Human Dimensions of Wildlife

ISSN: 1087-1209 (Print) 1533-158X (Online) Journal homepage: https://www.tandfonline.com/loi/uhdw20

Human–Coyote Interactions in Calgary, Alberta

Victoria M. Lukasik & Shelley M. Alexander

To cite this article: Victoria M. Lukasik & Shelley M. Alexander (2011) Human–Coyote Interactions in Calgary, Alberta, Human Dimensions of Wildlife, 16:2, 114-127, DOI: 10.1080/10871209.2011.544014

To link to this article: https://doi.org/10.1080/10871209.2011.544014

Published online: 23 Mar 2011.

Human Dimensions of Wildlife, 16:114–127, 2011

ISSN: 1087-1209 print / 1533-158X online
DOI: 10.1080/10871209.2011.544014

Human–Coyote Interactions in Calgary, Alberta

VICTORIA M. LUKASIK AND SHELLEY M. ALEXANDER

Department of Geography, University of Calgary, Calgary, AB, Canada

Urban coyotes have been studied in few Canadian cities, despite the apparent increase in negative human–coyote incidents. Our study was designed to develop a baseline understanding of the magnitude, severity, seasonality, and spatial distribution of these incidents in Calgary. We used citizen reports of human–coyote incidents, collected by the City of Calgary between 2005 and 2008. Reports were categorized into five levels from sightings to conflict. Conflict was most common during Pup-Rearing season and most often reported in central, higher-density communities in close proximity to small greenspaces. Incident levels were examined for seasonal trends and spatial patterns. Most incidents were sightings (89%); only 5% were conflicts. The presence of anthropogenic food conditioning likely predisposed coyotes to conflict, and in support we briefly discuss our complementary diet analysis. Our findings fill a gap in knowledge that is critical for monitoring and managing urban coyotes and human–coyote conflicts in Calgary.

Keywords *Canis latrans*, citizen reports, coyote, diet, human–wildlife conflict, management, nuisance wildlife, urban

Humans have a long history of conflict with coyotes (*Canis latrans*). For over a century ranchers have considered coyotes as pests that should be eradicated from the landscape, due to the potential threat they pose to livestock (Berger, 2006; Fox & Papouchis, 2005). Despite ongoing attempts to remove coyotes, the species has persisted and in some cases thrived in response to control efforts (Gese & Bekoff, 2004). With a distribution that now stretches across the Americas from the Arctic to Panama, coyotes have successfully adapted to a variety of habitat types, including urban areas (Bounds & Shaw, 1994; Fox & Papouchis, 2005). Urban areas offer a variety of microhabitats, which include natural and anthropogenic (human-related) food resources, such as garbage. In some urban areas garbage has supplemented the coyote's natural diet and led to food conditioning. The latter process is often associated with habituation to humans, subsequent loss of fear of humans, and may be linked to human–coyote conflict (Beckmann & Berger, 2003; Ditchkoff, Saalfeld, & Gibson, 2006; Timm, Baker, Bennett, & Coolahan, 2004; White & Gehrt, 2009). While studies have implied a link between coyote diet and human–coyote conflict (Carbyn, 1989; Gibeau, 1998; Grinder & Krausmann, 1998; Timm et al., 2004),

The authors would like to thank NSERC, the University of Calgary—Department of Geography, and the City of Calgary for funding. We would also like to thank Bill Bruce of Animal Services at the City of Calgary for providing data, and two anonymous reviewers for their feedback that strengthened this manuscript.

Address correspondence to Victoria M. Lukasik, Department of Geography, University of Calgary, 2500 University Dr. NW, Calgary, AB, T2N 1N4, Canada. E-mail: vlukasik@gmail.com

this connection has rarely been tested directly. Yet, the emergence of human–wildlife conflict as a result of habituation is not unexpected for coyotes; conflict evolves for numerous species across the globe, particularly habituated carnivores (Bagchi, Goyal, & Sankar, 2003; Breitenmoser, 1998; Merrill, Mattson, Wright, & Quigley, 1999; Stahl, Vandel, Herrenschmidt, & Migot, 2001; Wilson et al., 2005; Woodroffe, Lindsey, Romañach, Stein, & ole Ranah, 2005). Unfortunately, when any one carnivore species comes into conflict with people, no matter the root cause, it raises concerns that all carnivores pose an unreasonable threat to the safety of local citizens. This perception has resulted in many carnivore species being persecuted, sometimes to the point of extirpation or extinction (Berger, 2006).

In our study area (Calgary, Alberta) a coyote attack on a child in 2005 led many citizens to be concerned for the safety of children and pets. Public response was volatile and in some cases called for the elimination of coyotes from the city. While two coyotes were shot in response to this attack, the City of Calgary became interested in learning more about the coyotes and ways to minimize conflict, preferably with non-lethal means. Just prior to the attack, a citizen reporting system (one component of "Calgary 311") was developed by the City of Calgary, as a means to track human–coyote incidents (herein referred to as "incidents"). To date, no formal analysis has been conducted to understand the frequency or magnitude of the incidents reported to Calgary 311. Our study was developed to characterize the trends and spatial patterns of incidents that were reported to 311 between 2005 and 2008. We also explored potential relationships between these incidents and the diet of coyotes in the City of Calgary, based on Lukasik (2009). Our broad research questions included:

1. What kind of human–coyote incidents are taking place in Calgary?
2. Are there seasonal differences in the type of incidents reported?
3. Does reported severity of incidents vary geographically across Calgary?

Methods

Study Area

Research was conducted in the City of Calgary, located in southwestern Alberta, in the foothills of the Canadian Rocky Mountains. Calgary has a population of over one million people in an area of 5,107 km^2 (Statistics Canada, 2006) and is composed of an inner city surrounded by sprawling suburbs. The mean population density is 211.3 residents/km^2 (Statistics Canada, 2006), with the greatest density near the core and a decreasing density trend outwards.

