CHAPTER 11

Animal Behavior, Cognition, and Human–Wildlife Interactions in Urban Areas

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Introduction

Interactions between humans and wildlife are accelerating as urban expansion continues (1). Human–wildlife interactions in cities typically arise when humans engage with nature (e.g., visiting green spaces or installing bird feeders) and/or when animals exploit anthropogenic resources and infrastructure for food, travel, and shelter. These interactions subsequently lead to a range of outcomes, including positive, neutral, and negative outcomes that vary in both intensity and frequency (2–4). Though most human–animal interactions are either positive (e.g., derived intrinsic and cultural benefits) or neutral, negative interactions garner considerably more attention than the others (2), with tremendous potential to sway public opinion about individual organisms and biodiversity more broadly. Moreover, given the broad diversity of human perceptions and tolerance of wildlife, a single interaction can yield wildly different outcomes for both the people and wildlife in an interaction. It is thus essential to deconstruct the increasing complexity, subjectivity, and pluralistic perspectives of human–animal interactions (5,6).

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These negative interactions, referred to as human–wildlife conflict (HWC), can yield various negative manifestations for people, such as livestock depredation, injury or loss of pets, physical attacks, disease transmission, and traffic accidents (e.g., 7–10). HWC also includes human effects on wildlife, such as habitat destruction, poisoning, disease, physical and chemical pollution, predation by pets (e.g., by domestic cats; *Felis catus*), and poaching (11–14). Although conflict can take many forms, most conflict results from wildlife behaviors that are misaligned with human desires, which can be highly variable. Consuming food or securing shelter on human property, for example, may be tolerated or even encouraged by humans if the species in question is not perceived as a threat or a nuisance (e.g., squirrels; [*Sciurus sp.*] and songbirds [*Passeri*]). However, if feeding or taking shelter is perceived as problematic (e.g., rats [*Rattus sp.*] and coyotes [*Canis latrans*]), this may motivate residents or urban wildlife managers to prevent such behaviors from occurring (Figure 11.1). Thus, the process by which and intensity with which conflicts arise with wildlife in urban environments, and how conflicts are managed, are not only dependent on the needs of a particular species, but also the perception of that species by people (15). Because high human densities compel wildlife to live alongside people much more intimately in urban versus nonurban areas, cities must produce strategies that actively foster coexistence. Doing

Lauren A. Stanton et al., *Animal Behavior, Cognition, and Human–Wildlife Interactions in Urban Areas.* In: *Urban Biodiversity and Equity.* Edited by: Max R. Lambert & Christopher J. Schell, Oxford University Press. © Oxford University Press (2023). DOI: 10.1093/oso/9780198877271.003.0011

Figure 11.1 Illustrations of how foraging in urban environments may lead to negative interactions between people and wildlife. Although seed feeders are typically intended for birds, other species, such as rodents, will capitalize on them as a source of food (top left). Many species, including pigeons, will feed on garbage, especially when it is not contained or easily accessible (bottom left). Gardens and fruit trees provide urban residents with fresh food and beauty, but are also appetizing to generalist species like chacma baboons (top right). Urban carnivores, including coyotes, may prey upon free-ranging domestic species (middle right). Providing bowls of dry kibble for outdoor cats is prohibited in many places due to the attraction of wildlife, including striped skunks and raccoons (bottom right). The degree to which each foraging scenario is considered problematic will depend on the perception of the people involved, and, in most cases, can be mitigated by human actions and behaviors. Images courtesy of: Jonathan Bliss (mouse on bird feeder); Elizabeth Carlen (pigeons on garbage); Gaelle Fehlmann (baboon on fence); Tali Caspi (coyote with cat); Sarah Benson-Amram (skunk and raccoon food bowl).

so provides a mechanistic pathway that will be essential for conserving biodiversity in cities.

Here, we briefly review how human–animal interactions in urban systems shape wildlife behavior and cognition, highlighting how, when, and why HWC arises in urban environments. We illustrate how conservation behavior principles can be applied in wildlife management, and how these same principles can be co-opted to promote human–wildlife coexistence. Finally, we highlight how the integration of wildlife and human behavioral responses into management can help promote equitable coexistence strategies in human-dominated landscapes.

Understanding and managing urban wildlife behavior

Urban wildlife cognition and behavior

Detecting and avoiding danger, finding food and shelter, and securing mates are critical aspects of fitness and survival in any given environment. To overcome these challenges, animals rely on a variety of **sensory** and **cognitive** abilities that successfully guide their **behavior**. This includes **perception**, **attention**, recognition and categorization of cues, as well as several forms of **learning**, memory, and **problem solving** (16). Over time and generations, animals develop cognitive specializations and behavioral adaptations that enable them to overcome challenges experienced in their environment, shaping each individual's **umwelt** (16). Because urban environments are different from the ancestral environments of many species, animals must learn how to adjust to the new, contemporary challenges associated with city life (17,18). For instance, urban environments may not provide the same resources that a species has encountered in its evolutionary past, and species compositions may vary tremendously within and between urban areas (17,19,20). Thus, urban animals may face different predator assemblages and sources of food than those experienced in nonurban or ancestral environments, or increased competition for resources (21). Furthermore, urban environments may have higher temperatures, greater physical and chemical pollution (e.g., lights, noise, lead), and novel anthropogenic stimuli (e.g., various artificial structures and objects) to which animals must respond appropriately (22).

Given the novelty, complexity, and heterogeneity of urban environments, cognition can allow wildlife to better persist in cities by avoiding environmental mismatches and maladaptation (e.g., **evolutionary traps**), and by creating or altering behaviors that facilitate resource acquisition and avoidance of danger (23). Such behaviors will emerge from a cognitive process whereby individual animals recognize opportunities and dangers and weigh the perceived costs and benefits associated with each, which are informed by several factors unique to the species and individual (24). The resulting behavioral adjustments often differentiate urban individuals from their nonurban counterparts.[1]

Common behavioral adjustments typically include shifts in diet, communication, activity patterns, problem-solving, and temperament (43–45). For example, anthropogenic or non-native sources of food have been documented in species across trophic levels including leopards (*Panthera pardus*; 46,28), house sparrows (*Passer domesticus*; 47,29), and American white ibis (*Eudocimus albus*; 48, 30). Urban individuals may also become conditioned to humans, demonstrating less fear (i.e., appearing bolder) or aggression (i.e., appearing more docile) compared to other, nonurban populations (49). In some instances, acquisition of new foods and other resources will require enhanced **behavioral** and **cognitive flexibility** or problem-solving skills (20,22). Indeed, some research suggests that urban species and individuals have larger relative brain sizes (50) and cognitive experiments with birds (e.g., *Parus major*; 33,34,51,52) and rodents (e.g., *Apodemus agrarius*; 53,35) have found superior learning and problem-solving abilities in urban individuals compared to their nonurban counterparts (Figure 11.2). Although not as widely studied, within-city heterogeneity can also shape wildlife behaviors and should be considered when managing urban wildlife. Urban cockatoos (*Cacatua galerita*) in Sydney, for instance, demonstrate neighborhood-specific bin-raiding techniques and may be in a cognitive arms race with humans despite tireless work to prevent the development of these undesirable behaviors (54,55) (Figure 11.3).

