**Spatial, Temporal and Contextual Predictors of Conflict with Urban Coyotes from a 10-Year Community Reporting Database**

***April 29 2021***

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**ABSTRACT**

In cities throughout North America, sightings of coyotes (*Canis latrans*) have become common and reports of human-coyote conflict are rising. Also increasing is public demand for proactive management to prevent conflict, but achieving that requires more information about the spatial, temporal and contextual correlates of conflict and how they are changing over time. An important source of this information is the direct observations of citizens who may report both coyote behaviour and their perceptions of their interactions with coyotes. We used a web-based reporting system to collect *N* = 7,872 reports of coyotes that were voluntarily submitted in the city of Edmonton, Alberta, between January 2011 and December 2020. Each report contained the time and date of the sighting or interaction, the location, and xx% also contained optional comments. We develped a standardized classification method to extract further information from the comments including the coyote response to people, human perception of coyotes, the human activity occurring? at the time of the interaction, and the presence or mention of pets or children, which we defined as vulnerable individuals. We used ordinal regression to determine the effect of several spatial, temporal and contextual variables on the likelihood of interactions occurring that were suggestive of conflict, measured by both the boldness of coyote responses to humans and negative human perception of coyotes. We found that both measures of conflict were more likely in modified open, mowed and residential areas, and during the pup-rearing season. Reports that mentioned pets or children were more likely to describe negative interactions. Over the 10 years of reporting, descriptions of coyote behaviour increased on our boldness scale, while human perceptions became less negative. This combination suggests that humans and coyotes are habituating to one another with increased tolerance of coyotes in Edmonton. Our results provide important information for proactive management actions to prevent conflict, including public education about protecting pets, preventing food-conditioning of urban coyotes, and using aversive conditioning to increase wariness of coyotes in residential areas.

**INTRODUCTION**

Urban landscapes are inhospitable for many animal species, but some survive and thrive in cities and suburbs, bringing them into close contact with humans. In North America, well-known examples of such species include Racoons (*Procyon lotor*), House sparrows (*Passer domesticus*) and Norway rats (*Rattus norvegicus*; McKinney 2006). These synanthropic species are highly adaptable and have undergone population expansions even as the global increase of urbanization diminishes biodiversity and displaces other species (Foley et al. 2005; McKinney 2006). Most large carnivore species have experienced substantial range contractions because they cannot persist alongside high densities of humans (Woodroffe 2000). One exception to this pattern is the coyote (*Canis latrans*), which has emerged as a highly successful carnivore that flourishes in urban environments throughout North America (recent range ref like Hody and Kays) characterized by frequent interactions with humans (Bateman & Fleming 2012).

Increasing populations of urban coyotes is associated with an extensive range expansion across North America since the early 1800s following human land-use changes and mesopredator release associated with the widespread extirpation of wolves (*Canis lupus*; Gompper 2002; Prugh et al. 2009; Hody & Kays 2018). Even densely populated cities attract coyotes, which are now known as a well-known urban exploiter (McKinney 2006; Bateman & Fleming 2012). Coyotes success in urban areas is attributed partly to behavioural plasticity that allows them to occupy home ranges of highly variable sizes with minimal amounts of naturally vegetated habitat, and to increase their nocturnal activity to avoid periods of high human activity (Grubbs & Krausman 2009; Gese et al. 2012; Newsome et al. 2015; Poessel et al. 2016; Ellington & Gehrt 2019). Coyotes are also omnivorous with remarkable breadth of natural diets (ref), with the capacity to consume many kinds of anthropogenic food resources including urban compost and garbage, fruit from ornamental trees, pet food, and free-roaming pets (Fedriani et al. 2001; Fox 2006; Murray et al. 2015a; Murray et al. 2016; Nation & St. Clair 2019). Another contributor to coyote success in urban environments is shifting public perceptions towards a greater acceptance of coyotes and reduced approval of lethal population control (Lawrence & Krausman 2011; Jackman & Rutberg 2015; George et al. 2016; Sponarski et al. 2018).

Interactions between rrban coyotes and people are usually benign and the vast majority occur without any conflict (Drake et al. 2021). Urban coyotes also provide several benefits to humans by controlling rodent and smaller mesopredator populations to increase urban biodiversity (Crooks & Soule 1999; Soulsbury & White 2015), scavening animals that died from other causes (ref), and providing aesthetic enjoyment. Up to 50% of city-dwellers accept or desire the presence of coyotes in urban areas (Lawrence & Krausman 2011; Soulsbury & White 2015; Draheim et al. 2019; Drake et al. 2020). However, negative interactions between humans and coyotes attract considerable media attention (Alexander and Quinn 2011?) and there has been an apparent increase in human-coyote conflict in cities and suburbs across North America over the past decade or more (Baker & Timm 2017; Poessel et al. 2017a).

Human-coyote conflict occurs when coyotes pose real or perceived threats to the well-being of humans or their pets (Madden 2004). In cities, factors related to coyotes and other wildlife that affect conflict include behaviour, health and exploitation of human resources, whereas factors related to humans that affect conflict include attitudes toward wildlife, activities and behaviours (Schell et al. 2020). Although human-coyote conflict includes the spread of zoonotic diseases and property damage (Catalano et al. 2012; Luong et al. 2020), its most common manifestation is the risk that coyotes pose to the safety of humans and their pets (White & Gehrt 2009). Coyote attacks on pets and humans are uncommon, but appear to be increasing (White & Gehrt 2009; Baker & Timm 2017). Coyotes sometimes eat outdoor cats and small dogs (Poessel et al. 2017b; Nation & St. Clair 2019), and may behave territorially towards both cats and dogs, leading to attacks (Gehrt et al. 2013; Poessel et al. 2017b). Attacks on pets can endanger pet owners who may be bitten while intervening (Poessel et al. 2013) and these attacks can lower tolerance of the public towards coyotes (Draheim et al. 2013). Direct coyote attacks on humans are extremely rare, but attacks on children are typically predatory and cause serious injury (Carbyn 1989; White & Gehrt 2009; Baker & Timm 2017). Attacks on humans are the most severe form of conflict, and can generate substantial media attention and degradation of public tolerance towards urban coyotes (Alexander & Quinn 2011; Draheim et al. 2019).

Human-coyote conflict is often measured retroactively from attacks (White & Gehrt 2009; Baker & Timm 2017; Poessel et al. 2017a), but conflict potential can also be assessed from coyote behaviour or perceptions by people. . Conflict-prone coyote behaviour could includeincreased boldness or aggression towards humans and their pets (Baker & Timm 2017). In general, urban coyotes are bolder around people than rural animals, likely from repeated interactions with humans, reduced human persecution, and anthropogenic food conditioning (Schell et al. 2018; Breck et al. 2019; Young et al. 2019a). Conflict potential also relates to the risk people perceive of injury to themselves, children, or pets. Although these perceptions may not align with the actual risk of an attack based on coyote behaviour, they can indicate public tolerance towards coyotes, and, subsequently, acceptance of various forms of wildlife management and policy (Sponarski et al. 2018; Draheim et al. 2019). Human perceptions of risk are affected by past encounters with coyotes, previous knowledge of pet or human attacks, and broader wildlife value orientations (Draheim et al. 2013; Sponarski et al. 2016; Drake et al. 2020). Understanding changes in coyote behaviour towards humans and the human perception of coyotes enables proactive conflict mitigation, instead of limiting management to responsive action after attacks (Baker & Timm 2017).