Calgary contains numerous rivers and water bodies, many of which are bordered by riparian habitat (Foley, 2006). Numerous parks and greenspaces are designated across the city, particularly along the Bow and Elbow rivers. The climate is highland continental, which includes long, variable winters and short, warm summers. Calgary has a hilly topography, with elevation ranging from 1,060 m above sea level in the river valleys to 1,240 m above sea level in the surrounding hills, and is located on the boundary of the Aspen Parkland and Fescue Grassland Natural Region (Foley, 2006). The variation in elevation and ecoregions contribute to the number of microclimates and thus the high biological diversity within the city.

Human–Coyote Incidents

Reports of human–coyote incidents were provided by the City of Calgary and include voluntary reporting by citizens between January 2005 and August 2008. We categorized these reports into five "incident levels" that represent an increasing degree of contact and/or aggression between coyotes and humans. We created incident levels based on Carbyn's (1989) research on coyote aggression. Our modified incident levels included: (1) sighting only, (2) coyote seen eating garbage or being fed, (3), coyote following or stalking people and/or pets, (4) aggression (e.g., growl, snap, charge) exhibited toward people or their pets, and (5) physical contact with human or pet.

The first incident level included only coyote sightings, which Gehrt, Anchor, and White (2009) note can occur without resulting in conflict. The second incident level included reports of coyotes scavenging through human garbage as well as eating food intentionally left out by people. Both previously noted behaviors can lead to food-conditioning, which is associated with increased risk of conflict (Bounds & Shaw, 1994; Fox & Papouchis, 2005; Gehrt et al., 2009; Grinder & Krausmann, 1998; White & Gehrt, 2009). The scavenging of human-associated foods by coyotes, however, was not considered a conflict in itself. Incident level 3 included reports of coyotes stalking a human or their pet. As indicated by Timm et al. (2004), this may be the precursor to an attack, but in reports it was often not clear whether the coyotes in question were truly stalking the individual(s) reporting the incident, or simply walking along the same path or near them. When aggressive behavior was observed without physical attack, these were classified as incident level 4 where the Calgary 311 reports provided enough detail of a clear danger to the person or pet. Those reports that showed evidence of an attack on a person or a pet were classified as incident level 5. An attack is here defined as any harmful, physical contact between a coyote and a human or pet, including scratching, biting, mauling. In the latter, we did not separate attacks of humans from pets, as in the 311 reports it was not always clear whether or not a pet was involved in the incident. When pets are being attacked their owners may become involved as they attempt to protect and defend their pets (see White & Gehrt, 2009). For our analysis, incident levels 4 and 5 were aggregated to represent human–coyote conflict. A sample of incident report descriptions and how they were classified is shown in Table 1.

To statistically compare incidents in Calgary, we assumed minimal to no bias in the incident reporting frequency across all five incident levels. We felt confident that minimal reporter bias existed. We expected that, if any bias existed, it would result in under-representation of sightings (level 1), as the public would have far less motivation to report a sighting than an aggressive incident. For our purposes, it was considered more acceptable to overestimate conflict than underestimate. All 311 reports lacking sufficient detail to categorize into incident level were removed from analysis. All reports missing a spatial reference were also removed. Of the 1,743 incidents reported to Calgary 311, 1,684 met our requirements for use in analysis.

Incident Level Analysis

Incident reports were summarized in tabular form (Table 2). We used Pearson's chi-square to test for significant differences among levels of conflict. A chi-square test was performed first among all levels (levels 1 to 5) and then among a subset of levels (across levels 2 to 5). Finally, we removed level 1 and conducted a pairwise chi-square test of non-aggressive incidents (level 2 and 3) versus conflict (level 4 and 5). The tests were

Table 1
Sample description of incident reports from the City of Calgary (January 2005–April 2008) including incident level attributed to each description

Incident level	Description of incident	Date reported
1	No incidents just running in park, seemed quite docile	24/05/2005
1	Coyote was heading towards the river	27/06/2006
1	Caller reports coyote is hiding in trees	31/12/2006
1	Caller advises that the coyote was chasing a rabbit	11/08/2006
1	Coyote wandering around at bus loop	09/06/2007
1	Coyote was right behind caller's home, walking through green space; caller was watching from window; caller wants city to do something—get rid of them	13/06/2007
2	Caller states that this was a very large coyote who has been scavenging in her garbage for the last 4 months—every week without fail	19/03/2007
2	Coyote scavenging near school	18/01/2008
3	Caller was flagged down by a runner as he was being stalked by two coyotes, one injured, back and tail looked deformed	24/02/2007
3	Caller states that the coyote is stalking and watching her two golden retrievers that are in the back yard. Caller was advised to remove the dogs from the back yard to safety	22/03/2007
3	Caller walking dog, coyote reported to be stalking people and dogs and oblivious to regular human contact; bikes, joggers, walkers	06/11/2007
4	Coyote chasing squirrels—letter carrier was growled at	25/08/2006
4	Caller has no fence; coyote came into yard the other day and tried to attack caller's dog. Caller kicked coyote and it ran off	11/06/2007
5	Caller witnessed coyote in parking lot killing cat	21/05/2005
5	Coyote got into the yard of the address and the owner's dogs attacked and killed it on her back step	05/10/2007

Table 2
Number and percent of human–coyote incidents reported in the City of Calgary between January 2005 and April 2008, by conflict level

Conflict level	Number of reports	Percent of reports
1	1,499	89
2	32	2
3	67	4
4	48	3
5	38	2
Total	1,684	100

configured to determine the differences among incident levels (1–5, then 2–5) or behaviors (conflict vs. non-conflict). We used this multi-level approach to determine if any one type of human–coyote interaction was most common in Calgary and to compare conflicts with non-conflict interactions, similarly to how White and Gehrt (2009) compared predatory to non-predatory attacks.