In these ways, cognition may serve as a mechanism that buffers individuals against environmental challenges within urban environments (i.e., **cognitive buffer hypothesis** (30,31,38,39)) and, paradoxically, places them at odds with humans (56).

[1] Avilés-Rodríguez et al.'s chapter discusses how modern molecular approaches demonstrate situations where urban wildlife populations are genetically diverging from nearby nonurban populations, including by spatial isolation and adaptation.

Glossary table

Term	Definition
Attention	The focus of an animal's interest or concern. Because an animal cannot attend equally to all of the stimuli that it perceives at a given time, attention is a limited commodity. An animal must, therefore, selectively attend to whatever is most salient. (77,16,25)
Behavior	The coordinated responses (i.e., actions or inactions) of living organisms to internal and/or external stimuli. Typically excludes responses more easily characterized as developmental changes. Unlike cognition, the behavior of an animal is directly observable. (16,26)
Behavioral flexibility	A broad term that refers to an individual organism's ability to modify its behavior in response to change and variation in its environment. Often used interchangeably with the term cognitive flexibility, which additionally considers the neural and cognitive mechanisms that underpin flexibility in behavior (e.g., inhibition control). (27,28)
Classical conditioning	A form of associative learning in which a relationship is formed between a novel stimulus and an existing stimulus, such that an animal learns one external cue predicts another (may also be referred to as Pavlovian conditioning). (16,29)
Cognition	The mechanisms by which individual animals acquire, process, store, and act on information from their environment. Unlike behavior, the cognition of an animal is difficult to observe and is often, therefore, inferred. (16)
Cognitive buffer hypothesis	Suggests that the primary adaptive function of a large brain is to buffer individuals against environmental challenges by facilitating the construction of behavioral responses. (30,31)
Ecological trap	A specific type of evolutionary trap where an organism makes a maladaptive habitat choice (despite the availability of higher-quality habitat). (32)
Evolutionary trap	A case where, often due to human activity, formerly reliable environmental cues no longer indicate high-quality resources and, consequently, lead an organism to make maladaptive behavioral or life-history choices that yield reduced fitness (despite the availability of higher-quality options). (18,32)
Habitat selection	A hierarchical decision-making process that results in an individual's disproportionate use of certain habitats over others, ultimately influencing their survival and fitness. (33)
Habituation	A form of nonassociative learning that leads to decreased responsiveness to a stimulus that is repeatedly encountered and not followed by any kind of reinforcement. Generally considered to be the opposing counterpart to sensitization. (16,34,35)
Human shield hypothesis	The idea that prey use areas with humans and human infrastructure as a buffer against predation risk. (36)
Landscape of fear	The spatially explicit distribution of predation risk perceived by individuals in a given population. (37)
Learning	A change in an animal's state that is gained through experience. There are many forms of learning, including associative (e.g., operant and classical conditioning) and nonassociative (e.g., habituation and sensitization), as well as asocial (i.e., gained through an individual's own experiences) and social (i.e., gained through observation of, or interaction with, another individual or their by-products). (16,38)
Operant conditioning	A form of associative learning in which a relationship is formed between a stimulus and a response, such that an individual learns to associate its behavior with a particular event or outcome (may also be referred to as instrumental conditioning). For example, aversive conditioning, a common wildlife management strategy, is a form of operant conditioning that creates an association between an undesirable behavior and a negative cue (e.g., fear, pain, illness). (16,29)
Perception	An individual's interpretation of sensory information within its environment. (16,39)
Problem solving	The ability to overcome challenges and obstacles in order to achieve a goal. This is often assessed by presenting animals with novel, but ecologically relevant, operant foraging problems (e.g., puzzles). (40,41)
Sensitization	A form of nonassociative learning that leads to increased responsiveness to a stimulus that is repeatedly encountered and followed by some kind of reinforcement. Generally considered to be the opposing counterpart to habituation. (16,34,35)
Sensory	Refers to an organ or system that conveys, or procures, sense impulses that allow an animal to collect information about its environment. (16,39)
Sensory modalities	Receptors of various stimuli (e.g., light, sound, smell, taste, touch, magnetism) that give rise to particular sensations (e.g., vision, audition, olfaction, gustation). (25)
Tolerance	Capacity to endure continued exposure to a stimulus or environmental condition (e.g., intensity of disturbance) before responding in a defined way. (35)
Umwelt	The integration of an individual's perceptual world and effector world. In other words, it is an animal's own self-world formed by the kinds of information its sensory modalities can process and it acts as the subject. (16,42)

Figure 11.2 Research on how humans and urban environments affect the behavior and cognition of wildlife with implications for human–wildlife coexistence. Left side (top to bottom): Marmosets approaching a researcher making behavioral observations at an urban park in Belo Horizonte (Minas Gerais, Brazil). Assessing the effects of human gaze on herring gull behavior in a coastal town (Cornwall, UK). Setting up a camera trap and novel object to assess animal boldness at an urban park in Oakland (California, US). Placing a Global Positioning System (GPS) collar on an urban leopard outside of Mumbai (Maharashtra, India). Right side: Image of a GPS-collared bobcat taken by a trail camera. Novel object testing to assess boldness in urban grackles. Giving-up density testing to assess risk perception of humans in California ground squirrels. A raccoon standing next to an automated testing device used to assess learning and cognitive flexibility. Puzzle tasks used to compare the problem-solving abilities of urban and nonurban Barbados bullfinches (white plastic cylinder) and striped field mice (colorful LEGO house).
Images courtesy of: Marina Duarte (marmosets), Madeline Goumas (gulls); Cesar Estien (camera trap); Nikit Surve (leopard); Kevin Crooks/CSU/USGS (bobcat); Alison Greggor (grackle); Jennifer E. Smith (ground squirrel); Lauren Stanton (raccoon); Louis Lefebvre (bullfinch); Valeria Mazza (mouse).