To mitigate the real and perceived risks of coyotes to humans, knowledge of the spatial, temporal and contextual variables that contribute to its occurrence is essential. Identifying spatial variables that predict negative interactions between humans and wildlife enables targeted proactive management in high-risk areas (Delsink et al. 2013; van Bommel et al. 2020). Likewise, understanding when negative encounters are most likely to occur at diel, monthly, and inter-annual scales, is imperative for conflict mitigation (Morehouse & Boyce 2017; Soulsbury 2020). Contextual variables that interact with spatial and temporal variables to influence the odds of conflictinclude presence of pets or children, the number of coyotes, and the health status of individual animals (Poessel et al. 2013; Olson et al. 2015).

Over the past decade, public reports of coyote sightings and encounters have emerged as an invaluable source of information for researchers studying the spatial, temporal and contextual variables associated with human-coyote conflict. This information source allows researchers to conduct otherwise difficult long-term studies over large geographic areas while simultaneously engaging and educating members of the public (Weckel et al. 2010; Frigerio et al. 2018). Voluntary reports of coyote activity have been collected through websites (Wine et al. 2015; Mowry et al. 2020), city reporting databases (Lukasik & Alexander 2011; Poessel et al. 2013), public surveys (Weckel et al. 2010), and apps (Mueller et al. 2019; Drake et al. 2021). Studies resulting from analyses of these datasets have focused largely on the broad patterns in reports and have identified temporal trends in reporting as well as socioeconomic and landscape factors associated with their occurrences (Weckel et al. 2010; Wine et al. 2015; Mowry et al. 2020). In Calgary, Alberta, Lukasik and Alexander (2011) found that most negative incidents were associated with high-density neighborhoods and the city’s river valley corridor, and occurred during the pup-rearing season (May – August). In both Calgary and Edmonton, Alberta, anthropogenic food consumption was a key correlate of increased conflict (Lukasik & Alexander 2011; Murray et al. 2015a). In Madison, Wisconsin, Drake, Dubay and Allen (2021) identified road distance, seasonality and time of day as important factors predicting distance between humans and coyotes, which they interpreted as a proxy for conflict (Drake et al. 2021).

In this study, we used reports collected over 10 years from an online database in Edmonton, Canada to explore spatial, temporal and contextual variables. In addition to quantifying seasonal, diel, and location patterns in the reports, we categorized comments describing the boldness of coyote behaviour towards people, context of human activity, and human perceptions of threat posed by coyotes to people. Based on the observation by others that coyotes exhibit greater boldness in association with territorial behaviour (refs), we predicted that boldness scores from comments would increase in natural and open areas, particularly during the pup-rearing season (Gehrt et al. 2009; Poessel et al. 2013; Wine et al. 2015). Based on observations by others that coyote presence is less accepted by the public in residential areas (Draheim et al. 2019), we predicted that these would be the sites with more negative comments about human safety. Based on the finding that people are particularly concerned about the safety of children near coyotes (Sponarski et al. 2018), we predicted that reports indicating the presence of children or pets would express more negative perceptions of coyotes. (. By quantitatively assessing human-coyote interactions with thousands of reports over many years, we hope to better inform proactive management practices that could facilitate coexistence between humans and coyotes in urban environments across North America.

**METHODS**

**Study Area**

Our study took place in the city of Edmonton, Alberta, Canada (53.54728oN, 113.50068oW), which is large in both area (684 km2) and population (976,223 in 2019 census; City of Edmonton 2019). As a northern city, Edmonton is characterized by warm summers (Jun-Aug daily average = 16.7°C) and cold winters (Dec-Mar daily average = -9.7°C;

Environment and Climate Change Canada 2018). Edmonton is located within the central parkland natural subregion – an area composed of productive agricultural lands interspersed with wetlands and mixed forests of aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*) and spruce trees (*Picea spp*; Natural Regions Committee 2006). The city is bisected by the North Saskatchewan River valley and several large ravines, which form a network of minimally developed natural areas. (Figure 1).

**Online Report Collection**

We used a web-based platform launched in July 2010 to collect voluntarily submitted reports of coyotes from members of the general public on the Edmonton Urban Coyote Project website (<https://www.edmontonurbancoyotes.ca/reportsighting.php>). We promoted the website during media interviews, public lectures, and social media posts, through word of mouth, on labels attached to wildlife cameras in the city, and via a link to the website was added to the City of Edmonton website (<https://www.edmonton.ca/residential_neighbourhoods/pets_wildlife/Coyotes.aspx>) that was added in 2019. Fields in the reporting form included the data, time (recategorized post-hoc as night or day, see below), type of report (sighting or encounter), nearest intersection to the report location, additional observations, comments or concerns, and the reporter name and contact number. We also included a Google EarthTM interface with a prompt for the reporter to precisely locate the report by placing a pin on the map. The entire reporting database was downloaded as a CSV file with each report receiving a unique ID number. The coordinates for 2,645 reports (34%) were missing from the map interface and were instead assigned post-hoc using Google MapsTM based on the reported nearest street intersection and information in the comments (i.e. if a specific park or building was named). We excluded 245 reports that were located outside of the study area, and 15 reports made prior to January 1 2011. We also excluded 250 reports from recently annexed undeveloped parkland to the southwest and northeast, limiting the extent of our study area to 565 km2. To encourage participation, no registration or login was required, and we identified and removed 1,562 spam or duplicate reports.

**Spatial and Temporal Patterns in Public Reporting Data**

We mapped the point location of each coyote report (Figure 2). We conducted a multi-distance cluster analysis using Ripley’s K function to determine if reports were significantly clustered throughout the study area (Haase 1995). Next, we assessed the distribution of reports across land cover classes. We characterized land cover classes using geospatial data from the City of Edmonton Urban Planning Land and Vegetation Inventory (uPLVI) database, a high resolution (minimum polygon size = 1 ha) database that uses remotely sensed imagery and Softcopy photogrammetry to identify land cover types for urban land use decisions (City of Edmonton 2018). We re-classified existing uPLVI site types into six land cover classes representing various degrees of human development and coyote habitat suitability (Figure 2; Table 1). We calculated the proportion of reports within each land cover class and used a chi-square goodness of fit test to compare the observed count of reports to the expected count, which we calculated by multiplying the total number of reports by the proportion of each land cover class in the study area (Poessel et al. 2013).

To describe the spatial distribution of reports, we compared reports to randomly generated points based on their proximity to the ravine system, the nearest road, and the nearest building. Within a minimum convex polygon created around all report locations using a convex hull minimum bounding geometry type (ref), we generated 8,000 random points. We mean-centered and scaled proximity metrics, and confirmed that they were not correlated (rho < 0.6). We constructed a logistic regression model with report type (report or non-report) as the response variable and scaled ravine distance, road distance, and building distance as predictors. We did not account for spatial autocorrelation in this analysis so we conservatively considered proximity metrics significant if *P* < 0.01.

To examine temporal characteristics of reports, we examined inter-annual, monthly and diel trends in reporting. We evaluated long-term changes in reporting by measuring the frequency of reporting, in four-month intervals, from January 2011 to December 2020. We quantified monthly trends in reporting by calculating the mean annual reports for each month. To reflect the biological seasons of coyotes (Morey et al. 2007), we calculated the percentage of total reports that occurred during the breeding (January 1 – April 30), pup rearing (May 1 – August 31), and dispersal (September 1 – December 31) seasons.

