to which the deterrents employed at each station would impact animal feeding at surrounding stations. It’s important to note that the location where each of stations was placed throughout the experiment was shuffled in every successive trial. Once all stations were placed one of the three remaining unprotected boxes was tightly covered in a 35X37” piece of bird mesh. The bird mesh was secured by staking the mesh into the ground with seven metal pegs. One noise maker was then placed at each corner of the second to last unaltered station. The noise makers were made prior to the trials by tying two aluminum pie trays together and securing them loosely to the upper end of a stick approximately 30cm foot tall. The final unaltered station was left unprotected as a control. Once placed a photo was taken of each station. See *Figure 1* for the final set-up of each station.

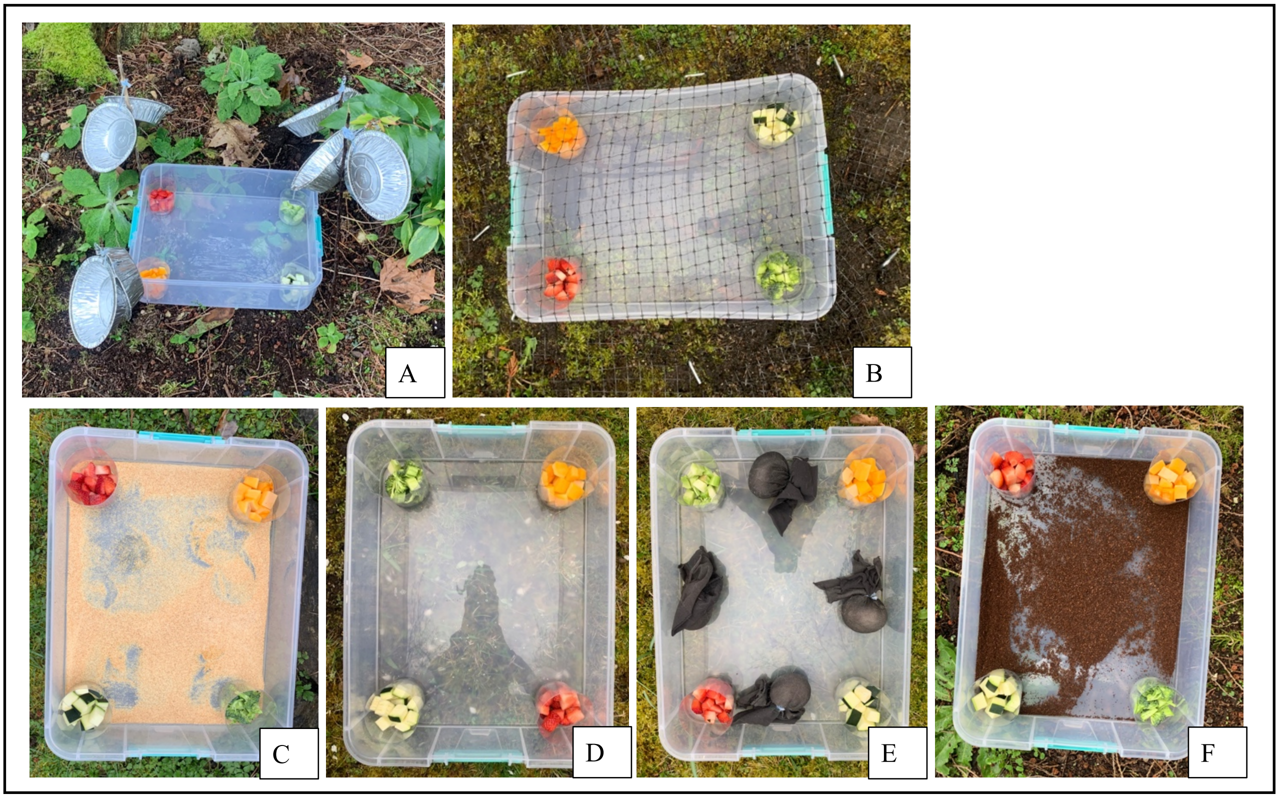

Figure 1. Images of the six feeding stations used to test the effectiveness of five wildlife deterrents. Each station was protected by and used to evaluate one of the five deterrents. A sixth station that remained unprotected was included as a control. All photos were taken between March 23rd – 29th, 2021. The number of food pieces left in the stations at the end of each trail was used to evaluate the effectiveness the tested deterrent. Six trails were performed in total. The feeding station types, named according to which deterrent they tested included (as labelled above): A - noise maker, B - bird mesh, C- garlic powder, D - control (no deterrent), E – predator scent and F - coffee grounds.

In each trial the stations were left out for twelve hours starting between 8:30-9:30am. After each trial before the stations were collected a photo of each of them was taken. The number of food pieces left in each cup and the weight of food in each cup was then measured and recorded. Throughout each trial notes were taken on the weather, presence/ absence of animals around the yard, if the wind was strong enough for the noise makers to be audible and on the amount of foot traffic that the yard received. The before and after trial photos of each station were also used to take notes any visible changes that the stations experienced (ie. spilt food).

Data Analysis

Since very little food was taken, the number of food pieces left the rather than the number taken from the stations was analyzed. Initially an ANOVA was performed to identify if the total number of food pieces at the end of the trials differed significantly between any of the feeding stations, however the data obtained did not meet the normality assumption of an ANOVA so non- parametric Friedman's test was run instead. Data obtained from all six trails was included within analysis.

Results

As shown in *Figure 2*, minimal feeding took place at the stations throughout all six trials. Furthermore, little variation in feeding was observed between stations regardless of which humane deterrent was protecting it and if a deterrent was protecting it. The only station from which food was the control station, which contained one less strawberry piece at the end of the first trial. Besides that, all stations across all other trials still contained eighty food pieces at the end of the day.