Figure 11.3 Examples of urban wildlife management that are based on an understanding of animal behavior and cognition. From left to right: images of humans performing aversive conditioning with a herd of elk by running with a hockey stick covered with flagging material (top) and with a coyote by throwing a tennis ball covered with flagging tape (bottom). Habitat modifications that illustrate the addition of artificial structures to encourage basking of Western pond turtles (top) and the installation of underpasses to provide corridors for mountain lions (bottom). Next, a Cooper's hawk sits next to a plastic owl effigy used to deter avian occupancy (top) and multiple objects placed on trash bins to prevent opening by sulfur-crested cockatoos (bottom). Note: stationary effigies, like plastic owls, are largely ineffective when used alone as depicted in the photo (i.e., as opposed to being paired with other frightening stimuli like movement, sound, lights, etc.). Signs that warn people to avoid interacting with an aggressive mother goose (top) and to refrain from feeding wildlife (bottom).

Images courtesy of: Elsabé Kloppers/Banff Elk Aversive Conditioning Project (elk); Sean Clarkson (coyote); Max Lambert (turtle); Winston Vickers/Karen C. Drayer Wildlife Health Center, UC Davis (mountain lions); Marie Cerda (hawk and owl effigy); Barbara Klump/Max Planck Institute of Animal Behavior (cockatoo); Gabby Barnas (aggressive mother goose sign); Lauren Stanton (procyonid and primate feeding sign).

Managing urban wildlife behavior

While there are various strategies for alleviating HWC, most have historically centered around lethally removing or altering the behavior of urban wildlife. Lethal management, such as poisoning and trapping, may be an effective means of reducing population numbers locally or removing individuals deemed problematic (e.g., 55). However, there are often undesirable consequences of widespread culling and targeted lethal removals (15). New individuals can migrate back into these areas and potentially exacerbate management issues further via animal social instability or disease, as is seen in European badgers (*Meles meles*; 42,43,57,58). Individual animals may also show evolutionary and plastic responses that reduce the efficacy of such lethal strategies, thereby worsening conflict issues. For instance, rats repeatedly develop resistance to anticoagulant rodenticides (59), and some species, like coyotes, demonstrate compensatory reproduction (i.e., increased breeding and litter sizes) when breeding individuals are lethally removed from a population (60). Moreover, animals will avoid toxic baits and traps over time via individual and social learning processes (e.g., 46,47,61,62). Because lethal management is only partially effective and can be tumultuous with the public (63), nonlethal, behavior-based solutions are essential for mitigating urban HWC (Figure 11.3).

To prevent HWC in cities, it is imperative to know the natural history and ecology of a focal species, and how this intersects with various local, urban environmental features and patterns (Figure 11.2). For example, vehicular collisions with ungulates are typically highest during breeding seasons and daily foraging times (64) and animals may behave more aggressively when accompanied by vulnerable offspring (65). Within cities, low-income neighborhoods encompassing higher building vacancy and reduced municipal services may experience increased populations of "pest" species and the potential for disease spread (66,67). Furthermore, certain individual animals may be more dependent on anthropogenic food resources than their conspecifics due to conditioning (e.g., via direct or indirect feeding by humans (68,69) or competition (70,71)). Because urban wildlife behavior is influenced by the spatiotemporal distribution of resources within a city, as well as other neighborhood-specific attributes and local human behaviors, it is critical to avoid static, one-dimensional management strategies and, instead, recognize each individual and species within a given city as a distinct entity.

Behavioral-based solutions to HWC are growing and have been extensively discussed in both academic and management-focused literature (e.g., (48,57,60,63,72–74) (Table 11.1). For situations where animals are seasonally or consistently making use of a particular location or resource that is deemed problematic, oftentimes the most straightforward solution is to identify and either remove or exclude animals from the attractant. For example, removing bird feeders or capping chimneys can prevent unwanted visitation and residency from striped skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), and opossums (*Didelphis virginiana*) (72,75). When removal or exclusion is not possible or insufficient, use of nonlethal deterrents or aversive conditioning strategies may be necessary. These strategies entail harassment, lights, flavors, sounds, smells, and

Table 11.1 Examples of how knowledge of animal behavior and cognition has been leveraged in urban wildlife management.

Issue	Strategy
Western pond turtles (*Emys marmorata*) are an imperiled species endemic to the North American western coast and are poised to be listed under the Endangered Species Act soon. They are skittish around humans and will immediately abandon their basking sites if they see people. This is a problem in urban areas because turtles are ectotherms that rely on basking for warmth in order to metabolize their food, clear parasites and pathogens, and become sexually active. Furthermore, urban pond management typically involves the removal of large pieces of wood because it is not considered to be aesthetically pleasing and makes pond maintenance more challenging. However, this practice reduces potential basking sites for turtles.	Observations of Western pond turtle behavior in an urban waterway of Davis, CA allowed researchers to estimate the distance that turtles can see humans and subsequently flee by abandoning their basking sites. Practitioners in urban areas of California have since installed logs or artificial basking platforms that were far enough away from walking paths where people can still see the turtles but the turtles are not disturbed by people and will continue basking (Figure 11.3). This simple habitat manipulation addresses a key limiting habitat feature for this imperiled species in urban areas. (76) (MR Lambert, personal experience)
Road and railway collisions with wildlife pose economic losses and safety concerns for humans and are a major source of wildlife mortality around the globe (especially for large carnivores and ungulates). Previous strategies, including fences and visual warning systems (e.g., flashing lights), are reported to be only marginally effective at preventing train collisions. Although acoustic warning systems using sirens have shown more promise, animals will habituate to the sirens over time, meaning that these systems may only be temporarily effective at preventing train collisions.	Researchers in Japan and Poland have recently implemented train warning systems that emit recordings of alarm calls of local animal species. Preliminary findings suggest that animals are highly responsive to the alarm calls, and these "natural" warning systems are effective at reducing train collisions. Importantly, because these signals are ecologically relevant, it is less likely that habituation to the alarm calls will occur, providing a more long-term solution. (77,78,79)
In urban areas, animals may become habituated to humans and learn to capitalize on anthropogenic resources. In cases where habituation and associative learning become problematic, such as through overpopulation, loss of natural behaviors, disruption of trophic relationships, or threats to human safety, managers may elect to use aversive conditioning to sensitize animals to humans and deter the use of urban spaces and resources. Although aversive conditioning can successfully alter behavior, there is substantial individual variation in animal response to aversive conditioning treatments, and its desired effects may be lost (i.e., extinguished) over time.	Researchers have applied principles from animal personality and learning theory to better understand the efficacy of aversive conditioning treatments in elk (*Cervus canadensis*) that congregate in towns adjacent to Canadian protected areas (Banff and Jasper National Parks). Bold elk demonstrate greater responsiveness to aversive conditioning treatments (e.g., humans chasing elk with hockey sticks covered in flagging tape; Figure 11.3), but also faster extinction of learned wariness compared to shy elk, which may help explain the individual variation in responses to aversive conditioning. In accordance with learning theory, researchers also found that the frequency of aversive conditioning treatment matters: when aversive conditioning is too mild or infrequent, wariness of humans will not be learned by elk, but when implemented too frequently, it becomes predictable and increases the likelihood of habituation to the treatment. It is, therefore, suggested that aversive conditioning be conducted at intermittent frequencies (e.g., once every two weeks), as this will allow wariness of humans to be learned and maintained over longer periods of time. (80–82)

