CITY OF LONG BEACH COYOTE MANAGEMENT PROJECT

Final Report

Submitted by:

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Loyola Marymount University
Center for Urban Resilience

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COVER PHOTO: Coyote pups captured by one of the motion activated game cameras located at Long Beach Fire Department Station 19 as part of the LMU Center for Urban Resilience Coyote Management Project.

CONTRIBUTORS & ACKNOWLEDGEMENTS

A project like this one is not possible without the contributions of many researchers and partners. We are grateful to the LMU Center for Urban Resilience (CURes) staff who helped get this project started and contributed to data collection and analysis throughout the three-year study. In particular, Dr. Peter Auger and Maria Curley played key roles in setting up initial contacts, establishing field sites and methods, and collecting data. CURes staff members George Dinius, Lisa Fimiani, and Emily Simso also contributed to the field work, management of student research assistants, and analyzing and reporting results. Arizona State University doctoral student Kate Weiss produced a detailed review of existing coyote research to add context to our findings in Long Beach. CURes undergraduate research assistants were integral to gathering and analyzing three years of field data, as well as contributing to other aspects of the study, including developing survey materials, transcribing interviews, etc. They included: Dominic Beachler, Jaci Findlay, Stephen Gloudeman, Nicole Infantino, Alexis Isaev, Christopher Jaime, Jordan Lindsey, DeLisa Madere, Julia Pradel, Ashley Rietmann, Grace Riggs, Haley Ryan, Matt Sheridan, Barbara Velasco, Armaan Zare.

We are grateful to the many scientists and practitioners who we consulted to establish our data collection and analysis approach, as well as the organizational leaders who participated in key informant interviews and residents who responded to our survey.

We acknowledge the hard work of Ted Stevens, from the City of Long Beach Animal Care Services, as an important partner in getting this project launched and overseeing the progress through the years. And of course, the City of Long Beach for providing the support to make this project possible. We hope that the findings are useful in furthering your coyote management efforts. We stand ready to help the City implement these interventions.

EXECUTIVE SUMMARY

Staff from the Loyola Marymount University Center for Resilience, in collaboration with officials from the City of Long Beach conducted a multiyear analysis of coyote ecology, risk, and management options to be implemented. The project was designed to incorporate local data, regional information and national examples to be applied to the challenges of coyote management in Long Beach. The project was initiated in response to increase concern about the safety of coyotes living within the city and their impact on domestic animals, especially cats. The project occurred at a prescient period in urban coyote research as many parallel projects were taking place across the country, with a few focused in Southern California. As such, the project activities morphed during the period of three years to better capture the new information that was being made available by collaborating scientists in the area and by research teams across the country.

The data from Long Beach and other studies indicate that coyotes in Southern California present an increasing risk to domestic animals, especially cats, when compared to both historical studies and other locations across the country. These findings have been supported by multiple research efforts by other scientific teams and by our additional work that is currently underway in Culver City. As a result of these findings, the management challenges for coyotes in Southern California have increased in scope and complexity. Cities across the region are struggling to find effective and humane interventions that can ameliorate the threats presented by coyotes, especially those directed towards domestic animals and people.

Our recommendations include: 1) increasing specialized education for stakeholders with regard to reducing coyote risk, 2) implementing a suite of interventions at the individual parcel level that can decrease the potential threat from coyotes, 3) following a tiered response to coyote management with respect to documented incidences, and 4) introducing a palette of strategies that can be applied to residential pet owners as they try to find a balance between pet safety and outdoor activities.

This report and its appendices contain detailed information and resources that can be used to address these recommendations. As part of this project, we developed a localized formal in-school curriculum that is available online to the Long Beach Unified School District and other schools in the area. We have also developed a backyard safety survey that can be implemented with relative ease. Finally, the report itself provides a wealth of information pulled together from our data collection in Long Beach as well as other cities throughout the US. These resources can be used by themselves or be incorporated into the development of additional outreach materials. While the Covid-19 pandemic has impacted the feasibility of certain in person community engagement and outreach interventions, these materials can still be utilized immediately. The CURes team stands ready to provide virtual workshops, presentations, and professional advice on individual coyote incidents and the options the city might use to reduce risk.

1. INTRODUCTION

This report details the results of a three-year examination of coyotes in the City of Long Beach, from 2016 to 2019, undertaken by the Loyola Marymount University (LMU) Center for Urban Resilience (CURes). In an effort to understand holistically the challenges surrounding coyotes in Long Beach, CURes conducted an applied research project that included both ecological and social scientific research, development of educational materials, and recommendations for the City of Long Beach. This type of *social-ecological* approach allows for a better understanding not only of the coyote populations and their behavior, but also of the human population and their interactions with this urban wildlife.

Our understanding of coyote behavior in urbanized habitats is undergoing significant change. Since we began the project in Long Beach, at least three additional studies have been initiated or expanded in Southern California (National Park Service, University of California Extension Service, Cal State Northridge). Each is attempting to better elucidate the foraging choices that coyotes make and ways in which those choices are impacted by the interactions they have with humans. Some focus on diet choices (e.g., Larson et al. 2020), and others, such as those led by UC biologist Dr. Niamh Quinn, on the impact of hazing as a management practice. In addition, we have launched additional studies in Culver City and across greater Los Angeles in a project conducted in collaboration with Arizona State University. We are hopeful that these collective studies will yield additional helpful information in our attempts to create effective, humane and lasting management strategies for reducing human and domestic animal conflict.

Perhaps the most salient take-home point from these projects is that the individual variation among coyotes and their families is considerable, and that management interventions will need to be carefully considered and likely iterative as we learn more. Two recent non-lethal bites along a trail path in Mission Viejo (July 2020) have increased public concern highlighting the high stakes surrounding the issue of human safety in the presence of coyotes. In this instance, the suspected coyote was trapped and euthanized as part of a coordinated response to the threat. A previous attack on an elderly man in Laguna Beach (May 2020) resulted in the capture and euthanasia of two male coyotes. However, further analysis revealed that the bite was delivered by a female coyote and that the two males were not responsible for the attack, illustrating the importance of thoroughly investigating instances such as these.

The goal of any successful management plan is to minimize the need for lethal predator control to break the cycle of dependency of coyotes on direct human resources that create the ecological conditions for dangerous conflict. The suggestions we put forth in this document highlight that need and provide alternative solutions.

2. CAMERA TRAP ANALYSIS

Studies of coyotes in urban environments have revealed that coyotes do not prefer urban environments to their natural habitat (reviewed in Gehrt and McGraw 2007). Vegetation is patchy throughout urban environments, so it is often more difficult to locate preferred prey (Ellington and Gehrt 2019). Anthropogenic food sources (e.g. trash, pet food) are available but are often low in fat and protein and high in carbohydrates (Murray et al. 2015). Thus, coyote territory size actually increases with percentage

of urban landscape within the territory as they may have to travel greater distances to hunt for high quality prey rather than consuming anthropogenic food sources (Gehrt and McGraw 2007; Figure 1).

Coyotes also have to alter their behavior to live around human populations. Coyotes in areas where they are not persecuted by humans are most active during the daytime. However, in areas where they are highly hunted or surrounded by high densities of humans, they alter their behavior to increase activity at night (Kitchen et al. 2000) In addition, freeways and busy streets create dangerous areas that may create areas that are difficult for animals to cross when searching for food or mates. In fact, a study in Chicago showed the cars presented the biggest threat to the survival of urban coyotes (Gehrt and McGraw 2007). However, coyotes are becoming more prevalent in neighborhoods and city parks throughout the country, including crowded cities such as Chicago, New York, and Los Angeles. A question facing researchers is: how are coyotes using this environment and how do they travel through neighborhoods as they search for places to den and hunt? Does their switch to nocturnal behavior adjust their overlap with other mammal species and do those species alter their behavior in response?

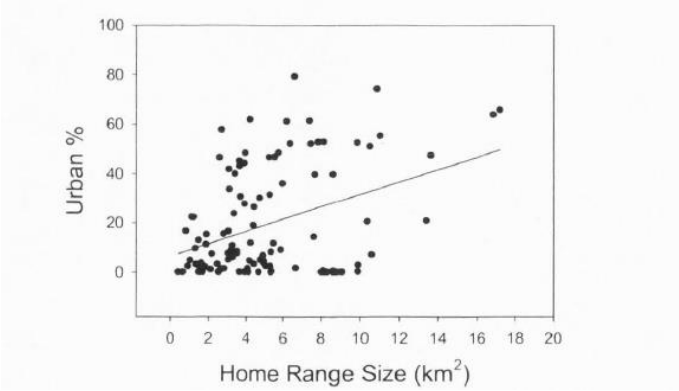

Figure 1. Coyote territory size increases with percentage of urbanized habitat (Gehrt and McGraw 2007).

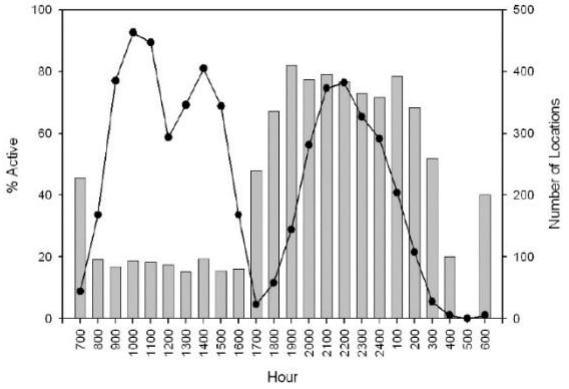

Figure 2. Activity behavior of coyotes in Chicago where bars represent frequency of active locations and lines represent number of locations per hour (Gehrt et al. 2011).

There are two primary ways to gather this data: radio telemetry and remote camera traps. Each has its own set of advantages and disadvantages. Radio telemetry allows researchers to pinpoint exact locations of coyotes and record travel routes throughout the day. This paints a complete picture of coyote activity during the lifespan of the collar (Ellington and Gehrt 2019). However, animals must be trapped in order to attach collars, collars can be expensive and tracking the locations of the coyotes can be time-consuming (pers comm). The initial outline for this project aimed to utilize radio telemetry to follow the movements of one or more coyotes, but this was not feasible based on several factors including permits, timing, and funding. The second method involves setting up motion-sensing camera traps throughout the area of interest and analyzing the photos collected. This method is ideal because it is less invasive and more cost effective than radio telemetry (Frey et al. 2017). The limitations are that

researchers can only view behavior where the cameras are established and do not know where the animal travels from that site (Frey et al. 2017). Yet it is often the preferred method for animals that are elusive and difficult to track, such as coyotes and other predators that often evade detection (Frey et al. 2017). Since coyotes are nocturnal and tend to avoid people, camera traps often present the best means for understanding travel and behavior, though it does not give a complete understanding of coyote travel time and energy usage throughout the day. For this project, camera traps were employed at two study locations.

The first location chosen was a grassy open space adjacent to Long Beach Fire Department Station 19, situated between a golf course and a busy road (Figure 3). Coyote sightings had been reported on the golf course, and firefighters reported hearing howling at night and what appeared to be a coyote family living nearby. The cameras were first set up in the summer of 2016 to establish field protocol. Once the methodology was tested and stable, data collection began during the following spring. A total of 14 motion activated cameras were deployed at seven stations, running continuously throughout the day and night, from June-November, 2017. Cameras were set in duplicate with one capturing video and the other photographs. Undergraduate research assistants regularly visited the site to replace the camera batteries and collect the memory cards, which were analyzed for the presence of coyotes and the time of day. In total, 33,102 images were analyzed, with 680 coyote occurrences documented during the collection period. These coyotes appeared to be a family group, with pups appearing early in the data collection (see cover photo). As shown in Figure 4, nearly 75% of the total observed coyotes were present during the hours of 8 p.m.-8 a.m. while the remaining 25% were present from 8 a.m.-8 p.m. The most frequented hours included 3:00-3:59 a.m. (n = 59), 5:00-5:59 a.m. (n = 84), 6:00-6:59 a.m. (n = 103).

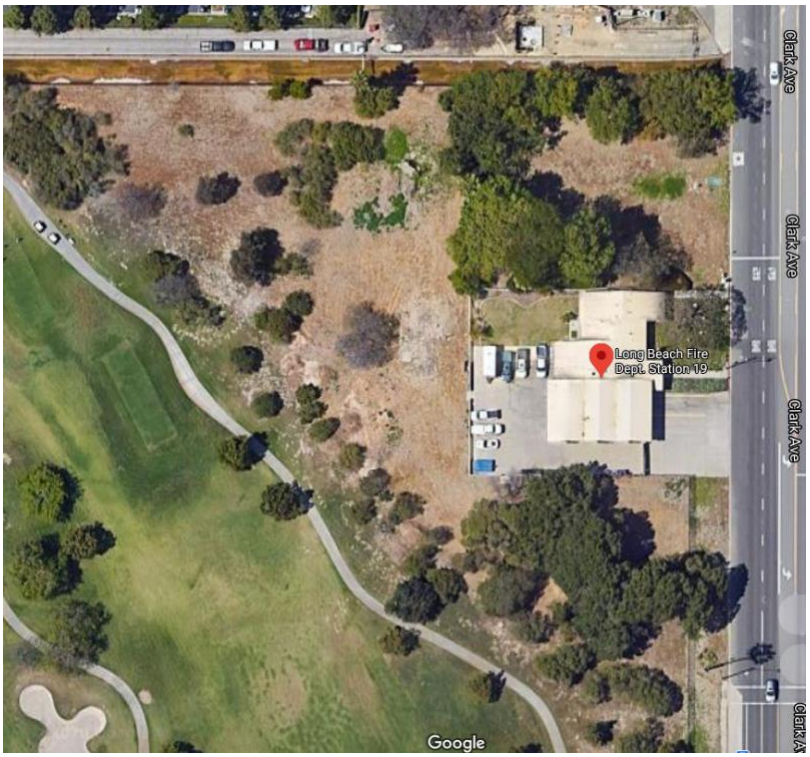

Figure 3. Study Location 1: Open space adjacent to Fire Station 19 in Long Beach, Calif.