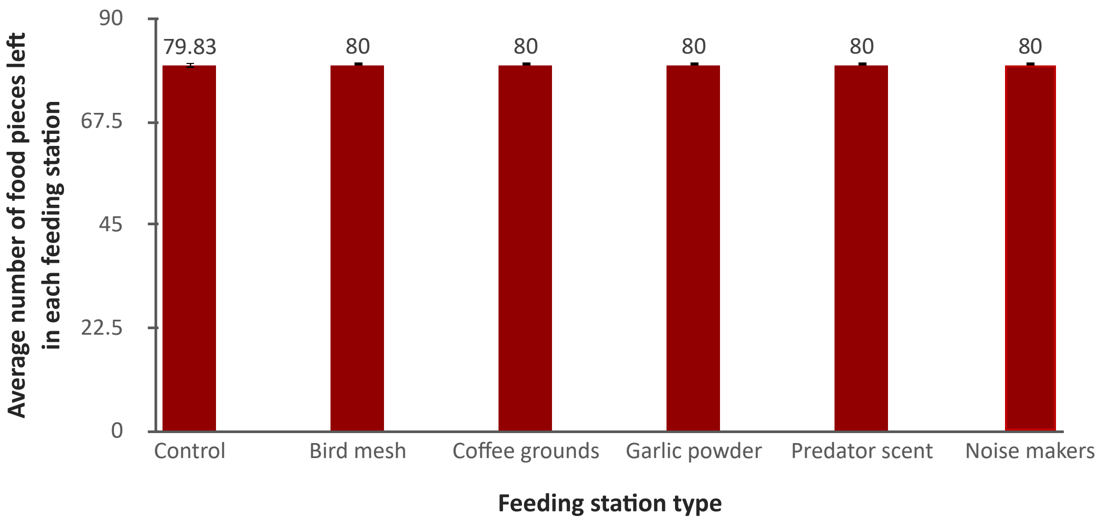

Figure 2. The above data was collected in the yard of a personal residence in Vancouver, British Columbia between the dates of March 23rd – March 29th, 2021. The impact of different wildlife deterrents on the feeding behaviour of local urban wildlife was assessed using six unique feeding station, protected by the deterrent indicated on the x-axis. The control station was left unprotected. The y-axis measures the mean number of food pieces left in each station at the end of the day across six trials. Before trials each food station was filled with eighty food pieces. The number above each bar indicates this mean (p-value = 0.4159, Friedman's test) and the error bars show the standard deviation of each mean. Error bars except the one for the control station bar are flat because no variation in feeding (SD = 0) was recorded at any station other than the control.

A Friedman's test on the number of pieces left in each station at the end of trial statistically confirmed that the selection of wildlife life deterrent chosen to protect the feeding stations had no significant effect on the amount of food taken by animals (P = 0.4159). $\propto = 0.05$ was used as the significance level, chosen to follow the traditional standard for biological research.

A qualitative assessment of the stations at the start and end of each trial indicated that not only were animals not taking food from the stations but that they were not visiting them altogether. After every trial no dirt appeared to have been tracked into the stations, no food was split and the garlic powder and coffee grounds in the scent deterrent stations did not appear to have been displaced by animals. It is important to note however that there was rainfall during four of the trials, making it challenging to assess if any observed changes to the stations were the result of animal activity or simply the rain. Although both birds and squirrels were observed in the yard throughout the trials there was noticeably less animal activity during trials with rain compared to those without.

Discussion

Based on the statistical analysis performed, I am unable to reject the null hypothesis that the selection of wildlife deterrent has no effect on the amount of food taken by animals. With this, no support can be provided to the hypothesis that the tested deterrents prevent animals from feeding at the stations with varying efficacy. Without statistical evidence to support this notion, my initial prediction that bird mesh would be most effective in deterring wildlife is also not supported. Although no food was taken from the bird mesh station during any of the trials, making it appear effective, this conclusion is invalid since no difference in feeding was observed between stations. Since all other stations including the control experienced minimal or no feeding, it is likely that the apparent effectiveness of the deterrents is rather a reflection of an experimental design unsuitable for the research question. The methods used in this study would therefore have to be modified to determine which deterrent out of those tested is most effective. Some possible underlying causes for the lack of feeding observed include that the yard selected was not a suitable location, the weather affected normal feeding behaviour and that the stations induced a neophobic response in the animals.

As mentioned, a possible reason for why such minimal amounts of feeding was recorded at the stations is that the yard chosen was not suitable location for the experiment. Furthermore, this lack of suitability could be due to there not being enough wildlife in the region where to yard is located to adequately assess the efficacy of the deterrents. Alternatively, it is also possible that the fauna in the area have access to sufficient food sources and have no need to seek out new ones. Although possible, the former explanation is unlikely since wildlife, birds and squirrels in particular, were seen around the yard throughout the experiment. Furthermore, the produce types used in the stations were specifically chosen to target squirrel, since they had been observed to be most abundant prior to the start of the trials. It is therefore more likely the animals did not feed at the stations simply because they felt no need to. The neighborhood where the experiment performed has lots of plants and vegetation. This observation indicates that natural food resources for fauna are abundant. If the local wildlife already has access to reliable and abundant food sources, they likely do not spend time seeking out new food sources like the feeding stations. This theory, aiming to explain the lack of feeding observed throughout the experiment, can be further supported by the observation that the stations consistently appeared undisturbed at the end of trials. An observation that indicates that animals were not approaching the stations. To address this possible error in experimental design, the experiment could be reconducted in a new location, one where natural sources of food are less abundant and where local wildlife likely invests more energy into finding novel food sources.

