THE CANADIAN SCIENCE FAIR JOURNAL

ARTICLE

# A Case Study of Wildlife Feeding and Coyote Attacks in Vancouver's Stanley Park

**By: Jonathan Leung | Edited by: Vanessa Poirier | Layout by: Ahmed Nadeem**

Age: 14 | Vancouver, British Columbia

**2022 CWSF Silver Medalist, Greater Vancouver Regional Science Fair Gold Divisional Award, BC Nature Award, UBC Zoology Award and Chief Judge Award, 2021 CWSF: Bronze Medalist Greater Vancouver Regional Science Fair: Gold Divisional Award, BC Nature Award, In Ink Scientific Writing Award and UBC Statistics Award, 2020 BC and Yukon Virtual Science Fair: BC Nature Award and BC Agriculture in Classroom Award**

In this project, I investigate the relationship between wildlife feeding and coyote attacks in Vancouver's Stanley Park. I collect and analyze data from 96 wildlife feeding reports by species, location, time of day, and month. In the analysis by species, coyote feeding is shown to be the most prevalent. In the analysis by location, there is one area where 3 coyote attacks are in proximity to a cluster of 17 wildlife feeding incidents. In the analysis by time of day, most of the attacks occur around dawn (6 - 8 am) and at night (9 pm - 12 am) but the wildlife feeding counts are not high during these periods. In the analysis by month, there are 2 periods – December to January and July to August, which account for more than 70% of the attacks. The wildlife feeding trend does not correlate with the attack trend. A goodness of fit Chi-squared test confirms the attacks are not distributed uniformly over the study period. Although wildlife feeding is one of the likely causes of the attacks, I discuss several other attack theories which include anthropause, encampment and human activities, and abnormal coyote behaviour. Preventive measures against future coyote attacks such as the enforcement of wildlife feeding laws, installation of signs, wildlife resistant garbage bins and aversion conditioning are presented. Monitoring wildlife feeding incidents is a laborious task as it requires the presence of many eyewitnesses. It may be possible to put GPS-camera collars on the coyotes and record their eating activities. Scat analysis is also useful to determine if the coyotes are consuming anthropogenic food.

## INTRODUCTION

Stanley Park is a world-famous urban park and tourist attraction located in Vancouver, BC. Among the many wild animals that live in Stanley Park, the coyote (Canis latrans) is one of the top predators. From December 2020 to August 2021, Stanley Park saw an unprecedented total of 52 coyote attacks (Leung, 2022). In the 30 years prior to December 2020, there had only been 10 coyote attacks recorded in Stanley Park (Cecco, 2021). I am interested in understanding why this sudden increase in attacks occurred. Wildlife feeding is a human-wildlife interaction that lets wild animals consume food handed out by humans. Previous research has shown that wildlife feeding can cause dependency on humans (Orams, 2002). Habituated coyotes lose their natural fears of humans and associate humans with food (Timm et al., 2004). There are many reported cases where wildlife has become unnaturally aggressive when the animals are fed by humans for prolonged periods (Orams, 2002). It is possible coyote aggression could be linked to the consumption of anthropogenic food that changes the coyote's gut microbiome (Sugden et al., 2020).

Section 31.1 of the British Columbia (BC) Wildlife Act states that people must not attract "dangerous wildlife" (such as bears, cougars, bobcats, wolves, and coyotes) by intentional feeding, attempted feeding, or leaving any attractant (Government of BC, 1982). The offender is subject to high penalties and even imprisonment. On October 4, 2021, the Vancouver Park Board enacted the amended Parks Control & Ticket Offences Bylaws to prohibit anyone from feeding any wildlife directly and indirectly, and ticket any offender with a $500 fine.

Besides the enactment of wildlife feeding laws, "Do Not Feed Wildlife" signs were placed in hotspot areas in Stanley Park to discourage people from feeding wildlife. Most garbage bins have open lids in Stanley Park. When the garbage bins are filled up and not emptied regularly, they become an easy food source for wild animals. Stanley Park is operating a pilot program to install wildlife-proof garbage bins in certain locations.