continued

Table 11.1 *Continued*

Issue	Strategy
Many urban habitat features, such as lawns, ledges, and utility poles, provide unintentional harborage for various avian species. Group foraging, nesting, and roosting can lead to property damage and accumulation of feces around homes, buildings, and public spaces, prompting the removal of the birds to be desired by urban residents. In agricultural landscapes, managers and farmers often employ avian frightening devices that are species- and context-specific, typically incorporating a combination of lights, sounds, movement, and even taxidermies applied at unpredictable intervals. However, the use of such frightening devices may be too time-consuming and disruptive for conflict mitigation in urban areas. Although stationary effigies, like plastic owls (Figure 11.3), serve as popular alternatives in urban areas, they are largely ineffective due to rapid habituation by birds.	Dynamic frightening devices that can recognize and respond to specific species and behaviors may be a promising new management tool in urban areas. For instance, a Denmark-based research group is developing adaptive scaring technology that uses automatic recognition of barnacle goose (*Branta leucopsis*) vocalizations to identify undesirable behaviors (e.g., foraging) and subsequently activate auditory frightening stimuli (e.g., distress calls). Such selective application of aversive conditioning can help reduce the likelihood of habituation by wildlife and disturbance to the public. Other conflict scenarios with urban birds can be resolved with simpler habitat modifications using physical barriers, such as nets and spikes. For example, researchers in Pretoria, South Africa found that bird spikes placed on buildings were more effective at reducing pigeon numbers on a university campus compared with several commercially available visual deterrents. Integration of alternative roosting and nesting options alongside exclusion measures can bolster coexistence in urban areas. Examples of such innovative, bird-friendly designs date back to 16th-century Persia (e.g., "pigeon towers") and can be seen in other works of modern architecture, including Oscar Niemeyer's "Pombal" in Brasília (Brazil) and Antoni Gaudí's "Parc Güell" in Barcelona (Spain). (86–85)
In South Africa, troops of chacma baboons (*Papio ursinus*) will enter urban spaces in search for anthropogenic food. During these brief, high-activity "raids," baboons will forage in garbage bins, cars, and homes, and try to take food directly from people. Such interactions threaten the health, safety, and food security of residents, and often result in the killing of baboons. The adaptive responses of baboons to various mitigation attempts over time have made the management of this negative interaction between humans and baboons very difficult.	In Simon Town, researchers attempted to alter a troop's raiding behavior by providing a supplemental feeding patch located away from people and urban areas. Although food provisioning alone did not significantly reduce urban space use by the troop, it became more effective when paired with exclusion from the main food waste sites (i.e., when enclosed in wire mesh). Another study in Cape Town found that field rangers engaged in the monitoring and deterrence of baboon troops reduced the amount of time baboons spent in urban areas by 70%, and that the intensity of deterrence had a significant effect on baboon activity as well. New research focused on individual and social behavior of baboons is providing additional insights on the adaptive responses of baboons to field rangers that can be used to improve aversive conditioning strategies (e.g., identify which individual baboon(s) to target; frequency and consistency of strategy). The implementation of multiple management strategies informed by behavioral research is effectively reducing the frequency of conflict between people and baboons with additional solutions on the horizon. (86–88)

startling movements (or preferably a combination thereof) to repel animals from a given attractant or to **sensitize** animals to humans and other anthropogenic dangers (e.g., roads and railways). To ensure that animals will respond successfully, these strategies must be tailored to the species' sensory modalities such that it can be perceived and attended to by the focal individual(s). For instance, scent-based deterrents are more salient for species with greater olfactory capabilities, such as rodents and carnivores, whereas visual deterrents may be most effective for species that are more reliant on visual information, such as birds and primates (16).

A critical point of note is that eventual **habituation** or **tolerance** to behavioral-based strategies may undermine mitigation efforts. Animals typically habituate to the continued use of nonlethal tools that lack a negative stimulus, and thus additional frightening stimuli may need to be periodically administered. Alternating practices and employing multiple deterrents that target different **sensory modalities** at once may also be more effective than when left permanently or used singularly (72,29,34). This may be particularly applicable for urban individuals that are likely to be behaviorally flexible and/or highly conditioned to the use of anthropogenic resources (56). Importantly, such strategies will only be effective at deterring or repelling wildlife if alternative resources and attractants are available (59,73; Table 11.1). As such, it is equally important to design and manage urban habitat in ways that will reduce conflict and promote the well-being of both people and wildlife living there.

Managing urban habitats

Heterogeneity in urban habitats

Legacies of residential segregation and ongoing social inequity have created unequal environmental services and benefits within cities, and this affects the well-being of, and relationship between, people and animals (15,89).[2] For example, socioeconomically advantaged groups living in greener, more biodiverse neighborhoods (i.e., the luxury effect; 64,90) generally experience a higher frequency of positive interactions with a diversity of wildlife, whereas disadvantaged groups living in impoverished neighborhoods may not only experience fewer positive interactions, but also have more negative interactions with pest species (6,91). Nevertheless, residents of marginalized communities may be less likely to report conflict with wildlife, possibly due to distrust of local governments (92). They may also harbor general apprehension toward greening initiatives due to the perceived dangers associated with vegetation (93) and fear of displacement or erasure via neighborhood gentrification (94). Such differences in urban resident experiences and perspectives toward wildlife should be taken into account when managing urban habitats (95).