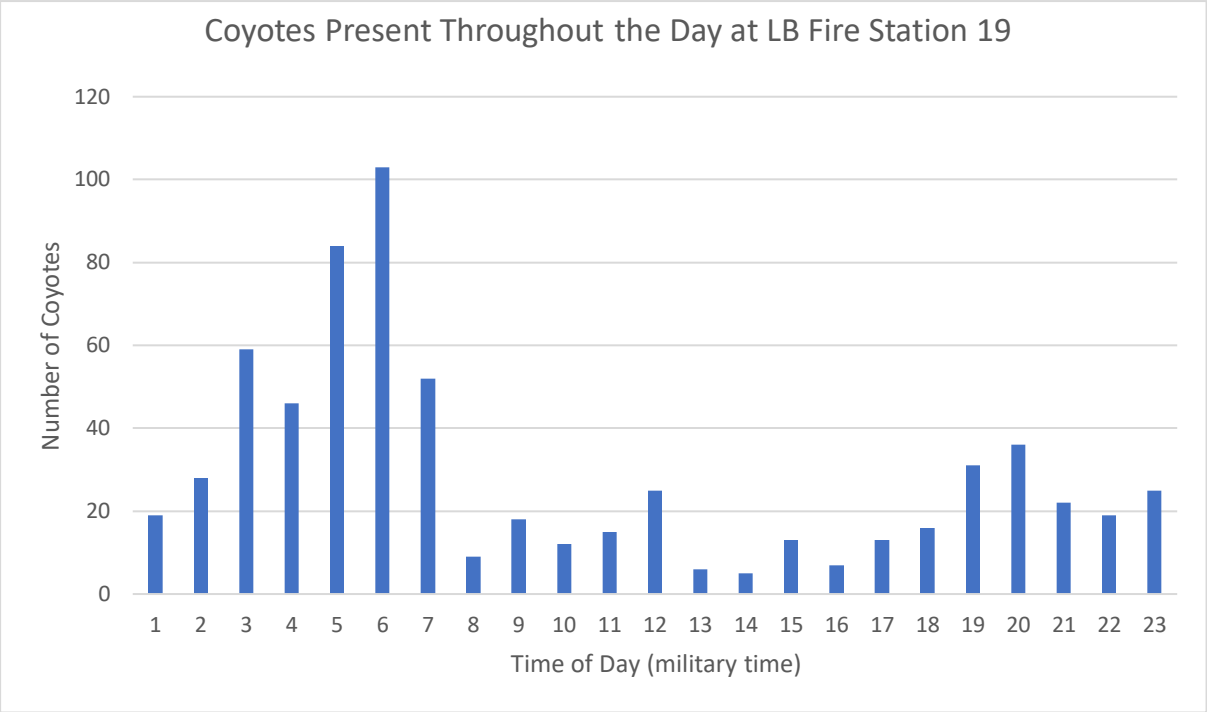

Figure 4. Number of coyotes recorded during each hour of the day during the six-month period that game cameras were capturing images at Fire Station 19 in Long Beach, Calif.

Camera trap stations then were moved to the second study location beginning January 2018 (Figure 5). Jauregui Nursery in Long Beach (Figure 5) was selected as the second site due to a number of characteristics. It is in close proximity to extensive suburban sprawl, provides a secure location for deploying camera traps, and is sufficiently large to afford coyote denning locations. The Tree Nursery is 1.7 miles long and 175 feet wide and contains 35 acres. Inside the Nursery are three dirt roads: one that runs the entire length of the nursery in the center of the property and two others along the left and right sides of the property, to the west and east of center. The Nursery is separated into two parts that are divided by E Wardlow Road. The northern section ends at Carson St. to the north; the southern section ends at E. Spring Street to the south. Access for coyotes is available at many points of ingress throughout the Nursery. Running parallel to the road on the east side is the San Gabriel River aqueduct and a bike path. That human-built corridor runs the entire length of the property from north to south and overlaps with green space to the south and west at the El Dorado Park East and Nature Center.

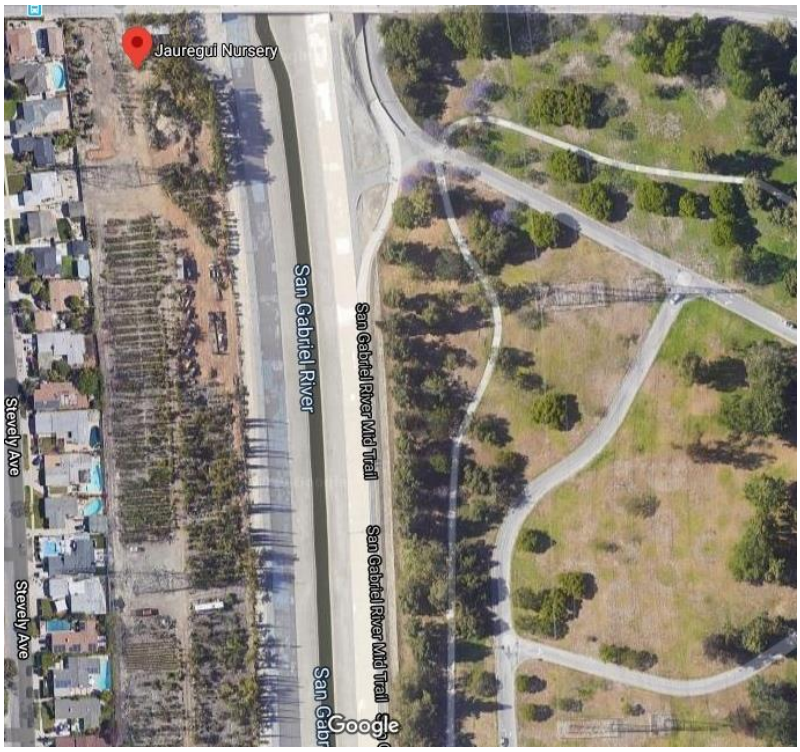

Figure 5. Study Location 2: Jauregui Nursery in Long Beach, Calif.

Cameras were placed strategically along the main road throughout the nursery on April 28, 2018, and remained there until the end of the year. Undergraduate research assistants collected memory cards on a monthly basis and recorded which animals were observed during what times of day and what, if any, behavior could be recorded. The cameras captured more than 250,000 images, which were sorted by research assistants who scanned each image for animals. Of the images, 684 were of coyotes, hundreds more than any of the other animals captured. The cameras captured 84 images of cats, 65 of squirrels, 48 of rabbit (a primary prey source of coyotes), 36 raccoon and 18 of opossum and skunk (Figure 6).

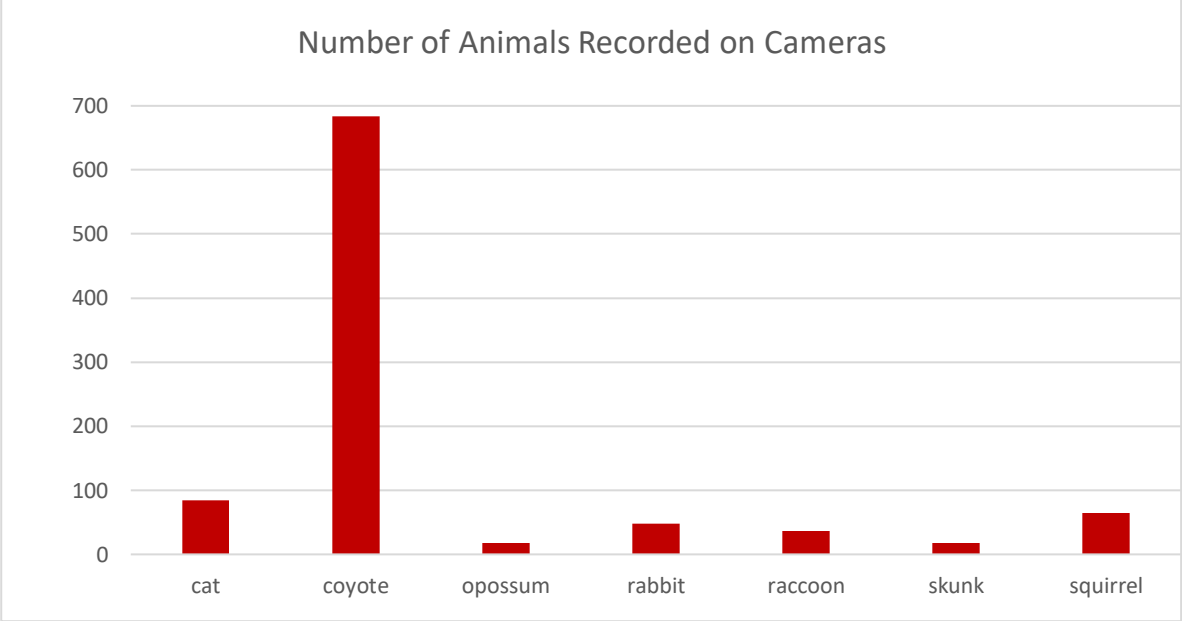

Figure 6. Number of animals captured on still motion game cameras in Jauregui Nursery in Long Beach, Calif.

Coyotes were never captured in an image with another animal (see Appendix for photos), but there were a handful of occasions where a cat, skunk or raccoon was seen at the same camera within an hour of a coyote. Coyotes were significantly more active between 7 p.m. and 7 a.m. (Figure 7), confirming the findings at the first study location. This switch to nocturnal life is thought to be an adaptation as coyotes found in natural areas are typically seen frequently during the day (Kitchen et al. 2000). This overlaps with prey such as rabbit, seen primarily at night, and cat, which could be seen throughout the day, as well as opossum, skunk and raccoon, which are not prey items but are frequently found in urban areas utilizing similar food sources. In contrast to coyotes, cats, which are typically nocturnal, have altered their behavioral patterns to be active throughout the day as well, when they can avoid predation from coyotes (Kays et al. 2015). Coyotes were spotted at the same location within an hour of a raccoon four times, a rabbit three times, a skunk once and a cat twice. Thus, it appears that raccoons change their behavior least to accommodate coyotes. The next highest overlap was rabbits, which are a preferred prey source for coyotes, which may be hunting them. However, of the 15 cameras that recorded the most coyote activity, only three had more than sporadic visits from other animals, and only one had nocturnal cat activity. In general, then, it would appear that other animals, including cats, avoid areas high in coyote density.

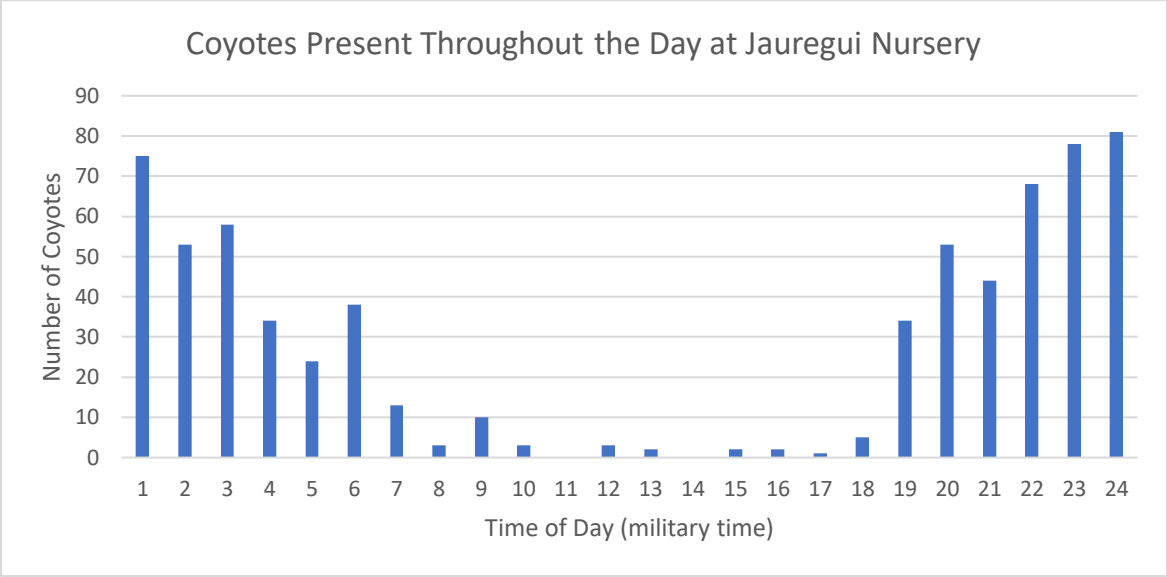

Figure 7. Number of coyotes recorded during each hour of the day during the eight-month period that game cameras were capturing images in Jauregui Nursery in Long Beach, Calif.

None of the images captured revealed animals eating or hunting. The majority of pictures recorded animals standing or walking through the area, appearing to use it primarily as a travel corridor. There were some pictures of coyotes resting and playing, but these were minimal. Thus, these areas with high vegetation and limited human development appear to be used as travel corridors through the neighborhood. As an average of 2.8 coyote images were captured per day, compared to less than 1 for every other animal, this appears to be an important corridor as well. Since these coyotes also have high

levels of cat hair in their scat (see Figure 11), this may be an area that should be strongly considered for management strategies.

3. SCAT ANALYSIS

As urban areas continue to expand and coyote populations increase their range throughout North and Central America, conflicts between humans and coyotes increase. In fact, in Los Angeles, there has been concern about the increased exposure to coyotes, some aggressive with people and their pets, since the late 1990s (Timm et al. 2004). The main proposed contributor linked to this increase for urban predators in general is anthropogenic food sources (Hopkins et al. 2012). Coyotes are dietary generalists, which means they can exploit a wide array of food sources and have been known to eat everything from rodents and rabbits to fruit and trash (reviewed in Gehrt and McGraw 2007). A study of coyotes in Canada revealed that urban coyotes had even more diverse diets than rural populations, including multiple species of mammals, insects, birds, trash and fruit (Murray et al. 2015; Figure 8). Urban coyotes were 47% more likely than rural coyotes to have more than one type of mammal per scat and consumed 29% less animal, making up for that with anthropogenic food sources (Murray et al. 2015). Among animals that urban coyotes are known to consume are domesticated cats, bringing them into further conflict with humans (White and Gehrt 2009).

Many of the seminal studies on coyote diet have been conducted in Chicago and found that even in urban areas, coyotes do not utilize anthropogenic resources as a high percentage of their diets (Gehrt and McGraw 2007). Particularly, these studies found that coyotes rarely preyed on domestic animals, such as cats and dogs, which made up only 1-2% of their diet (Gehrt and McGraw 2007). Studies in Alaska, Arizona, Canada and Denver backed this up (Hernandez et al. 2002; Murray et al. 2015; Poessel et al. 2017; Prugh 2005), though a study in Alabama showed they made up about 8% of coyote diet (Santana and Armstrong 2017) and one in Washington found that cats made up 13% of the coyote diet (Quinn 1997).

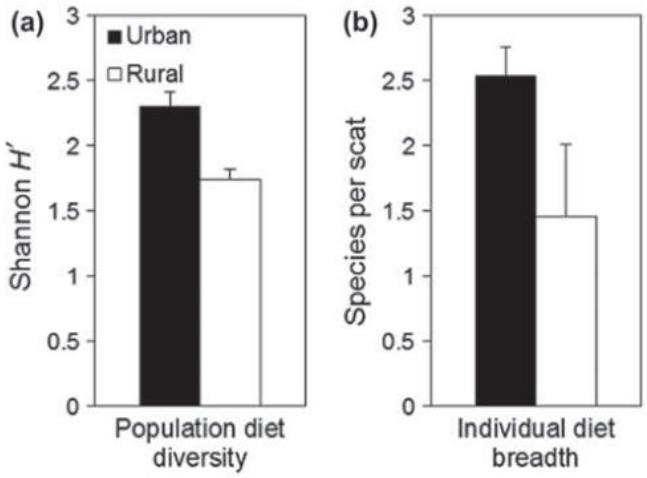

Figure 8. Murray et al. (2015) used the Shannon Diversity Index to calculate diversity of diets and found that urban coyotes showed more dietary diversity and individual breadth than rural counterparts.