The Stanley Park Ecology Society (SPES) is also looking at aversion conditioning as part of a comprehensive wildlife coexistence program to reduce the human-coyote conflicts in Stanley Park. Also known as humane hazing, aversion conditioning is a set of actions and gestures to communicate to the coyotes to stay away from humans (Sampson and Van Patter, 2020). It involves the persistent use of one's body along with additional stimuli (such as shaker cans, umbrellas, and garbage bags) to send a clear message to the coyotes.

In this paper, I investigate the relationship between wildlife feeding and coyote attacks in Stanley Park. I collect and analyze data from 96 wildlife feeding reports by food category, location, time of day and month and look for any possible relationship with coyote attacks. I test a null hypothesis of uniformly distributed attacks from December 2020 to August 2021.

## METHODS AND MATERIAL

From August 13 to September 6, 2021, I paid 14 visits to the Lost Lagoon and Beaver Lake area in Stanley Park and recorded 35 wildlife feeding incidents. I collected the feeding report data by filling in Google Forms online and taking photos and videos with my iPhone (Figure 1). The SPES began collecting wildlife feeding reports in February 2021. I combined my 35 incidents with another 61 incidents supplied by the SPES and built a database of 96 wildlife feeding incidents. Each feeding report included the following: date and time of occurrence; GPS coordinates; feeding type—direct, indirect, or accidental; type of food; and animal being fed. It should be noted that many incidents can stay unreported because there were no eyewitnesses at that time. Although the 96 reports are a small subset of the actual number of wildlife feeding incidents, they may shed some light on the potential relationship between wildlife feeding and coyote attacks.

For indirect and accidental feeding, the eyewitness would make their best guess of the targeted animals based on the location and the type of food that was left behind. In these cases, the types of animals being fed are solely assumptive. People were wanting to feed coyotes but a person directly feeding a coyote was not witnessed firsthand.

I also test a hypothesis of uniformly distributed attacks using a Chi-squared ($\chi^2$) goodness-of-fit test (Zeltzer, 2020). The null hypothesis ($H_0$) states that 52 coyote attacks are distributed uniformly over 9 months, whereas the alternative hypothesis ($H_a$) states that the coyote attacks are not distributed uniformly during this period. If $H_0$ is correct, an average number of 5.78 attacks is expected each month.


**Figure 1. Examples of wildlife feeding that occurred in Stanley Park in 2021.**

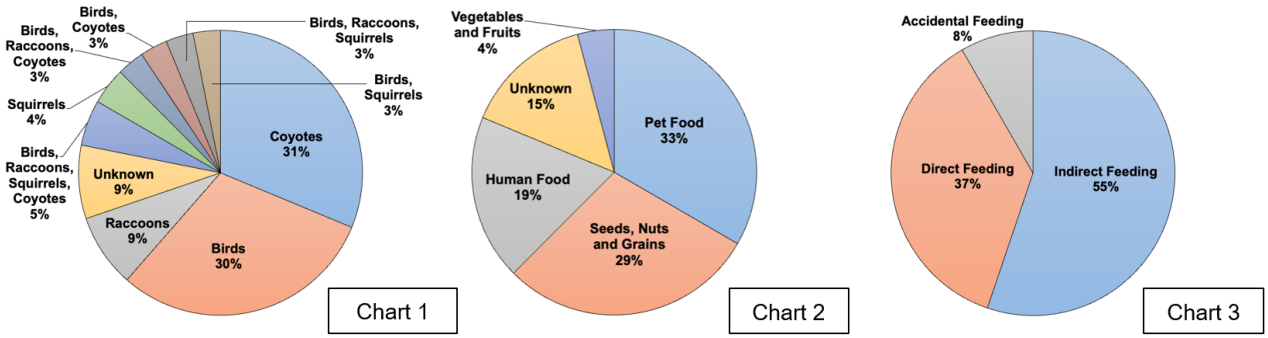


**Figure 2. Pie Charts categorizing the type of animal being fed, the type of food, and the feeding method. There are some food types (such as bread) that could be consumed by a few different animals and hence Chart 1 also shows groups of targeted animals as different categories.**