Although the effects of environmental disparities on human health and well-being have long been articulated in the environmental justice literature, we currently do not know the extent of racial oppression and social inequality on animal behavior, cognition, and human–wildlife interactions (89). For instance, environmental disamenities like heavy metal pollution (e.g., affecting European honey bees [*Apis mellifera*]; 96), roadway noise (e.g., affecting rats; 71,97), and use of pesticides (e.g., affecting bobcats [*Lynx rufus*]; 72,98) are typically higher in neighborhoods of low-socioeconomic status (e.g., 99–101) and can disrupt physiological, behavioral, and cognitive development. Furthermore, diets high in anthropogenic foods may increase animal boldness through complex pathways in the gut–brain axis (e.g., 76,102), indicating that increased access to garbage via poor municipal services could have reverberating consequences on wildlife behavior. Vacant, unmaintained structures are hospitable for many "pest" species, which can thereby increase population numbers and the potential for disease transmission in neighborhoods with greater vacancy and general disrepair (66,77,78,79,92,103,184). Similarly, increased consumption of anthropogenic subsidies by wildlife due to a lack of municipal services and improper waste management can be distressing to people and can negatively impact urban wildlife health (e.g., periodontal disease and hyperglycemia in raccoons (104,105); compromised immune function in coyotes (106).

Thus, the same environmental disamenities that disproportionately harm minoritized communities might spillover to jeopardize wildlife and human–wildlife relationships.[3] Providing environmental education, equitable green space access and infrastructure, efficient waste management, sound housing integrity, and maintaining/modernizing transit routes are a few of the many justice-centered habitat management strategies that can promote environmental health and more positive interactions with urban wildlife across cityscapes (89).

Animal behavior and cognition research is central to urban design and planning

There is growing recognition that urban areas can play a role in biodiversity conservation by attracting and supporting animal populations (107,108).[4] Some of the features that attract animals to cities include protection from predators that may

[2] Hoover's and Scarlett's chapter discusses contemporary impacts and historical legacies of systemic racism and classism on urban nature.

[3] Byers et al.'s chapter outlines the intricate relationships between equity and human and wildlife health in cities.

[4] Lambert's and Schell's chapter details the emergence of urban biodiversity conservation in science and society.

be excluded by urbanization (i.e., **human shield hypothesis**, (36,84,85,109)), built structures that serve as shelter and nest sites, and food sources that are provided both intentionally and unintentionally (107,110,111). It is important to recognize that these attractants can produce unintentional negative conservation outcomes by enhancing non-native populations, increasing HWC, or reducing the fitness of native species, yet they also have the potential to contribute to conservation. For instance, nest boxes can be designed with optimal dimensions to attract native birds, with guards to protect against predators, and without the perches that tend to attract more aggressive species (112). Thus, a behavioral approach to urban biodiversity conservation involves understanding the specific cues animals use in **habitat selection**, providing those cues, and ensuring that they lead native species to places where they can be successful while avoiding any unintentional negative outcomes.

Green spaces are an important tool for promoting urban biodiversity, particularly when they are restored or designed with cues that encourage settling, shelter, food, and breeding resources used by native wildlife (107,108,113). Designing green spaces that are attractive to native wildlife often involves planting specific trees and plants, mimicking the habitat structure of nearby wildlands, incorporating riparian areas into city parks, and clustering them with other green areas and gardens to allow connectivity within the urban matrix[5] (114–117). Indeed, connectivity of green spaces presents a major challenge for wildlife and can be difficult to achieve, especially when it conflicts with other management goals. For instance, fences and other linear barriers can be useful for mitigating HWC in and near cities (15), yet they can have varying effectiveness (118) and can shift problematic human–wildlife interactions elsewhere (119). Fences also produce ecological "winners" and "losers" depending on context and scale, impacting factors as varied as habitat structure, community structure, animal behavior, and gene flow (120). Thus, careful planning and integration of green spaces and fencing should be undertaken when designing urban habitats.

For species that use social information to select habitat, conspecific cues—including acoustic calls, odors, or visual models—may help bring animals to high-quality habitat (113,121). The mainstreaming of such approaches may be useful in future, cutting-edge biodiversity management strategies, such as urban translocations.[6] In addition to incorporating cues that attract animals to urban green spaces, it is also critical to limit cues that repel them, which may include chemical, noise, and light pollution, or the presence of humans (73). If minimizing human disturbance is not possible, the impacts of those stimuli may be gradually reduced over time with repeated exposure through deliberate strategies to promote habituation (113,122). Of particular concern is the potential for cities and restored habitats to become **ecological traps** (123) if animals are attracted to urban settings but populations fail to persist because of excess predation, low-quality food, low reproductive success, or mortality associated with HWC (124). Hence, wildlife populations in cities must be studied and managed carefully, typically with a species-specific approach, to detect and disarm ecological traps (125,126).

There have been repeated calls for mechanistic research on how urban systems affect HWC and biodiversity in order to inform urban planning (111,123,124). For example, we need a better understanding of the factors that influence individual colonization, dispersal, breeding success, mortality, and responses to human disturbance (124). Understanding how various wildlife species perceive cues and make decisions that guide their behavior in urban environments will enable us to predict how wildlife should respond to urban habitat designs and manipulations (Figures 11.2 and 11.3). This will help inform the optimal size, type, and connectedness of green spaces, determine when they become

[5] Stanford et al.'s chapter outlines key urban ecological design principles that enhance habitat quality for city planning.

[6] Spotswood et al.'s chapter begins creating an urban conservation toolbox and emphasizes the need to report standard conservation tools, innovate tools, and create new approaches for urban biodiversity given the unique nature of urban environments.

ecological traps, and suggest ideal buffer areas and limits to human visitation, with the ultimate goal of increasing biodiversity, decreasing HWC, and minimizing the homogenizing effects of urban environments (123,124).

One issue that has been studied extensively is how road crossing structures can be designed to target and enhance use by different taxa, depending on features like location, size, vegetation, nearby ponds, and elements that block noise and light (127–129) (Figure 11.3). Wildlife overpasses are not typically implemented in urban settings because of their high cost and space requirements compared to underpasses (127). However, the world's largest wildlife overpass, the Wallis Annenberg Liberty Canyon Wildlife Crossing (LCOC), is currently being constructed over US-101 in Los Angeles County, largely due to a successful public campaign to protect mountain lions (*Puma concolor*) in this urban biodiversity hotspot (127,128). Previous research on the behavior of mountain lions and other wildlife species has demonstrated that excessive noise and light can inhibit the use of wildlife crossings (129). Therefore, to increase its use by wildlife, several structural features are being integrated into the LCOC, including strategically placed noise barriers and berms, that will provide functional reduction of anthropogenic noise and glare and contribute to a more attractive approach zone for mountain lions and other urban species (128).

Many of the urban improvements that benefit wildlife can also benefit human health and well-being (95).[7] However, not all urban residents will support environmental initiatives that increase green space or wildlife populations. Furthermore, without education and participation in wildlife management strategies, residents may continue engaging in behavior that unknowingly contributes to HWC. Thus, it is essential that urban planning, ecological restoration, and neighborhood improvements be equitable and accompanied by educational outreach and partnership with local communities.