Furthermore, it is also a possibility that the lack of interaction with the feeding stations was caused by inclement weather. There was substantial rainfall during four out the six trials conducted. On these days there was also a semi- consistent overcast and noticeable levels of wind. Many animals common to urban environments, such as squirrels, take shelter when it rains, reducing the amount of time that they can spend foraging for food (“Where do”, 2019). It is important to note however that no food was taken from the stations during trials without rain, suggesting that this explanation may not be the primary cause underlying the insignificant results obtained.

Finally, neophobia caused by the presence of the stations could also explain the absence of feeding. By definition, neophobia is the avoidance of novel stimuli (Benson-Amram & Holekamp, 2012). Since the stations were both man-made and not previously experienced by local wildlife, it is possible that animals avoided them out of fear. With this, to address the possible impact of neophobia the feeding stations could be filled and left around the yard unprotected for several weeks leading up to the experiment to allow for the animals become habituated to them.

Conclusion

The overall aim of this experiment was to identify the most effective humane wildlife deterrent out of garlic powder, coffee grounds, dog hair (predator scent), noise makers and bird mesh. Nearly no food was taken from any of the stations and so we were unable to provide support to the hypothesis that the tested deterrents prevent animals from feeding at the stations with varying efficacy. With this, the prediction that bird mesh would be the most effective deterrent also could not be supported. Although insignificant results were obtained, this study provided useful insight on how the effectiveness of different deterrents could be better evaluated in future work. Such findings may help facilitate the use of humane deterrents, allowing for better co-existence between humans and urbanized wildlife in the future.

Acknowledgment

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Appendix

Table 1A- Raw data for trial #1

	initial number of food pieces & weight of food (g)				number of food pieces at end of trial & weight of food (g)				total pieces taken & total change in weight (g)
food type	broccoli	squash	strawberries	zucchini	broccoli	squash	strawberries	zucchini	
station type									
control	20 & 14	20 & 33	20 & 31	20 & 37	20 & 16	20 & 33	19 & 32	20 & 36	1 & +2
bird netting	20 & 14	20 & 35	20 & 31	20 & 37	20 & 17	20 & 35	20 & 31	20 & 37	Ø & +3
coffee grounds	20 & 14	20 & 35	20 & 31	20 & 37	20 & 14	20 & 35	20 & 31	20 & 35	Ø & -2
garlic powder	20 & 13	20 & 35	20 & 31	20 & 37	20 & 14	20 & 36	20 & 30	20 & 37	Ø & +1
noise makers	20 & 14	20 & 32	20 & 33	20 & 37	20 & 17	20 & 33	20 & 32	20 & 36	Ø & +2
dog hair	20 & 15	20 & 32	20 & 32	20 & 37	20 & 17	20 & 33	20 & 31	20 & 37	Ø & +2

Table 1B – Raw data for trial #2

	initial number of food pieces & weight of food (g)				number of food pieces at end of trial & weight of food (g)				total pieces taken & total change in weight (g)
food type	broccoli	squash	strawberries	zucchini	broccoli	squash	strawberries	zucchini	
station type									
control	20/15	20/35	20/31	20/38	20/19	20/40	20/40	20/45	Ø/+25
bird netting	20/14	20/33	20/31	20/37	20/19	20/37	20/37	20/44	Ø/+22
coffee grounds	20/15	20/34	20/32	20/37	20/17	20/42	20/38	20/42	Ø/+21
garlic powder	20/15	20/34	20/33	20/37	20/23	20/39	20/37	20/42	Ø/+22
noise makers	20/16	20/33	20/32	20/37	20/21	20/41	20/36	20/44	Ø/+29
dog hair	20/15	20/35	20/32	20/37	20/18	20/40	20/35	20/40	Ø/+14