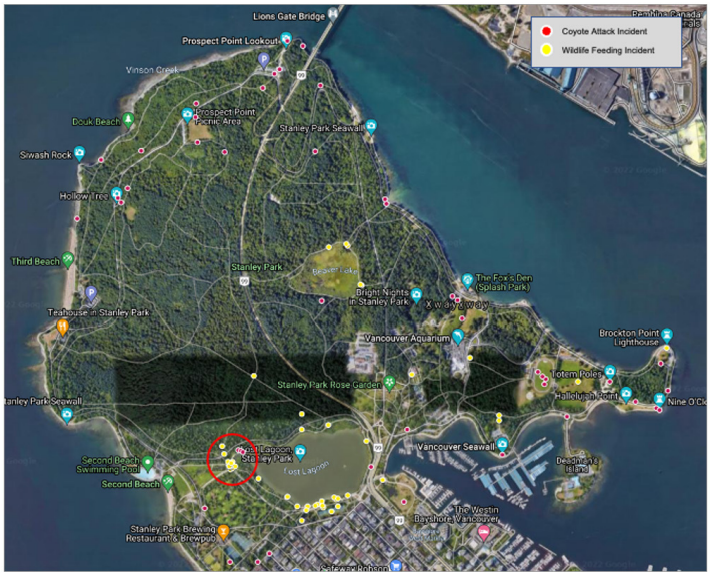


**Figure 3. A map showing coyote attacks and wildlife feeding incidents in Stanley Park during Dec. 2020 - Aug. 2021.**

## ANALYSIS BY CATEGORY

In Figure 2 below, Pie Chart 1 shows that the top target animal identified is coyotes at 31%. In Pie Chart 2, pet food is the top category at 33%. In Pie Chart 3, indirect feeding - leaving food on the ground is the most prevalent at 55%.

## ANALYSIS BY LOCATION

I wanted to examine if there is any relationship between the wildlife feeding locations and the coyote attack locations. Thanks to the coyote attack information supplied by SPES, I can put the wildlife feeding and coyote attack locations on the same map (Figure 3). The wildlife feeding reports were mostly around the Lost Lagoon and Beaver Lake area (due to the monitoring focus in these 2 areas). There were 4 coyote attacks (3 in the northwest and 1 in the east near Highway 99) in the Lost Lagoon area. Most of the attacks happened in the northern part (Prospect Point and Hollow Tree) and eastern part (Vancouver Aquarium, Brockton Oval and Nine O'clock Gun) of Stanley Park. There were also 3 attack incidents (bottom of Figure 3) that were next to the residential area bordering Stanley Park.

## ANALYSIS BY TIME OF DAY

Figure 4 shows the temporal distribution of feeding incidents and coyote attacks over a 24-hour period. There are 5 feeding incidents that occurred at unknown times because there was no time recorded in the SPES database.

## ANALYSIS BY MONTH

Coyote attacks followed a downward trend during the first 3 months and 2 coyotes were killed (Figure 5). The attack trend then reversed in April. Despite the killing of another 4 coyotes in July, the number of attacks peaked at 13 in August. The wildlife feeding count does not appear to follow the same trend as coyote attacks.

Referring to Figure 5, the coyote attacks appear to be non-uniform when high attack counts were concentrated in 2 periods – December to January and July to August.

Using the Chi-squared Goodness of Fit Test to test my null hypothesis of uniformly distributed attacks, my calculations (Table 1) arrive at a $\chi^2$ value of 22.42. Since 22.42 is greater than 20.09 (1% significance level with a degree of freedom of 8), the null hypothesis is rejected with a 99% confidence level. Using this information, I can determine that the attacks are distributed non-uniformly.

## DISCUSSION

In Figure 2, Pie Charts 1 and 2 are showing some evidence that humans feeding coyotes is indeed a problem.