In California, however, these results are dramatically different. Larson et al. (2015) found cat in 29% of coyote scat in San Diego (Table 1), and in neighborhoods throughout Los Angeles, reports of coyotes killing cats have reached record numbers. In Culver City, 73 cats were killed during a two-year period in

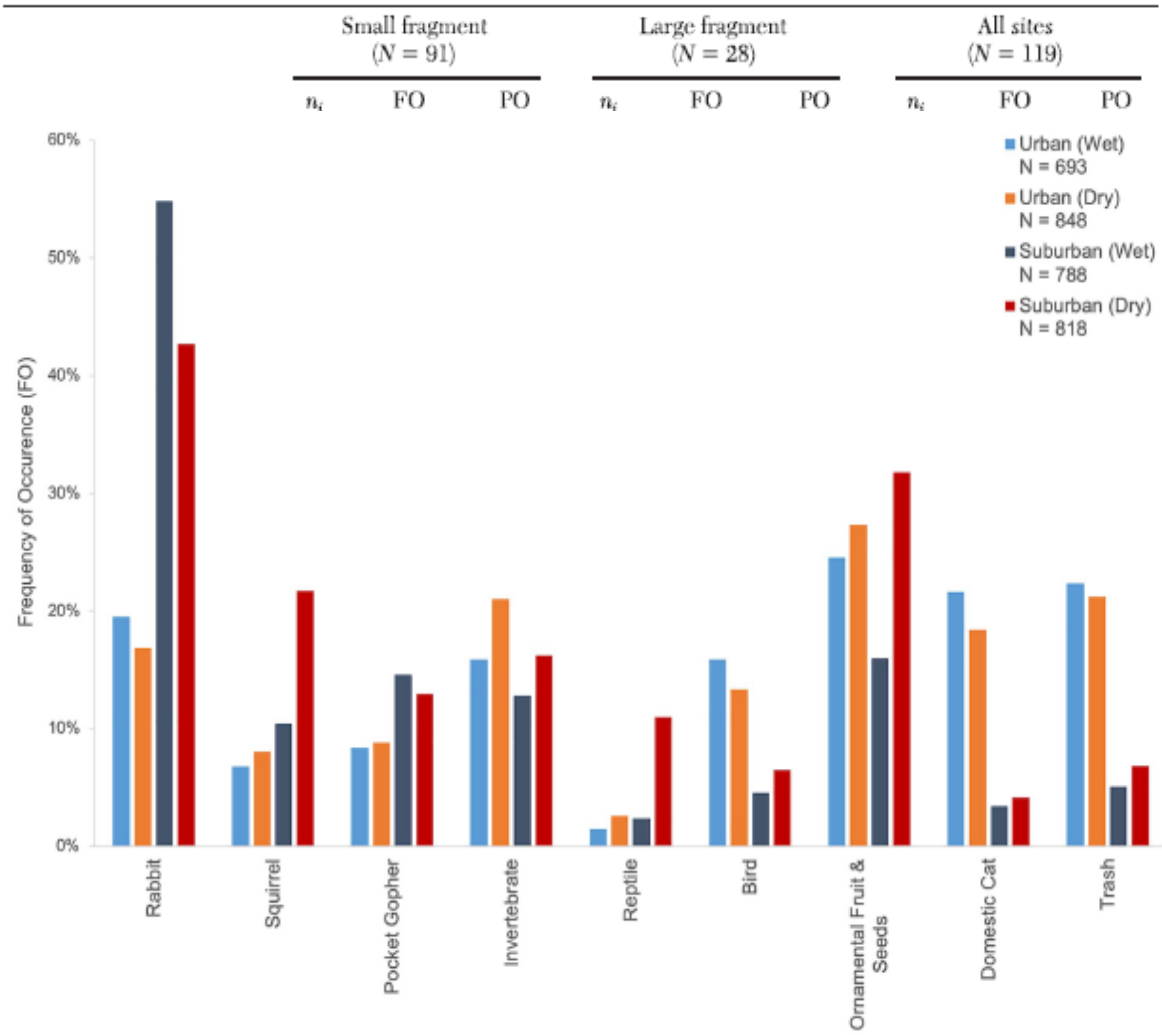

Figure 9. Frequency of occurrence of prey items in coyote scat throughout Los Angeles County, which included collection in urban and suburban areas during both wet and dry seasons (Larson et al. 2020).

2018-2019 (pers comm). A large study conducted throughout the greater Los Angeles area by the National Park Service found cat remains in 20% of coyote scat, indicating that this is a more common occurrence throughout Los Angeles than other reported studies (Larson et al. 2020; Figure 9). In order to determine why this difference occurs, researchers must understand how coyote behavior and diet differs in Los Angeles vs other large cities, such as Chicago and Tucson. Is this behavior typical of urban Los Angeles coyotes or are a few individuals causing most of the damage? Are there unique aspects of the Southern California landscape, prey selection, or animal behavior that lead to these differences?

To better identify when and if coyotes regularly consume domestic cats and other pets (e.g., domestic dogs (*Canis familiaris*) throughout the U.S., we reviewed the literature to identify what coyotes eat in rural, urban, and suburban contexts. We surveyed Google Scholar using key words relating to "coyotes," "scat," "diet," and "urban" to locate 64 peer-reviewed scientific journal articles, Masters theses, and

Dissertations. From this, we identified papers that (1) specifically reported values for the Frequency of Occurrence (FOC, i.e., the percentage of collected scats containing a given item) of various foods in coyote scats and that (2) reported discrete FOC values by degree of urbanization or by a location that could then be identified as urban, suburban, or rural via Radeloff et al. (2018)'s Wildland-Urban Interface explorer (http://silvis.forest.wisc.edu/data/wui-change/). This resulted in a total of 14 documents that met our inclusion criteria. However, many of these papers reported data across multiple study sites, each of which was considered a separate case. In total, we therefore included data from 58 cases (40 rural, 11 suburban, and 7 urban). As some papers reported both annual and seasonal data, cumulative analyses across seasons excluded overlapping data. We recorded the FOC values for each prey item per case in a data table. Papers differed significantly in how they reported data (e.g., some reported the number of scats that had each individual species of various small rodents, while others reported a cumulative value for the total number of scats including small rodents). To ensure values were not over-represented, when cumulative values were not provided, we selected the highest FOC for a species within a given taxonomic group.

In most regions of the U.S., coyote scats contain 0 – 3.2% domestic cat and 0 – 0.3% domestic dog across rural, suburban, and urban areas (McClure 1993, Arjo et al. 2002, Cepek 2004, Manning 2007, Carrera et al. 2008, Schrecengost et al. 2008, Boser 2009, Turner et al. 2011, Dowd and Gese 2012, Swingen et al. 2015, Cypher et al. 2018). Exceptions to these trends are seen in Denver, CO and southern, CA. In Denver, CO, high numbers of coyote scats both domestic cat and domestic dog, though these values are associated with high rates of generalized middle-sized carnivore consumption, suggesting coyotes in the Denver Metropolitan Area may consume domestic cats as a result of competition instead of targeted predation (Poessel et al. 2017). Yet, literature in southern California has identified domestic cats as contributing significantly to coyote diets despite low rates of middle-sized carnivore consumption, suggesting competition may not drive cat predation in these areas (Shargo 1988, Larson et al. 2015, 2020). In these studies, domestic cats are reported in 20-29% of surveyed scat samples in urbanized areas of San Diego and LA County, CA (Larson et al. 2015, 2020).

Across the U.S., domestic cat consumption appears to almost exclusively occur in urban areas (Fig. 1, 55 cases). However, it should be noted that only four papers reported urban coyote scat data in a manner which we could include in our analysis (i.e., Manning 2007, Larson et al. 2015, 2020, Poessel et al. 2017), and so it is possible values vary across cities in ways we do not yet understand. Indeed, Manning (2007), which reviewed coyote diets in Pinellas County, FL, did not report any domestic cats in urban coyote scats.

Coyote scats in rural areas appear to have higher variation in the frequency of prey items found as well as prey type compared to suburban or urban areas, which may be due, in part, to regional differences in prey availability (Figure 10). Deer and ungulate predation also appear to be lower in urban compared to suburban or rural regions (Figure 10). Interestingly, coyotes across level of urbanization seem to consume higher than expected rates of insects (Figure 10). Lastly, though vegetation, seeds, and fruits were commonly seen in coyote scats across habitat type, coyotes in urban areas appear to consume much higher rates of anthropogenic foods (e.g., trash) than other areas (Figure 10).

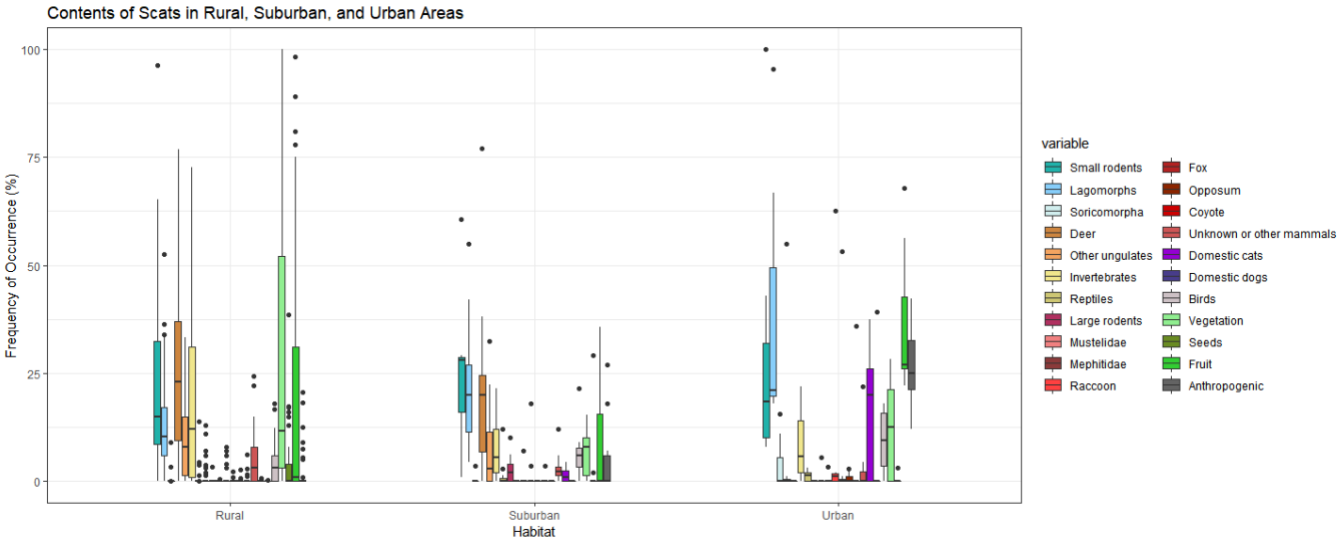

Figure 10. The Frequency of Occurrence (FOC) of various prey items in coyote scats in rural, urban, and suburban areas, as identified throughout the literature (55 cases).

To begin to understand how Long Beach coyote diets compared to those collected throughout the rest of the region, we collected scat samples for dietary analysis. We attempted two types of analysis: dry analysis and DNA analysis. The aim was to look for how many cats appeared in coyote scat as well as a well-known natural prey (rabbits), which appears in more than 40% of coyote scat in Chicago, Alaska, and Arizona studies. While dry analysis is a standard that has been used on scat analysis for decades, new research is demonstrating that species can be identified in scat from DNA molecular analysis as well (Mumma et al. 2016). Unfortunately, DNA analysis did not work with the methodology available at Loyola Marymount University. Thus, we have to make conclusions based on dry analysis, which consists of drying collected scat in an oven placed at 60 degrees Celsius overnight to kill pathogens then placing it in nylon stockings and washing and drying it in a commercial washing machine and dryer, which removed all particles and left behind only hair and bone. The scat was collected at the Jauregui Tree Nursery at 7200 E. Wardlow Rd (see Figure 5). This site was collected based on observing evidence of frequent coyote usage, numerous entry points, and value as a movement relatively human-free movement corridor throughout the City. To determine the presence of cat or rabbit, we identified hair, which is quite distinctive, from the scat underneath the microscope.

Students walked the transect on a monthly basis throughout 2018 and collected 21 scat samples that were fresh enough when collected to be analyzed. Of those 21 scat samples, 14 contained cat hair and 12 contained rabbit hair (Figure 11). Thus, 70% of the scat collected contained cat hair, significantly higher than previous studies. Interestingly, nine of the scat samples contained both cat and rabbit hair. One potential hypothesis for the increased amount of cat in the diet of Los Angeles coyotes has been that a decrease in traditional prey sources, such as rabbits and rodents, has caused coyotes to switch to consuming cats, which would be a less preferred prey. However, if coyotes have both cats and rabbits in

the same scat samples, this means they are consuming both in the same bowel cycle. This means that cats may not be less preferred, and coyotes, as a generalist species, have learned that cats are an equally available and nutrient-rich prey source. Larson et al. (2015) found that people living around their study sites averaged 1.7 pet cats and 70% let their cats roam free outdoors. This increase in pet cats that are allowed outdoors may be increasing the interactions with cats in natural areas, leading to higher cat consumption.

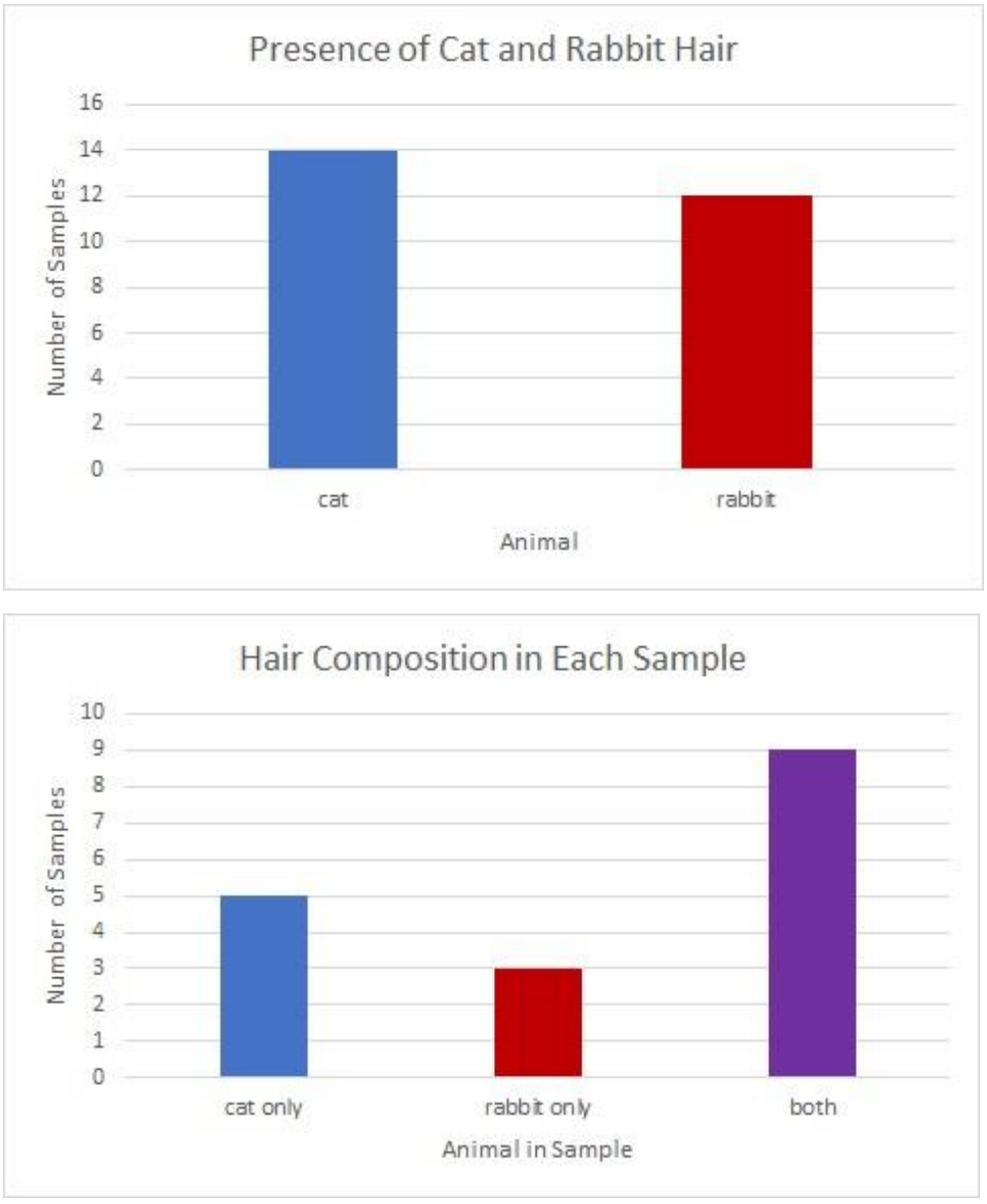

Figure 11. We collected 21 scat samples from a Long Beach nursery and found that 14 of those samples contained cat while only 12 contained rabbit (top). In addition, nine of those samples contained both cat and rabbit (bottom).