Reporters submitted time of day using a drop-down menu with the option to select hourly times between 5 AM and midnight, or one of the following categories: dawn, morning, afternoon, evening or night. We manually categorized time of day into either day or night. Day included the categories of morning or afternoon, or any hourly time at least half an hour after sunrise and half an hour before sunset, which varies substantially across the year due to Edmonton’s northern latitude. Night included the categories night and dawn, or any times half an hour before sunrise or after sunset. We excluded 842 reports in which time was submitted as evening or without a selected time from all daily temporal analyses. We calculated the percentage of reports occurring at night or during the day.

**Classification of information in report comments**When submitting a report, users were asked to indicate whether the report was a sighting defined as observations at a distance with no interaction, or encounters, defined asinteractions at close range. Because most reports (95.4 %, *N* = 7502) included optional comments with information about coyote behaviour, context, or human perceptions, we developed a Google Form to classify the information contained in comments with categorical or ordinal variables. We began by removing all reports in which coyotes did not interact with humans or the report was submitted as a sighting where further information could not be extracted as an observation (i.e. comments were vague or uninformative, or indicated no human-coyote interaction). We classified the remaining reports for the boldness of coyote behaviour and the perceptions of people. We described boldness withnine ordinal scale values (OSV) ranging from avoidance responses (e.g., ran away) to highly aggressive interactions (e.g., made physical contact with pet; Table 2). We excluded 399 reports where the observer was driving (and so could not interact with the coyote) and coyote response could not be determined. For human perceptions of coyotes, we classified reports on a three-point ordinal scale from positive (e.g., beautiful), neutral (e.g., curious), to negative (e.g., scared) based on the explicit presence of words from a compiled list that directly relate to human perceptions (Table 3). We included 920 reports in which we could determine human perceptions from comment details.

We extracted four contextual variables from report comments describing the presence of vulnerable individuals (children or pets, excepting reports of cat depredation), the human activity occurring at the time of the report (e.g., cycling), the number of coyotes, and coyote health (e.g., mangy; Figure 11).

We assessed the repeatability of report classification between classifiers by randomly selecting and re-classifying five subsets of twenty reports and calculating the percentage of reports that differed between observers (ref?).

**Statistical analyses**

We calculated the percentage of reports for each conflict level as indicated by coyote behavioural responses and human perceptions (Table 2, Table 3). Within the conflict levels for each response variable, we calculated the percentage of reports occurring in each land cover type, during coyote seasons, during diel periods and within each category of contextual variables also including whether dogs were leashed and if the human hazed the coyote (Table S1). We used Spearman’s ranked correlation test to explore the relationship between coyote response to humans and the human perception of coyotes on a subset of reports in which both could be quantified (*N* = 559). We used ordinal regression to determine the spatial, temporal and contextual predictors for each of coyote boldness and human perception with the *polr* function in the package MASS (Ripley et al. 2020).

To quantify the spatial predictors of human-coyote conflict, we generated spatial predictor variables measured at a 10 x 10 m cell size within a 100, 200, 400, 800 and 1600 m circular buffer of each report. These variables included: the proportion of each land cover type (defined above), building density (proportional area of building footprints; Statistics Canada 2019), and the distance to roads (in meters) using the City of Edmonton single line street network geospatial database. We applied an exponential distance decay function to road distance measurements (*e*-*ad*, d = distance to roads, a = 0.002), transforming values exceeding a few hundred meters to zero and confining all values to be between zero and one (Nielsen et al. 2009). We used univariate ordinal regression models to determine the best-fit scale for habitat variables and building density (Wine et al. 2015) with Akaike information criterion (AIC; Burnham & Anderson 2004). After removing correlated variables our spatial predictors for models of coyote responses to humans were: distance decay to roads, building density (200 m), and the proportion of natural (800 m), modified open (200 m), mowed (100 m), water (200 m), residential (100 m) and commercial land cover classes (1600 m). For models of human perceptions, spatial predictors were the distance decay to roads, building density (200 m), and the proportion of natural (1600 m), modified open (1600 m), mowed (800 m), residential (800 m) and commercial (100 m).

To identify the best spatial predictors, we constructed ordinal regression models with every combination of variables listed above and extracted top models with ΔAIC < 2 of the top model using the *dredge* function in the package MuMIn (Barton 2020). From the top models (ΔAIC < 2), we used the *model.avg* function in MuMIn (Barton 2020) to calculate model-averaged weighted coefficients for the predictor variables and estimated 99% confidence intervalsto determine the spatial predictors significantly predicting a change in coyote responses to humans or human perceptions of coyotes.

To examine temporal predictors of coyote responses and human perceptions, we used a Pearson’s chi-square test of independence to compare reports between day and nightand biological season.

We further explored temporal changes in both coyote responses and human perceptions by defining circumstances associated with human-coyote conflict as OSV ≥ 6 for coyote response and negative perception (OSV = 3). Then we calculated the percentage of conflict reports among seasons with ordinal regression and among years with Poisson regression.

e included a covariate for the total number of reports from each year to control for changes in overall reporting frequency.

To determine the contextual predictors of human-coyote conflict while avoiding correlated variables, we constructed univariate ordinal regression models for each of coyote reponse and human perception with each of the four contextual variables: indication of vulnerable individuals, human activity, the number of coyotes, and coyote health. We compared these contextual variables to other reports for which there was no mention of the predictor variable.

For each of our ordinal regression models, we evaluated model fit by comparing AIC to that of the null model and assessed the significance of specific categories within each predictor using the overlap of 99% confidence intervals, choosing this value conservatively because our analysis failed to account for spatial autocorrelation (ref).Unless otherwise specified we considered results significant if *P* < 0.05 or if the 95% confidence intervals did not overlap zero. We used ArcGIS Pro v2.7 (Esri 2020) to map report locations and quantify spatial variables, and we conducted all statistical analyses in RStudio software (R Core Team, 2019).

**RESULTS**

*Spatial and Temporal Trends in Reporting*

From January 1 2011 to December 31 2020, 7,863 unique reports were submitted to the Edmonton Urban Coyote Project website. Reports were distributed throughout the city (Figure 1), but they were. clustered in space based on Ripley’s *K-*function (observed K > upper 95% confidence limit). Within the land cover classes, reports were mostly from residential (45 %) or mowed habitat (22 %), followed by commercial (11 %), natural (10 %), and modified open areas (9.7 %). The distribution of reports across habitat types differed significantly from expected values based on the proportion of each habitat type that was available in the study area, with more reports than expected in mowed areas and fewer in commercial areas (χ2 = 2879, *P* < 0.001; Table 1, Figure 3). Compared to available locations, report locations were significantly closer to the river valley system, roads, and buildings (Table 4). Reports were more common during day (59.1 %) than night (40.9 %). On a monthly basis, reporting was highest from October through March and lowest during spring and summer months (Figure 4). Monthly reports converted to 37 % of reports during the breeding season and 21 % and 42 % in the pup rearing and dispersal seasons, respectively. Reporting increased throughout the duration of the website’s availability from 2011 to 2020 (Figure 5).