In inspecting the red circled area in Figure 3, the 3 coyote attacks that happened in the northwest corner of the Lost Lagoon are close to a cluster of 17 wildlife feeding activities in the area. A relationship may still exist even though there is a lack of wildlife feeding reports. This is because the reported incidents only represent a small subset of all the incidents and most incidents are most likely left unreported. I visited one of the other locations (Prospect Point Lookout) once on a Sunday morning (August 15, 2021) and did not find any evidence of wildlife feeding.

The time-of-day occurrence of wildlife feeding and coyote attacks appear to be independent of each other (Figure 4). Although 4 or more attacks occur more frequently around dawn (6-8am), at night (9-10pm and 11pm-12am) and at unknown times, the wildlife feeding counts are not exceptionally high during these

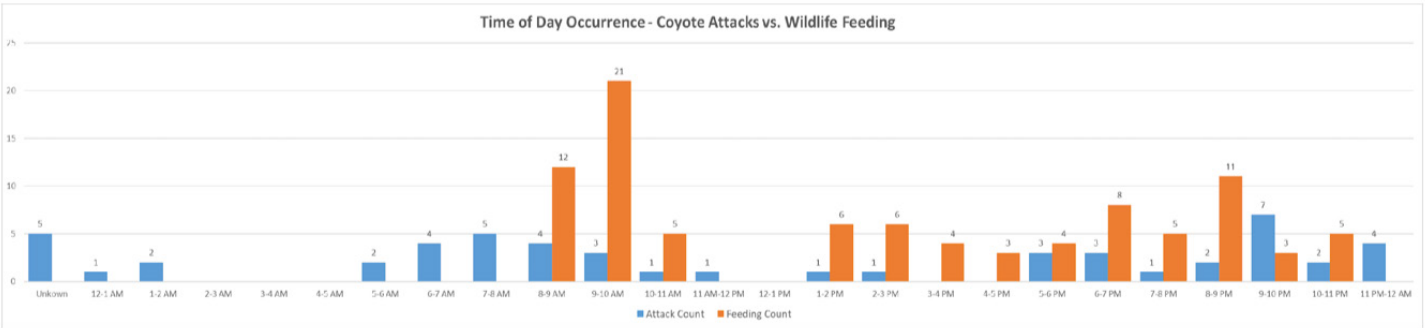


**Figure 4. Bar graph showing the occurrence of coyote attacks and wildlife feeding during different hours of the day.**

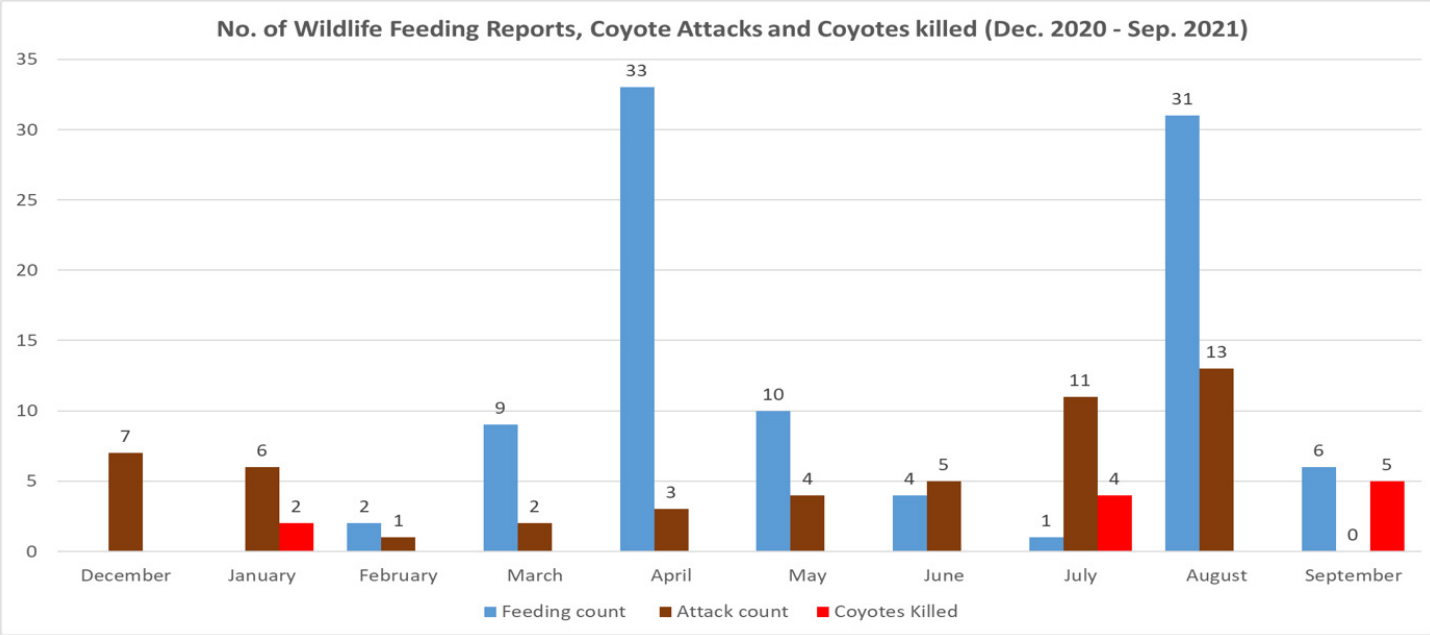


**Figure 5. The bar graph shows the counts for reported wildlife feeding incidents, coyote attacks (including humans and pets) and coyotes killed over 10 months. Note the SPES did not start collecting wildlife feeding information until February 2021 and hence December and January show zero wildlife feeding counts.**

periods. There might have been wildlife feeding before 8 am, but they were not reported because no eyewitnesses were present.

Looking at Figure 5, there are 31 feeding incidents and yet there are only 3 attacks in April. The wildlife feeding counts then trended down before they jumped back to their highest in August. Specifically, when I look at the targeted animals for wildlife feeding in April and August, 21 out of 33 incidents are linked to coyotes in April while only 1 out of 31 incidents are linked to coyotes in August. I