Seasonal Analysis

Coyote incidents were classified according to biologically relevant seasons (Morey, Gese, & Gehrt, 2007), including: Breeding (January 1–April 30), Pup-Rearing (May 1–August 31), and Dispersal (September 1–December 31). Incidents were classified by date into one of these seasons, and tested for uniformity across seasons, to explore whether Calgary coyotes have a propensity to behave more aggressively or defensively in certain seasons (Morey et al., 2007). We did not test for aggressive or defensive behavior as in Morey et al. (2007) due to the lack of detail in the Calgary 311 reports. Instead we consider that a human–coyote conflict (level 4 or 5) generally implies one of these behavioral classes. We tested seasonality because the effects of seasonality are considered important in understanding coyote behavior (Morey et al., 2007; White & Gehrt, 2009). Carbyn (1989) suggested that the Pup-Rearing season may be a time of food-stress for breeding coyotes and therefore a period of time when human–coyote conflict is elevated.

We tested for significant differences in frequency of incidents among seasons using Pearson's chi-square and contingency tests (White & Gehrt, 2009). We also calculated the effect size to determine the strength of the relationship found among seasons using Cramer's V. A value of .10 indicates a minimal relationship, .30 a typical relationship and .50 or greater a substantial relationship (Vaske, 2008). We used an odds ratio to determine the "risk of conflict" in each season (Vaske, 2008). The odd-ratio test expresses "risk" based on probability from the incidents, with 0 representing no risk, and 1 representing the highest risk. This does not determine the actual risk of an encounter with coyotes, but the "risk" as a probability based solely on the number of incidents reported during each season (PASW, 2009) and provides a clearer indication of seasonality in incident levels.

Spatial Analysis

We mapped coyote incidents in ArcMap 9.2 (ESRI, 2006; Redlands, California). To determine whether there was significant clustering of incident levels across Calgary, we conducted a spatial point pattern analysis using Ripley's K-function from a scale of 500–10,000 m (Haase, 1995). We also examined the proximity of human–coyote conflicts (level 4 and 5 incidents) to sites where coyote scats collected by Lukasik (2009) showed evidence of human-associated food. We used ArcGIS 9.2 to create a 2 km buffer around each focal scat site and then calculated the frequency of each incident level within the merged buffers. The 2 km buffer was selected to represent the smallest possible coyote home range (Fox & Papouchis, 2005; Gehrt, 2004; Gehrt et al., 2009) in which a statistically useful frequency of incidents would occur. Chi-square tests were used to compare the number of conflicts at each scat survey site. Finally, we mapped human–coyote conflicts (incident levels 4 and 5) onto a map of Calgary for visualization and qualitative identification of any spatial trends. This map represented the number of reported conflicts per community, and is suitable only to highlight sites with a relatively high frequency of conflict.

Results

Incident Levels

We analyzed 1,684 human–coyote incidents that were reported to Calgary 311 from January 2005 to April 2008. All five incident levels have been reported in Calgary (Table 2). The majority of reported incidents (89%) fell within incident level 1, sightings. Human–coyote conflicts (incident levels 4 and 5) made up 5% of all reports (Table 2).

We found a significant difference in the frequency of occurrence of all five incident levels ($\chi^2 = 5015$, $df = 4$, $p < .05$). After removing level 1 from analysis, to account for any effect of its relatively large sample size, levels 2–5 were also found to be significantly different ($\chi^2 = 15.24$, $df = 3$, $p < .05$) with level 3 incidents being most common. No significant difference was found between non-conflict incidents (level 2 and 3) and conflicts (level 4 and 5), when sightings were removed ($\chi^2 = 0.78$, $df = 1$, $p > .10$).

Seasonal Analysis

Human–coyote incidents in Calgary exhibited statistically significant seasonal variation ($\chi^2 = 30.92$, $df = 8$, $p < .001$). Figure 1 shows the number of Calgary 311 reports by incident level and season. When examining each incident level separately, coyotes were sighted most frequently during the Breeding season (656 reports) and least frequently during the Pup-Rearing season (356 reports). Levels 2 to 4 showed little seasonal variation, but incident level 5 was reported most commonly during the Pup-Rearing season (19 reports) and least frequently during the Breeding season (4 reports). While we found a significant difference in incident level by season overall, the effect size indicated the relationship was not substantial ($V = .096$).

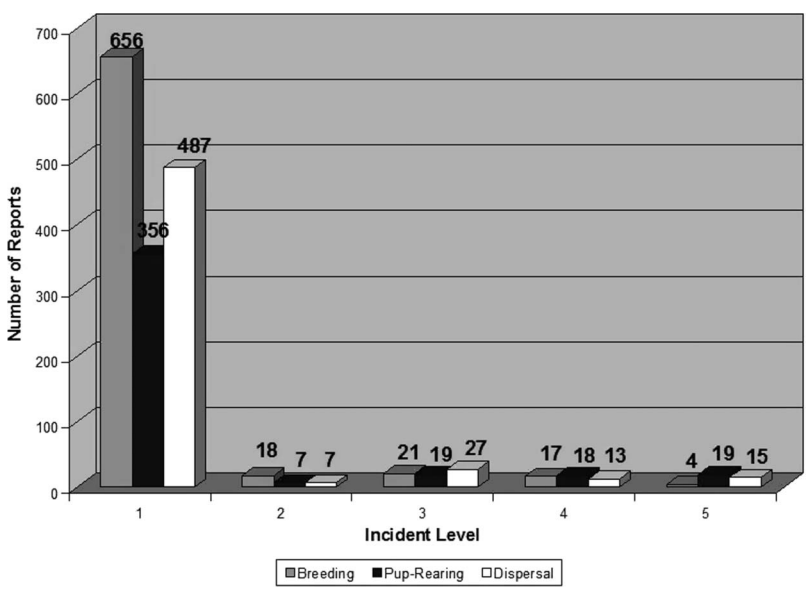

Figure 1. Seasonal reports of human–coyote incidents by incident level. Seasons: Breeding (January 1–April 30), Pup-Rearing (May 1–August 31), and Dispersal (September 1–December 31).