*Coyote response to humans and human perceptions as indicators of conflict.*

The mean total repeatability of report classification was 91%, and the mean repeatability of report classification for coyote response to humans or human perception categories were 77% and 96%, respectively. Among all classified reports, 59.6 % were observations with no human-coyote interaction. Within the subset of reports used in the analyses of coyote responses to humans (*N* = 2,585), interactions characterized by avoidance (OSV = 1 or 2; 28.3%) or neutral behaviours (OSV = 3 or 4; 39.8%) were more common than bold (OSV = 5, 6, 7; 23.1%) and aggressive reports (OSV = 8 or 9; 8.8%). The reports that revealed an aspect of human perceptions (*N* = 920) were predominantly negative (67.2%), followed by neutral (18.1%) and positive perceptions (14.7%). Among the reports that permitted classification of both coyote reponse and human perception, there was a significant positive relationship in ordinal values wherein negative perceptions (OV = 3) were associated with bolder coyote behaviours (rho = 0.29, *P* < 0.001; Figure 6) .

We examined land cover variables to predict the boldness of coyote responses to humans and foundsix ordinal regression models were within 2 AIC; all models included building density (200 m), and proportion of habitat comprised by modified open (within 200 m), commercial (within 1600 m) and open maintained (within 100 m) as variables (Table SI?). The distance decay to roads and water (within 200 m) were present in three of the top models and natural habitat (witin 800 m) was in two models. The proportion of modified open habitat and mowed habitat predicted significantly bolder coyote responses to humans, while building density predicted a significant decline in the boldness of coyote response (Figure 7). In a similar analysis of human perception, twenty-six models had ΔAIC< 2, and this subset included all of the predictor variables, reveling that all variables had some influence on human perceptions. However, only the proportion of residential area (800 m) was significant appearing in all but one of the top models, and predicting more negative perceptions (Table SI X; Figure 7).

Analysis of season revealed that coyote responses to people were bolder during the pup-rearing season, relative to the dispersal or breeding seasons (Figure 8). Conversely, the human perception of coyotes was slightly, but not significantly, more likely to be negative during the dispersal season (Figure 8). Analysis diel patterns showed that coyotes tended to exhibit bolder responses during the day, when human perceptions were more likely to be positive (OV = 1; Figure 8), but 99% confidence intervals for both relationships included zero. higher log odds likelihood of a negative interaction during daylight hours, although the human perception was more likely positive during the day but with low significance (Figure 8). The percentage of monthly reports describing bold or aggressive coyote responses was highest during the pup-rearing season, while the percentage of negative human perceptions did not vary among months (Figure 9). Poisson model outputs indicated that bold or aggressive reports have increased significantly since data collection started in 2010 (Table 5), but the number of reports expressing negative human perceptions has decreased over time (Table 6).

Contextual variables were important predictors of both the coyote response to humans and human perceptions (Figure 10). The presence or mention of cats, dogs, children or multiple vulnerable individuals significantly increased the likelihood of more conflict-indicative coyote responses to humans, which was paralleled by a similarly significant rise in negative perceptions when any of the vulnerable individual groups were mentioned. Of the human activity categories, negative responses of coyotes were more likely while walking and less likely while cycling, driving or in the home or yard. Human perceptions were significantly less negative when cycling or driving. For the number of coyotes, both indicators of conflict were significantly lower when reporters mentioned seeing only one coyote. When coyote health was indicated the coyote response to humans was significantly less indicative of conflict. When coyotes were identified as healthy humans perceived them more positively, but apparent poor health had no effect on human perceptions.

**DISCUSSION**

Human-coyote conflict is increasing in urban areas throughout North America (refs), creating a need to better understand the correlates of conflict that may result from spatial, temporal, and contextual variables that might be future subjects of mitigation. We approached this goal using almost 8000 reports collected over 10 years on a website-based community reporting database (Figure 11). As broad patterns, we found that reports of coyote were more prevalent than expected in mowed areas and during the fall dispersal period, and increased over time. By classifying report comments to describe each of coyote responses and human receptions, we found that bolder behaviours by coyotes were associated with negative perceptions of coyotes by people. The boldness of coyote responses increased in modified open and mowed areas and declined with building density, while negative perceptions of coyotes by people increased with the amount of residential area. Seasonally, coyotes responses were bolder during the pup-rearing period, but there was little seasonal change in human perceptions. Over years, boldness scores of coyotes have increased while the frequency of negative perceptions by people has declined. Both the boldness of described coyote responses and negative perceptions by people increased when vulnerable individuals, including children and pets, were present or mentioned. We found that coyote responses to humans were more indicative of conflict in modified open areas or mowed areas but less indicative of conflict in areas with greater building densities. By contrast, we found that the strength of negative human perceptions was significantly higher in residential areas. We also found that reports that occurred during the pup-rearing season indicated more negative interactions based on the coyote response to humans. We identified a significant increase in bold and aggressive coyote responses to humans over the past ten years, and found that human perceptions had become less negative. We also found that real or perceived negative interactions were more likely when cats, dogs, or children were mentioned in the report.

Because coyotes are more likely to have territories and dens in natural or open areas (Gehrt et al. 2009; Dodge & Kashian 2013), we predicted that coyotes in these areas would exhibit bolder responses to people. We found partial support for this prediction; coyote responses to humans were bolder significantly more indicative of conflict in modified open and mowed areas, but not in natural areas. perhaps because coyotes remained visible for longer in open areas. . Our findings are similar to those of Poessel et al. (2013), who also reported increased negative encounters in open areas but not natural areas in Denver, Colorado, and with Wine et al. (2015) who found that coyote encounters were more likely in managed clearings in Mecklenburg County, North Carolina. This pattern may occur because coyotes are visible for longer, thus appearing to be bolder, in open areas, or because bolder animals are more likely to occupy areas with less vegetative cover possible explanation is that individual coyotes with higher boldness are more likely to use open environments because of a greater risk-tolerance, the trait measured by boldness (Carter et al. 2013), as has been reported brown bears (*Ursus arctos*; Bombieri et al. 2021).

Our finding that human perceptions of coyotes was more frequently negative in residential areas, supports an initial prediction that human tolerance for coyotes would decline in this context. This result supports similar findings by others that people are less tolerant of urban coyotes near their homes compared to tolerance for their broader presence in cities (Bonnell & Breck 2017; Drake et al. 2020). Anecdotally, many reports expressed concern that coyotes may pose a threat to children in their neighborhoods who are playing in parks or walking outside, and this sentiment likely fuels much of this negative perception of coyotes in neighborhoods.

We identified a strong seasonal trend in negative interactions, with bolder responses to people during the pup-rearing season. This trend in coyote behaviour matches our own predictions as well as patterns reported in Calgary, Alberta (Lukasik & Alexander 2011) and across North America (White & Gehrt 2009). During the denning period, coyotes may defend their dens from perceived threats posed by dogs or humans (Bombieri et al. 2018).. Interestingly, we found that the frequency of reports was greater during the fall and winter months (dispersal and breeding seasons), and lowest in spring and summer (pup-rearing), again consistent with past studies (Lukasik & Alexander 2011; Poessel et al. 2013; Drake et al. 2021). This result may have occurred because coyotes are less visible during increased cover from deciduous vegetation or because breeding coyotes avoid visibility to people during the pup-rearing season. Such avoidance of detection by people may contribute to coyote selection for den sites away from edge habitat (Dodge & Kashian 2013). In our study, defence of den sites is likely the reason coyotes exhibited bolder responses to people during the pup-rearing season. .