expected the wildlife feeding trend would follow the coyote attack trend, but this is not the case. The under-representation of actual wildlife feeding incidents may have caused the trending error. Other factors that may have influenced the feeding trend could be the park's publicity around coyote attacks which may have decreased feeding.

In Figure 6, there are 3 periods in the annual reproduction cycle of coyotes – breeding season, pup rearing and dispersal (SPES, 2021). The highest number of attacks occurs during July and August. These 2 months coincide with the period when the coyote pups would begin to learn to hunt on their own. I theorized the attacks could be caused by coyote pups. These inexperienced pups may not have any hunting skills for wild prey and instead follow their habituated parents to associate humans with food. It turns out the 11 coyotes that were captured and euthanized were all young adults or adults (N. Xenakis, personal communication, November 1, 2021). The coyote pup theory which is one of the consequences of wildlife feeding is therefore ruled out.

Figure 6- the reproduction cycle of coyotes. The 12 months are divided into 3 4-month periods – the breeding season (January to April), the pup rearing season (May to August) and finally the dispersal season (September to December).

## OTHER COYOTE ATTACK HYPOTHESES

Although wildlife feeding can be one cause of coyote attacks, 3 other alternative hypotheses are being considered:

Anthropause – anthropause is a new term invented to refer to the global slowing of human activities during the COVID-19 lockdown (Rutz et al., 2020). It may be possible the sudden change in human activities during and after the COVID-19 lockdown may have caused a change in coyote behaviour. To test this hypothesis, it would be necessary to track the daily number of visitors and compare it against the coyote attack trend. Unfortunately, no such visitor data was available.