[7] Byers et al.'s chapter's approach to One Health in cities outlines how to improve wildlife and human well-being together.

Managing human expectations and behavior

Urban wildlife behavior as a function of human behavior

Managing animal behavior and habitats are important components for fostering urban human–wildlife coexistence, yet urban wildlife behavior is fundamentally a function of human behavior. Individual animals and species demonstrate differentiated behaviors depending on their perception of humans, which can be measured using assessments like flight initiation distances (e.g., 106,130), giving-up densities (e.g., (107,131), and playbacks (e.g., 108,132) (Figure 11.2). For example, one study found that residents of Seattle were more discouraging toward birds compared to residents of Berlin and, correspondingly, found higher flight initiation distances in Seattle vs. Berlin with the highest scores exhibited by species typically considered to be a nuisance (i.e., crows [*Corvus brachyrhynchos*] and starlings [*Sturnus vulgari*]; 133). Species like pigeons (Columba livia) or squirrels that are generally ignored by humans are likely to habituate to the presence of humans over time, whereas species that fear humans or are repelled by anthropogenic pollution (e.g., noise) may become sensitized to human presence. Urban species ranging from small primates (marmosets; *Callithrix penicillata*) to large carnivores (mountain lions) will avoid humans by adjusting their activity (134–137) and movement (i.e., **landscape of fear hypothesis**; 138) around predictable human cues (e.g., diurnal vs. nocturnal patterns, weekday vs. weekend activities). Indeed, pulses and pauses in human activity will affect animal activity, which was most clearly illustrated during the recent stay-at-home orders during the Covid-19 pandemic, when many animals altered their movement and habitat use patterns in response to reduced human activity (138). Interestingly, species that receive frequent, mixed feedback from humans (e.g., sometimes fed, ignored, and/or harassed) may attend to certain cues that allow them to recognize and differentiate among individual humans, and may categorize humans as "safe" or "dangerous" (22,139). Thus, urban wildlife behavior is increasingly understood as a reciprocal function with human behavior (140,141), highlighting the importance of understanding what drives human attitudes and behaviors toward wildlife.

Perceptions and attitudes toward urban wildlife

Human–wildlife interactions in cities and elsewhere are heavily influenced by people's perceptions, experiences, values, and attitudes (e.g., 142,143).[8] Importantly, human attitudes and tolerance are both commonly used proxies for predicting human behaviors toward wildlife, such as whether a person will support or actively participate in (legal or illegal) lethal removal of certain species or "problem individuals" (e.g., 10,144,145). As such, human behavior, situated within sociocultural and political contexts, is a critical component of all human interactions with wild animals (146). These behaviors can be driven by many factors, including experience and emotion, relationships with the sociopolitical surroundings, and resulting risk perceptions and attitudes (147). For example, residents of Singapore were more likely to exhibit tolerance of, and positive attitudes toward, nuisance wildlife if they had had more childhood nature experiences (148). Sociocultural and religious feeding practices in cities around the world may provide personal enjoyment and connection with nature (69,149) despite it sometimes contributing to poor health (e.g., 126,150) or increased aggression in urban wildlife (e.g., 151,152). People's perceived (even if not real) risks from certain species can also be strong predictors of whether they have negative attitudes toward the conservation of other species (143).

Just as wildlife perceptions of their environment are important drivers of human–wildlife interactions, so too are people's perceptions of their environments. Across the global spectrum of human–wildlife interactions, human perceptions of wildlife and of each other have a strong influence on how humans interact with and manage certain wildlife species. "Human–human conflicts," such as inequities, cultural differences, and top-down policies, underlie nearly all human–wildlife conflicts (153,154).[9] People's perceptions can vary across scales and locations, differ from what is scientifically or ecologically recorded, and influence wildlife conservation and coexistence efforts (155–157).

For example, in many cities there exists a debate over whether coyotes "belong" within cities (see Case study: The ubiquitous urban coyote), especially as they pose a threat to people's outdoor cats, pets, and poultry (9). People's propensities to support lethal control of urban coyotes can be influenced by their gender identity, level of fear toward coyotes, where they live, and willingness to interact with their local government agencies (e.g., 134,158). Yet, people who express concern about conflicts with urban wildlife, stemming from both actualized conflict instances (e.g., crop raiding and loss of domestic animals) and intangible factors (e.g., personal anxiety), can still support nonlethal interventions for the wildlife in question (159). This dichotomy of opinion between advocates for domestic animals and advocates of wildlife conservation is common in cities and can impact urban wildlife conservation policies. Human perceptions of particular species are also key to understanding how to promote coexistence (155). For instance, people are more supportive of conservating species for which they have an aesthetic appreciation (e.g., red-tailed hawks [*Buteo jamaicensis*]; 136,160) than those that they fear or deem aesthetically unpleasing (e.g., bats [*Chiroptera* spp.]; 137,161).

Improving attitudes and behaviors toward urban wildlife

Urban human populations are not uniformly welcoming to wildlife in their backyards and many people do not have equitable access to nature, positive interactions with wildlife, and the benefits of conservation policies (89). Fortunately, there are many strategies currently in use to foster pro-environmental perspectives, such as tolerance and local environmental stewardship, in urban areas.

[8] Larson's and Brown's chapter details the perceptions and motivations of people toward biodiversity in cities and suburbs.

[9] Kar Gupta et al.'s chapter illustrates the value of developing flagship or umbrella species for urban conservation as ways to bridge human–human conflict.

For instance, providing equitable access to environmental resources and services is key to addressing within-city heterogeneity in experiences with and risk perceptions about urban wildlife. People from low socioeconomic and ethnic minority backgrounds have been found to have access to fewer acres of urban parks, and access to parks with lower quality and safety than more privileged groups (162). Because childhood nature experiences and other forms of place-based nature experiences for all age groups can have positive effects on attitudes toward wildlife and the environment (148,163,164), cities should prioritize bolstering and perpetuating nature access programs and organizations, such as City Parks Alliance (https://cityparksalliance.org/) and Groundwork USA (https://groundworkusa.org/). Additionally, to be most impactful, cities should foster educational programs on urban wildlife that provide experiential training about wildlife behaviors, reducing wildlife attractants, familiarization with green spaces and safety, and employing nonlethal wildlife management techniques.

Case study The ubiquitous urban coyote

Coyotes have rapidly expanded their range and now live in most urban areas across North America (165). They can be of concern to humans because of the risks they may pose, including attacking people or their pets. While incidences of attacks are low relative to the abundance of people and coyotes living in urban areas and the frequency of human–coyote encounters (166), coyotes require management strategies that ensure human safety (and perceived safety) while allowing for coexistence. Research has long focused on how coyotes navigate urban environments, and we have learned that urban coyotes may be bolder than rural coyotes (41,167,168), descend from a few individuals (169), temporally avoid humans (170–172), and take advantage of anthropogenic food resources (106).