Over the 10 years of our reporting database, coyote responses to people increased in boldness scores, supporting conclusions by others that human-coyote conflict is increasing across North America (White & Gehrt 2009; Baker & Timm 2017). We defined boldness as the tendency for coyotes to approach and interact with people, similar to other definitions of risk-taking behaviour (Carter et al. 2013). Recent studies have identified greater boldness in urban coyotes compared to rural conspecifics, suggesting that increasing human-coyote conflict in cities may be linked to rising urban coyote boldness caused by a reduction in human persecution, repeated benign interactions with humans, and an increase in access to anthropogenic food (Breck et al. 2019; Young et al. 2019a). There is also evidence that coyote boldness towards humans is passed from parents to offspring, which would further accelerate the increase in boldness-driven conflict (Schell et al. 2018). Increasing density of coyotes in urban areas (ref) may also select for increasing boldness as a consequence of increasing competition with conspecifics (refs). We believe that our study is the first to measure an increase in coyote boldness over time, albeit indirectly through public reports of coyotes.

Despite the increase in the boldness of coyote responses to people we documented over time, the proportion of reports that exhibited negative perceptions of coyotes declined over the same period. Others have predicted that public acceptance of coyote presence in cities will grow over time, even if direct negative interactions continue to occur (Lawrence & Krausman 2011; Jackman & Rutberg 2015). Our study corroborates these findings and suggests that people in Edmonton have become less likely to negatively perceive urban coyotes, despite their growing presence and an apparent increase in antagonistic coyote behaviour towards humans. This relationship may be similar to one described in brown bears where both humans and bears are capable of habituating to the presence of the other, mediated by resource availability and density (Smith et al. 2003).

Of the contextual variables examined in this study, we found that the presence or mention of vulnerable individuals caused an increase in both the boldness of the coyote reponses and the likelihood of negative human perceptions. Both increases are indicative of conflict. Mention of pets as vulnerable individuals in conflict-indicating reports aligns with the finding by others that the vast majority of reported negative interactions with coyotes stem from pet attacks (Poessel et al. 2013; Baker & Timm 2017) and knowledge of these attacks from media reports can generally reduce public tolerance for urban coyotes (Alexander & Quinn 2011; Draheim et al. 2013). In our reporting database, aggressive encounters most commonly involved dogs (65.6%), and most frequently involved off-leash dogs (19% of reports where further details were given; Table S1) but also included leashed dogs (11.2%) and dogs that were in their owners’ yards (12.2%), suggesting that aggressive coyotes are not always deterred by leashing or containment. Anecdotally, some reports stated that coyotes attempted to play with domestic dogs (*N* = 11), which may corroborate the findings of Boydston et al. (2018), who concluded that interactions between dogs and coyotes are more complex than simply coyote-driven aggression. Domestic and feral cats are well-known prey for coyotes (Nation & St. Clair 2019), and our reporting database included several reports of cat depredations (16.7% of reports coded as xxxxxx involved cats, Table S1). Human perceptions were more negative when pets were mentioned, perhaps amplifying media reports of pet attacks, which can reduce public tolerance of coyotes.

Similar to pets, reports mentioning children described bolder coyote behaviour and more negative human perceptions. Attacks on children attract substantial media attention, are more likely to lead to serious injury (Carbyn 1989; Alexander & Quinn 2011) and more likely to be predatory in nature (White & Gehrt 2009). Children were mentioned in only 3.62% of aggressive encounters in our database (Table S1) and none of the 121 reports where coyotes made physical contact with pets or people involved attacks on humans of any age, together suggesting that the overall risk of attacks on humans was minimal. Nonetheless, a child was attacked by a coyote in our study area during the study period (news report).

Other contextual variables included the human activity at the time of the coyote observation, number of coyotes, and health status, but inferences about all of these were limited by small sample sizes. Coyotes exhibited bolder responses when people were walking and when more coyotes observed. When coyote health was mentioned, boldness scores declined. Human perceptions were less negative when observers were cycling or driving, when a single coyote was observed, and when coyotes were described as healthy. All of these results are consistent with contexts where people would logically feel more secure. By contrast, people may feel less secure when coyotes appear to be hunting in packs as sometimes occurs (Gese et al. 1996). reports mentioned that an individual was walking, coyotes behaved more boldly, likely because people often walk with pets, whereas accompaniment by a pet is less common when people are cycling, in their home or yard, or driving. Human perceptions were less negative when reporters were cycling or driving, likely because people feel more positively when they interact with a coyote while feeling secure. A feeling of greater safety or security may also explain why people perceived coyotes less negatively when there was a single coyote mentioned. Although not significant, our findings also showed that when more coyotes were mentioned the probability of antagonistic coyote responses or negative human perceptions increased and we hypothesize that this effect could be because coyotes often hunt or forage in packs (Gese et al. 1996), and thus may be more likely to behave boldly towards pets or people when in greater numbers. Lastly, we found that when coyote health was identified as either healthy or unhealthy, the coyote response to humans was less indicative of conflict. We think this could be because reporters being more likely to notice and characterise a coyote’s health in encounters where they are not preoccupied with potential risk (i.e. when coyotes were not behaving boldly or aggressively). Healthy coyotes were associated with more positive human perceptions, which could be an artefact of how reports were coded; reports that stated that coyotes were healthy may also be more likely to use one of the key words that would identify a human perception as positive (i.e. beautiful).

Our study had several limitations that are important to note when interpreting our results. First, public reports were non-randomly and non-independently collected, which introduces various forms of bias commonly associated with community reporting databases (Dickinson et al. 2010; Poessel et al. 2013; Sullivan et al. 2014). For example, a single reporter may provide multiple reports that are non-independent in the human perception of coyotes, or a coyote could be reported by multiple individuals in short succession. Previous studies have found that reports are more likely to occur from affluent neighborhoods with higher education levels, to bias reporting locations relative to measured variables (Wine et al. 2015; Mowry et al. 2020). Our posthoc quantification of coyote responses and human perceptions from a community reporting database did not provide comparable information to empirical behavioural observations of animals (e.g., Breck et al. 2019) or randomized public surveys ((e.g., Drake et al. 2020) and should be interpreted cautiously. Importantly, the descriptions of coyote behavioural responses in our reports were not independent of human perceptions of those same behaviours. We recognized the correlated nature of our reports over space and time and attempted to mitigate the Type 1 errors that might result by using conservative significance estimates with99% confidence intervals. Despite these limitations, we join others in suggesting that community reporting databases provide much relevant information about human-coyote interactions and conflict (Weckel et al. 2010), but that subsequent investigations would benefit from prompting reporters to provide more specific information in reports to support analyses that are anticipated a priori by research teams that include biologists, social scientists, and wildlife managers.

Despite these limitations, our findings support several of the management actions that are already being implemented in our study area and elsewhere to reduce conflict between humans and coyotes. If coyote boldness is generally higher in open areas presenting greater risk to human and pet safety (Poessel et al. 2013; Wine et al. 2015), management might target these areas for public education (ref), attractant removal (ref), and aversive conditioning programs (Bonnell & Breck 2017; Breck et al. 2017). we suggest that management actions should focus on reducing the likelihood of negative interactions with public education campaigns to reduce conflicts with pets, increase awareness of hazing techniques, and, when necessary, the targeted removal of problem individuals (Fox 2006; Baker & Timm 2017; Breck et al. 2017). Proactive management should aim to limit coyote use of residential areas (Murray and St. Clair 2017), but if these fail and clusters of highly aggressive coyote behaviour occur, targeted removal of problem individuals may be necessary (Breck ref). . Management efforts might be increased before and during the pup-rearing season, to minimize conflict then that was identified in our study and others (Lukasik & Alexander 2011). Important management messages might include the need to keep dogs on-leash in high risk areas, contain smaller pets within coyote-proof fencing (Draheim et al. 2019), and train citizens to haze coyotes that behave boldly in human-use areas (Baker & Timm 2017). These actions are likely to increase opportunities for coexistence by coyotes and people in cities across North America.