In the odds-ratio test, the Pup-Rearing season had the highest values for both all incidents excluding sightings (.18), and conflicts (.10), whereas the Breeding season had the lowest odds ratios, with .09 for all incidents including sightings and .03 for conflicts. These results indicate that both human–coyote incidents as well as conflicts in particular, were least likely to take place during the Breeding season.

Spatial Analysis

Figure 2 displays reported conflicts by location. Each incident level showed significant clustering according to Ripley's K-function. The frequency of incidents across the seven coyote scat collection sites (see Lukasik, 2009) also were significantly different ($\chi^2 = 191.49$, $df = 6$, $p < .001$). The lowest number of reported incidents were observed within the North Glenmore/Weaselhead (NGW) area (28), a large park with rich, native riparian and forest habitat and located on the western boundary of Calgary. The highest number of reported incidents were centralized around Nose Hill (NH) Park (182), one of the largest parks in Calgary and containing native grassland habitat, but surrounded by residential neighborhoods in northern Calgary (Table 3).

The frequency of conflict (incident levels 4 and 5) was related to sites where coyote scat and dietary analysis were conducted, and a significant difference in the number of reported conflicts was found between sites ($\chi^2 = 25.09$, $df = 6$, $p < .001$). Sites with the greatest number of reported conflicts were Stanley Park/Rideau (SPR; 14) and Tom Campbell Hill (TCH; 16); the two smallest parks in the study. Both of these parks are located near the core of the City. The fewest conflicts were reported in Fish Creek (FC) Park (1) followed by NGW (2); both are large and relatively natural parks. We mapped conflict by community (Figure 3), and found the frequency of reported conflicts per community ranged from zero to six over the period from January 2005 to April 2008. Human–coyote conflict was most often reported in close proximity to a river and in central Calgary (Figure 3). To a lesser extent, several communities in northwestern Calgary have reported conflicts. These are communities with lower human density than the more central communities, but with numerous, often large parks and greenspaces within them.

Discussion

Incident Levels

While all levels of human–coyote incidents were observed in Calgary, the reporting frequency across levels was not uniform. Sightings (level 1) accounted for 89% of all reports, which far exceeded any other incident level. This high rate of coyote sightings relative to conflicts (level 4–5) suggests that presently, human encounters with Calgary's coyotes are generally not aggressive, and as a population coyotes pose a relatively low threat to human or pet safety. Conflict is likely limited to particular individuals within the population. This result is consistent with observations of Gehrt et al. (2009), who found that even coyotes living in highly developed urban parts of Chicago tended to avoid humans. Specifically, Gehrt et al. (2009) found that only 4% of all collared coyotes ($n = 7$) were associated with conflict, and of these most were diseased, the majority sick with mange. Only after becoming sick were coyotes found to become nuisance coyotes. In fact, when excluding these individuals, only 2 out of 181 radio-collared coyotes were considered nuisances, with only one likely to fit our criteria for a coyote involved in human–coyote conflict (reportedly attacking and killing domestic animals; Gehrt et al., 2009). Similarly to Gehrt