The limitation to this study is that all of the scat samples were collected from the same transect. Since coyotes are territorial, and one family of four was believed to occupy the nursery territory, we may have

captured samples only from this family. Without DNA analysis available, there is no way to know how many coyotes actually contributed to this sample. Thus, we might have captured a family of coyotes that has learned to specialize on cats rather than uncovering a pattern that would persist throughout Southern California. The presence of cats, which is much higher than any other study, may just be a result of the small sample size.

4. CAT BEHAVIOR ANALYSIS

While it is important to study coyote behavior to determine why coyotes in southern California are consuming significantly more cats than in other areas, that is not the only piece of the puzzle from which we can glean information. Researchers can also learn about the dynamics between the two populations by studying cat behavior. Little is known about free-roaming cat behavior, but it has recently come to the forefront as cats are thought to reduce urban biodiversity by preying on birds, lizards and other small prey (Schmidt et al. 2007). Thus, researchers have begun studying movement patterns of both owned and unowned cats in and around cities. In general, unowned cats have a larger home range than owned cats (Schmidt et al. 2007); however, even owned cats can travel up to a mile in a day (Ogan and Jurek 1997). Cats in Chicago, where predation by coyotes is low, alter their behavior to avoid coyotes (Gehrt et al. 2013), as coyotes prefer the natural areas and cats primarily move throughout the urban areas. Potentially, then, coyote predation might not be rare because of a difference in coyote behavior, but a difference in cat's response to coyotes when compared to cats in southern California. A study in the eastern United States found similar results: coyotes were present in natural areas where there were few cats, and density of cats was 300 times higher, where coyotes were rare (Kays et al. 2015). Thus, cats are able to alter their behavior when coyotes are present, reducing the risk of predation. The question facing researchers then is: does cat behavior influence coyote predation? Can cats modify behavior to avoid coyotes?

To determine if cats in Long Beach changed their movement based on presence of coyotes, we aimed to fit six Long Beach cats with GPS trackers and record their movement patterns. This was first piloted with a cat in Westchester named Smokey who was allowed free roam of his neighborhood during the day (Figure 12). Smokey showed a similar home range to previous cats, traveling several city blocks in a given day (Figure 12), so we deployed six similar GPS collars to cats who were allowed to roam near the Jauregui Nursery where we recorded high levels of coyote activity during our camera trap study. Unfortunately, only one of the collars was recovered from a cat who was found dead three weeks after the study began. The recovered data show that the cat did have a relatively large range of travel (Figure 13); however, because there were no other cats with which to compare this behavior, we do not know if it was indicative of a behavioral change.

Figure 12. Smokey with his GPS collar and his movement patterns through Westchester on February 19, 2017.

Because studies in Chicago, where cats make up between 1-3% of coyote diet (Gehrt and McGraw 2007), revealed that cats alter movement patterns to avoid areas with high coyote traffic, future studies should incorporate cat behavior beyond the pilot efforts of this project. This will require placing GPS collars on free-roaming cats, both owned and unowned, that can be recovered after several months to observe patterns. Studies should consider monitoring cats both in areas with high and low coyote density to see if there is a difference. Combining this with radio telemetry studies on coyotes and camera trap data can produce a complete picture of the territory overlap between a mesopredator and top predator.

Figure 13. Movements of cat tracked through Long Beach, Calif., near the Jauregui Nursery.

However, movement patterns may not be the only behavioral differences between Los Angeles cats and cats in other cities. Many of the cats being predated upon in the Los Angeles area, including Long Beach, appear to be free-roaming domesticated cats (pers comm). Domestication of animals in known to lead to a variety of changes, including reduced sensitivity to stimuli that may be threatening to a wild animal and reduced aggression (reviewed in Price 1999). Both of these could result in behavioral changes that make domesticated animals more vulnerable to predation, which they appear to be (Price 1999). Various videos of cat and coyote interactions reveal an interesting pattern: when cats turn to face a coyote, the coyote typically responds by backing away; however, when the cat flees, the coyote chases, making the cat vulnerable (pers comm). In fact, a study by Grubbs and Krausman (2009) found that in 32 cat-coyote interactions, 19 resulted in cat death. Has domestication altered cat behavior designed to

reduce behavior toward humans and other pets had consequences that has resulted in a lack of defense behavior when faced with a predator?

Little work has been done on cat temperament and behavior when compared with other domesticated species and even some species of wild animals (Ha and Ha 2017). However, the few studies that have been conducted indicate that cats have behavioral syndromes that include many traits, such as aggression and sociality with other cats (Ha and Ha 2017). Cats, in comparison to other domesticated animals, are often treated as solitary animals, living in isolation in their homes without the interactions given to other pets, particularly dogs with which we live as closely. However, if there are enough resources in their environments, feral cats often occupy social colonies that range in size from only a few individuals to larger colonies and engage in many social behaviors, such as grooming, playful interactions and sleeping in packs (Crowell-Davis et al. 2003). These interactions often influence personality traits and behavioral responses throughout the cat's adult life, especially when raised in social colonies (Crowell-Davis 2007). Thus, cats may learn defense behaviors from interactions with other cats, giving feral cats an advantage over domesticated cats in interactions with predators such as coyotes.

5. KEY INFORMANT INTERVIEWS

In addition to our examinations of coyote activity and scat contents, and preliminary efforts to understand cat behavior, we employed social science methods including key informant interviews. Interviews are an important method in any social-ecological project to establish an understanding of the human side of the issue. In this project, interviews were conducted in two ways: 1) informally through meetings, field visits, conference calls, and email exchanges, and 2) formally through an interview protocol developed by the CURes social science team, reviewed by the City of Long Beach, and approved by the Institutional Review Board at Loyola Marymount University.

During the first two years of the project, the research team engaged in a series of informal key informant interviews. This included ongoing contact with the City of Long Beach Animal Care Services and Parks staff; regular meetings with wildlife researchers from Cal State Long Beach, University of California Cooperative Extension, and the National Park Service; and meetings and site visits with representatives from the Long Beach Fire Station 19, the Jauregui Tree Nursery, El Dorado Nature Center, and the Cat Cove. These informal interviews allowed us to build knowledge about the study sites and establish trust in the community.

In Year 3 of the project, we conducted a series of formal interviews to better understand the perspectives of professionals that interact with coyotes as part of their work. Participants were chosen through purposive sampling, meaning that they were selected for certain characteristics. The criteria for sampling were that each interviewee had professional experience with coyotes in the City of Long Beach, and that the sampled group represented a variety of organizations, including those working in the realms of wildlife management, conservation and education, academic research, and community engagement. Given these criteria, we started with a list of 18 possible interviewees, and chose a total of six with whom to conduct interviews. Participants were from the City of Long Beach (Animal Care Services and El Dorado Nature Center), the National Park Service, California State University - Long Beach, and a Long Beach neighborhood council.

Five interviews were conducted in November and December of 2018, with six individuals (two participants were from the same organization). The interviews took approximately 30 minutes each and were semi-structured. That is, while each participant was asked the same set of eight predetermined questions, all questions were open-ended without a fixed range of responses. This allowed the interview to draw out both concrete information as well as more narrative experiences that may provide context to the management of coyotes in Long Beach. Each conversation was transcribed, and the transcripts were then analyzed using an established qualitative method of descriptive coding (Gibbs, 2007). Researchers reviewed the manuscripts multiple times to identify common repeating concepts found throughout the interviews, and developed a set of descriptive codes—short phrases that summarize the repeating topics.

There were five descriptive codes that best represented the primary concepts mentioned by interviewees when considering the challenges and opportunities related to wildlife management and public outreach surrounding coyotes in Long Beach. These were: 1) Positive or Unconcerned Citizens vs. Vocal Minority, 2) Concern for Pets/Kids, 3) Lack of Public Awareness, 4) Need for Education, and 5) Importance of Coexistence/Awareness. Figure 14 displays how those concepts were distributed among interviewees, which will be described further below.

	DESCRIPTIVE CODE				
INTERVIEWEE'S ORGANIZATION	Positive or Unconcerned Citizens vs. Vocal Minority	Concern for Pet/Kids	Lack of Public Awareness	Need for Education	Importance of Coexistence/ Awareness
Long Beach Animal Care Services	√	√	√	√	√
El Dorado Nature Center		√	√	√	√
Cal State Long Beach	√	√		√	√
Neighborhood Council	√	√	√	√	√
National Park Service	√	√	√	√	√

Figure 14. Primary concepts as mentioned by interviewees for the Long Beach Coyote Study.

1) Positive or Unconcerned Citizens vs. Vocal Minority

As shown, four of the five interviews included discussions about the concept of *Positive or Unconcerned Citizens vs. Vocal Minority*. The interviewees shared the view that most residents feel positively or neutral about coyotes in their city, which was expressed in statements such as: "a lot of people love them and think they're here to stay and we should work around them" and "I would say a vast majority of people are not horribly concerned about coyotes." However, the predominant positive or neutral sentiments are undermined by what was termed by several interviewees as a vocal minority: those who view coyotes negatively. As described by one participant, this vocal minority is "a small sect of people

that just think that, you know, coyotes are these evil creatures." This can present challenges to elected officials and other public employees who are charged with striking a balance between addressing the strong feelings of a few while still effectively governing for all residents.

2) Concern for Pets/Kids

There seemed to be consensus among all those interviewed that most negative feelings toward coyotes stemmed from residents' fear of the coyotes attacking small children, dogs, and cats, which was given the descriptive code *Concern for Pets/Kids.* As explained by an interviewee: "[People come in thinking] 'I'm scared this coyote is going to eat me. It's going to eat my children.'" Another participant described seeing evidence of a disemboweled cat in the neighborhood and attributing it to a coyote attack. These types of sightings, while not necessarily proof of coyote attacks, can raise public concern. This was highlighted in the following statement, "there's probably more people that feel negatively about coyotes than most other species because they might be having some conflict with them or scared of them or losing pets to them."

3) Lack of Public Awareness

Four of the five interviews mentioned *Lack of Public Awareness* as a challenge to managing urban coyotes. This was expressed directly by one interviewee, who said "I think the biggest challenge with urban wildlife just in general is lack of knowledge with the animals." Several described how unlikely it is that coyotes will attack children, and the low risk of them attacking pets, especially if proper precautions are taken. One stated, "cats and dogs are not their favorite food." Another talked about how certain typical coyote behaviors may be misconstrued as threatening.

Participants believed that in some cases, the issue is not a lack of information as much as the spread of misinformation. When asked how frequently residents hear about coyotes, one participant said: "It kind of comes in waves, it's like, in my opinion, urban myth. Kind of gets promulgated and goes through the cycle. You know, through NextDoor, neighbors talking about it, or it gets in the paper." The power of information sharing (or misinformation sharing) through social media was something highlighted by several of the interviewees. One interviewee said that a big challenge was with people who share as truth "what they might have heard somewhere or read somewhere" and that this misinformation becomes accepted as what is actually happening. City officials and other wildlife professionals are then tasked with addressing the lack of information as well as changing public opinions that may have been formed around misinformation. A participant emphasized this, stating: "The dissemination of accurate information is a very tough challenge for Long Beach."

4) Need for Education

Related to the lack of public awareness, all those interviewed discussed a *Need for Education* to help the public better understand coyote behavior and ecology. One said, "Once you explain [to residents] the way their ecology is and that they work and replace themselves, and transient coyotes and all of that, they kind of realize that they're not going away." Others stressed the importance of helping people "learn how to protect their pets" and "trying to teach people how to be good neighbors with urban wildlife."

Participants also talked about some of the opportunities and challenges to educating the public. A few suggested conducting targeted outreach with children—with one interviewee putting it this way: "If you educate the kids about this sort of stuff then they can educate their parents." Other ways to educate that were discussed were public talks, meetings, and forums. One interviewee recognized the resource challenges to education: "lots of city governments, state governments, and you know, everywhere, don't have the money for education." Another described the need to conduct outreach that is tailored for specific audiences, as it is unlikely that one approach will affect all residents in the same way. As one participant stated: "I think the challenge is trying to develop arguments that will hit home for them and change minds."

5) Importance of Coexistence/Awareness

All interviews included a discussion of the *Importance of Coexistence/Awareness* related to coyotes living in close proximity to humans. A few of the interviewees talked about the historical context of coyotes, with one stating: "There basically have been coyotes in Los Angeles as long as there's been a Los Angeles." Another described the importance of coexistence bluntly: "It's just something that people are going to have to learn how to live with, because they're not going away. Not any time soon."

Several identified the value that humans receive by coexisting with coyotes in urban environments; in particular, the removal of other nuisance wildlife. One participant explained: "[Coyotes] provide some benefits too – as it is, we do get complaints about too many raccoons, or too many skunks, or too many possums. I'm like 'you think it's bad now – if we were to get rid of all the coyotes, that would explode.'"

Most of the interviewees saw an opportunity to raise awareness about better ways for residents to live with coyotes in cities, and to reduce the conflicts between them. As one said: "I think with knowledge and interactions with animals… I think that's where there's more understanding and therefore more tolerance."

These interviews provide some insight into the challenges and opportunities facing professionals in the City of Long Beach in the management and public education surrounding urban coyotes. While the interviews were largely designed to help shape development of the survey of the public (Section 6), we report them here because the findings can be useful on their own.

The themes of the interviews largely point to a need for a public educational outreach strategy to be incorporated into any management efforts. This is supported by research in other cities. Changing public attitudes is one part of the challenge: Draheim et al. (2013) found that personal attitudes towards a species contribute to the approval or disapproval of the species' presence; people who fear animals are less likely to support their presence in an urban environment. As one possible solution, a study in Portland (Rasmussen, 2015) concluded that educational tools can be effective for providing information and shaping attitudes about urban coyotes, and that increased public access to education about how to live safely with coyotes is an important tool for proactive management.