**Acknowledgements**

We thank Cassondra Stevenson for assistance with ArcGIS software, Sage Raymond for providing valuable feedback on this manuscript, and Jonathan Wild for assistance classifying reports. We deeply appreciate [give number] volunteers who donated their time to help classify coyote reports (can you list their names?)and hundreds of community members who submitted reports of coyotes. We respectfully acknowledge that this work was conducted on Treaty 6 territory, a traditional gathering place for diverse Indigenous peoples including the Cree, Blackfoot, Métis, Nakota Sioux, Iroquois, Dene, Ojibway/ Saulteaux/Anishinaabe, Inuit, and many others.

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Table 1. Land cover classes representing different degrees of human development and coyote habitat suitability in Edmonton, Alberta.

|  |  |
| --- | --- |
| **Land Cover Class** | **% Study Area** |
| 1. Natural (forest, wetland and naturally non-wooded areas) | 8.2% |
| 1. Modified open (agricultural and deforested open areas that aren’t frequently maintained) | 16.0% |
| 1. Mowed grass | 7.7% |
| 1. Water (anthropogenic or natural in origin) | 2.7% |
| 1. Residential areas | 42.0% |
| 1. Highly developed commercial areas | 23.4% |

Table 2. Coyote response to humans as categorized from community reports and associated ordinal scale values (*N* = 2585 reports).

|  |  |  |
| --- | --- | --- |
| **Coyote Response to Humans** | **Ordinal Scale Value** | **% Reports** |
| Sighting with no interaction | NA | 59.6 % |
| Ran away | 1. | 7.8 % |
| Walked away | 2. | 4.2 % |
| Did not appear to notice or care about people | 3. | 12.4 % |
| Watched the reporter | 4. | 4. 2 % |
| Vocalized directly at the reporter | 5. | 0.06 % |
| Followed or stalked pets or people | 6. | 4.9 % |
| Approached pets or people | 7. | 2.5 % |
| Chased or charged pets or people | 8. | 2.1 % |
| Made physical contact with pet | 9. | 1.6 % |

Table 3. Human perception of coyotes as categorized from community reports and associated ordinal scale values (*N* = 920 reports).

|  |  |  |
| --- | --- | --- |
| **Human Perception of Coyotes** | **Ordinal Scale Value** | **% Reports** |
| No human perception could be determined from report | NA | 87.0 % |
| Positive (reports containing words like love, happy, exciting, cool or beautiful) | 1. | 1.7 % |
| Neutral (reports containing words like surprised or curious, or denying negative reaction) | 2. | 2.1 % |
| Negative (reports containing words like scared, nervous, disturbed, concerned, uncomfortable or alarmed) | 3. | 7.9 % |

Table 4. Logistic regression model output comparing the probability of a report to a non-report location based on proximity to the ravine system, roads, and buildings.

|  |  |  |  |
| --- | --- | --- | --- |
| Predictor Variable | Estimate ± Std. Error | *z* | *P* |
| (Intercept) | - 0.055 ± 0.017 | - 3.28 | 0.001 |
| Ravine Distance | - 0.27 ± 0.017 | - 15.9 | < 2 x 10-16 \* |
| Road Distance | - 0.53 ± 0.027 | - 19.4 | < 2 x 10-16 \* |
| Building Distance | - 0.19 ± 0.023 | - 8.11 | 5.11 x 10-16 \* |

\* asterisk indicates significant effect

Table 5. Output from Poisson model with the number of annual reports with coyote response to humans ≥ 6 (indicating bold or aggressive encounters) as a function of the total number of annual reports and time.

|  |  |  |  |
| --- | --- | --- | --- |
| Predictor Variable | Estimate ± Std. Error | *z* | *P* |
| (Intercept) | -0.879 ± 0.865 | - 1.02 | 0.309 |
| Time (Years) | 2.38 x 10-4 ± 5.78 x 10-5 | 4.12 | 3.76 x 10-5 \* |
| Total Number of Reports | 1.40 x 10-3 ± 1.77 x 10-4 | 7.90 | 2.91 x 10-15 \* |

\* asterisk indicates significant effect

Table 6. Output from Poisson model with the number of annual reports with negative human perceptions of coyotes as a function of the total number of reports and time.

|  |  |  |  |
| --- | --- | --- | --- |
| Predictor Variable | Estimate ± Std. Error | *z* | *P* |
| (Intercept) | 5.05 ± 0.91 | 5.54 | 3.06 x 10-8 |
| Time (Years) | - 1.39 x 10-4 ± 6.16 x 10-5 | - 2.25 | 0.024 \* |
| Total Number of Reports | 1.60 x 10-3 ± 1.89 x 10-4 | 8.48 | < 2 x 10-16 \* |

\* asterisk indicates significant effect

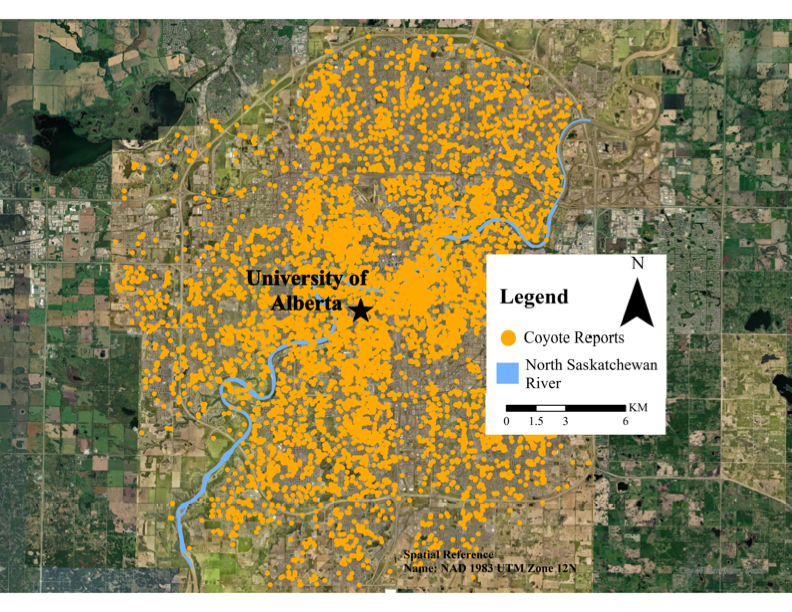


Figure 1. Location of xxxx coyote reports submitted to the Edmonton Urban Coyote Project Website from January 1 2011 to December 31 2020 and used in the associated analyses.

