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Advancing best practices for aversion conditioning (humane hazing) to mitigate human–coyote conflicts in urban areas

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Abstract: Coyotes (*Canis latrans*) are now recognized as a permanent feature in urban environments across much of North America. Behavioral aversion conditioning, or humane hazing, is increasingly advocated as an effective and compassionate alternative to wildlife management strategies, such as trap and removal. Given a growing public interest in humane hazing, there is a need to synthesize the science regarding methods, outcomes, efficacy, and other relevant considerations to better manage human–coyote conflicts in urban areas. This paper was prepared as an outcome of a workshop held in July 2019 by Coyote Watch Canada (CWC) to synthesize the literature on aversion conditioning. The paper also includes the deployment experiences of members of the CWC Canid Response Team. Herein, we propose best practices to enhance the efficacy of aversion conditioning for the management of urban wildlife, particularly coyotes. We detail recommendations concerning: the importance of consistency, adaptability, humaneness, and clear goals; training and proactive implementation; and the need for a comprehensive wildlife coexistence program. We further detail additional considerations surrounding domestic dogs (*C. lupus familiaris*), public perceptions, and defining behavior and conflict. We hope this synthesis will assist wildlife managers and local governments in identifying and deploying nonlethal human–coyote conflict mitigation strategies that are effective, humane, and community supported.

Key words: aversion conditioning, canid, *Canis latrans*, coyote, human–wildlife conflict, humane hazing, nonlethal, urban wildlife management

Coyotes (*Canis latrans*; Figure 1) are increasingly recognized as a permanent feature of urban environments across much of North America (Hody and Kays 2018). As highly adaptable generalist omnivores, they are proficient foragers who make use of a range of natural and anthropogenic foods within cities (Gehrt et al. 2011, Murray et al. 2015, Poessel et al. 2017). Heightened public awareness of their presence and concern over the potential for negative interactions, especially with domestic pets, have increased community interest and the dialogue surrounding human–coyote conflict (Alexander and Quinn 2011, Elliot et al. 2016, Draheim et al. 2019). At the same time, the public may be increasingly concerned with the use of lethal control options, which have been the status quo for managing predators and other "nuisance" wildlife (Messmer et al. 1997*a*, Wittmann et al. 1998, Messmer et al. 1999, Martínez-Espiñeira 2006, Jackman and Rutberg 2015). In addition to public perceptions, there are ethical, scientific, and legal considerations affecting the use of lethal control options in urban environments (e.g., Sterling et al. 1983, Messmer et al. 1997*b*, Treves and Karanth 2003, Treves et al. 2016, Bergstrom 2017).

Concomitantly, behavioral aversion conditioning, also termed humane hazing, is increasingly advocated as an effective and compassionate alternative to wildlife management strategies such as trap and removal (involving translocation or lethal interventions; Shivik 2004, Bonnell and Breck 2017, Breck et al. 2017). Bonnell and Breck (2017, 147) defined aversion conditioning as "deliberate negative conditioning. A training method that employs immediate use of deterrents or negative stimulus to move an animal out of an area, away from a person or discourage an undesirable behavior or activity. Hazing is conducted to sensitize coyotes to the presence of humans or human spaces such as backyards and play spaces. Hazing does not harm animals, humans, or property."

Among the approaches commonly termed hazing, there are a number of competing definitions. Project Coyote (n.d.) differentiates between passive hazing, or making an area

Figure 1. A mother eastern coyote (*Canis latrans*) feeds her pups in a residential backyard in the city of London, Ontario, Canada (*photo by J. Merner for Coyote Watch Canada*).

unsuitable for coyotes (i.e., habitat modification, attractant removal, deterrents), and active hazing, or responding to coyote activity to reshape their behaviors and create avoidance. Breck et al. (2017) stated that nonlethal (as well as lethal) approaches also may be either proactive or reactive. In proactive hazing, all coyotes in an area are conditioned to avoid interactions with humans prior to any specific concerns. Conversely, reactive hazing targets specific individuals who have already started to demonstrate behaviors that are viewed as undesirable by the community. The coyote management and coexistence plan in Chicago, Illinois, USA (Chicago Animal Care and Control n.d.) differentiates between basic hazing, in which residents routinely appear "big and loud" to scare coyotes away, versus high-intensity hazing, in which trained professionals respond to particular incidents using a variety of tools such as projectiles or pepper spray. A number of additional deterrent strategies are employed in rural settings, including flandry, conditioned taste aversion, and guard animals, but are either less implementable or have yet to be explored in urban settings (Shivik and Martin 2000, Shivik 2004, Parr et al. 2017).

Despite increased public interest in the use of hazing to manage human–coyote conflicts, the evidence available regarding the methods, outcomes, efficacy, and relevant considerations is conflicting and poorly supported (Shivik 2004, Grant et al. 2011, Bonnell and Breck 2017, Breck et al. 2017). The lack of published data on the efficacy of aversion conditioning and the factors that influence its success have been used to argue against the widespread implementation of nonlethal conflict-mitigation strategies (e.g., Brady 2016). However, studies that report mixed results of hazing efficacy have acknowledged limitations, including: (1) difficulty in quantifying coyote behavioral responses to hazing; (2) no standard approach for assuring and assessing the competency of those administering the treatment, especially if conducted by members of the lay public; (3) difficulty in relating short-term behavioral responses of coyotes to long-term changes in behavioral patterns; and (4) pronounced differences between treatment and control sites that likely confound study results (Bonnell and Breck 2017, Breck et al. 2017).

As local governments and wildlife managers attempt to develop human–wildlife conflict mitigation strategies that are effective, humane, and community supported, there is a need for guidance regarding if and how aversion conditioning can be successfully implemented as a nonlethal response strategy (Young et al. 2019).

To respond to this need, in July 2019 Coyote Watch Canada (CWC) convened an Aversion Conditioning Best Practices Workshop to discuss existing evidence and recommendations on aversion conditioning. Coyote Watch Canada is a community-based and volunteer-driven federal not-for-profit wildlife organization that collaborates with a broad range of stakeholders to develop and implement nonlethal human–wildlife conflict solutions. We have demonstrated success in facilitating the development and implementation of sustainable, effective, and compassionate wildlife coexistence programs, with a focus on canids (coyotes and foxes). We provide: multilevel educational programming; private, municipal, and provincial level consultation; on-site and in-office training; and support for municipal wildlife conflict mitigation policy development. Our methods are field tested and have evolved through decades of implementation and experimentation. Our longest-running program is in the Niagara Region of Ontario, Canada, which after over a decade of collaboration now represents a flagship model for our Wildlife Strategy Framework (City of Niagara Falls n.d.; Coyote Watch Canada n.d., 2013).