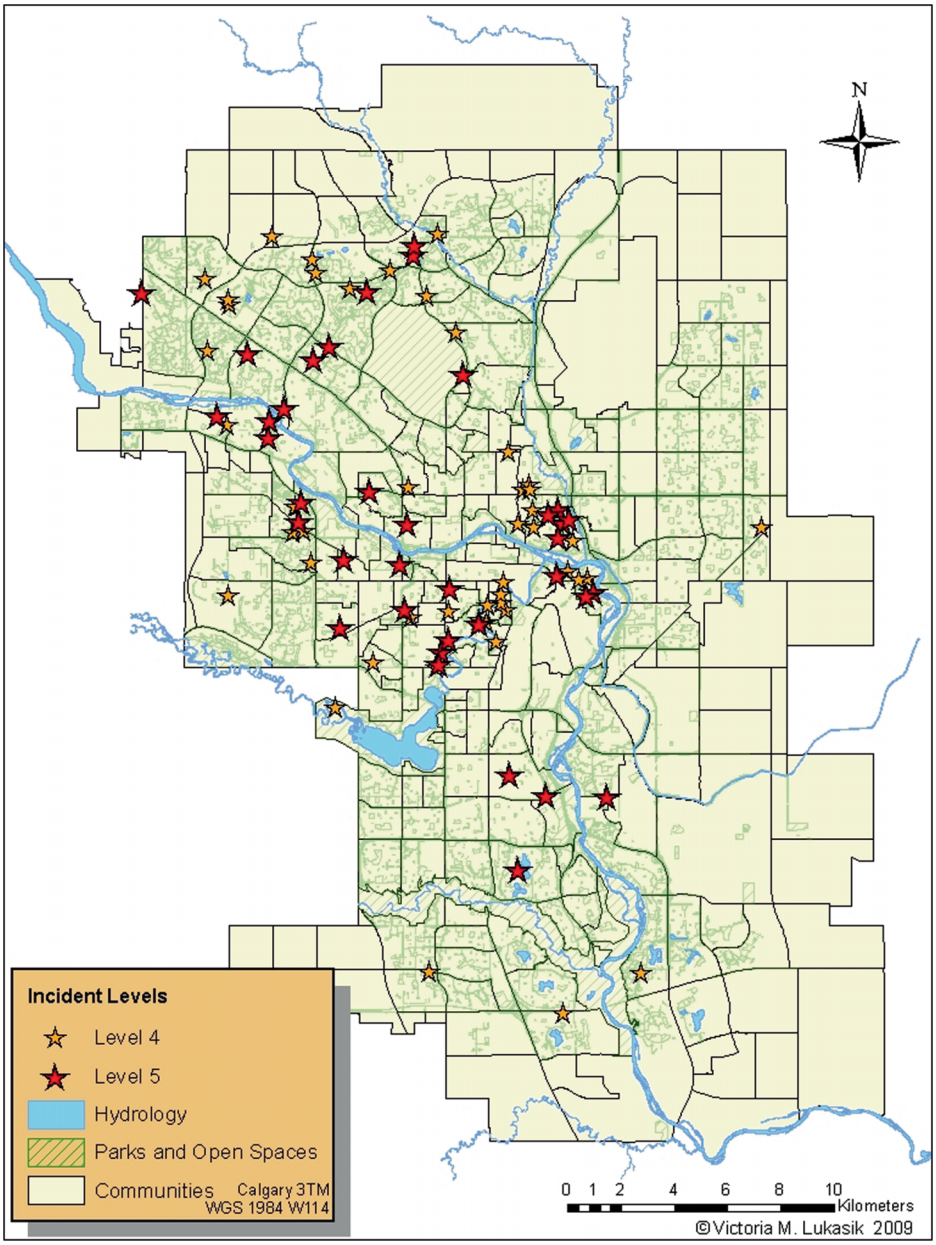

Figure 2. Human–coyote conflicts (level 4 and 5 incidents) reported within Calgary (January 2005–April 2008).

et al. (2009), we observed that physical attacks (incident level 5) comprised only 2% of all reports investigated in Calgary. Notably, the attack upon a child that took place during the reporting period (April 2005; Canadian Broadcasting Corporation, 2005) was not within the 311 reports. As this particular incident would have represented the only human attack ever documented in Calgary, its absence from the data is certainly notable. However, due to the unique and extreme nature of this incident in relation to all the others in our dataset, it

Table 3
Coyote reports by incident level within 2 km buffer of scat collection locations at each site

Incident level	AL	ED	FC	NH	NGW	SPR	TCH	Total
1	66	87	54	169	16	125	154	671
2	5	0	0	3	1	4	3	16
3	1	4	2	4	9	15	4	39
4	4	4	0	4	2	9	10	33
5	1	7	1	2	0	5	6	22
Total	77	102	57	182	28	158	177	781

Sites: AL (Arbour Lake), ED (Edworthy Park), FC (Fish Creek Provincial Park), NH (Nose Hill Park), NGW (North Glenmore Park/Weaselhead Natural Area), SPR (Stanley Park/Rideau), TCH (Tom Campbell's Hill).

likely would have been reported to city police and medical authorities, and not to Calgary 311. The attack occurred early in the development of the reporting tool, and no further attacks on humans are known to have taken place in Calgary since this event.

When excluding sightings (level 1), no significant differences were found between the number of reported non-conflict incidents (levels 2–3) and conflicts (levels 4–5). Considering that the majority of incidents that we categorized as conflicts did not involve physical contact, and the actual numbers of conflicts is very low (less than 3% of incidents at level 4 and 2% at level 5), it is clear that human–coyote attacks in Calgary are uncommon.

Seasonal Analysis

Statistically significant seasonal differences were found among incident levels 1 to 5, though the effect size indicated a minimal relationship. Human–coyote conflicts were highest during the Pup-Rearing season, which is consistent with Timm's (2006) suggestion that serious conflicts are likely due to coyotes protecting their den and pups from pets, particularly in dog off-leash areas. It also follows Grubbs and Krausman's (2009) observation that coyotes in Tucson attack and kill more domestic or feral cats during the breeding season than at any time of the year. Coyote sightings were reported most during the Breeding season. Coyote daily movements are typically far greater during both the Breeding and Dispersal seasons than during the Pup-Rearing season (Fox & Papouchis, 2005), which in theory should lead to greater visibility to people. During Breeding season foliage is greatly reduced as well, allowing coyotes to be seen more easily in Calgary. In Chicago, however, White and Gehrt (2009) found no seasonal relationship in coyote conflict. Although we conclude that the Pup-Rearing season may be a time of increased conflict—particularly as coyotes may be defending their pups from the numerous off-leash dogs that are walked in the City—we need to be cautious in over-emphasizing the effect of seasonality on conflicts.

Spatial Analysis

All incident levels were clustered significantly in space across Calgary. Our interpretation assumes no reporter bias across the city. We believe that incidents, particularly conflicts, should be less prone to reporter bias than sightings, as conflicts are considered "abnormal" or "serious" regardless of location, and our central concern in this paper is the occurrence