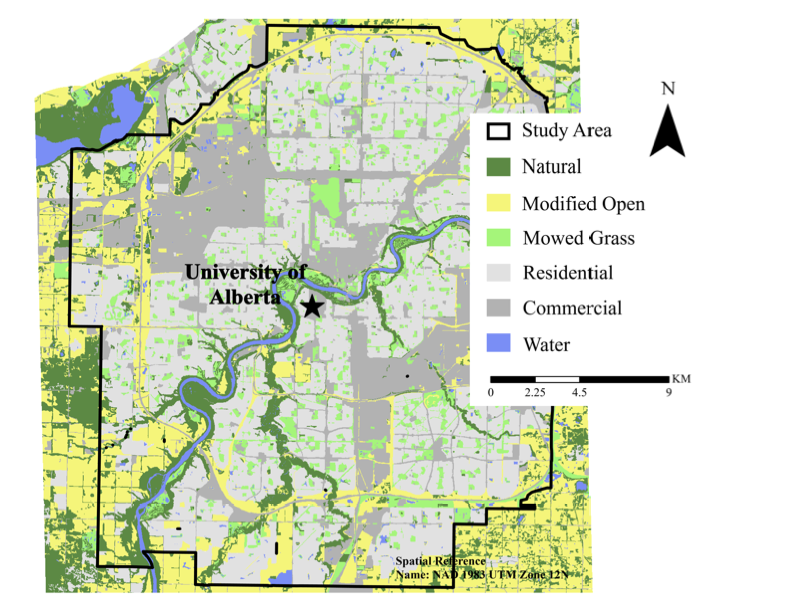


Figure 2. Land cover classifications representing various types of coyote habitat re-classified from the City of Edmonton uPLVI 2018 Land Cover Layer (City of Edmonton 2018)

Chart, bar chart

Description automatically generated

Figure 3. Observed and expected counts of coyote reports within each land cover class. Reports were collected from the Edmonton Urban Coyote Project website between January 1 2011 and December 31 2020, and land cover classifications were determined from the City of Edmonton uPLVI 2018 Land Cover Layer (City of Edmonton 2018).

Chart, histogram

Description automatically generated

Figure 4. Average number of annual coyote reports from each month. Reports were collected from the Edmonton Urban Coyote Project website between January 1 2011 and December 31 2020.

Chart, bar chart

Description automatically generated

Figure 5. Number of reports submitted to the Edmonton Urban Coyote Project website from January 1 2011 to December 31 2020. Reports are represented in four-month intervals to show their relationship with biological coyote seasons.

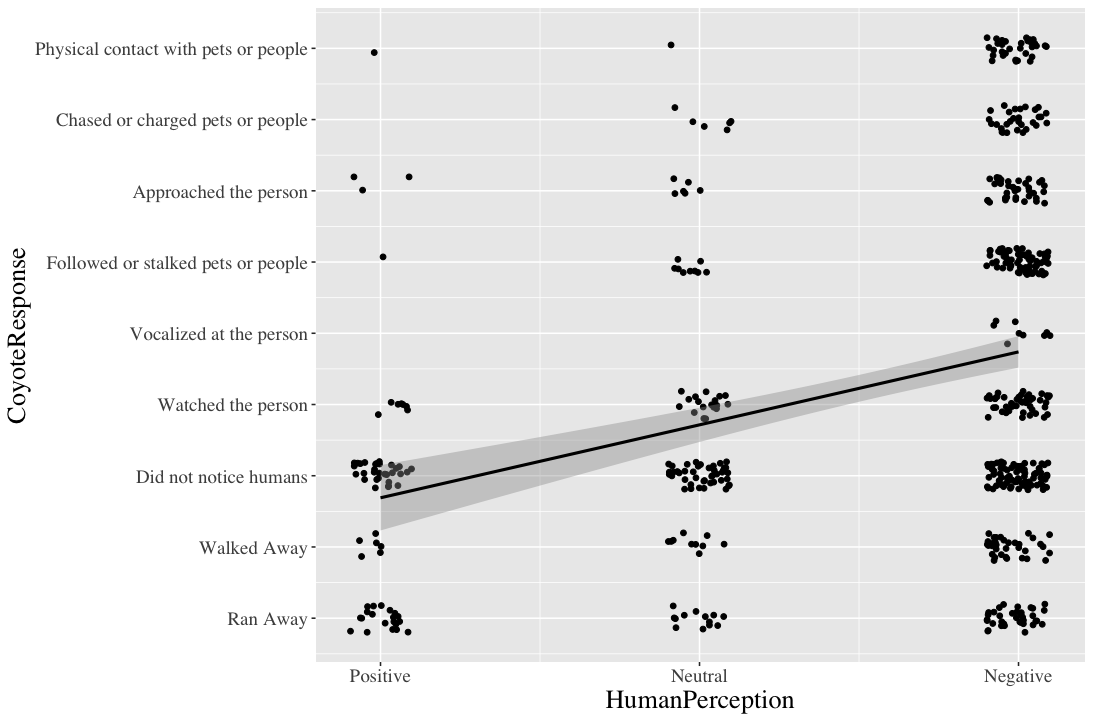


Figure 6. The relationship between coyote response to humans on a nine point ordinal scale and three categories of human perceptions of coyotes from the same reports.

Chart

Description automatically generated

Figure 7. Ordinal regression model output of the spatial predictors of coyote response to humans and human perception as indicators of human-coyote conflict. Model-weighted coefficients shown by points were calculated by averaging the weighted coefficients of the top models selected based on AIC < 2 from the top model. Error bars show 99% confidence intervals of the model fixed effect coefficients.

Chart, box and whisker chart

Description automatically generated

Figure 8. Outputs from four ordinal regression models of the temporal predictors of coyote response to humans and human perceptions as indicators of human-coyote conflict. Variables for each univariate model are shown on the x axis with colors indicating the categories within the variable. Error bars show 99% confidence intervals of the model fixed effect coefficients.

Chart, bar chart

Description automatically generated

Figure 9. Monthly trends in the percentage anong xxxx reports indicating higher levels of human-coyote conflict based on ordinal values ≥ 6 for coyote boldness negative expressions of human perceptions of coyotes.

Chart

Description automatically generated

Figure 10. Output from 8 univariate ordinal regression models examining the effect of contextual predictor variables on the likelihood of coyote response to humans and human perceptions as indicators of human-coyote conflict. The reference category for each model is the reports where the contextual predictor could not be classified (unknown reports). Error bars show 99% confidence intervals.

Diagram

Description automatically generated

Figure 11. Process model outlining how this study investigated the spatial, temporal, and contextual variables associated with human-coyote conflict, as indicated by the coyote response to humans and human perceptions.