Workshop participants included research-

Table 1. Terms used and the results of a Google Scholar search to compile literature on aversion conditioning for coyote (*Canis latrans*) management published between 2000 and 2019, Coyote Watch Canada, St. Davids, Ontario, Canada.

Search term	Date range	Results yielded	Results pages scanned	Papers included
Coyote "aversion conditioning"	Since 2000	283	10	2
Coyote "aversive conditioning"	Since 2000	556	10	12
Coyote hazing	Since 2000	903	10	4
Coyote deterrent	Since 2000	3,460	10	1
Coyote repellant	Since 2000	2,170	10	1
Coyote haze	Since 2000	4,290	10	0
Coyote harass	Since 2000	2,340	10	3
Coyote harassment	Since 2000	3,900	10	2
Coyote nonlethal	Since 2000	3,030	10	1
Mined from reference lists	Since 2000	N/A	N/A	2

ers and members of the CWC Canid Response Teams (CRTs). The CRTs consist of volunteers trained in CWC's field-tested methodology who consult and collaborate to implement on-the-ground response such as investigation, rescue, and conflict resolution. Team members have a combined total of >35 years of experience in implementing humane wildlife strategies. The CRTs provide on-site investigation, wildlife rescue and release assistance, and assessment and mitigation directives, including deployment of aversion conditioning.

In this paper, we synthesize the results of the 2019 workshop with contemporary literature to advance a set of recommendations and considerations (i.e., best practices) for using aversion conditioning as a nonlethal management tool for mitigating human–coyote conflicts in urban areas. We briefly describe the methods employed to generate coyote aversive hazing best practices, relay the key recommendations in terms of the what, when, who, and how of implementing aversion conditioning for urban canid management, and conclude by describing additional relevant considerations concerning domestic dogs (*C. lupus familiaris*), public perceptions, and defining behavior and conflict.

Table 2. Coding nodes (themes) employed in NVivo 12 coding of 2019 peer-reviewed and gray literature search results on aversion conditioning for coyotes (*Canis latrans*). Emergent codes in italics. Coyote Watch Canada, St. Davids, Ontario, Canada.

Primary nodes	Secondary nodes
Considerations	Humane Geography Public safety Pups/den Other
Definition	
Dogs	
Failure	
Food attractants	
Gaps	
Limitations	
Noise	
Projectiles	
Recommendations	
Visual	
Other	

Methods

To conduct the literature review, we compiled peer-reviewed sources using the Google Scholar search engine. We included only sources published since the year 2000, as we aimed to synthesize recent literature reflective of the current state of knowledge on aversion conditioning. We detailed search parameters and results (Table 1). We reviewed reference lists of included articles to identify further sources that aligned with the search. Combined methods yielded 27 unique articles.

Table 3. Summary of best practices for aversion conditioning (humane hazing) to mitigate human–coyote (*Canis latrans*) conflicts in urban areas.

Aversion conditioning methods should be adaptable, humane, and applied consistently. We recommend the garbage bag method and do not support the use of dogs (*Canis familiaris*) or projectiles in hazing.
All members of the public should be encouraged to implement basic hazing techniques where appropriate, but high-intensity hazing involving targeted responses to hotspots should only be conducted by personnel who have been trained by someone with firsthand experience deploying the methodology.
Mitigation measures should be implemented proactively, rather than reacting to escalating conflict scenarios, and after investigating the circumstances and planning the most effective response.
Aversion conditioning should not be implemented in isolation, but rather as part of a comprehensive wildlife coexistence program that attends to the 4 cornerstones of investigation, education, enforcement, and prevention.
Coyote management goals should be clearly defined, approaches consistently deployed, and effects monitored to measure efficacy based on an agreed upon definition of success.
Interactions between coyotes and domestic dogs should not be classified as "conflict," and efforts should be made to educate and enforce responsible pet practices, including not allowing dogs to roam freely in wildlife areas. It should be acknowledged that hazing may be less effective when domestic dogs are present, and the priority should be to remove the dog from areas where coyotes may be denning.
When implementing aversion conditioning, public outreach and education should prioritize ensuring that residents understand the purpose of hazing as a humane wildlife response tool and that it not inadvertently validate unnecessary and inappropriately high levels of wildlife harassment.
"Proximity tolerance" should replace "habituation" in wildlife research, management, and policy vocabularies.
Nonlethal interventions such as aversion conditioning should be seen as an appropriate response and mitigation tool for coyotes engaging in any behavior that is deemed undesirable by the community.

Secondly, we identified relevant gray literature by first searching for "coyote humane hazing" and "coyote aversion conditioning" in the Google search engine. This search identified possibly useful organizations and locales with relevant recommendations or other documents on aversion conditioning. This search resulted in the following secondary searches: "project coyote," "Stanley park coyote," "city of Calgary coyote," "San Francisco coyote," "Chicago coyote management and coexistence plan," and "humane society coyote hazing guidelines." Searches resulted in 5 unique documents for coding.

We analyzed the documents generated by our searches by qualitative coding in QSR International's NVivo (QSR International Pty Ltd., Version 12, 2018). We established nodes (themes) *a priori* and others emerged as the data were analyzed. Nodes included: considerations, definitions, failures, gaps, limitations, and recommendations as well as specific approaches (dogs, noise, projectiles, visual; Table 2).

We synthesized literature review findings into a workshop package, which was distributed to participants in advance of the workshop. The 1-day workshop consisted of 2 parts, each with distinct goals: (1) to draft a set of best practices; and (2) to discuss the tensions, gaps, and responses to existing literature and recommendations. There were 7 workshop participants with >35 combined years of experience in deploying response protocols to reshape interactions with canids, including aversion conditioning techniques. We present key best practice recommendations and additional considerations (Table 3).