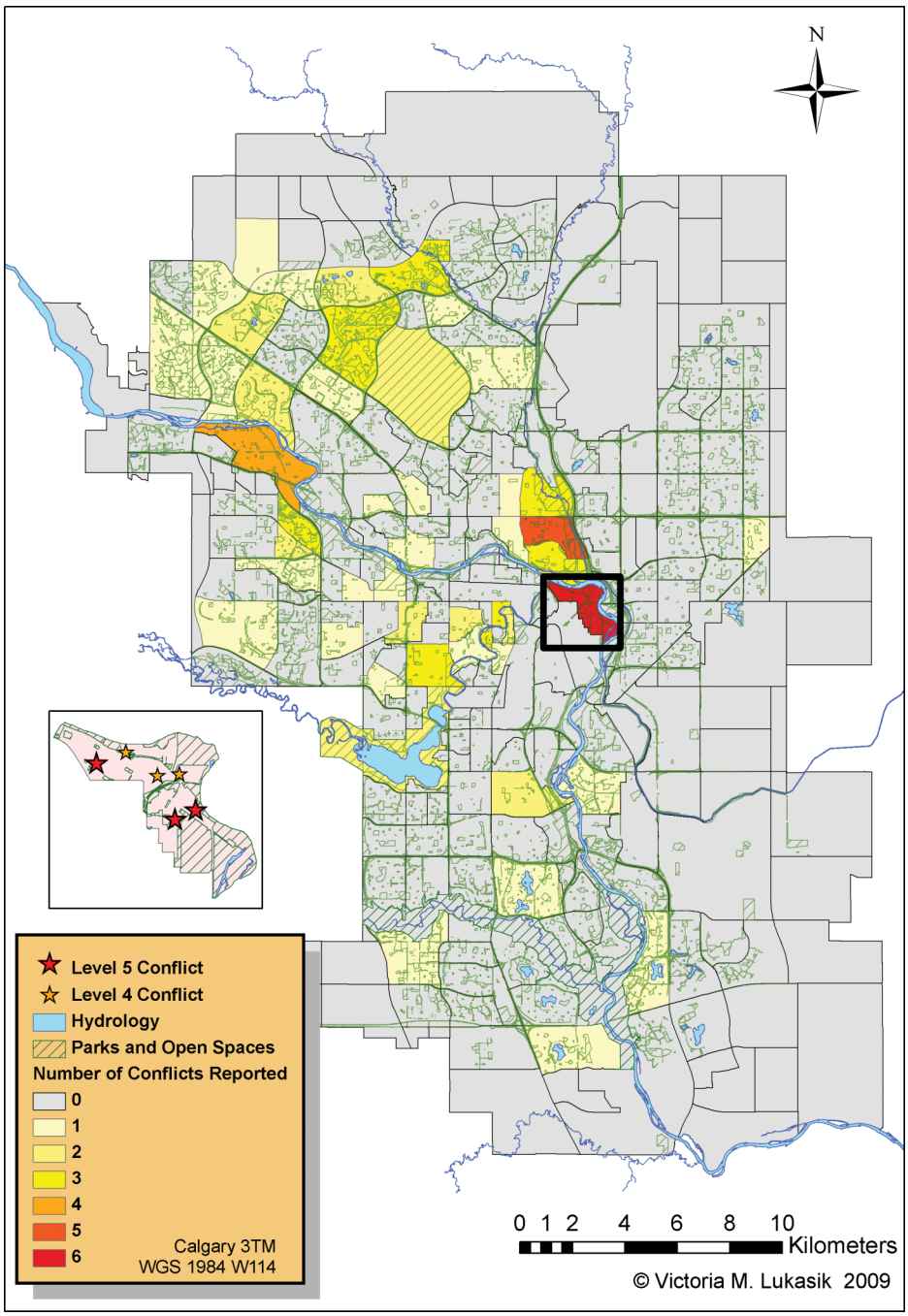

Figure 3. Number of human–coyote conflicts (incident levels 4 and 5) per community reported by citizens in the City of Calgary (January 2005–April 2008).

of human–coyote conflict. The low variation in clustering among incident levels (based on Ripley's K-function) indicated that both conflicts and sightings are clustered. Sightings may be clustered due to a clustered distribution of coyotes across Calgary. Clustering in conflict may indicate that certain individual coyotes in Calgary cause the majority of

human–coyote conflict (Gehrt et al., 2009), or that these sites have habitat characteristics that promote human–coyote conflict. For example, Timm (2006) and Worcester and Boelens (2007) implied that shrubby, sloped habitat attracts coyotes and may contribute to human–coyote conflict. We suspect that conflicts in Calgary are likely due to both attractive habitat characteristics and certain nuisance coyotes.

The number of reported human–coyote conflicts differed by community. Communities with the highest frequency of reported conflicts tended to be located in central Calgary and in close proximity to a river with shrubby, riparian habitat. These communities had high human densities, which may result in greater encounter rates between humans and coyotes and thus a greater possibility of habituation, which could lead to a higher frequency of conflict. In addition, the greater human density may result in increased availability of human-associated foods, which may supplement the diet of coyotes in Calgary leading to food-conditioned coyotes (Timm et al., 2004). Importantly, the presence of humans alone does not necessarily lead to habituation. Grinder and Krausman (1998) found that coyotes in Tucson did not tend to become habituated to humans if not encouraged through food conditioning or other means. Similarly, Gehrt et al. (2009) found that urban coyotes living in the most developed parts of the city tended to avoid humans, human-associated foods, and conflict. Bounds and Shaw (1994) found that coyote conflicts existed in the United States National Parks that reported humans feeding wildlife, not necessarily those with the greatest number of visitors. These papers support the idea that food-conditioning, more so than coyote habituation to human presence, lead to human–coyote conflict. In Calgary, coyotes consume a diet made primarily of rodents and vegetation, although human-associated food (primarily garbage) was found in 14% of scats analyzed (Lukasik, 2009). Scats that contained the latter coincided in space with sites where we found our highest rates of human–coyote conflict. Thus, as in other locations, it appears that human–coyote conflict in Calgary is primarily a result of food-conditioning, and not habituation alone.

Our results suggest that aggression of coyotes toward humans in Calgary is likely limited to a small number of coyotes within the urban population. However, the connection between diet (i.e., anthropogenic food sources) and reported conflicts indicate that problems do exist and, without adequate management response, could lead to serious human–coyote conflict (Howell, 1982; Timm et al., 2004). The City of Vancouver implemented a rigorous coyote program including monitoring, education, bylaws against wildlife feeding, and aversive conditioning techniques (e.g., chasing coyotes with noisemakers) after coyotes became a problem in the city. After seven years in place, human–coyote conflicts are greatly reduced (Worcester & Boelens, 2007). Therefore, human–coyote conflict could be minimized if the City of Calgary collaborates with other agencies that oversee coyote management by sharing information and integrating sightings provided by the citizens of Calgary (Wieczorek Hudenko, Decker, & Siemer, 2008). With a greater knowledge of how coyotes are interacting with people across the City of Calgary, as well as a greater understanding of human perceptions toward coyotes, managers can make informed decisions to reduce conflict and improve public education. Conflict may increase if no sufficient monitoring and management system is put into place, or, decrease if appropriate action and management is taken.