Table 1C – Raw data for trial #3

	initial number of food pieces & weight of food (g)				number of food pieces at end of trial & weight of food (g)				total pieces taken & total change in weight (g)
food type / station type	broccoli	squash	strawberries	zucchini	broccoli	squash	strawberries	zucchini	
control	20/15	20/34	20/31	20/36	20/14	20/33	20/~~28~~ 29	20/34	~~20~~ 0/-6
bird netting	20/14	20/36	20/32	20/37	20/15	20/35	20/33	20/36	~~20~~ 0/0
coffee grounds	20/15	20/35	20/32	20/37	20/13	20/33	20/31	20/32	~~20~~ 0/-10
garlic powder	20/15	20/36	20/32	20/37	20/18	20/34	20/30	20/35	~~20~~ 0/-3
noise makers	20/14	20/36	20/33	20/37	20/14	20/35	20/32	20/36	~~20~~ 0/-3
dog hair	20/14	20/35	20/32	20/~~36~~ 37	20/13	20/35	20/29	20/37	~~20~~ 0/-4

Table 1D – Raw data for trial #4

	initial number of food pieces & weight of food (g)				number of food pieces at end of trial & weight of food (g)				total pieces taken & total change in weight (g)
food type / station type	broccoli	squash	strawberries	zucchini	broccoli	squash	strawberries	zucchini	
control	20/~~14~~ 16	20/35	20/32	20/36	20/14	20/33	20/29	20/34	0/-9
bird netting	20/14	20/34	20/33	20/36	20/16	20/31	20/31	20/35	0/-4
coffee grounds	20/14	20/35	20/33	20/36	20/13	20/35	20/30	20/35	0/-5
garlic powder	20/14	20/34	20/32	20/36	20/13	20/33	20/30	20/36	0/-4
noise makers	20/14	20/35	20/32	20/36	20/15	20/34	20/30	20/35	0/-3
dog hair	20/14	20/35	20/32	20/36	20/14	20/36	20/31	20/35	0/-1

Table 1E – Raw data for trial #5

	initial number of food pieces & weight of food (g)				number of food pieces at end of trial & weight of food (g)				total pieces taken & total change in weight (g)
food type / station type	broccoli	squash	~~strawberries~~ zuchini	~~zucchini~~ strawberries	broccoli	squash	strawberries	zucchini	
control	20/14	20/34	20/~~34~~ 37	20/34	20/17	20/36	20/unknown	20/40	0/N/A ~~unknown~~
bird netting	20/14	20/36	20/~~34~~ 37	20/	20/16	20/36	20/33	20/37	6/N/A
coffee grounds	20/14	20/36	20/~~34~~ 36	20/	21/16	20/36	20/33	20/39	0/N/A
garlic powder	20/14	20/35	20/~~32~~ 36	20/	20/17	20/36	20/32	20/39	0/N/A
noise makers	20/15	20/34	20/~~34~~ 37	20/	20/16	20/35	20/28	20/37	0/N/A
dog hair	20/15	20/35	20/~~32~~ 35	20/	20/15	20/36	20/30	20/37	0/N/A

Table 1F – Raw data for trial #6

	initial number of food pieces & weight of food (g)				number of food pieces at end of trial & weight of food (g)				total pieces taken & total change in weight (g)
food type	broccoli	squash	strawberries	zucchini	broccoli	squash	strawberries	zucchini	
station type									
control	20/16	20/35	20/~~32~~ 32	20/37	20/15	20/34	20/31	20/35	0/-5
bird netting	20/16	20/35	20/~~33~~ ~~32~~ 33	20/38	20/12	20/32	20/28	20/34	Ø/-6
coffee grounds	20/16	20/~~35~~ 36	20/~~32~~ 32	20/37	20/18	20/34	20/31	20/36	Ø/-2
garlic powder	20/15	20/36	20/~~32~~ 32	20/37	20/14	20/33	20/31	20/34	Ø/-8
noise makers	20/~~15~~ 15	20/36	20/~~32~~ 32	20/37	20/14	20/34	20/30	20/34	0/-8
dog hair	20/15	20/35	20/32 ~~32~~	20/36	20/13	20/32	20/30	20/33	0/-10