Results

What: rigorous methods that are consistent, adaptable, and humane

In terms of what constitutes effective aversion conditioning, methods should be consistent, humane, deliver clear messaging, and be flexible in adapting to novel scenarios. Many

Figure 2. A member of Coyote Watch Canada demonstrates the garbage bag method (*photo by Coyote Watch Canada*).

sources note that hazing must be applied consistently and persistently to be effective (Timm et al. 2004, Grant et al. 2011), and our experience supports this. If it is only performed by 1 or 2 individuals in a neighborhood while other residents continue to make their property or company comfortable and appealing to coyotes, this mixed messaging risks eliciting poor results. Targeted education campaigns within community hotspots are therefore critical in terms of ensuring residents work together to apply mitigation measures consistently. There is evidence that domestic dogs can differentiate humans both by scent (Schoon and De Bruin 1994) and visually (Huber et al. 2013). Anecdotal observations from our CRTs and in the literature (Grant et al. 2011) similarly suggest that coyotes can recognize individual humans, and therefore if there are only the same few individuals hazing, coyotes may learn to avoid only them. Where aversion conditioning is being conducted by individuals in a professional role who wear a uniform (e.g., animal control, humane society, police), we will at times recommend that officers practice aversion conditioning without the uniform if the coyote has adapted to responding to those in uniform but does not act in a consistent manner with members of the public.

Aversion conditioning is not a specific method, but rather a collection of interventions designed for a certain aim: to communicate to coyotes to move and/or stay away; it is a toolkit of actions and gestures designed to maintain healthy boundaries between wildlife and humans. A wide variety of stimuli have been employed and can be successful (e.g., shaker cans, umbrellas, garbage bags). Generally, deployment involves using one's body along with additional visual or auditory stimuli or tools to send a clear message. The key to success lies not in the specific tool used, but rather the intention of the deployer, effective communication, and persistence. Clear messaging is integral to communicating effectively with canids. In domestic dog training, body language and gestural communication are key and are more effective than visual or auditory communication alone (D'Aniello et al. 2016, Scandurra et al. 2017). Thus, yelling at a coyote from a window may not always be effective, and physically advancing toward the coyote with purpose is often required. What works in 1 situation may not be effective in another (Grant et al. 2011), so some degree of persistence and adaptability may be required. Because each coyote will have a different history and there may be inherent differences in behavior, not all coyotes will respond similarly to the same stimuli. Efficacy requires creativity, flexibility, and innovation, along with skills to analyze the context and respond accordingly, which is why we emphasize the importance of experience and training in the following section.

One technique CWC frequently recommends is the garbage bag method (Figure 2). Quite simply, it involves unfurling and rapidly snapping a large, air-filled garbage bag loudly. It can be accompanied by walking toward the coyote and using a firm, loud voice to encourage the coyote to move away. Benefits of this method include: coyotes are often averse to loud and unfamiliar noises (Darrow and Shivik 2009), and this, if done properly, can be quite dramatic; and unlike whistles or airhorns, this method has the added benefit of providing a visual stimulus, which is why we recommend a black or green garbage bag rather than clear. It creates a visual barrier, and shiny billowing plastic can be an alarming sight to an animal. Finally, it is accessible and simple to carry and use. While other methods might have a similar effect, such as popping open an umbrella, garbage bags can fit easily into your pocket, are inexpensive, and are available anywhere. This method can be easily used by any member of

the public regardless of age or ability. It has been used extensively in the communities in which we work, both by members of our team, first responders (animal control or services, bylaw, humane society, law enforcement, etc.), and the public, achieving the desired outcome (e.g., immediate: the coyote is redirected out of the area in an encounter; long-term: coyote behavior is reshaped to avoidance, leading to a reduction in coyote complaints in an area).

Concerns have been raised that coyotes may become tolerant to a single tool; for instance, over time they may learn that snapping a garbage bag does not present a threat and stop responding to it. We have not encountered this in our experiences and feel it is important to reiterate that effective mobilization of aversion conditioning is less about any 1 specific tool and more about intention and persistence. Our high degree of success in this method is because if an individual coyote does not respond to a given stimulus, we immediately employ another tactic and follow through until the desired response is elicited. If insufficient response is generated through snapping the garbage bag, then one should walk quickly and with purpose toward the coyote while snapping it and/or vocalize loudly and firmly. Clear and confident body language and assertive voice is more important than sophisticated tools or body size in obtaining desired results. Thus, evolving public perceptions from fear and misinformation to understanding and empowerment is key to human–coyote coexistence.

Finally, although recommendations for aversion conditioning generally specify that methods should not harm coyotes, a discussion of what constitutes "harm" and how to avoid it is often lacking. Hazing, by definition, induces fear, which could constitute psychological harm, but which is preferable to the lethal control measures that are often implemented if conflicts remain unresolved. Generally, the aim of hazing is not to cause physical harm to coyotes. This means, for instance, throwing objects near, not at, them. It means being mindful of the circumstances and possible risks to coyotes (e.g., not hazing them onto a road). Humane practices also mean not forcing a family to relocate their den, unless the situation is dire. Most sources recommend that hazing not be conducted near pups or an active den site (Project Coyote n.d., Bonnell and Breck 2017). In addition to welfare considerations, there is a risk that new den sites that result from forced relocation may be even more problematic than the original site (Colorado Parks and Wildlife n.d.). Finally, it is commonly advocated that sick or injured coyotes should not be hazed (Project Coyote n.d., Bonnell and Breck 2017). We agree with the former, because of the possible harm associated with additional stress, but would add that appropriately responding to sick or injured coyotes should entail efforts to rescue and rehabilitate where such opportunities and resources are available.

We advocate against the use of dogs or projectiles such as clay bullets in hazing because these methods are inhumane, and we challenge their efficacy. In terms of dogs, intentionally creating conflict between 2 canids puts both at risk and is unethical. Furthermore, given that domestic canines are key drivers of human–coyote conflict in urban areas (Bombieri et al. 2018), enabling an augmentation of this conflict by intentionally creating antagonistic situations is irresponsible. We suggest that in any situation where dogs are currently used to haze coyotes, a person could deploy the aversion conditioning methodologies described here with less risk to all involved, and likely with greater efficacy. In terms of projectiles such as clay bullets or paintball guns, the risk of injuring the animal is an important welfare concern. We also question the intention of hazing done at such a distance, as it is misaligned with the goal of preventing proximate encounters, making it difficult for the coyote in question to link stimulus to response (Shivik 2004).