Conclusion

Human–coyote conflict exists in Calgary, although the relative frequency is much lower than sightings. This suggests strongly that the majority of citizens currently co-exist with coyotes successfully. Measures can be taken to reduce these conflicts, and this situation

should be closely monitored to ensure that conflict does not increase. More detailed and consistently recorded information is required from incident reports, as well as a monitoring system set up to evaluate the reports over time. An online mapping tool is currently being launched to provide this necessary information (Alexander & Quinn, 2008). Wecel, Mack, Nagy, Christie, and Wincorn (2010) emphasize the value of using data provided by citizens as a way to obtain data quickly and at minimal cost, particularly in human-dominated landscapes, both for use as baseline data, as well as for monitoring. This tool will be designed so that citizens can report coyote activity that they witness or experience in a user-friendly, accurate manner. The information gained from our present analysis will be used to focus our tool development, and combined, should provide city officials a much clearer picture of the current coyote situation as well as how it is changing overtime. Our present research provides necessary baseline to support future research and to track changes over time that may represent an increased risk for human–coyote conflict, and help to determine how best to mitigate these conflicts.

More conflict occurred in Calgary during the Pup-Rearing season, and in higher-density communities (central Calgary), particularly where parks, greenspaces, and/or riparian habitat coincide with higher human densities. Although minimizing access of coyotes to anthropogenic food sources is considered of greatest importance in reducing conflict, we expect that restricting public access to certain Calgary parks and greenspaces during the Pup-Rearing season may also contribute to a reduction of human–coyote conflict. One approach may be to operate off-leash areas only on a seasonal basis, and to restrict human and pet access to areas with known coyote dens. Successful examples of off-leash areas that constrain humans and pets spatially but provide excellent experiences for multi-users and wildlife conservation do exist in Calgary. Southland Park, located in southeastern Calgary, is a notable example that may be used as a prototype for future design. Numerous stakeholders and specialists, including park users, animal specialists and behaviorists, were consulted in the revitalization of the park and design of new off-leash areas. These off-leash areas include a canine circuit, open areas for play, and fenced training areas, which are spatially separate from the regions of the park that area being protected for wildlife or where native vegetation is being re-established.

The need for greater management of public access to parks is particularly true for the central, riverside parks in Calgary, where habitat is optimal for coyotes. We suggest that a minimum action that should arise from our work is a targeted educational campaign informing the public of areas where conflicts occur, and the seasons when they or their dogs are at higher risk of experiencing a conflict with coyotes, as well as how to minimize human–coyote conflicts (Marion, Dvorak, & Manning, 2008). Ideally, a program combining public education campaigns with garbage management, enforcement of bylaws prohibiting wildlife feeding and an aversive conditioning program, such as is in place in Vancouver (Worcester & Boelens, 2007), is recommended for Calgary.

Continued study of coyote diet along with availability studies of prey populations, vegetation sampling and garbage availability would provide a clearer picture as to how coyotes are selecting their food resources. Studies that have adequate data to formally test the relationship between human–coyote conflict and food-conditioning would help underscore the importance of food management. Urban studies on aversive conditioning of coyotes would be of great value, and may help to determine the best way to prevent habituation of coyotes to humans. Such studies would determine how coyotes react to methods such as fladry (flagging) and perhaps more extreme methods such as rubber bullets to scare coyotes. While aversive methods are sometimes unsuccessful (Bounds & Shaw, 1994), Worcester and Boelens (2007) have shown that when used persistently they can

help to reduce human–coyote conflicts. These methods should be utilized and monitored for efficacy in the City of Calgary as well as other urban areas with coyotes, as they may be effective in keeping coyotes away from certain areas, such as schools and play grounds, as well as maintaining a healthy level of wariness, even fear, towards humans.

Finally, we suggest that coyote incident reports must be standardized across all urban areas where coyotes are present (White & Gehrt, 2009) and continue to be monitored. These data should regularly be analyzed to understand not only the current human–coyote situation, but how it is changing over time and space. This could be a valuable indicator of whether human–coyote conflict is increasing, allowing appropriate action to be taken before conflict escalates dramatically.

References

Alexander, S. M., & Quinn, M. S. (2008, May). *Perceptions Surrounding Coyote Conflict in Urban Greenspaces: Preliminary Results from a Media Content Analysis*. Presented at the Canadian Parks for Tomorrow: 40th Anniversary Conference. Calgary, Alberta.

Bagchi, S., Goyal, S. P., & Sankar, K. (2003). Prey abundance and prey selection by tigers (*Panthera tigris*) in a semi-arid, dry deciduous forest in western India. *Journal of Zoology of London*, *260*, 285–290.

Beckmann, J. P., & Berger, J. (2003). Rapid ecological and behavioural changes in carnivores: the responses of black bears (*Ursus americanus*) to altered food. *Journal of Zoology*, *261*, 207–212.

Berger, K. M. (2006). Carnivore-livestock conflicts: Effects of subsidized predator control and economic correlates on the sheep industry. *Conservation Biology*, *20*, 751–761.

Breitenmoser, U. (1998). Large predators in the Alps: The fall and rise of man's competitors. *Biological Conservation*, *83*, 279–289.

Bounds, D. L., & Shaw, W. W. (1994). Managing coyotes in U.S. National Parks: Human-coyote interactions. *Natural Areas Journal*, *14*, 280–284.

Canadian Broadcasting Corporation. (2005). Coyote shot after two Calgary toddlers attacked. Retrieved from http://www.cbc.ca/canada/story/2005/04/20/coyote-attacks050420.html

Carbyn, L. N. (1989). Coyote attacks on children in Western North America. *Wildlife Society Bulletin*, *17*, 444–446.

Ditchkoff, S. S., Saalfeld, S. T., & Gibson, C. J. (2006). Animal behavior in urban ecosystems: Modifications due to human-induced stress. *Urban Ecosystems*, *9*, 5–12.

Environmental Systems Research Institute (ESRI). (2006). Multi-Distance Spatial Cluster Analysis (Ripley's k-function) (Spatial Statistics). *ArcGIS 9.2 Help Topics*. Redlands, CA: Author.