However, it is important to determine what types of education may be most effective. For example, one study of human sentiments toward urban coyotes in North Carolina found that "connection to coyotes had the greatest effect on predicting coyote perceptions, suggesting efforts to promote positive

emotional connections to wildlife may be a better way to increase acceptance of carnivores in urban areas than focusing on biological knowledge" (Drake et al., 2020).

Thus, there is likely not a one-size-fits-all educational strategy surrounding urban coyotes. We would recommend a combination of educational outreach strategies, including incorporating coyote curricula as part of K-12 education (Section 7). Rasmussen (2015) also found that online educational tools associated with citizen science projects are a viable option for efficient, inexpensive management of urban coyote populations. The City of Long Beach may consider enhancing existing outreach activities, such as increasing and promoting the programs and resources at the El Dorado Nature Center and/or through Animal Care Services to include more coyote-related education and possibly citizen science efforts.

6. SURVEY OF RESIDENTS

In Year 3 of the project, a social survey was conducted with residents in the City of Long Beach. CURes researchers developed a short questionnaire to assess public knowledge and perceptions of, and interactions with, coyotes. Demographic questions were also asked to determine how well respondents represented the population of Long Beach. The questionnaire was informed by survey instruments in previous studies (for example, Lawrence and Krausman, 2011; Elliot et al., 2016), the input of both ecologists and social scientists on the research team, and the information gathered in Years 1 and 2. The survey design and implementation were approved by the Institutional Review Board at Loyola Marymount University.

A mail survey was sent to a randomly selected subset of Long Beach residents. This was chosen as the best method to reach a broad swath of the population of the City. To do this, data were acquired from the LA County 2018 Tax Assessor Parcel Database (County of Los Angeles, 2019). Property information was extracted for residential parcels in the City of Long Beach, excluding vacant parcels. This produced a list of 96,379, comprising both multi-family (17,093) and single family (79,286) residences. The number of units across multi-family residences equaled 89,144. Thus, single family (79,286) + multi-family (89,144) addresses totaled 168,430, which closely aligned with 2013-2017 Census estimates of 165,001 households in Long Beach. The RAND() formula in Microsoft Excel was used to produce 5,000 randomly selected addresses. This number was chosen in anticipation of an 8-10% response rate, as is typical in mail surveys. A return of 384 surveys was desired to meet established population representation standards (Krejcie and Morgan, 1970).

The survey was sent along with an introductory letter and a self-addressed, postage paid return envelope on May 13, 2019 (see Appendix for survey materials). Recipients were given three weeks to complete the survey. Of the 5,000 sent, 255 were returned undeliverable, bringing the total sampled population to 4,745. Of these, 347 responses were received (7.3% response rate).

Knowledge and Perceptions of Coyotes

Survey respondents were asked five multi-part questions about their knowledge, perceptions, and interactions related to coyotes.

Please indicate how strongly you agree or disagree with the following statements.

Table 2. Responses to survey statements regarding coyotes in Long Beach.

Statement	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
A. I think about coyotes in my neighborhood often. (N=341)	29%	32%	6%	24%	9%
B. I see coyotes in the way I see raccoons, opossum, and skunks. (N=343)	22%	32%	8%	27%	11%
C. I have an understanding of coyote behavior. (N=337)	15%	14%	25%	37%	9%
D. I believe that coyotes should be allowed in the City of Long Beach. (N=344)	22%	18%	31%	20%	9%
E. I am aware of where coyotes live and travel in the City. (N=341)	13%	18%	18%	40%	11%
F. I have heard about the City's coyote management activities. (N=343)	32%	33%	19%	14%	2%
G. I believe that coyotes and humans can live in the same places. (N=342)	17%	16%	25%	30%	11%
H. I am satisfied with the City's coyote management activities. (N=342)	11%	10%	71%	6%	2%

As shown in Table 2, respondents were asked to indicate their agreement to a number of statements (A-H) regarding their perceptions and knowledge of coyotes in the City of Long Beach.

A. One-third (33%) of respondents agreed or strongly agreed with the statement "I think about coyotes in my neighborhood often."

B. The majority (54%) of respondents disagreed or strongly disagreed that they "see coyotes in the way I see raccoons, opossum, and skunks."

C. While 46% agreed or strongly agreed that "I have an understanding of coyote behavior," over half of respondents disagreed or were not sure.

D. Forty percent (40%) disagreed or strongly disagreed with the statement "I believe that coyotes should be allowed in the City of Long Beach." Another 31% of respondents were not sure, and 29% agreed or strongly agreed.

E. Approximately half (51%) agreed or strongly agreed that they were "aware of where coyotes live and travel in the City." The remaining 49% of residents strongly disagreed, disagreed, or were not sure.

F. A large majority (74%) of respondents strongly disagreed, disagreed, or were not sure if they had "heard about the City's coyote management activities."

G. Most respondents either agreed or strongly agreed (41%) or were unsure (25%) about the statement "I believe that coyotes and humans can live in the same places." Another one-third (33%) of respondents disagreed or strongly disagreed.

H. The large majority (71%) of survey respondents were unsure about the statement "I am satisfied with the City's coyote management activities." Another 21% disagreed or strongly disagreed, and only 8% agreed or strongly agreed that they were satisfied.

Have you encountered any coyotes in your neighborhood? N= 346

Results show that 59% of respondents (204 total) reported encountering coyotes in their neighborhood.

> **If so, how many times?** Of those who had encountered coyotes, there was an average of 4 encounters per person.
>
> **When was your last encounter?** There were 179 respondents reporting the dates of their last encounter with a coyote, spanning December, 1995 to June, 2019. However, most (156) of the encounters were reported in the past three years (2016-2019), with 57 encounters reported as occurring in the previous six months (January-June, 2019).
>
> **Which of the following best describes your encounter(s)? (Check all that apply)**
>
> - Sighting only = 182
> - Coyote threat to another animal/pet = 28
> - Coyote injury to another wild animal/pet = 10
> - Coyote killing of another wild animal/pet = 41
> - Dead Coyote = 6
> - Coyote threat to human = 10
> - Coyote injury to human = 0
> - Coyote killing of human = 0
>
> Most encounters were a coyote sighting only, though there were reports of a coyote killing, threatening, or injuring another wild animal/pet. A very small number reported a coyote threat to a human, and even fewer reported encountering a dead coyote.

Do you know anyone else who has encountered a coyote(s) in your area? If so, approximately how many people? N= 343

Results show that 60% (206 total) of respondents reported knowing other people who have encountered coyotes. Of the respondents who reported knowing other people who encountered coyotes, the average number of other known people was 6.

Do you have any of the following pets? (Check all that apply) If so, do you have concerns about coyotes and the safety of your pet(s)?

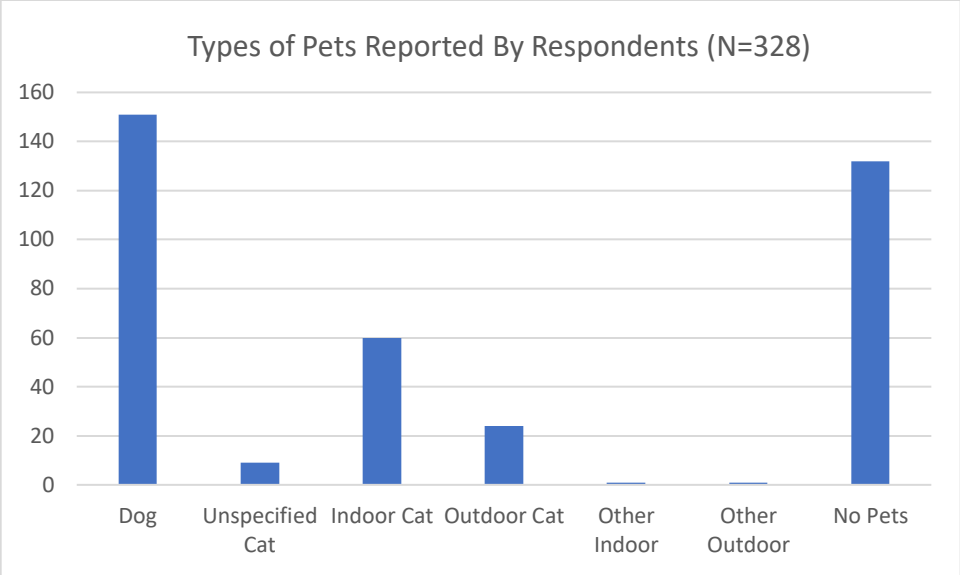

Figure 15. City of Long Beach Coyote Survey respondents reported the types of pets they have at home.

As shown in Figure 15, most respondents reported either having a dog at home (46%) or having no pets (40%). Much smaller numbers reported having an indoor (18%) or outdoor (7%) cat. The majority of pet owners (59%) reported having concerns about coyotes and the safety of their pets.

Do you have children living at home with you? Do you have concerns about coyotes and the safety of your children? What is the age of your youngest child (in years)? N= 341

25% of respondents report having children living in their homes. Of these individuals, 46% have concerns for the safety of their children. The average age of the youngest child is 10.4 years.

Demographic Responses

Residents were asked questions about their age, length of residency in Long Beach, homeownership status, ethnic and racial identities, income, and education. This information is reported below in Table 3, alongside citywide data reported by the U.S. Census Bureau (2018).

Table 3. Comparison of Survey Responses to Demographic Data from the 2017 American Community Survey (ACS) 5-Year Estimate of Long Beach, Calif.

Subject	This Survey	ACS Data
SEX AND AGE		
Total population	335	346,764*
Average age	56.8 years	45.1 years
HOUSING		
Households	338	165,001
Owner-Occupied	81%	40.0%
Renter-Occupied	19%	60.0%
RACE		
Total population	336	470,489
White	62.8%	56.0%
Black or African American	4.5%	14.5%
American Indian and Alaska Native	1.5%	2.3%
Asian	7.1%	15.0%
Native Hawaiian and Other Pacific Islander	1.2%	1.5%
Some other race	5.3%	15.8%
Prefer not to answer	17.4%	n/a
HISPANIC OR LATINO AND RACE		
Total population	328	470,489
Hispanic or Latino (of any race)	11.6%	42.8%
Not Hispanic or Latino	68.0%	57.2%
Prefer not to answer	20.4%	n/a
INCOME IN THE PAST 12 MONTHS		
Total Population	235	157,591**
Average income	$102,787	$61,425
EDUCATIONAL ATTAINMENT		
Total Population	332	309,217***
Some High School	0.3%	20.2%
High School Diploma or GED	5.1%	18.7%
Some College	20.5%	23.7%
College Degree	44.0%	26.7%
Graduate or Professional School	30.1%	10.8%

*Total population for age was calculated from ACS data for respondents 20 years and over

**Total population for income was taken from the ACS category, “Full-time, year-round workers with earnings”

***Total population for educational attainment was taken from the ACS category, “25 years and over”

Discussion

As shown in Table 3, responses to the demographics questions showed that the residents that chose to take the survey were on the whole older, more likely to own their homes, more likely to be White and less likely to be Hispanic or Latino, earning higher income, and had attained a higher level of education

than the average Long Beach resident. It must be noted; however, that many respondents chose "prefer not to answer" for several of the demographic questions.

The results from the remainder of the survey provided insight into survey takers' interactions with, perceptions of, and self-reported knowledge about coyotes in Long Beach. While the majority of respondents did not report thinking about coyotes often, one-third did agree that they think about coyotes often. This was further supported by a majority (59%) reporting that they had an encounter with a coyote, though most of these were reported as "sighting only," and only about 16% reported having an encounter with a coyote in the last six months. Still, there were a number of respondents that reported encounters with coyotes that involved threat (8% of respondents), injury (3% of respondents), or killing (12% of respondents) of another wild animal or a pet. The majority (59%) of pet owners and nearly half (46%) of respondents with children at home were concerned about coyotes and the safety of their pets or children. These findings indicate that coyotes are on the minds of many Long Beach residents, and that pet owners and people with children at home have high levels of concern regarding the threats of coyotes.

While the survey did not directly test respondent knowledge of coyote behavior or activities, about half of the respondents self-reported that they understand coyote behavior (46% agreed) and that they are aware of where coyotes live and travel in the City (51% agreed). This was not expected, as past research has shown that the general public is not typically well informed about urban coyotes. For example, a previous survey of LA County residents found that knowledge of coyote ecology, behavior, and how to react to a coyote encounter was extremely poor, irrespective of the respondents' attitude toward wildlife in general or coyotes in particular (Elliot et al, 2016). Residents that believe they know how to respond to urban coyotes may be more likely to conduct activities that further attract coyotes. They may also be more likely to spread misinformation, as was the concern among some of the interviewees from this study (Section 5). This suggests a need for education for the majority of the population. The City may consider implementing a future follow-up questionnaire that asks participants more specific questions about coyote ecology and behavior. This would identify areas of particular lack of awareness or misunderstanding among the public, which would help in developing targeted outreach materials.

The majority of respondents (54%) did not agree that they see coyotes in the same way that they see raccoons, opossums, and skunks. Other research has shown that residents enjoy seeing wildlife in their neighborhood (Baker and Harris, 2007; König, 2008; Mankin et al., 1999), but this sentiment may not extend to seeing coyotes in the neighborhood (Elliot et al., 2016). Indeed, a sizeable portion of those responding believed coyotes should be kept out of the city, as indicated by 40% disagreement with the statement "I believe that coyotes should be allowed in the City of Long Beach" and 33% disagreement with the statement "I believe that coyotes and humans can live in the same places." Given what is known about urban ecosystems and coyote population dynamics, it is nearly impossible to eradicate coyotes from a given location. Even if it was possible, it is not desirable, as removal of one species would have cascading effects on the ecosystem.

It did seem clear that there was not broad understanding of the City of Long Beach efforts to manage coyotes. A large majority (74%) of respondents strongly disagreed, disagreed, or were not sure if they had "heard about the City's coyote management activities." Additionally, the largest single response

category was “unsure” in response to the statement: “I am satisfied with the City’s coyote management activities.” This lack of public awareness as well as the overall lack of concurrence seen across the responses to the agree/disagree statements presents both a challenge and opportunity for the City of Long Beach. It reveals a need to raise public awareness regarding the City’s efforts (including the results of this report), which may also provide opportunities to educate residents about coyote behavior and how they can change their own human behavior.

These survey results support the findings and conclusions from the key informant interviews (Section 5). Ultimately, there is a need for accurate and consistent information about urban coyotes. One example of how a city approached this issue is the Co-Existing With Coyotes Project (CWC) in Vancouver, Canada. As described by Worcester and Boelens (2007), this multifaceted approach was developed to “reduce conflict between coyotes, pets, and people by providing information to both targeted and general audiences as well as providing a direct response to individual coyotes that are starting to, or are displaying, behavior of concern. The general public is reached through an information phone line, the distribution of brochures and posters, website resources, and permanent signs in parks and green spaces. Specific audiences are taught through the ‘Coyotes 101’ school program, interpretive walks, and presence at public events. Program staff coordinate with public agencies to locate, evaluate, and use non-lethal deterrents whenever possible with problem coyotes. The CWC program has played a key role in reducing conflict between people and coyotes in the greater Vancouver area.” The CWC is a program of one non-profit organization, the Stanley Park Ecological Society; however, they receive funding from and work closely with city and province government agencies to implement the effort. The City of Long Beach may consider a similar approach, involving municipal and non-profit partners. The environmental stewardship database developed for this project (Section 8) could be a starting point for building a coyote outreach and education coalition, and the curricula created (Section 7) could form the foundation of both formal and informal educational efforts.