Best practice: Aversion conditioning methods should be adaptable, humane, and applied consistently. We recommend the garbage bag method and do not support the use of dogs or projectiles in hazing.

Who: training

One of the more challenging questions related to aversion conditioning is who should be deploying it. Hazing is often undertaken by those in professional roles or official capacities, such as individuals working in animal control, parks staff, police, etc. Some recom-

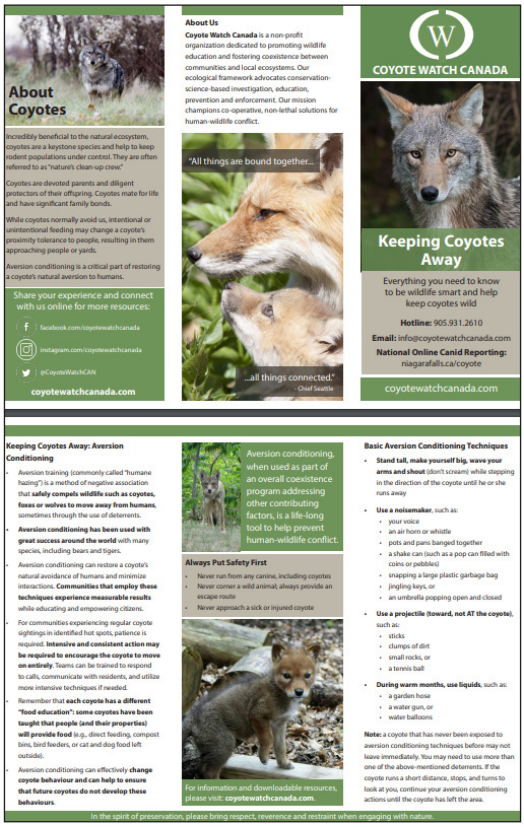

Figure 3. Coyote Watch Canada's "Keeping Coyotes Away" brochure (*available from https://www.coyotewatchcanada.com/files/CWCKEEPING-COYOTES-AWAY-BROCH0920.pdf*).

mendations target broad audiences, suggesting that all members of the public haze coyotes. There is increasing discussion of "hazing crews" who can respond to hotspots and apply aversion conditioning (e.g., see Brennan 2017). Bonnell and Breck (2017) recruited 207 volunteer community scientists around the Denver Metropolitan Area, Colorado, USA, who were then trained in hazing and asked to record any coyote encounters or instances of deployment. But questions of who should be trained and how, as well as who should do the training, remain unaddressed.

The approach advocated by our organization aligns with the city of Chicago coyote management and coexistence plan's (Chicago Animal Care and Control n.d.) differentiation of basic versus high-intensity hazing. All members of the public should be encouraged to practice basic hazing techniques, such as the garbage bag method, where appropriate. Our organization's educational literature includes a brochure on keeping coyotes away, which details basic hazing techniques (Figure 3). Some jurisdictions have incorporated instructional videos on hazing within their educational materials, such as the Town of Oakville (2016), Ontario. However, in situations of hotspots where concerns have escalated, effective aversion conditioning to mitigate the situation may require high-intensity hazing (in conjunction with thorough investigation). High-intensity hazing should be deployed only by trained personnel, such as animal control, humane society, parks staff, or wildlife organization employees or volunteers. Those deploying high-intensity hazing should have received comprehensive training on assessing conflict scenarios and effective use of the appropriate mitigation techniques. As noted by Bonnell and Breck (2017, 154), "hazing is a complex concept and is difficult to teach using non-personal media such as on-site signs," and therefore, in-person training is recommended. We recommend that training on aversion conditioning only be conducted by those who have firsthand experience deploying the methodology. For instance, CWC regularly holds training sessions for municipal employees in animal management or first response roles. We do not support the formation of hazing crews by members of the lay public. Any targeted or high-intensity hazing response should only be undertaken by skilled professionals or volunteers capable of assessing and responding to the potential complexity of each situation and who are trained and supported by those with expertise and firsthand experience.

Best practice: All members of the public should be encouraged to implement basic hazing techniques where appropriate, but high-intensity hazing involving targeted responses to hotspots should only be conducted by personnel who have been trained by someone with firsthand experience deploying the methodology.

When: monitoring and timely response

Often there has already been an escalation of concerns over a period of weeks or months by the time interventions are deployed (Carillo