Encampment and human activities – there are homeless people who set up tents to live in Stanley Park. I am unsure if these homeless people have any interactions with the coyotes. Trail

**Table 1 – Chi-square calculations to determine whether the coyote attack pattern is uniform.**

| Month | Attacks | Expected | Diff. | Sq. Diff. | Sq. Diff/Expected |
|---|---|---|---|---|---|
| December | 7 | 5.78 | -1.22 | 1.49 | 0.26 |
| January | 6 | 5.78 | -0.22 | 0.05 | 0.01 |
| February | 1 | 5.78 | 4.78 | 22.83 | 3.95 |
| March | 2 | 5.78 | 3.78 | 14.27 | 2.47 |
| April | 3 | 5.78 | 2.78 | 7.72 | 1.34 |
| May | 4 | 5.78 | 1.78 | 3.16 | 0.55 |
| June | 5 | 5.78 | 0.78 | 0.60 | 0.10 |
| July | 11 | 5.78 | -5.22 | 27.27 | 4.72 |
| August | 13 | 5.78 | -7.22 | 52.16 | 9.03 |
| | 52 | | | | 22.42 |

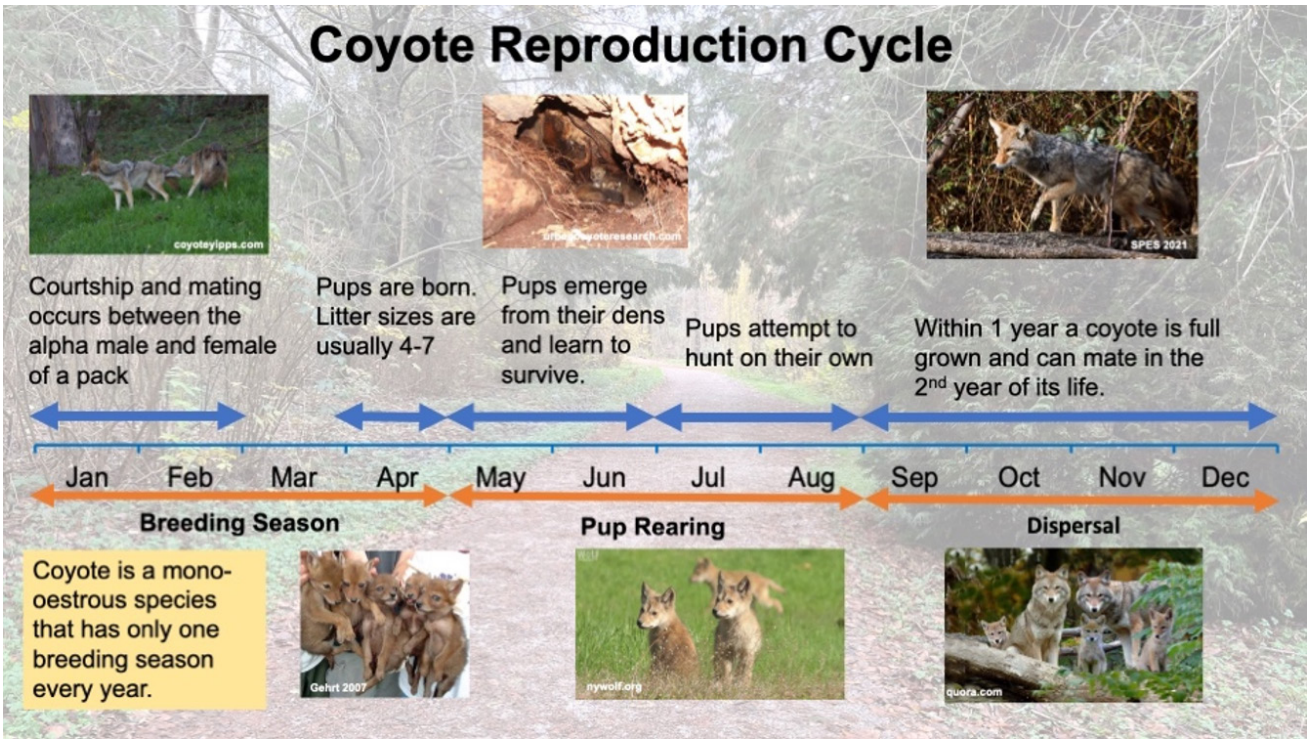


**Figure 6- the reproduction cycle of coyotes. The 12 months are divided into 3 4-month periods – the breeding season (January to April), the pup rearing season (May to August) and finally the dispersal season (September to December).**

cameras have also captured ongoing human activities at all hours at night (Breder and Fox 2021, Banks, 2021). These activities may have stressed the coyotes.