7. K-12 EDUCATION CURRICULA

University Student Engagement

Throughout the project, educational strategies and materials were developed and piloted through LMU’s on-campus coursework and guest lectures. Materials incubated in the campus environment become the basis for formal curriculum development. The work being conducted in Long Beach was integrated into courses being taught by CURes faculty and staff as a model for the integration of students in the Long Beach Unified School District.

In these courses, CURes faculty and staff presented information on the coyote research being conducted for the City of Long Beach and engaged students in discussion. Students learned about the physical and behavioral characteristics of coyotes, as well as the challenges faced by cities such as Long Beach, where coyotes, humans, and other animals (wild and domestic) must coexist.

In the 2018-2019 academic year, students in LMU’s Urban Ecology course had the opportunity to go on a field visit to the Jauregui Nursery, to learn first-hand about the Long Beach Coyote Project, including about coyote habitat and diet, the complex issue of cohabitation with humans, impact of coyotes on the environment, and the field equipment being used to monitor coyotes in Long Beach. LMU students

modeled activities that will be available to Long Beach Unified School District students as part of the curriculum.

Urban Wildlife Curriculum

Throughout the project, LMU CURes worked to develop appropriate urban ecology curricula to be used in K-12 schools to help students understand their role in the ecosystem and how that may relate to the coyote's role in the ecosystem.

The module is available here:
https://academics.lmu.edu/cures/partners/k12teachers/urbanecolab/module12/.

For this project we created a new module for Urban EcoLab, which is a free, on-line, open-access high school urban ecology curriculum. We have developed Module 12: Urban Wildlife, an entire interactive 20-lesson module for the City of Long Beach to incorporate into middle or high school curricula. This module was developed to be locally relevant to students in Long Beach, utilizing our coyote research as part of the content, which will help promote learning about and adapting to life with coyotes in Southern California. Relevant, subject-matter core Next Generation Science Standards (NGSS) were identified for Grades 9-12, and lessons and activities are on such topics as coyote ecology, genetics, behavior, competition for resources such as food and space, and the complex challenge of coyote-human coexistence. A Standards Alignment Chart has been created, and additional extended project ideas have been developed for this curriculum (see Appendix for materials). The completed curriculum materials may be brought to high school science teachers at the Ernest McBride High School in Long Beach, which is directly adjacent to Study Location 2 at the Jauregui Nursery, if Covid-19 restrictions allow.

The materials for Module 12 were created by CURes staff in close collaboration with local teachers. We integrated discussion and workshopping of the project into CURes' monthly Teacher Academy and the annual Summer Institutes that took place in the first two years of this project. Teachers were instrumental in providing ideas for curriculum and activities to teach middle and high school students about the ecology of wild animals like coyotes, that coexist with humans. Teachers then brought these ideas and information back to their classrooms for learning and discussion. Following the piloting of these curricula with the CURes cadre of teachers, the aim was to conduct a teacher workshop with interested teachers from Long Beach Unified School District. This was put on hold and can be implemented at a time and location to be identified with project partners when it is safe to enter the classroom or appropriate to deliver remotely.

8. INVENTORY OF ENVIRONMENTAL STEWARDSHIP ORGANIZATIONS

Stewardship Mapping is an established method to assess environmental stewardship groups in a given geographic region. These groups can represent non-profit, public, or private sector. The intent of developing a stewardship database is to provide a complete view of environmentally relevant capacities for the region. Developing relationships, collaborating, or leveraging capacity with these organizations can be beneficial for implementing policies and conducting outreach related to coyote management.

Researchers produced a list of 64 organizations (Table 4) in Long Beach that were identified as conducting environmental stewardship activities. For this project, an environmental stewardship organization was defined as one that works in the City of Long Beach to "conserve, manage, monitor, advocate for and/or educate the public about their local environments." Information was compiled for

all 64 organizations, including organizational type, mission, contact information, and geographic location.

We found that environmental stewardship is being conducted by organizations from all sectors, with 52% (33 organizations) representing the non-profit sector, 42% (27 organizations) representing the public sector, and just 6% (4 organizations) from the private sector. Of the non-profit sector groups, most (27 organizations) were 501(c)(3) designated organizations. Of the public sector, most were local city or county agencies (6 organizations) or City of Long Beach public schools (14 organizations), while the remaining 7 public entities were state or federal agencies, public universities, and a Joint Powers Authority. The large majority (84%) of the organizations were actually located in Long Beach, with the others located in Azusa, Calabasas, Commerce, Irvine, San Pedro, Seal Beach, Torrance, and a few with unknown locations.

The full Long Beach stewardship organization database is included as an Appendix to this report. In addition, 82 neighborhood associations were identified as catalogued by the City's Neighborhood Resource Center (http://www.longbeach.gov/lbds/hn/resource-center/neighborhood-groups/), which can serve as a supplementary resource.

Table 4. List of Long Beach environmental stewardship organizations.

Adventures to Dreams Enrichment	Everest International	Los Cerritos Wetlands Stewards, Inc.
Aquarium of the Pacific	Friends of Colorado Lagoon	Mckinley Elementary School
Audubon Society, El Dorado Chapter	Friends of Long Beach Animals	Moffatt & Nichol, Long Beach Office
Barton Elementary School	Garfield Elementary School	National Park Service, LA Urban Coyote Project
Boys and Girls Clubs of Long Beach	Green Education Inc.	NOAA Fisheries Southern California Coast Branch
Burcham Elementary School	Herrera Elementary School	Our Lady of Refuge Catholic School
California Coastal Commission, South Coast District Office	Housing Long Beach	Partners of Parks
California Native Plant Society, South Coast Chapter	International Bird Rescue	Patrick Henry Elementary School
California State Senator - 33rd District	Jauregui Tree Nursery	Port of Long Beach
California State University Long Beach, Mammal Lab	Long Beach Alliance for Children with Asthma	Prisk Elementary School
Catalina Island Conservancy, Long Beach Office	Long Beach Community Action Partnership	Rebuilding Together Long Beach
Century Villages at Cabrillo	Long Beach Environmental Alliance	St. Anthony Elementary School
City Fabrick	Long Beach Forward	St. Luke's Teaching Garden
City of Long Beach, Animal Care Services	Long Beach Heritage	Starr King Elementary School
City of Long Beach, Department of Public Works	Long Beach Marine Institute	The Cat Cove
City of Long Beach, Parks, Recreation & Marine Dept	Long Beach Neighborhood Foundation	The Growing Experience
Colin Powell Academy for Success	Long Beach Neighborhoods First	Twain Elementary School

Community Action Team	Long Beach Nonprofit Partnership, Inc.	University of California Cooperative Extension
Cubberley K-8 School	Longfellow Elementary School	Urban Community Outreach
Don't Waste Long Beach	Los Cerritos Wetlands Authority	Webster Elementary School
East Yard Communities for Environmental Justice	Los Cerritos Wetlands Land Trust	Whittier Elementary School
El Dorado Nature Center		

9. SUMMARY & RECOMMENDATIONS

Extensive details with respect to recommendations are embedded in each of the sections of the report. We have attempted to summarize those recommendations here and hope they serve as a guidepost for your considerations and action.

Our recommendations include; 1) increasing specialized education for stakeholders with regard to reducing coyote risk, 2) implementing a suite of interventions at the individual parcel level that can decrease the potential threat from coyotes, 3) following a tiered response to coyote management with respect to documented incidences and 4) introducing a palette of strategies that can be applied to residential pet owners as they try to find a balance between pet safety and outdoor activities.

1. Increasing specialized education for stakeholders with regard to managing and reducing the risks from coyotes

The relationship between humans and coyotes is complex and dynamic, driven both by the differing attitudes people have about coyotes and the individual variation in the behavioral ecology of the coyotes they encounter. Our data, along with multiple other studies suggest that Southern California is experiencing novel, increased risk of domestic animal predation from coyotes. These relationships will continue to evolve in response to the management techniques applied to this dynamic system at all levels: regional, municipal, neighborhood and individual. The wildlife interventions are likely to change through time in response to the population structure of coyotes in Long Beach, their movement patterns and open space management policies enacted in Long Beach and surrounding communities. While a significant portion of residents sampled were aware of coyotes (51%) and self-reported that they understood some of their behavior (46%), there remains much to improve in the general understanding of coyote ecology and an effective management response to the challenge. Despite the efforts of the LB Wildlife Services, most residents (92%) were either unaware, unsure or dissatisfied with the existing formal coyote management plan.

Many cities utilize pre-made brochures from the Humane Society and Project Coyote (see Table 5 for a summary of U.S. city coyote plans). However, some plans include unique material produced by the cities themselves, which we recommend as many cities experience unique challenges with regards to their coyote populations, such as Long Beach experiencing higher than typically reported levels of cat in the coyote diet. The City of New Castle, NY, opened their management plan with this, which is an important acknowledgment given the conflict in southern California: "New Castle residents have formed deep emotional attachments to their pets and, as current and former pet owners ourselves, our Committee

grieves for animals that have been lost. These pets cannot be replaced, but in their memory we can formulate a responsible, sustainable public policy to prevent future coyote-pet conflicts and address concerns regarding human safety. To that end, we strongly believe that the most effective solutions to coyote-pet conflicts will be found through a dispassionate, objective, and scientific evaluation of our ecosystem, animal behavior and human behavior."

Even though many do not utilize the recommended branding, most at least have been placed on city-branded materials, even they reiterate the same information. Brochures include photos, basic coyote ecology, human behavior that leads to conflict, who to contact if you experience conflict, and tips to reduce conflict. These tips include:

- Remove all sources of food and water.
- Keep pet indoors at night and inspect the yard before letting them out.
- Maintain fences and trim vegetation.
- Install motion sensor lights.
- Don't approach or feed wild animals and teach children not to do so.
- Walk dogs on a short leash and carry a walking stick, pepper spray or noisemakers when walking at night.
- Don't turn your back on or run from a coyote.
- Don't let pets interact with coyotes.
- Close pet doors at night.
- Haze or harass coyotes observed in your neighborhood and alert neighbors to sightings so they will know to do the same.

Based on what we have learned in our survey of residents and key stakeholders, it appears that we can do more to make residents aware of ways in which they can reduce conflict with coyotes, and we believe that begins with education.

As such, on-going sustained education efforts are likely critical in establishing and then maintaining a successful coyote management plan in Long Beach. These efforts include formal programs in the public and private schools, plus informal programs at the community level and within the neighborhoods. The tools for these interventions include the formal school curriculum that we have developed, the backyard coyote safety survey and sustained public information outreach similar to the efforts already underway in Long Beach.

Long Beach Wildlife Services, in collaboration with other parts of City government, have already taken a leadership role in the effort to educate local stakeholders. An active website, a digital map of incidences and a reporting system contribute to a measured monitoring and response system that is poised for future success. However, the implementation of the additional programs requires a dedicated effort through municipal staff, or an organization working in close collaboration with the City. Often, the education programs can be part of a local NGO public effort or the outreach mission of a local university extension program. These tools can be modeled in schools and community outreach programs, and can be used to empower local teams to serve as educators.

Table 5. Review of coyote management plans across the United States and which key components each utilizes.

City	Brochures	K-12 Education	Plan: Tiered Response	Backyard Assessment	Hotline	Hazing Guidelines
Anaheim, CA	X	X	X	X	X	X
Atlantic Beach, FL	X		X	X	X	X
Austin, TX	X		X		X	X
Brea, CA	X		X	X	X	X
Broomfield, CO	X		X		X	X
Calabasas, CA	X				X	X
Castle Pines North, CO			X		X	X
Centennial, CO	X	X	X			X
Cherry Hills Village, CO	X					X
Chicago, IL	X			X		X
Costa Mesa, CA	X		X	X	X	X
Cypress, CA	X		X	X	X	X
Davis, CA	X	X	X			X
Denver, CO	X		X		X	X
Fountain Valley, CA	X	X	X	X		X
Glendale, WI	X		X	X		X
Huntington Beach, CA	X	X	X	X	X	X
Long Beach, CA	X	X	X	X	X	X
Milwaukee, WI	X		X	X		X
Mount Pleasant, SC	X	X	X		X	X
New Castle, NY	X		X		X	X
Newport Beach, CA	X	X	X	X	X	X
Palos Verdes Estates, CA	X	X	X	X	X	X
Riverside, IL	X		X		X	X
Rosemead, CA	X		X	X		X
San Dimas, CA			X	X		X
Seal Beach, CA	X	X	X	X	X	X
St. Paul, IL						X
Superior, CO			X		X	
Torrance, CA	X		X	X	X	X
Vancouver, BC	X	X	X	X	X	X
Wheat Field, CO	X		X		X	X
Wheaton, IL	X		X		X	X
Whittier, CA	X		X	X		X
Yorba Linda, CA	X		X		X	X

While some plans mention contracting wildlife or conservation agencies to provide educational materials to schools (see Table 5), only Vancouver actually has such materials to which it refers. This consists of a 30-minute auditorium presentation and materials that can be sent to the school and used either in conjunction with the presentation or at the teacher's discretion. The program focuses on teaching students and their parents how to identify coyotes, understand coyote behavior, respond to coyotes and keep their yards/schools free from coyote attractants. Activities include making your school and yard free from coyote attractants, developing a coyote action plan, and making your own noisemakers for deterrents. We have developed an entire interactive 20-lesson module for the City of Long Beach to incorporate into middle or high school curriculums, which will help promote learning about and adapting to life with coyotes in Southern California.

2. Implementing a suite of interventions at the individual parcel level that can decrease the potential threat from coyotes

The conflicts that humans have with coyotes typically involve resources coyotes need, such as food, or perceived competition coyotes intuit from access to those resources. This can result in coyote aggressive behavior, predation on domestic pets as food, and attacks on domestic pets as perceived competitors. On rare occasions, coyote attacks can also be directed at humans. All of these outcomes range from unwelcome nuisances to tragedies. Most are avoidable through changes adopted by homeowners in their immediate vicinity.

Dietary studies in Los Angeles have revealed that resources other than live prey are luring coyotes into neighborhoods. Larson et al. (2020) revealed that urban coyotes are getting around 75% of their diet from anthropogenic sources, including pet food left outdoors, trash and fruit, such as citrus and figs. Thus, to gain a further understanding of what is attracting coyotes into urban areas, researchers at Loyola Marymount University have developed a coyote risk assessment survey for residents to determine how attractive their yard is to coyotes (see Appendix). This survey is currently being piloted in Culver City in areas of both high and low coyote density to understand differences in how residents are using their lawns in each area. Residents who are concerned about attracting coyotes should pick up all fruit in their yards, feed/keep pets indoors, increase fence heights to at least 7 feet (preferably with coyote rollers), and properly secure trash and composting piles. While no cities are currently offering assessments, some web sites do have self-audit backyard assessments. Our assessment includes observing the size and security of fences, pet food, water sources, unsupervised pets, bird feeders, composts, fruit trees and unsecured trash. In addition to the categories included in our assessment, some cities suggest cleaning up around barbecue grills after each usage and restricting areas under out-buildings where coyotes could hide. However, as mentioned above, these are all self-reported rather than objective and are not being used to collect data for the purposes of understanding human behavior in coyote-heavy neighborhoods. Integrating scientifically-monitored studies will help cities track which factors may be leading to increased coyote presence and improve education materials in attempts to reduce them.