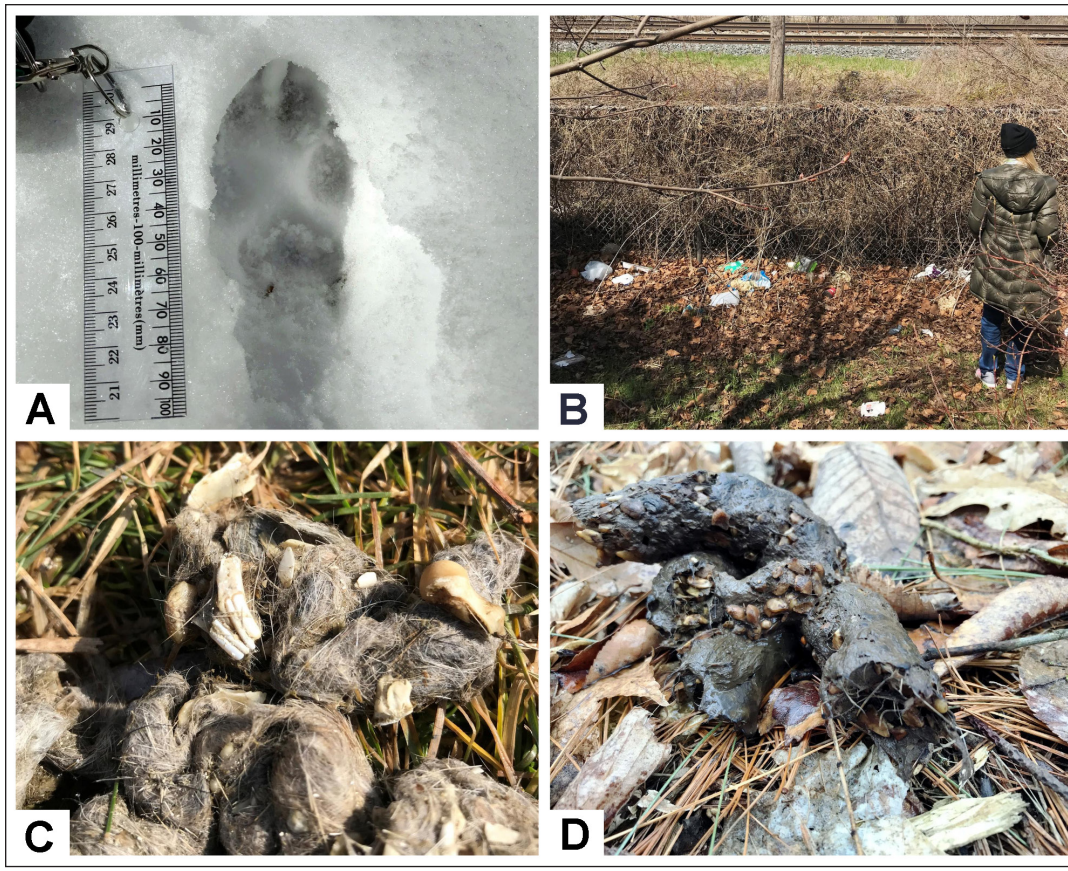

Figure 4. Investigation entails learning about the behaviors of coyotes (*Canis latrans*), human residents, and the context of interactions. This could involve: tracking coyotes (A); identifying any food attractants, such as garbage (B); and characterizing coyote diet, for instance looking for natural foods like fur and small mammal bones (C), or anthropogenic foods such as birdseed (D; *photos by L. Van Patter*).

et al. 2007). This is not ideal, but rather mitigation measures should be implemented proactively (Fox 2006, Breck et al. 2017). A system for reporting and monitoring encounters or concerns is invaluable in identifying and responding to possible emerging hotspots before conflicts can escalate. Ideally, hazing should be implemented after an investigation of contextual factors so that an understanding of drivers of conflict, goals of intervention, and effective mitigation techniques can be assessed and strategized (see next section).

Best practice: Mitigation measures should be implemented proactively rather than reacting to escalating conflict scenarios and after investigating the circumstances and planning the most effective response.

How: as part of comprehensive coexistence framework

In terms of how aversion conditioning should be implemented, our central recommendation is that it should not be used in isolation, but rather as part of a comprehensive wildlife coexistence framework. Aversion conditioning is often presented and assessed as a lone measure (e.g., Brady 2016, Bonnell and Breck 2017, Breck et al. 2017), despite the acknowledged imperative to address additional concerns, such as anthropogenic food provisioning (Timm et al. 2004, Baker 2007, Elliot et al. 2016, Baker and Timm 2017). Rather than advocating for the implementation of aversion conditioning as a solitary measure, CWC's 4-cornerstone approach to coexisting with wildlife entails prevention, investigation, education, and enforcement, each of which is briefly detailed below.

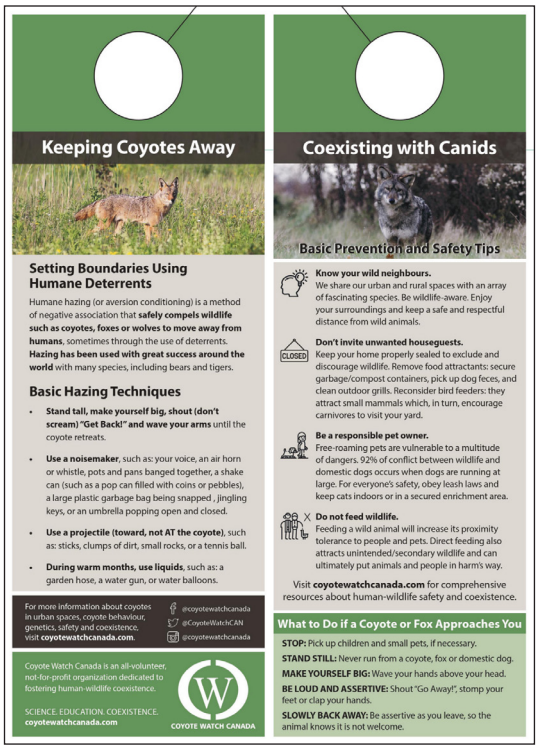

Figure 5. Coyote Watch Canada's "Coexisting with Canids" doorhanger (*available from https://www.coyotewatchcanada.com/files/CWCDoorHangerMay122018.pdf*).

Investigation. Investigation is key, as implementing appropriate responses requires an assessment of contextual factors relevant to each situation. Without understanding the root cause of conflicts, interventions may be inappropriate or ineffective, responding to symptoms rather than causes. Usually when there is a problem situation, conflict, or hotspot, feeding is the root issue (though other considerations may be relevant, such as off-leash dogs or infrastructure changes that disrupt foraging opportunities or travel routes and corridors; Alexander and Quinn 2012). Investigation might entail ground truthing, tracking, interviewing residents, and identifying food attractants (Figure 4). The aim is to establish the relevant factors contributing to instances of concern or conflict to help inform the most appropriate course of action. Aversion conditioning is an important tool in responding to many situations. However, implementing additional concurrent strategies such as community outreach and education or enforcement of wildlife feeding bylaws, may be equally important to ensuring a successful outcome. Without some investigation, it is impossible to understand the context, source of the issue, goal of the intervention, and how to best ensure its outcome.

Education. Education is integral to coexisting with wildlife in cities. It is particularly important to raise awareness of the consequences of intentional or unintentional food provisioning, including pet food, bird feeders, compost piles, accessible urban food gardens, and fallen fruit from trees. The urban coyote conflict literature emphasizes the importance of education about the consequences of feeding as well as wildlife-proofing property (Timm et al. 2004, Baker 2007, Carillo et al. 2007, Baker and Timm 2017). Education campaigns should be targeted and strategic. In a recent survey undertaken in Chicago, Illinois and in Los Angeles, California, USA, knowledge of and attitudes toward coyotes were highly variable, highlighting the challenges involved in reaching a consensus for appropriate management interventions (Elliot et al. 2016). Most respondents reported that when encountering a coyote, they were more likely to stand still or walk away than to try to scare the coyote away. The authors concluded that nature lovers may equally contribute to coyote conflict, as they are less likely to engage in hazing and more likely to participate in activities that attract wildlife (gardening, composting, bird feeding, etc.).