Research into coyote cognition is limited to only a few studies, but coyotes have demonstrated behavioral and cognitive flexibility across multiple tasks and experimental paradigms (173–175). This flexibility can facilitate the behavioral adjustment and spread of coyotes in urban environments. For example, urban coyotes primarily consume prey similar to that of rural coyotes (176) but have more diverse diets than rural coyotes, which is largely caused by the addition of anthropogenic food into the diets of urban coyotes (177). Urban coyotes are also bolder and more exploratory than rural coyotes (178), which allows them to discover and access more resources.

This same flexibility, however, may also be bringing coyotes into greater conflict with humans (56). For example, some urban residents intentionally feed coyotes or may provide food unintentionally, such as how urban coyotes are attracted to compost piles (179). In both scenarios, coyotes are more likely to make contact with humans which increases the spread of zoonotic diseases and rates of human–wildlife conflict. Similarly, emboldened coyotes may be more likely to attack humans and their pets (56,178). Conflicts with pets can be especially difficult to navigate because there are perceptions and beliefs associated with both coyotes and pets. For example, many cat owners believe their cats should be allowed to roam freely outdoors (180,181), and consider outdoor cats as family members (e.g., 181,192), and therefore may become vocal advocates for more intensive management of coyotes and other mesopredators even though domestic cats can cause considerable losses to native wildlife (182).

Despite the widespread presence of coyotes in urban areas across North America, observational and experimental research has only recently been used to inform management decisions that mitigate risks. For example, a study in the Denver Metropolitan area found that teaching residents to haze coyotes (183,194) as a nonlethal tool to reduce conflict may not be effective reactively (i.e., once a coyote has become too emboldened or involved in conflicts with humans) but can be used proactively (165,176). This work suggests that selective lethal removal may also be needed. In the same region, surveys of human views about lethal and nonlethal tools found that an individual's perceptions (e.g., fear) and beliefs about coexistence predicted support around lethal control (134,158). Researchers have also experimentally looked at how common practices can be used as nonlethal tools (e.g., 184,195) and how experiential learning can create more positive perceptions about coyote encounters (185,196). Cities are beginning to use these findings to create management and outreach (186,197), but additional work is still needed to improve the language used to describe coyotes (187,188,222,223) that addresses the complex beliefs and perceptions of people sharing spaces with coyotes (134,158,185,196).

Future directions in human–wildlife coexistence in cities

There are several exciting new frontiers in the study of urban wildlife behavior and cognition that will further inform our ability to promote coexistence between humans and wildlife. Recent research, for example, has begun to uncover the effects of urban diets and the gut microbiome on behavior (e.g., 189,141) and identified potential feedback loops that may be influencing human–wildlife interactions (e.g., 106,184). The distribution and abundance of food resources contribute to higher densities and more frequent social interactions for some species in urban environments (190), which has implications for not only zoonotic disease transmission, but also the evolution of animal sociality and behavior (e.g., raccoons) (191,192). Furthermore, studies that link behavior and cognitive ability to specific features of urban environments, such as human activity vs. human footprint, green space, and competition (e.g., 41,111,135,209), as well as fitness (51), are providing new insights and needed clarity on the role of cognition in urban living. However, many knowledge gaps remain. For instance, most studies discussed here focus on dichotomous comparisons between urban and nonurban cognitive and behavioral responses. Few within- and between-city comparisons of behavior exist (e.g., 109,133), which are essential for deconstructing the fine-scale contributions of societal inequity to the emergence of behavioral traits often associated with conflict in cities.

Future research on urban wildlife behavior can also be leveraged to gauge the well-being of urban populations, assess the effectiveness of various management strategies, increase positive perceptions of and experiences with wildlife, and predict the occurrence of conflict with urban species. For example, to understand whether greening efforts are increasing biodiversity and coexistence, investigating if and how animals are using resources within green spaces (e.g., food, shelter) and how they perceive and interact with humans (e.g., attraction, repulsion, indifference) will be more informative for long-term population establishment compared to single measures of abundance and richness. Furthermore, the ubiquity of common urban species often leads to the assumption that these individuals are "thriving" in cities, yet several studies demonstrate that urban populations may be in poor health, highly inbred, physiologically stressed, and combating ecological traps (13,193–195). Thus, quantifying wildlife health (e.g., body condition, diet, disease) and species-specific behaviors (e.g., movement, habitat use, communication, competition, reproduction) in urban environments can provide a useful baseline by which we gauge population trends and the success of our management strategies over time. In addition, because the temporal and spatial occurrence of human–wildlife interactions are moderately predictable, and conflict is hugely influenced by human perceptions and behaviors, quantification of social and ecological factors unique to a neighborhood can allow us to predict the occurrence of conflict and create more positive experiences with wildlife. For example, HWC in Chicago was most likely to occur in areas where humans and wildlife overlap; however, complaints of raccoons and opossums were more likely to be reported in high- versus low-income neighborhoods, despite higher occupancy of these species in low-income neighborhoods (92). Thus, pairing data on the behavior of urban wildlife across species, seasons, cities, and neighborhoods with participatory surveys on local human attitudes and interactions with wildlife will allow us to build predictive models that prevent impending conflicts based on: (1) how various wildlife utilize urban space and (2) how human residents vary in their perceptions of those wildlife.

Engaging urban residents in surveys and other participatory science efforts may provide extraordinary insight to help mitigate future conflicts. Participatory science[10] can be a productive method for gathering data about biodiversity and wildlife behavior (196), understanding and addressing HWC (197), and engaging community members with wildlife conservation issues (198). Researchers can actively develop participatory research projects

[10] Perkins et al.'s chapter details how to enhance the value of participatory science methods for better biodiversity data, improving environmental equity, and enhancing urban wildlife opportunities.

in collaboration with urban community members to manage motion-activated camera traps, assess water quality and other indicators, look for wildlife tracks, and undertake various other activities that can support management and coexistence goals coproduced with local communities. Researchers can also utilize freely available data collected through participatory science social networks in which people log organism sightings, such as iNaturalist (https://www.inaturalist.org/) and eBird (https://ebird.org/), both of which house substantial numbers of observations in urban areas. Additionally, urban residents are keen to express their experiences with wildlife, and often do so via neighborhood communication platforms such as NextDoor (https://nextdoor.com/). Despite the inherent reporting biases of all participatory social science networks, they are increasingly being viewed by scientists as a valuable resource for both public engagement and data collection about human–wildlife interactions (199,200). Finally, many local government agencies and institutions have options for reporting wildlife sightings and interactions (e.g., Carnivore Spotter: https://carnivorespotter.org/, and San Francisco Animal Care and Control coyote observation report: https://www.sfanimalcare.org/), which provide yet more avenues of both data collection and community engagement.