With the help of our backyard survey, homeowners can learn what elements of their property create the highest risk of coyote nuisance visitation. Some elements are obvious, such as leaving out pet food, human food waste or water. Others may be less obvious to the homeowner, such as fruits or other agricultural resources that coyotes consume. Removing these resources will dramatically reduce the motivation for coyotes to visit. If those resources are absent, and occasional visit by a coyote goes unrewarded and unlikely to be repeated. However, even an occasional reward from the yard will likely encourage a coyote to return over and over again. The key element of success in reducing human coyote conflict here, is to make sure that the resources are absent prior to the first visit. Interventions such as coyote rollers and other physical barriers around the yard are often used after the basic management strategies for resources have failed to be enacted.

Domestic pet management is an obvious and critical component to successful amelioration of human coyote conflict. If domestic animals are indoors, they are almost completely immune to aggression from coyotes. This is perhaps the area of most variation in human attitude about their relationship to, and

attitude about, coyotes. Pet owner attitude about the degree to which their pets are allowed outdoors varies considerably. There is an undeniable relationship between outdoor activities of pets and risk of coyote attack. While it is undesirable to many pet owners to keep cats and small dogs indoors, that risk of attack needs to be part the calculus that people do in both owning and managing their pets.

The risk to pets from coyotes is seasonal and peaks during the period of time that adults are trying to provide additional food for their juvenile offspring. The demand for protein is high, hunting occurs both day and night, and the risk to domestic animals increases. Typically, midsummer through fall is the window of highest risk in Southern California, although this varies considerably. For this reason, ongoing community monitoring will remain a critical feature of successful domestic pet management.

3. Following a tiered response to coyote management with respect to documented incidences

The City of Long Beach has already developed a system by which a tiered response to coyote aggression and conflict is managed. Although it may be tempting to remove and euthanize any coyotes that appear to be aggressive, that management plan is fraught with three significant problems. First, it is often difficult to identify which individual coyote is involved with the aggressive behavior. A recent human attack in Orange County in the Spring of 2020 illustrates this problem. In this instance, a person was bitten and two male coyotes were captured and euthanized. Only later was it revealed that they could not have been the aggressors as forensic analysis revealed the bite was delivered by a female coyote. Second, when a coyote family is disrupted and an adult is removed, that territory is likely to collapse and be reoccupied by one or more expanding coyote families. This has the effect of increasing the local population density which may further intensify the conflicts occurring in the neighborhood. Third, lethal wildlife management policies have significant ethical issues that are often left unaddressed.

With that in mind, lethal removal of coyotes should be used only as a last resort. Other interventions should be tried and the overall management response needs to be scaled to meet the degree of severity and risk experienced by humans. Overall, the presence of meso-predators such as coyotes in urbanized areas is generally a positive ecosystem service and likely serves to reduce human risk to zoonotic disease. Therefore, the management interventions need to strike a balance so that the positive benefits of resident coyotes can be enjoyed by the human community with the negative aspects managed with clarity of intent.

It is important to note that none of the plans in Table 5 have lethal measures in their policies unless coyotes are aggressive toward humans or pets in the presence of humans, with the exception of Torrance, CA, which authorizes seasonal trap and kill methods for reducing populations. In fact, Austin, TX, has made it illegal to kill coyotes, declaring itself a no-kill city. In the state of New York, if a coyote kills a pet, cities refer the citizen to a private trapper and expect the citizen to cover the cost of any attempted removal expense. Figure 16 is an example from the New Castle, NY, management plan of an infographic that explains these problems. We recommend similar education to help the public understand why lethal measures are not a viable solution.

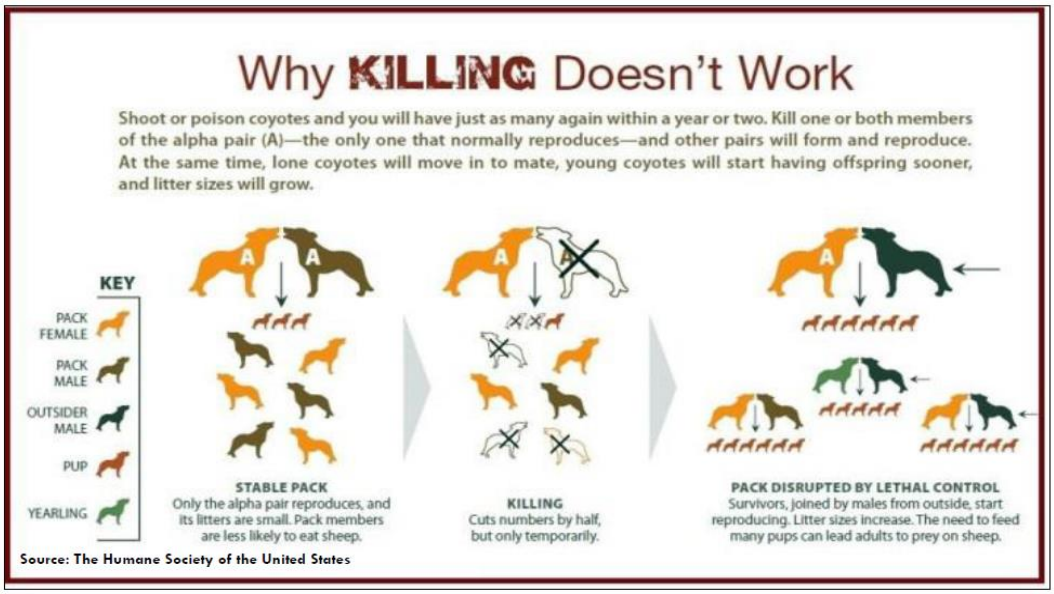

Figure 16. Infographic about the problems associated with lethal removal of coyotes.

Though lethal removal is often thought of as a last resort, a team of researchers in Austin, Texas, has developed a model that provides a more quantitative method to rank problem coyotes (Farrar 2016). The team kept geo-location data on all coyote sightings and ranked them based on behavior displayed by the coyote with aggression toward an adult human during the day being the highest score. They then asked residents to rank their tolerance of certain behaviors. Coyotes that violated any of these behaviors were mapped onto an area, and those areas were then targeted for heavier management plans. The Center for Urban Resilience has begun a similar model in the City of Culver City, where cat behavior has been labeled of top public concern. We are currently mapping all coyote sightings (blue dots in Figure 17) and distinguishing pet kills (red dots in Figure 17) and then targeting those areas for more intense management programs, including radio telemetry of coyotes in high kill areas. Moving forward this may be the best way to use both camera trap data and citizen science reports to improve coyote management plans.

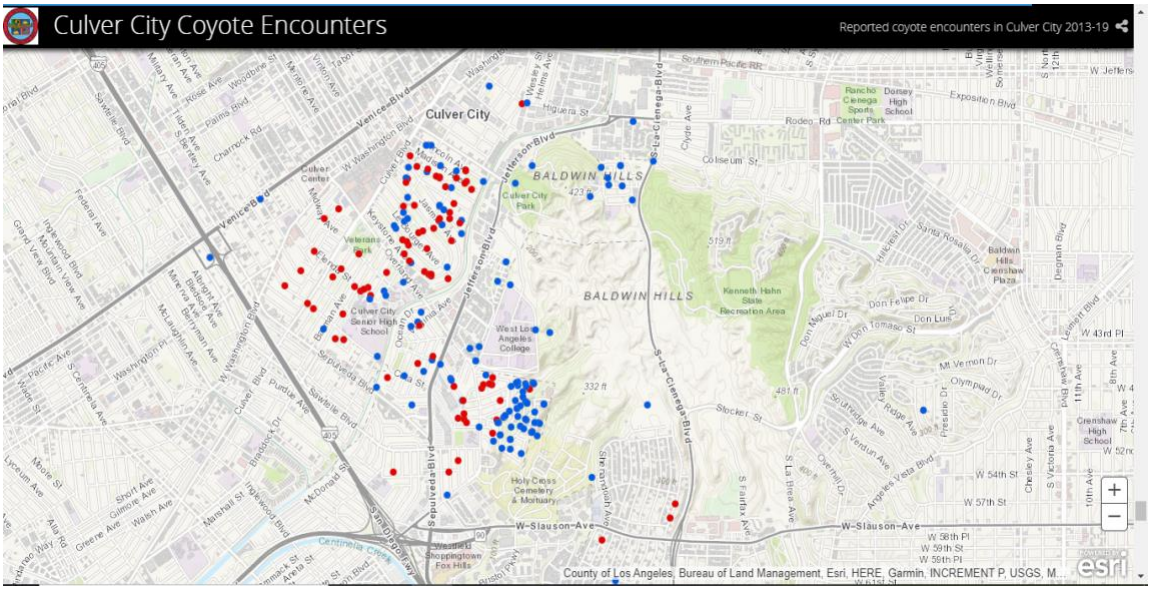

Figure 17. A map of coyote sightings in the City of Culver City with the blue dots denoting coyote sightings and the red dots representing pet kills. The data is collected by the city and mapped by researchers at Loyola Marymount University each month.

4. Introducing a palette of strategies that can be applied to residential pet owners as they try to find a balance between pet safety and outdoor activities.

Individual management of human-coyote risk remains one of the most effective tools in ameliorating coyote aggressive behavior around a resident's house and activity area. Interventions include: 1) removing food resources from coyote foraging areas, 2) isolating domestic pets from areas of coyote activity, 3) actively hazing coyotes when observed on, or near the property, and 4) carefully recording and reporting all coyote sightings to appropriate officials.

Removing food resources is a critical part of reducing unwanted coyote visits to a yard or local neighborhood. Coyotes maintain large activity areas and may move a dozen miles of more in a single night. If their attempts to gather food resources from the immediate area are unsuccessful and met with low key hostility in the form of hazing, this can significantly reduce the probability of a return visit. This effect is multiplied when all neighbors practice the same plan. Combined efforts to deny foraging coyotes food resources will cause them to shift their hunting patterns to the more fruitful areas of their range. As a result, the natural food resources of coyotes, such as small mammals, may become a more extensive part of their diet. These prey species are most likely found in the most highly vegetated areas in the peri-urban areas – away from residential property.

The results of the scat analysis, and research gathered from other studies in the area, point to exciting directions for future research. First of all, as we continue to collect scat from other areas in Southern California, we find scat typically on more natural trails and in edge habitats rather than neighborhoods.

As coyotes typically have ranges between 5-13 km^2 (Gehrt et al. 2011) and are territorial, it is important to find a number of green spaces throughout a metropolitan area to get an array of samples. Larson et al. (2015) and Larson et al. (2020) likely found lower percentages of cat in coyote diet because of the large sample sizes gathered throughout San Diego and Los Angeles, respectively. In addition, the advance of DNA molecular analysis has added an additional dimension to studying scat: individuals can be identified from DNA found in scat (Mumma et al. 2016). Thus, in addition to finding DNA of prey consumed, which may not yield wildly different results given that coyotes consume a lot of prey hair, which can be easily identified under a microscope, researchers can identify which individuals are consuming which types of prey. Thus, if only select individuals are consuming cats, we can identify those individuals and target them for management programs. If only the individuals with high percentage of cat in their diets are removed, then the City could initiate hazing programs on coyotes that would occupy territories after other individuals are removed and prevent them from learning that cats can be a preferred food source.

Another future direction for scat analysis is identifying differences in gut microbiome in coyotes that consume cats as prey vs those that do not. Gut microbiome has been linked to behavioral differences in animals, such as anxiety and exploration (reviewed in Ezenwa et al., 2012), which may affect ability to respond to anthropogenic changes. In fact, a study on squirrels found that gut microbiota was related to stress responses and varied between urban and rural populations (Stothart et al., 2016). Consuming anthropogenic food sources may change coyote gut microbiomes in a way that changes behavior, either increasing or reducing anxiety behaviors, which could potentially change prey consumption behaviors. Researchers at Loyola Marymount University will be collaborating on a large captive coyote study that will identify behavioral differences in coyote populations based on diet and gut microbiome. We hope that this work will guide future studies that will allow us to uncover how diet affect behavioral differences in coyotes in Southern California in hopes of reducing future conflict.

Domestic cats and small dogs are at risk when the travel alone outside the home. The risks involve many factors, including exposure to zoonotic disease, being struck by a car, consuming poisonous bait or food, injurious encounters with other cats or domestic dogs, and lethal encounters with coyotes. While each of these particular risks vary with location, ecological conditions and various municipal policies, the focus of this report is the role that coyotes play in local community. We cannot stress enough that the safest place for suburban and urban domestic cats is indoors. Kittens raised as indoor cats adapt readily to that life and often avoid the risks described when cats venture outdoors. Especially with risk to attack from coyotes, no strategy works more effectively that keeping domestic cats indoors.

However, if a cat owner feels compelled to allow their cats outside, there are some strategies they can employ to reduce the risks of coyote attack. First, the cats should be let out during the day under human supervision. During daylight hours, the risk of coyote attacks is lower and the presence of humans reduces the likelihood that coyotes will approach. Second, domestic cats can be trained to walk on a leash or harness. The tethered connection provides the ability to control where the cats roam and allows rapid retrieval of the cat in dangerous conditions. This approach has become more common in urbanized communities.

Studying behavioral responses of domesticated vs feral cats in response to predators or larger conspecifics through boldness assays may allow researchers to uncover differences between populations. If this is the case, domesticated cats could potentially be trained to respond differently to predators that might reduce their risk of attack, at cat "hazing" technique. While no one has currently conducted these studies, the handful of studies on cat behavior reveal that early interactions during development, such as play with other cats (West 1974), can induce aggressive or defense behavior later in life (Adamec et al. 1980). Thus, future research should incorporate differences in domesticated and feral cat behavior and behavior modifications that owners could teach in order to help their cats defend themselves.

As coyotes increase use of urban areas, whether simply for traveling or for denning and hunting, humans must respond in a way that discourages from using habitat that puts humans and pets in danger. The typical recommendation when witnessing a coyote in close proximity to urban populations is referred to as 'hazing,' which consists of attempts to scare the coyote through verbal or physical action (Bonnell and Breck, 2016). However, success of this technique is variable. According to a study conducted by Baker (2007), hazing is only effective when coyotes are first seen in the neighborhoods. After they are already familiar with the neighborhoods, hazing may work for a few months, but coyotes will return to previous bold behavior. Therefore, it is important to begin hazing efforts as soon as coyotes are spotted in urban neighborhoods. Bonnell and Breck (2016) found that even when people were trained to properly haze, success ranged from the coyote fleeing to approaching the hazing human. This may depend on the behavior of the person or the temperament of the coyote. For example, if a coyote has previously found that a yelling human will not harm it, they may continue to ignore the hazing. A case study in Chicago showed that an aggressive coyote could be coerced into relocating through a hazing protocol, but the protocol lasted for several days and was conducted by coyote researchers (pers comm). Thus, any coyote management plan must include a massive community education component and willingness on the part of researchers and animal control to persistently haze problem coyotes if they cannot be removed from the area. Since coyotes who show reduced fear toward humans can pass these traits on to offspring (Schell et al. 2018), hazing programs are important for coyotes who frequent human-populated areas. Hazing plans include some or all of the following guidelines:

- Hazing should only be used when appropriate, such as when coyotes are in crowded areas with humans, approaching humans and their pets, or occupying human-populated areas during the day time.
- Hazing should begin aggressively as it is designed to startle the coyote. Coyotes may not react to hazing at first because they may not understand how to respond to humans, and may desensitize if the hazing efforts are too small initially and gradually increase.
- The more often a coyote is hazed by a variety of people in a variety of ways, the more effective hazing will be. Coyotes can recognize people and learn to avoid only certain individuals.
- The coyote must understand that hazing is coming from the human, so the hazer must be visible to the coyote.