Abnormal coyote behaviour – coyotes have been captured on trail cameras acting scared, erratic, and paranoid when alone and lunging at people when confronted (Hudlow, 2021). As of August 2021, the necropsies of the euthanized coyotes did not find any rabies to explain this behaviour. The complete toxicology report is pending (K. Walker, personal communication, January 14, 2022).

## FUTURE RESEARCH

The issue of wildlife feeding arises from our complicated relationship with animals. Depending on the circumstances, wildlife feeding can have a positive or negative impact on the animals. In the context of coyotes in Stanley Park, this impact is clearly a negative one. Today, collecting wildlife feeding data relies on eyewitness reports. Given Stanley Park covers a lot of open space, it is difficult to record all the wildlife feeding incidents without involving a lot of people. Even with a lot of people, it is still impossible to capture every single incident because some can happen at odd hours (for example, some people were picnicking at the park and got bitten at 1:30 am) and in isolated locations. Perhaps a better approach is to switch the monitoring from the human feeders to the coyotes being fed.

The SPES and the University of British Columbia (UBC) have set up 24 trail cameras to monitor the coyotes in Stanley Park (K. Walker, personal communication, September 20, 2021). I also learned that the Chicago Urban Coyote Research Project has put radio collars on more than 600 coyotes over 20 years (PBS Terra, 2021, 2:39). Instead of having the camera at a fixed location, it is also possible to integrate the camera into the radio collar. During the Spring of 2021, the University of Minnesota Voyageurs Wolf Project fastened a GPS-camera collar on a wolf and discovered the animal was hunting fish (Gamillo, 2021). The camera collar has a drop-off feature that allows the collar to pop off automatically after a preset time. The collar can be retrieved without catching the animal. This technology can potentially be used to monitor the coyotes in Stanley Park.

Like the microbiome in the coyote's stomach, the coyote scats may reveal the make-up of the coyote diet. If the scats are analyzed to have a lot of anthropogenic food content, then there will be little doubt the coyotes are being fed by humans. I understand research is already underway to collect and analyze coyote scats in Stanley Park.

## CONCLUSIONS

By analyzing the wildlife feeding and attack data by category, location, time of day and month, I found that coyotes are the most targeted animal and pet food is the most common food type for feedings. There is an area (Lost Lagoon) where 3 coyote attack locations are in proximity to 17 wildlife feeding locations. There are 3 time periods (6-9am, 9-10pm and 11pm-12am) that have the most attacks. No time-of-day correlation is observed between wildlife feeding and coyote attacks. The monthly histogram shows over 70% of the attacks occurred in 4 months: December, January,

July and August, but no monthly correlation is found between the two events. Finally, a Chi-square goodness of fit test indicates the coyote attacks are non-uniform from December to August, 2021. Although wildlife feeding can be a common cause of coyote attacks, there is no main cause identified in this study. Three other attack theories have also been proposed: anthropause, encampment and human activities in Stanley Park, and abnormal coyote behaviour. Future research areas may include studying video footage captured using trail cameras and GPS collar cameras and scat analysis.

## ACKNOWLEDGEMENTS

First, I thank Nadia Xenakis, Urban Wildlife Programs Coordinator of the Stanley Park Ecology Society for her guidance on this project. Next, I thank Dr. Kristen Walker, Assistant Professor of Teaching, Faculty of Land and Food Systems at UBC. I also want to thank my other project reviewers Mr. Eric Chen and Ms. Laurel Anderson, both of Lord Byng Secondary School, and Wai Kwok Law. Finally, I want to thank my Canadian Science Fair Journal editor Nathan Badry for thoroughly reviewing my paper and providing useful comments.