Thus, education efforts should target specific behaviors (i.e., what to do and not do), as opposed to attempting to shift broader attitudes concerning coyotes or other wildlife (Elliot et al. 2016). Along with conducting an investigation, one of the first responses undertaken by CWC when we are called into a community or made aware of an emerging hotspot is to schedule outreach meetings and/or circulate educational materials to the surrounding community, such as our doorhanger about coexisting with canids (Figure 5).

Enforcement. Enforcement of wildlife-related bylaws and ordinances, such as those that prohibit feeding, should be consistent to prevent coyotes from becoming used to frequenting anthropogenic resources or spaces (Fox 2006). Although education is often effective, a key question is "how many 'cheaters' does it take to change a coyote's behavior?" (Schmidt and Timm 2007, 299). Despite education, some

individuals may still be inclined to provide food, and therefore the creation and enforcement of bylaws and ordinances to prevent such behaviors and ensuing conflict scenarios is key. Partnerships and coordination between agencies are central to the success of human–wildlife conflict responses (Fox 2006). Relationship building across agencies and within communities ensures that information transfer and response occurs in a timely and effective manner. Within partner communities, CWC forges relationships with law enforcement, animal control, environmental and parks staff, neighborhood associations, and other relevant bodies to ensure alignment of expectations, efficient division of responsibilities, and clear communication and response pathways.

Prevention. Ultimately, strategies should prioritize prevention, as opposed to response. Proactive nonlethal strategies entail "altering the behavior of coyotes prior to the onset of conflict" (Breck et al. 2017, 134). Proactive interventions are preferable to reactive, wherein one responds to a situation after significant conflict has emerged. Proactive preventative strategies include education and enforcement, but there are also ways in which aversion conditioning can be used proactively. Generally, this involves practicing wider-scale basic hazing to maintain healthy boundaries between coyotes and humans sharing space in an urban environment.

Best practice: Aversion conditioning should not be implemented in isolation but rather as part of a comprehensive wildlife coexistence program that attends to the 4 cornerstones of investigation, education, enforcement, and prevention.

A final best practice in terms of how aversion conditioning is implemented pertains to defining and measuring success. It is imperative to clearly define the goals of response efforts from the outset. Grant et al. (2011, 21) noted that a common mistake is that "hazing is employed regardless of the specific behaviors or actions of the coyote…hazing should only be used if a coyote is behaving in a way that is unacceptable to the public or is using an area that residents deem unacceptable." Therefore, communities need to define which spaces are and are not acceptable for coyotes to occupy and determine levels of tolerance for specific behaviors. Ideal scenarios will involve community consensus and consistent application of techniques to discourage the presence of coyotes where they are deemed unacceptable and intervention in response to behaviors that are viewed as problematic. Coyotes need to live somewhere, and they need to make a living. If a coyote is walking across a field into a treed area, there is no need to haze it. If it is resting next to a sidewalk during a busy time of day, there will likely be community interest in discouraging this behavior. What is acceptable or not is subjective and will vary by community. The ultimate goals of management will vary accordingly, as will the strategies employed to attain these goals.

Finally, measuring success of aversion conditioning efforts is also a challenge. In our organization's experience, deployment of basic or high-intensity hazing along with other relevant mitigation efforts (i.e., education and enforcement to remove food attractants) will result in a decrease of incidents reported and frequency of encounters or conflicts. However, it is important to note that individual coyote response to hazing may vary, and a lack of immediate decrease in sightings does not indicate failure, but rather that persistent action may be required. We caution against oversimplification of anticipated outcomes, such as Bonnell and Breck's (2017, 150) "response coding of coyotes…being hazed by citizen scientists to rank individual coyote response to hazing from -4 (most averse) to 1 (coyote approaches)." Although some manner of typology may be useful, individual coyote responses to hazing techniques will depend greatly on contextual factors such as the presence of dogs, food resource being accessed, age of individual, proximity of den site, and the coyote's history of interactions with humans. If a coyote fails to move away, this may not indicate that hazing is ineffective, but rather that the coyote is reluctant to leave a nearby den site or pups. If a coyote "moves <10 feet away after input, stops and looks back in the direction of stimulus <10 feet from the original starting point" (rank -1 on Bonnell and Breck's [2017, 150] responses), they may be confused about the intentions of the deployer or reluctant to leave a valuable food resource. If a coyote approaches, is the deployer with a dog that is perceived as a threat to the coyote's territory

or family? Individual responses will depend greatly on the coyote's history and food conditioning, as well as the efficacy of the specific treatment being employed. Individuals who are not confident and committed and who do not sufficiently follow through are not communicating effectively to the animal, and a lack of response should not be seen as problematic coyote behavior nor a failure of the methodology itself. This highlights the importance of training to response success.

Best practice: Coyote management goals should be clearly defined, approaches consistently deployed, and effects monitored to measure efficacy based on an agreed upon definition of success.

Additional considerations

Along with the best practices discussed above, there are several additional factors that are important to consider when implementing aversion conditioning: presence of domestic dogs, public perceptions, and consistent definition of behavior and conflict. We detail each of these briefly below and advance several further best practices that incorporate considerations of the complexities surrounding these factors.

Domestic dogs

A key consideration both from the literature and our experience involves the presence of domestic dogs, which can exacerbate human–wildlife conflict (Lukasik and Alexander 2011, Alexander and Quinn 2012, Bowes et al. 2015). In the case of coyotes, an analysis of Canadian print media between 1995 and 2010 found that 23.8% of articles reporting on conflicts with coyotes specifically pertained to coyote–dog interactions and were characteristic of territorial conflicts (Alexander and Quinn 2011). In our experiences, territorial conflicts with off-leash dogs is one of the primary drivers of human–coyote conflicts in urban areas. In terms of mitigating conflict, education pertaining to the risks to dogs, wildlife, and humans of allowing dogs to roam is important, along with the creation and enforcement of leash laws. This is important for protecting not only dogs and coyotes, but the many other wildlife species that are at risk from roaming dogs, which are an increasingly recognized conservation threat (Lenth et al. 2008, Young et al. 2011, Hughes and Macdonald 2013, Doherty et al. 2017).