- Hazing can take the form of aggressive stances, yelling and arm waving, or utilize tools, such as noise makers, projectiles, hoses, or water guns with vinegar. If it can be multisensory (incorporate more than one hazing method), that is even better.
- Coyotes are creatures of habit, so if a coyote is frequenting an area with high human traffic, it is important to haze him there so that habit will be broken.
- Hazing must continue until the animal leaves.
- Hazing must be consistent, each time the animal is present.
- Hazing must not injure the animal, and no one should ever haze an injured animal, as they can be aggressive and unpredictable.

Successful management of human coyote conflict will need to be ongoing and dynamic. The state of the science with respect to the understanding of coyote ecology is improving rapidly. Ongoing studies on the effectiveness of hazing, coyote foraging behavior, domestic behavior in the presence of coyotes, and alternative methods of discouraging foraging will all inform future management plans. In addition, the results of our ongoing work in Culver City will be shared with the City of Long Beach. This collaborative approach among cities and research teams will result in more effective management and a better plan for generalizing our responses to the human coyote conflict.

10. REFERENCES

Adamec, R. E., Stark-Adamec, C., & Livingston, K. E. (1980). The development of predatory aggression and defense in the domestic cat (*Felis catus*): I. Effects of early experience on adult patterns of aggression and defense. *Behavioral and Neural Biology*, *30*(4), 389-409.

Arjo, W. M., Pletscher, D. H., & Ream, R. R. (2002). Dietary overlap between wolves and coyotes in northwestern Montana. *Journal of Mammalogy, 83*, 754–766.

Baker, P. J., & Harris, S. (2007). Urban mammals: what does the future hold? An analysis of the factors affecting patterns of use of residential gardens in Great Britain. *Mammal Review*, *37*(4), 297-315.

Bonnell, M. A., & Breck, S. W. (2017). Using resident-based hazing programs to reduce human-coyote conflicts in urban environments. *Human–Wildlife Interactions*, *11*(2), 5.

Boser, C. L. (2009). Diet and hunting behavior of coyotes in agricultural-forest landscapes of New York State. Thesis. State University of New York - Syracuse.

Carrera, R., Ballard, W., Gipson, P., Kelly, B. T., Krausman, P. R., Wallace, M. C., Villalobos, C., & Wester, D. B. (2008). Comparison of Mexican wolf and coyote diets in Arizona and New Mexico. *Journal of Wildlife Management, 72*, 376–381.

Cepek, J. D. (2004). Diet composition of coyotes in the Cuyahoga Valley National Park , Ohio 1. *Ohio Journal of Science, 104*, 60–64.

County of Los Angeles (2019). Assessor Parcel Data – 2018. *County of Los Angeles Open Data.* https://data.lacounty.gov/Parcel-/Assessor-Parcels-Data-2018/mk7y-hq5p

Crowell-Davis, S. L., Curtis, T. M., & Knowles, R. J. (2004). Social organization in the cat: a modern understanding. *Journal of Feline Medicine and Surgery*, *6*(1), 19-28.

Crowell-Davis, S. L. (2007). Cat behaviour: social organization, communication and development. In *The Welfare of Cats* (pp. 1-22). Springer, Dordrecht.

Cypher, B. L., Kelly, E. C., Westall, T. L., & Van Horn Job, C. L. (2018). Coyote diet patterns in the Mojave Desert: Implications for threatened desert tortoises. *Pacific Conservation Biology, 24*, 44–54.

Dowd, J. L. B., & Gese, E. M. (2012). Seasonal variation of coyote diet in northwestern Wyoming: Implications for dietary overlap with Canada lynx? *Northwest Science, 86*, 289.

Draheim, Megan, et al. (2013). Attitudes of College Undergraduates Towards Coyotes (*Canis Latrans*) in an Urban Landscape: Management and Public Outreach Implications. *Animals*, *3*(1), 1–18. doi:10.3390/ani3010001.

Drake, M. D., Nils Peterson, M., Griffith, E. H., Olfenbuttel, C., DePerno, C. S., & Moorman, C. E. (2020). How Urban Identity, Affect, and Knowledge Predict Perceptions About Coyotes and Their Management. *Anthrozoös*, *33*(1), 5-19.

Ellington, E. H., & Gehrt, S. D. (2019). Behavioral responses by an apex predator to urbanization. *Behavioral Ecology*, *30*(3), 821-829.

Elliot, E. E., Vallance, S., & Molles, L. E. (2016). Coexisting with coyotes (*Canis latrans*) in an urban environment. *Urban Ecosystems*, *19*(3), 1335-1350.

Ezenwa, V. O., Gerardo, N. M., Inouye, D. W., Medina, M., & Xavier, J. B. (2012). Animal behavior and the microbiome. *Science*, *338*(6104), 198-199.

Farrar, R. O. (2016). A balanced approach to the adaptive management of urban coyotes. In *Proceedings of the Vertebrate Pest Conference* (Vol. 27, No. 27).

Frey, S., Fisher, J. T., Burton, A. C., & Volpe, J. P. (2017). Investigating animal activity patterns and temporal niche partitioning using camera-trap data: challenges and opportunities. *Remote Sensing in Ecology and Conservation*, *3*(3), 123-132.

Gehrt, S. D., & McGraw, M. (2007). Ecology of coyotes in urban landscapes.

Gehrt, S. D., Brown, J. L., & Anchor, C. (2011). Is the urban coyote a misanthropic synanthrope? The case from Chicago. *Cities and the Environment (CATE)*, *4*(1), 3.

Gehrt, S. D., Wilson, E. C., Brown, J. L., & Anchor, C. (2013). Population ecology of free-roaming cats and interference competition by coyotes in urban parks. *PloS one*, *8*(9).

Gibbs, G. R. (2007). Thematic coding and categorizing. In Gibbs, G. R. *Qualitative Research kit: Analyzing qualitative data* (pp. 38-55). London, England: SAGE Publications,

Grubbs, S. E., & Krausman, P. R. (2009). Observations of coyote-cat interactions. *The Journal of Wildlife Management*, *73*(5), 683-685.

Ha, D., & Ha, J. (2017). A subjective domestic cat (Felis silvestris catus) temperament assessment results in six independent dimensions. *Behavioural Processes*, *141*, 351-356.

Hernández, L., Parmenter, R. R., Dewitt, J. W., Lightfoot, D. C., & Laundré, J. W. (2002). Coyote diets in the Chihuahuan Desert, more evidence for optimal foraging. *Journal of Arid Environments*, *51*(4), 613-624.

Hopkins III, J. B., Koch, P. L., Schwartz, C. C., Ferguson, J. M., Greenleaf, S. S., & Kalinowski, S. T. (2012). Stable isotopes to detect food-conditioned bears and to evaluate human-bear management. *The Journal of Wildlife Management*, *76*(4), 703-713.

Kays, R., Costello, R., Forrester, T., Baker, M. C., Parsons, A. W., Kalies, E. L., ... & McShea, W. (2015). Cats are rare where coyotes roam. *Journal of Mammalogy*, *96*(5), 981-987.

Kitchen, A. M., Gese, E. M., & Schauster, E. R. (2000). Changes in coyote activity patterns due to reduced exposure to human persecution. *Canadian Journal of Zoology*, *78*(5), 853-857.

König, A. (2008). Fears, attitudes and opinions of suburban residents with regards to their urban foxes. *European Journal of Wildlife Research*, *54*(1), 101-109.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 30(3), 607-610.

Larson, R. N., Morin, D. J., Wierzbowska, I. A., & Crooks, K. R. (2015). Food habits of coyotes, gray foxes, and bobcats in a coastal southern California urban landscape. *Western North American Naturalist*, 339-347.

Larson, R. N., Brown, J. L., Karels, T., & Riley, S. P. (2020). Effects of urbanization on resource use and individual specialization in coyotes (*Canis latrans*) in southern California. *PLoS One*, *15*(2), e0228881.

Lawrence, S. E., & Krausman, P. R. (2011). Reactions of the public to urban coyotes (*Canis latrans*). *The Southwestern Naturalist*, 56(3), 404-409.

Mankin, P. C., Warner, R. E., & Anderson, W. L. (1999). Wildlife and the Illinois public: a benchmark study of attitudes and perceptions. *Wildlife Society Bulletin*, 465-472.

Manning, D. L. (2007). A comparative ecological study between coyotes (*Canis latrans*) in a protected and urban habitat: A closer look at enteric parasites and diet between Florida coyotes. University of South Florida. Master Thesis, 1–80.

McCleery, R., Ditton, R., Sell, J., & Lopez, R. (2006). Understanding and Improving Attitudinal Research in Wildlife Sciences. *Wildlife Society Bulletin (1973-2006), 34*(2), 537-541.

McClure, M. F. (1993). Densities and diets of coyotes near Saguaro National Monument. University of Arizona.

Mumma, M. A., Adams, J. R., Zieminski, C., Fuller, T. K., Mahoney, S. P., & Waits, L. P. (2016). A comparison of morphological and molecular diet analyses of predator scats. *Journal of Mammalogy*, *97*(1), 112-120.

Murray, M., Cembrowski, A., Latham, A. D. M., Lukasik, V. M., Pruss, S., & St Clair, C. C. (2015). Greater consumption of protein-poor anthropogenic food by urban relative to rural coyotes increases diet breadth and potential for human–wildlife conflict. *Ecography*, *38*(12), 1235-1242.

Ogan, C. V., & Jurek, R. M. (1997). Biology and ecology of feral, free-roaming, and stray cats. In *Pages 87-92 in JE Harris, and CV Ogan, (eds.), Mesocarnivores of northern California: biology, management, and survey techniques, workshop manual. August 12-15, 1997, Humboldt State University, Arcata, CA. The Wildlife Society, California North Coast Chapter, Arcata, CA 127.*

Poessel, S. A., Mock, E. C., & Breck, S. W. (2017). Coyote (*Canis latrans*) diet in an urban environment: variation relative to pet conflicts, housing density, and season. *Canadian Journal of Zoology*, *95*(4), 287-297.

Price, E. O. (1999). Behavioral development in animals undergoing domestication. *Applied Animal Behaviour Science*, *65*(3), 245-271.

Prugh, L. R. (2005). Coyote prey selection and community stability during a decline in food supply. *Oikos*, *110*(2), 253-264.

Radeloff, V. C., Helmers, D. P., Anu Kramer, H., Mockrin, M. H., Alexandre, P. M., Bar-Massada, A., Butsic, V., Hawbaker, T. J., Martinuzzi, S., Syphard, A. D., & Stewart, S. I. (2018). Rapid growth of the U.S. wildland-urban interface raises wildfire risk. *Proceedings of the National Academy of Sciences of the United States of America, 115*, 3314–3319.

Rasmussen, Z. A. (2015). *Coyotes on the web: Understanding human-coyote interaction and online education using citizen science.* Master's Thesis, Portland State University.

Quinn, Timothy. (1997). "Coyote (*Canis latrans*) food habits in three urban habitat types of western Washington."

Santana, E., & Armstrong, J. (2017). Food habits and anthropogenic supplementation in coyote diets along an urban-rural gradient. *Human–Wildlife Interactions*, *11*(2), 6.

Schell, C. J., Young, J. K., Lonsdorf, E. V., Santymire, R. M., & Mateo, J. M. (2018). Parental habituation to human disturbance over time reduces fear of humans in coyote offspring. *Ecology and Evolution*, *8*(24), 12965-12980.

Schmidt, P. M., Lopez, R. R., & Collier, B. A. (2007). Survival, fecundity, and movements of free-roaming cats. *The Journal of Wildlife Management*, *71*(3), 915-919.

Schrecengost, J. D., Kilgo, J. C., Mallard, D., Ray, H. S., & Miller, K. V. (2008). Seasonal food habits of the coyote in the South Carolina coastal plain. *Southeastern Naturalist, 7*, 135–144.

Shargo, E. S. (1988). Home range, movements, and activity patterns of coyotes (*Canis latrans*) in Los Angeles suburbs. <http://utas.summon.serialssolutions.com/link/0/eLvHCXMwY2BQMLNMNUy1SEpOSklJTLNMNjI0swAmDWC73DTVKDklxRBlHwxSae4myiDr5hri7KELKxXjU3Jy4s1NQKd-A_sBhmIMvImgdd95JeD9YSl8K7Q7dTyi3DfMqLMLfZZ92h4AhPYixA>.

Soulsbury, C. D., & White, P. C. L. (2015). Human – wildlife interactions in urban areas: A review of conflict, benefits and opportunities. *Wildlife Research, 42*, 541–553.

Stothart, M. R., Bobbie, C. B., Schulte-Hostedde, A. I., Boonstra, R., Palme, R., Mykytczuk, N. C., & Newman, A. E. (2016). Stress and the microbiome: linking glucocorticoids to bacterial community dynamics in wild red squirrels. *Biology Letters*, *12*(1), 20150875.

Swingen, M. B., DePerno, C. S., & Moorman, C. E. (2015). Seasonal coyote diet composition at a low-productivity site. *Southeastern Naturalist, 14*, 397–404.

Timm, R. M., Baker, R. O., Bennett, J. R., & Coolahan, C. C. (2004). Coyote attacks: an increasing suburban problem.

Turner, M. M., Rockhill, A. P., Deperno, C. S., Jenks, J. A., Klaver, R. W., Jarding, A. R., Grovenburg, T. W., & Pollock, K. H. (2011). Evaluating the effect of predators on white-tailed deer: Movement and diet of coyotes. *Journal of Wildlife Management, 75*, 905–912.

U.S. Census Bureau (2018). 2013-2017 American Community Survey 5-Year Estimates. Retrieved from https://factfinder.census.gov/

West, M. (1974). Social play in the domestic cat. *American Zoologist*, *14*(1), 427-436.

White, L. A., & Gehrt, S. D. (2009). Coyote attacks on humans in the United States and Canada. *Human Dimensions of Wildlife*, *14*(6), 419-432.

Worcester, R. E., & Boelens, R. (2007). The Co-Existing With Coyotes Program In Vancouver, B.C. (2007). *Wildlife Damage Management Conferences -- Proceedings*. 79. Retrieved from: https://digitalcommons.unl.edu/icwdm_wdmconfproc/79

APPENDIX

This Appendix contains the following documents:

1. Selected Photos from Game Cameras
2. Coyote Risk Assessment Backyard Survey
3. Long Beach Coyote Survey Invitation Letter
4. Long Beach Coyote Project – Mail Survey of Residents
5. Long Beach Database of Stewardship Organizations
6. Urban EcoLab Coyote Curriculum Overview