Table S1. Percentage of reports for categories of ordinal scale values (OSV) that occurred across categories of each spatial, temporal and contextual predictor variable.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Predictor Variables** | | **Coyote Response to Humans (% excluding unknowns)** | | | | | **Human Perception (% excluding unknowns)** | | |
| Variable | Categories | No Interaction  OSV NA  (59.6 %) | Avoidance  OSV 1, 2  (12.0 %) | Neutral  OSV 3, 4  (16.6 %) | Bold  OSV 5,6,7  (8.1 %) | Aggressive\*  OSV 8,9  (3.7 %) | Positive  OSV 1)  (14.7 %) | Neutral  OSV 2  (18.1 %) | Negative  OSV 3  (67.2 %) |
| Land Cover Type | Natural | 8.4 (372) | 13.0 (117) | 10.4 (129) | 16.9 (102) | 23.0 (53) | 13.3 (18) | 15.0 (25) | 10.8 (67) |
| Modified Open | 9.6 (426) | 8.6 (77) | 8.3 (103) | 12.9 (78) | 20.9 (48) | 8.1 (11) | 8.4 (14) | 10.5 (65) |
| Mowed | 21.4 (953) | 18.9 (169) | 24.8 (307) | 28.0 (169) | 21.3 (49) | 17.8 (24) | 25.1 (42) | 23.6 (146) |
| Residential | 47.2 (2100) | 48.0 (430) | 42.8 (530) | 32.7 (197) | 28.7 (66) | 42.2 (57) | 38.9 (65) | 45.6 (282) |
| Commercial | 12.2 (542) | 9.9 (89) | 12.9 (160) | 7.6 (46) | 3.9 (9) | 15.6 (21) | 10.8 (18) | 8.3 (51) |
| Water | 1.3 (58) | 1.5 (13) | 0.8 (10) | 1.9 (11) | 2.2 (5) | 3.0 (4) | 1.8 (3) | 1.1 (7) |
| Season | Breeding | 40 (1780) | 34.1 (305) | 37.4 (464) | 25.9 (156) | 29.6 (68) | 40.7 (55) | 39.5 (57) | 35.1 (217) |
| Pup Rearing | 19 (847) | 19.2 (172) | 18.6 (231) | 29.7 (179) | 37 (85) | 21.5 (29) | 26.3 (44) | 22.2 (137) |
| Dispersal | 41 (1824) | 46.7 (418) | 43.9 (544) | 44.4 (268) | 33.5 (77) | 37.8 (51) | 34.1 (57) | 42.7 (264) |
| Diel | Night | 37.2 (1654) | 42.5 (380) | 33.3 (413) | 33.5 (202) | 57 (131) | 33.3 (45) | 35.3 (59) | 39.2 (242) |
| Day | 43.8 (1950) | 43 (385) | 51.4 (637) | 46.4 (280) | 23.5 (54) | 51.1 (69) | 51.5 (86) | 41.1 (254) |
| Unknown | 19 (847) | 14.5 (130) | 15.3 (189) | 20.1 (121) | 19.6 (45) | 15.6 (21) | 13.2 (22) | 19.7 (122) |
| Number of Coyotes | One | 54.3 (2419) | 79 (707) | 72.4 (897) | 63.3 (382) | 58.7 (135) | 78.5 (106) | 74.9 (125) | 56.8 (351) |
| Two | 14.5 (647) | 12.5 (112) | 15.7 (195) | 19.2 (116) | 19.6 (45) | 8.9 (12) | 12.6 (12) | 18.0 (111) |
| Three | 4.81 (214) | 3.24 (29) | 3.71 (46) | 7.3 (44) | 4.78 (11) | 6.7 (9) | 4.8 (8) | 8.9 (55) |
| More | 3.91 (174) | 2.12 (19) | 2.58 (32) | 5.31 (32) | 8.26 (19) | 2.2 (3) | 3.6 (6) | 6.1 (38) |
| Unknown | 22.4 (997) | 3.13 (28) | 5.57 (69) | 4.81 (29) | 8.7 (20) | 3.7 (5) | 4.2 (7) | 10.2 (63) |
| Human Activity Mentioned | Walking | 4.38 (195) | 27.4 (245) | 32.5 (403) | 70.3 (424) | 53 (122) | 21.5 (29) | 37.1 (62) | 32.8 (203) |
| Cycling | 0.337 (15) | 3.02 (27) | 1.45 (18) | 0.332 (2) | 2.17 (5) | 2.2 (3) | 4.8 8) | 0.3 (2) |
| Outdoor Activity | 0.539 (24) | 3.8 (34) | 3.39 (42) | 4.15 (25) | 5.65 (13) | 2.2 (3) | 1.8 (3) | 2.8 (17) |
| Home/Yard | 18.6 (830) | 23 (206) | 15.2 (188) | 8.13 (49) | 13.9 (32) | 25.9 (35) | 19.8 (33) | 29.8 (184) |
| Driving | 6.04 (830) | 18.2 (163) | 17 (211) | 0.829 (5) | 1.3 (3) | 20 (27) | 12.6 (21) | 6.6 (41) |
| None | 70.1 (3118) | 24.6 (220) | 30.4 (377) | 16.3 (98) | 23.9 (55) | 28.1 (38) | 23.9 (40) | 27.7 (171) |
| Vulnerable Individual Mentioned | Dog | 6.81 (303) | 26.3 (235) | 30.9 (383) | 73.1 (441) | 65.6 (181) | 17.8 (24) | 32.3 (54) | 42.7 (264) |
| Cat | 0.786 (35) | 2.23 (20) | 1.45 (18) | 1.66 (10) | 16.7 (46) | 5.2 (7) | 0.6 (1) | 4.85 (30) |
| Children | 4.88 (217) | 3.69 (33) | 4.92 (61) | 3.48 (21) | 3.62 (10) | 2.2 (3) | 5.4 (9) | 12.9 (80) |
| Multiple | 1.86 (83) | 3.80 (34) | 4.04 (50) | 5.8 (35) | 7.97 (22) | 2.2 (3) | 3.6 (6) | 18.1 (112) |
| None | 85.7 (3813) | 64 (573) | 58.7 (727) | 15.9 (96) | 6.16 (17) | 72.6 (98) | 58.1 (97) | 21.4 (132) |
| Dog leashed? | On leash | 0.247 (11) | 2.79 (25) | 3.87 (48) | 11.4 (69) | 11.3 (26) | 2.2 (3) | 4.8 (8) | 6.1 (38) |
| Off leash | 0.38 (17) | 3.58 (32) | 2.26 (28) | 5.64 (34) | 19.6 (45) | 2.2 (3) | 2.4 (4) | 6.0 (37) |
| Home/Yard | 1.48 (66) | 3.8 (34) | 3.39 (42) | 3.98 (24) | 12.2 (28) | 3.0 (4) | 1.8 (3) | 9.4 (58) |
| Unknown | 97.9 (4357) | 89.8 (804) | 90.5 (1121) | 78.9 (476) | 57 (131) | 92.6 (125) | 91.0 (152) | 78.6 (485) |
| Hazing | Yes | 0.65 (29) | 29.3 (262) | 14.6 (181) | 42.1 (254) | 44.3 (102) | 9.6 (13) | 12.0 (20) | 27.7 (171) |
| No | 39.8 (1770) | 53.5 (479) | 62.1 (769) | 29.2 (176) | 16.5 (38) | 74.8 (101) | 75.4 (126) | 40.3 (249) |
| Unknown | 59.6 (2652) | 17.2 (154) | 23.3 (289) | 28.7 (173) | 39.1 (90) | 15.6 (21) | 12.6 (21) | 32.0 (198) |
| Coyote Health | Healthy | 12.2 (544) | 22.3 (200) | 20.6 (255) | 9.62 (58) | 9.13 (21) | 56.3 (76) | 27.5 (46) | 12.0 (74) |
| Unhealthy | 6.87 (306) | 6.7 (60) | 6.3 (78) | 3.48 (21) | 2.61 (6) | 3.0 (4) | 4.2 (7) | 5.2 (32) |
| Unknown | 80.9 (3601) | 70.9 (635) | 73.1 (906) | 86.9 (524) | 88.3 (203) | 40.7 (55) | 68.3 (114) | 82.8 (512) |