In terms of aversion conditioning, the presence of domestic dogs can present complications for deployment. Where a coyote is behaving defensively toward a roaming dog, the coyote may be less responsive to human hazing attempts, as the primary focus is on protecting its territory, resources, or family from encroaching canines. In this context, the priority is to maintain or create space between the dog and coyote. This can be done by calling the dog near, putting the dog on a leash, and slowly backing out of the area while deploying basic hazing techniques, such as the bag method described above. Bonnell and Breck (2017) reported that outcomes of hazing were negatively impacted by the presence of domestic dogs. In their research, "coyotes moved ≥10 feet away from the person hazing 49% of the time when no dog was present, but only 23% of the time when a domestic dog was present… dogs were present during 4 of 5 occasions when coyotes approached the person attempting to haze it" (Bonnell and Breck 2017, 153). The authors conclude, and we concur, that hazing can still be performed if an individual with a dog encounters a coyote, but that expectations of reduced efficacy in the presence of dogs should be clearly communicated to residents being educated about aversion conditioning. The response of individual coyotes to hazing in the presence of dogs will depend greatly on contextual factors, including proximity to a den, presence of pups, presence of food resource, and history of interactions with the individual dog or other domestic dogs.

Overall, education and enforcement concerning responsible pet practices are priorities for mitigating one of the largest sources of human–coyote conflict in urban areas. Where roaming dogs threaten coyote territories, resources, or families, we can expect coyotes to respond defensively. In instances where residents report behavior such as coyotes approaching or shadowing them while domestic dogs are present, the best practice is not necessarily to haze coyotes, but rather to ensure dogs are on leashes, or to keep dogs out of an area with known dens during pup rearing season. For instance, the Presidio Trust (2020) in California will tempo-

rarily close sections of trails to humans and/or domestic dogs when there are known active den sites.

Finally, we contend that interactions between domestic dogs and coyotes should not automatically be defined as conflicts or result in a coyote being designated as a problem individual. Contexts surrounding interactions need to be assessed on a case-by-case basis. As noted above, territorial interactions between animals is a natural process. If a dog is injured by a goose (Anatidae) protecting their young, the goose is not a problem animal, but rather the problem is inappropriate human behavior in allowing domestic pets to harass wildlife. The same should hold true in instances of altercations between coyotes and domestic dogs. This is common practice in many of the communities in which we work, including Toronto, Ontario, where the coyote response strategy stipulates that "a bite to another animal is not grounds for removal – it is normal coyote behaviour" (City of Toronto 2017).

Best practice: Interactions between coyotes and domestic dogs should not be classified as conflict, and efforts should be made to educate and enforce responsible pet practices, including not allowing dogs to roam freely in wildlife areas. It should be acknowledged that hazing may be less effective when domestic dogs are present, and the priority should be to remove the dog from areas where coyotes may be denning.

Public perceptions

One consideration that has received scant attention in the peer-reviewed and gray literatures is public perception. How the public perceives aversion conditioning will influence both uptake and willingness to conduct such practices at the community level and has the potential to present a risk to animal welfare. If members of the public do not understand the aims of hazing, they may be concerned about what they interpret as harassment or harm to wildlife. These concerns may be valid if best practices are not followed. Bonnell and Breck (2017) noted a reluctance to haze by some participants as a result of this perception, and Elliot et al. (2016) similarly reported that individuals who do not see coyotes as a problem are unlikely to haze them. There is a need to educate the public that if they see wildlife responders conducting aversion conditioning, the aim is not to harm or harass the animal, but rather that this action represents a humane, nonlethal intervention aimed at cultivating healthy human–wildlife boundaries by reshaping canid behavior.

Just as perceived harassment will offend those who have positive views of coyotes or concerns for animal welfare, such actions, if carelessly applied or insufficiently accompanied by educational efforts, may embolden those who wish to harm coyotes. We have observed communities wherein what was presented as hazing crews have functioned primarily as vigilantes attempting to harass resident coyotes. An example of the latter would be teams that market themselves as nonlethal and humane, but who use weapons, projectiles, or dogs indiscriminately across space, and even around dens. The inappropriate nature of such applications and the risks they pose to both human and coyote safety highlight the importance of education and the need to carefully assess how aversion conditioning programs and practices are applied, perceived, and communicated.

Best practice: When implementing aversion conditioning, public outreach and education should prioritize ensuring that residents understand the purpose of hazing as a humane wildlife response tool and not inadvertently validate unnecessary and inappropriately high levels of wildlife harassment.

Defining behavior and conflict

A limitation in the existing literature is the inaccurate and sometimes inappropriate characterization of coyote behavior. We address several terms and consider how they impact practices and perceptions around success and failure in aversion conditioning delivery. The first of these is the concept of habituation. Habituation is defined as an "animals' decreased responsiveness to humans due to repeated contact" (Geist 2007, 35). Most often the term "habituation," rather than being used as a neutral behavioral descriptor, is norma-

tively loaded as an undesirable, permanent state of a "problem animal." For instance, there is the claim that "habituated animals, those who have developed a psychological patience with our presence, are potentially much more dangerous than non-habituated, or 'wild' animals, because habituation is a state of unconsummated interest on the part of the animal, expressing itself as tolerance of and even an attraction to humans" (Geist 2007:35). Habituation as a descriptor of a fixed state is problematic due to the challenges in contextually defining a given animal's behavior and the limited evidence to support the prevailing assumptions that it is both a permanent state and inherently dangerous.

Based on field experiences of the CRTs of CWC deploying wildlife response measures, we advance that "proximity tolerance" is a more accurate description of coyote behavior, which reflects the complex and contextual interrelationship between individual coyotes and humans. Over time and based on experiences, coyotes' proximity tolerance with respect to humans (as well as other species, like domestic dogs) may change. This tolerance will depend on contextual factors, including the number, characteristics, and behaviors of the humans present, presence of dogs, if there is a food resource being accessed, and history of food provisioning and interactions. Just as experiences of food provisioning and positive interactions with humans may increase an individual's proximity tolerance, negative interactions such as hazing can effectively decrease this tolerance. Our experiences challenge the assertion that coyotes with high human proximity tolerance are always inherently dangerous. Our observations in the field have yielded no evidence that links proximity tolerance and aggression toward humans. However, it is in a community's interest to establish healthy boundaries with all wildlife, including coyotes, and restoring natural avoidance behaviors can be an important part of this. Unlike "habituation," "proximity tolerance" highlights that these behavioral characteristics do not represent a fixed state but rather a fluid relationship that can, with proper response, be reshaped.