## REFERENCES

Banks, K. (2021). Tracking aggressive behaviour of coyotes in Vancouver's Stanley Park. University Affairs.https://www.universityaffairs.ca/news/news-article/tracking-aggressive-behaviour-of-coyotes-in-vancouvers-stanley-park/

Breder, R. and Fox. L. (2021, August 5). Coyotes in Stanley Park are a human problem, not an animal problem. *The Georgia Straight*. https://www.straight.com/news/rebeka-breder-and-lesley-fox-coyotes-in-stanley-park-are-a-human-problem-not-an-animal-problem

Cecco, L. (2021, August 24). Mystery over surge in coyote attacks in Vancouver park. *The Guardian*. https://www.theguardian.com/world/2021/aug/24/mystery-over-surge-in-coyote-attacks-in-vancouver-park

Gamillo, E. (2021, April 21). Experience a day in the life of a wild wolf, as seen in stunning collar-cam footage. *Smithsonian Magazine* .https://www.smithsonianmag.com/smart-news/camera-collar-captures-first-ever-montage-wild-wolf-fishing-180977553/

Government of British Columbia. (1982). Wildlife Act [RSBC 1996] Chapter 488. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/96488_01

Leung, J. (2022). A case study of wildlife feeding and coyote attacks in Vancouver's Stanley Park [ProjectBoard slides]. *Youth Science Canada*. How? section, slide no. 3. https://projectboard.world/ysc/project/a-case-study-of-wildlife-feeding-and-coyote-attacks-in-vancouvers-stanley-park-jzldmv

Orams, M.B. (2002). Feeding wildlife as a tourism attraction: a review of issues and impacts. *Tourism Management*, 20, 281-293.

Pawson, C. (2021, September 26). Meet the 'park warriors' whose mission is to call out wildlife feeding in Vancouver. *CBC News*. https://www.cbc.ca/news/canada/british-columbia/meet-the-park-warriors-whose-mission-is-to-call-out-wildlife-feeding-in-vancouver-1.6189949

PBS Terra. (2021, November 4). What are wild coyotes doing in the big city? [Video]. *YouTube*. https://www.youtube.com/watch?v=OB7nomE1VL4&t=12s

Plana, V. (2021, October 5). You can now be fined for feeding urban wildlife in Vancouver parks. Daily Hive News. https://dailyhive.com/vancouver/vancouver-park-board-fine-feeding-urban-wildlife

Rutz, C., Loretto, MC., Bates, A.E. et al. (2020). COVID-19 lockdown allows researchers to quantify the effects of human activity on wildlife. *Nat Ecol Evol 4*, 1156–1159. https://doi.org/10.1038/s41559-020-1237-z

Sampson, L. and Van Patter, L. (2020). Advancing best practices for aversion conditioning (humane hazing) to mitigate human–coyote conflicts in urban areas. *Human–Wildlife Interactions* 14(2):166-183. https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1625&context=hwi

SPES (Stanley Park Ecology Society). (2021, July 29). Understanding urban coyotes. *SPES*. https://stanleyparkecology.ca/ecology/co-existing-with-coyotes/understanding-urban-coyotes/#year

Sugden, S., Sanderson, D., Ford, K., Stein, L.Y. and St., Clair, C.C. (2020). An altered microbiome in urban coyotes mediates relationships between anthropogenic diet and poor health. *Scientific Reports* 10 22207. https://doi.org/10.1038/s41598-020-78891-1

Timm, R.M., Baker, R.O., Bennett, J.R., Coolahan, C.C. (2004) Coyote attacks: an increasing suburban problem. Proceedings of the Twenty-First Vertebrate Pest Conference, pp. 47-57.

Zeltzer, J. [zedstatistics]. (2020, January 14). Chi-squared goodness of fit test! Extensive video! [Video]. YouTube. https://www.youtube.com/watch?v=ZNXso_riZag

## ABOUT THE AUTHOR - JONATHAN LEUNG

I am a grade 9 student from Lord Byng Secondary School and have participated in various science fairs since grade 7. I received several awards at the Greater Vancouver Regional Science Fair in 2021 and 2022. I was a 2021 bronze medalist and a 2022 silver medalist at the Canada Wide Science Fair. I am a member of the Lord Byng Math Contest Club and frequently participate in math competitions. In my spare time I enjoy playing the piano and trumpet. I currently play trumpet with the Lord Byng Wind Ensemble, Lord Byng Senior Jazz Band and Vancouver Academy of Music Symphony Orchestra.