Foley, J. (2006). *Calgary's natural parks: Yours to explore*. Calgary, Canada: Calgary Field Naturalists Society.

Fox, C. H., & Papouchis, C. M. (2005). *Coyotes in our midst: Coexisting with an adaptable and resilient carnivore*. Sacramento, CA: Animal Protection Institute.

Gehrt, S. D. (2004). Ecology and management of striped skunks, raccoons, and coyotes in urban landscapes. In N. Fascione, A. Delach, & M. E. Smith (Eds.), *People and predators: From conflict to coexistence* (pp. 81–104). Washington, DC: Island Press.

Gehrt, S. D., Anchor, C., & White, L. A. (2009). Home range and landscape use of coyotes in a metropolitan landscape: conflict or coexistence? *Journal of Mammalogy*, *90*, 1045–1057.

Gese, E. M., & Bekoff, M. (2004). Coyote. In C. Sillero-Zubiri, M. Hoffmann, & D. W. Macdonald (Eds.), *Canids: Foxes, wolves, jackals and dogs. Status survey and conservation action plan* (pp. 81–87). Gland, Switzerland and Cambridge, UK: IUCN/SSC Canid Specialist Group.

Gibeau, M. L. (1998). Use of urban habitats by coyotes in the vicinity of Banff Alberta. *Urban Ecosystems*, *2*, 129–139.

Grinder, M., & Krausman, P. R. (1998, June). Coyotes in urban areas: Conflicts and solutions. In G. J. Gottfried, C. B. Edminster, & M. C. Dillon (Comps.), *Cross border waters: Fragile*

treasures for the 21st century: Ninth U.S./Mexico Border States conference on recreation, parks, and wildlife. Proc. RMRS-P-5. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Tucson, AZ.

Grubbs, S. E., & Krausman, P. R. (2009). Observations of coyote-cat interactions. *Journal of Wildlife Management*, *73*, 684–685.

Haase, P. (1995). Spatial pattern analysis in ecology based on Ripley's K-Function: Introduction and methods of edge correction. *Journal of Vegetation Science*, *6*, 575–582.

Howell, R. G. (1982, February). The urban coyote problem in Los Angeles County. *Proceedings of the Tenth Vertebrate Pest Conference* (pp. 20–23). Davis, CA: University of California Davis.

Lukasik, V. M. (2009). *The diet and human interactions of urban coyotes in Calgary, Alberta*. (Master's Thesis). University of Calgary, Calgary, Canada.

Marion, J. L., Dvorak, R. G., & Manning, R. E. (2008). Wildlife feeding in parks: Methods for monitoring the effectiveness of educational interventions and wildlife food attraction behaviors. *Human Dimensions of Wildlife*, *13*, 429–442.

Merrill, T., Mattson, D. J., Wright, R. G., & Quigley, H. B. (1999). Defining landscapes suitable for restoration of grizzly bears *Ursus arctos* in Idaho. *Biological Conservation*, *87*, 231–248.

Morey, P. S., Gese, E. M., & Gehrt, S. D. (2007). Spatial and temporal variation in the diet of coyotes in the Chicago Metropolitan Area. *The American Midland Naturalist*, *158*, 147–161.

Progressive Analytical Software (PASW). (2009). Analysis of Risk. *SPSS Desktop Tutorial (PASW Statistics 17.0.2)*. Chicago, IL: Author.

Stahl, P., Vandel, J. M., Herrenschmidt, V., & Migot, P. (2001). The effect of removing lynx in reducing attacks on sheep in the French Jura Mountains. *Biological Conservation*, *101*, 15–22.

Statistics Canada. (2006). Community Profiles from the 2006 Census. Retrieved from http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CMA&Code1=825__&Geo2=PR&Code2=48&Data=Count&SearchText=calgary&SearchType=Begins&SearchPR=01&B1=All&Custom

Timm, R. M. (2006, October). *Coyotes nipping at our heels: A new suburban dilemma*. Paper presented at the Proceedings of the 11th Triennial National Wildlife and Fisheries Extension Specialists Conference, Big Sky, MT.

Timm, R. M., Baker, R. O, Bennett, J. R., & Coolahan, C. C. (2004, March). *Coyote attacks: An increasing suburban problem*. Paper presented at the Proceedings of 21st Vertebrate Pest Conference, Lincoln, NE.

Vaske, J. J. (2008). *Survey research and analysis: Applications in parks, recreation and human dimensions*. State College, PA: Venture Publishing.

Wecel, M. E., Mack, D., Nagy, C., Christie, R., & Wincorn, A. (2010). Using citizen science to map human-coyote interaction in suburban New York, USA. *Journal of Wildlife Management*, *74*, 1163–1171.

White, L. A., & Gehrt, S. D. 2009. Coyote attacks on humans in the United States and Canada. *Human Dimensions of Wildlif*e, *14*, 419–432.

Wilson, S. M., Madel, M. J., Mattson, D. J., Graham, J. M., Burchfield, J. A., & Belsky, J. M. (2005). Natural landscape features, human-related attractants, and conflict hotspots: a spatial analysis of human–grizzly bear conflicts. *Ursus*, *16*, 117–129.

Wieczorek Hudenko, H., Decker, D. J., & Siemer, W. F. (2008). Reliance on informants in wildlife management situation analysis—Shortcut or shortcoming? *Human Dimensions of Wildlife*, *13*, 459–470.

Woodroffe, R., Lindsey, P., Romañach, S., Stein, A., & ole Ranah, S. M. K. (2005). Livestock predation by endangered African wild dogs (*Lycaon pictus*) in northern Kenya. *Biological Conservation*, *124*, 225–234.

Worcester, R. E., & Boelens, R. (2007, August). The co-existing with coyotes program in Vancouver, B.C. In D. L. Nolte, W. M. Arjo, & D. H. Stalman (Eds.), *Proceedings of the 12th Wildlife Damage Management Conference*. (pp. 393–397). Corpus Christi, Texas: The Wildlife Society.