Best practice: "Proximity tolerance" should replace "habituation" in wildlife research, management, and policy vocabularies.

A further consideration is how conflict scenarios or problem coyotes are defined. A current limitation in both the scholarship and for wildlife practitioners is that "the definition of a 'problem coyote,' and what behaviors that coyote displays, varies greatly" (Draheim et al. 2019, 8). A frequently cited conceptualization of problematic coyote interactions is Baker and Timm's (2017; drawing on Baker and Timm 1998, Baker 2008) "Behavioral Progression of increasing coyote habituation to suburban environments." It progresses from level 1, "increase in coyotes on streets and in yards at night," to level 7, "coyotes acting aggressively toward adults in mid-day." The common assertion stemming from this classification is that once a situation has attained stage 3, "coyotes on streets, and in parks and yards, in early morning/late afternoon," or greater, "problem" individuals will need to be lethally removed, as nonlethal interventions such as aversion conditioning alone will not sufficiently address the problem (Baker and Timm 2017). For instance, Timm et al. (2004, 55) concluded: "once coyotes have begun acting boldly or aggressively around humans, it is unlikely that any attempts at hazing can be applied with sufficient consistency or intensity to reverse the coyotes' habituation. In these circumstances, removal of the offending animals is probably the only effective strategy." Due to the difficulties of testing such a claim in a non-experimental (naturalistic) setting, it is difficult to either support or challenge this widespread belief.

Coyote Watch Canada observations and experiences in deploying aversion conditioning do not support the assumption that it is not possible to reshape the behavior of coyotes who are beyond a certain level of "habituation." Our CRTs have experienced regular success in mitigating instances of human–coyote conflict even when encounters would have ranked highly on this scale, even at stages 5 or 6. The reason we do not include stage 7 is 2-fold. First, no member of our CRT has encountered a situation in which a coyote has acted aggressively toward humans. Second, the definition of "aggression" in the context of human–coyote interactions remains ill-defined within public discourse, policy, and management realms, as well as the scientific literature. We need more nuanced approaches to characterizing specific,

contextual behavioral responses, as opposed to assumptions and generalizations. Often "defensive-aggressive" behavior (as defined in the canid behavior literature, Fox 1970) is misinterpreted as "offensive-aggression," which can be frightening to those who do not understand what they are seeing. For instance, a coyote may demonstrate defensive behaviors toward domestic dogs within their home ranges or shadow humans with dogs to ensure they leave an area with pups or an active den, and such behaviors are often incorrectly interpreted as aggressive coyotes threatening or stalking humans. Rather than aggression, these are naturally protective behaviors in response to threats to self, family, or territory. There is also a noted trend of humans being bitten by coyotes while intervening in an encounter between a coyote and domestic dog (White and Gehrt 2009, Alexander and Quinn 2011), but as we noted above, incidental injuries as a result of canid–canid conflict should not be defined as "aggression" toward humans.

Furthermore, we find Baker and Timm's (1998, 2017) Behavioral Progression classification to be arbitrary. Why should stage 6, "coyotes seen in and around children's play areas, school grounds, and parks in mid-day," be ranked as more habituated than stage 5, "coyotes attacking and taking pets on leash or near owners; chasing joggers, bicyclists, other adults"? School grounds and parks often represent resource-rich areas containing human refuse and the small animals it attracts, so we would question why the presence of coyotes exploiting these resources in such areas would be characterized as highly problematic habituation, rather than simply signaling the need to manage direct human feeding and anthropogenic food attractants within such spaces.

Again, we assert that food conditioning and proximity tolerance should not be seen as fixed states, but rather as fluid, contextual relationships between individual humans and coyotes that can be reshaped. Similar findings have been noted elsewhere, for instance in Bogan's (2012, 103) research where "the 1 case of emboldened behaviors was sustained as a tendency for 4 weeks, and then transitioned back to avoidance behavior." Thus, we agree with Bogan's (2012, 104) assessment that "conflict interactions may result from short-lived, situation-specific events in which an animal quickly reverts back to an avoidance state." Along with attractant removal and responsible pet care practices, aversion conditioning can be an important part of reshaping coyote behaviors within such temporary conflict scenarios.

Best practice: Nonlethal interventions such as aversion conditioning should be seen as an appropriate response and mitigation tool for coyotes engaging in any behavior that is deemed undesirable by the community.

Conclusions

Our recommendations and considerations for aversion conditioning center on key questions wildlife researchers and practitioners grapple with in implementing this increasingly promoted tool. In terms of what aversion conditioning should entail, we detail the importance of consistency, adaptability, humaneness, and clear goals. In terms of who should implement these techniques and when, we speak to the difference between basic and high-intensity hazing, outlining recommendations in terms of training and proactive implementation. In terms of the how, we contend that aversion conditioning should not be implemented in isolation, but rather as part of a comprehensive wildlife coexistence program that centers on prevention, investigation, education, and enforcement.

In terms of the why, our underlying assumption is that, where possible, nonlethal interventions are always preferable to lethal control, as is increasingly advocated by the conservation community (Dubois et al. 2017). Not only is this an ethical imperative, but nonlethal methods have the potential to be more sustainable and effective in the long term. Lethal coyote management has been the status quo for hundreds of years, and the evidence of its inadequacy in mitigating human–coyote conflict is increasingly dramatic (Sterling et al. 1983, Knowlton et al. 1999, Kilgo et al. 2017).

Management implications

Coyotes are part of the fabric of our urban communities and will remain as such, whether humans wish it or not. Whether grounded in utilitarian arguments of ecosystem service

provision or based on ethical claims about our obligations to other species, we have an opportunity to reshape the nature of our relationships with urban canids into one that is based on promoting compassionate coexistence, and aversion conditioning is a key tool in working toward this end. Wildlife managers should not automatically conclude that there are fixed states of advanced habituation that require lethal removal. Further research based on field observations and community engagement should be conducted to better understand behavioral plasticity in coyotes and the efficacy of appropriately deployed nonlethal interventions such as aversion conditioning.

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