Perhaps the greater challenge is developing a tangible consensus around what coexistence entails. One recent definition of coexistence suggests it is "a dynamic but sustainable state in which humans and wildlife co-adapt to living in shared landscapes, where human interactions with wildlife are governed by effective institutions that ensure long-term wildlife population persistence, social legitimacy, and tolerable levels of risk" (147,201, p. 787). With so much variation in human attitudes and societal disparity present in any given city, let alone a region or nation, how can we determine what social legitimacy and tolerable levels of risk are? Although complex, the answer lies in partnering with communities to bolster environmental education and justice so that residents better understand local urban wildlife and have the tools that will allow people to actively participate in biodiversity conservation and coexist with wildlife.

Global perspectives

Both large-scale and within-city patterns and consequences of urban human–wildlife interactions have been studied worldwide but such studies have mostly been conducted in "Global North" nations, particularly the US (202). However, human values, culture, politics, and urban design show tremendous variation around the world. As such, our ability to apply wildlife behavior research and translate inferences about human–wildlife interactions from one part of the world to another requires a globally representative body of work. For example, human social factors, such as culture, politics, and religion, and ecological factors, such as season, vegetation structure, water availability, and green space sizes, all vary within and across urban areas worldwide (203). This results in variations in human–wildlife interactions across spatial and temporal scales, as well as variations in the types and levels of biodiversity that can be maintained (204). In a broader-scale example, different distributions of people and birds across multiple urban areas in England were correlated to ecosystem services and disservices provided by birds, where people in the lowest socioeconomic groups experienced the same level of disservices but fewer services (205).

Global research also demonstrates that these contextual factors can vary at a finer scale, within cities. Cities are usually heterogeneous in multiple ways, often as a function of socioeconomic histories and present experience. Socioeconomics and other cultural histories can lead to spatial differences in availability of green space and ecological health, which then determine where and how people and wildlife interact, as well as within-city differences in biodiversity outcomes (e.g., 89,63). For example, the size of long-tailed macaque (*Macaca fascicularis*) troops, and the relative number of infants within them, varied with active provisioning of food by tourists among three sites in Padang, Sumatra (206). The researchers noted that managing human provisioning could reduce macaque population growth and the growing rates of human–macaque conflict, such as crop-raiding and aggressive behavior toward visitors (207,208). Similar variation in human–wildlife interactions was seen in Belo Horizonte, Brazil, where the people who called the environmental police to report human-caused injuries to birds were more likely to have high salaries (209).

Variations in green space allocation and other types of land management within cities can also affect how vegetation is impacted by typical wildlife behavior. For example, there was little variation across 15 sites within the city of Wellington, New Zealand, in tree damage caused by sap-sucking behavior of North Island kākā birds (*Nestor meridionalis septentrionalis*, (166,210)). Instead, the most important predictors of damage were tree characteristics (e.g., tree species and diameter), which varied depending on the city's history of protecting and creating green space. To alleviate conflicts and dangers such as treefall, while maintaining high human tolerance for kākā, researchers recommended that managers prioritize planting and managing tree species that are more resilient to sap-sucking behavior. In short, diverse sociopolitical contexts and histories of biodiversity and wildlife management within cities can have consequences for human–wildlife interactions, human opinions on wildlife management, and resulting policies.

Social-ecological applications

While urban landscapes are rapidly changing, so are the perceptions, beliefs, and equity of people living in cities, as well as the way information is disseminated and absorbed. These changes will likely influence urban wildlife behavior, interactions with humans, and the positive and negative effects of cognition on human–wildlife interactions. It is critical that studies of urban wildlife behavior and cognition are intersectional (211), accounting for the sociopolitical landscape. This has the potential to improve human–wildlife coexistence via informed wildlife management, create opportunities for community involvement, and enhance environmental justice (89).

While a deep understanding of animal behavior and cognition can improve our ability to develop policies and management practices that improve coexistence, management actions and human behavior are often unrelated to policies and are instead based on human experience and histories (212,213). In some scenarios, outreach and education may be the best strategies for reducing human–wildlife conflicts, but in other cases better enforcement of policies may be needed (214). Further, there may be scenarios where efforts to reduce conflict are difficult to achieve because humans are unwilling to change their behavior, such that resources would be better invested elsewhere (215,224). However, these scenarios could improve by considering within-city differences that allow for better community engagement.

For example, for several decades leopards (*Panthera pardus fusca*) in Mumbai were involved in conflict after translocations (216) likely because of challenges acquiring food and shelter, especially when a hard release was used (217,218). However, researchers also recognized the methods communities used to capture leopards for translocations were varied, with many causing injury and stress to the leopards (219). At the same time, journalistic coverage of these capture events and human–leopard conflicts used negative and incendiary language (220). Subsequently, researchers worked with local officials from various parts of the greater Mumbai area on humane capture and handling (*personal communication to author Young*), while also hosting information clinics with journalists that challenged perceptions and beliefs (220). Today, these efforts have resulted in fewer deaths and injuries to leopards and people during and after translocations. This example combining an understanding of leopard behavior and management needs (i.e., post-translocation conflict propensity due to lack of resources) with the beliefs and perceptions of people illustrates the power in considering all aspects of urban communities to inform policies and actions.

Conclusion

Wildlife use cognitive abilities to guide their behavioral responses to environmental conditions (16). In urban environments, humans play an especially outstretched role in this process across multiple scales. From city design and resource distribution, to individual encounters with nature, to wildlife management and environmental policy, our actions have a prominent influence on the way animals perceive and behave in urban environments (91,140,141). To manage wildlife in a way that promotes coexistence and biodiversity, we must consider not only which ecological attributes make cities attractive, safe, and hospitable for a variety of species with unique needs and umwelten, but also how human attitudes and actions impact urban wildlife behavior and eventually feed back into human society. Like any wildlife conservation or management program, our success hinges on the support and participation of interested parties (5). Thus, we must work to become culturally competent and cognizant of the preferences and expectations of a diverse public, and thereby strive to develop and employ multiple urban management strategies that can serve all communities equally.

In many cases, urban habitat and wildlife management actions can improve the health and quality of life for both people and animals. Making cities more equitable, such as by increasing presence of and access to natural resources like wild habitats and alleviating exposure to disamenities like pollution, has the potential to increase biodiversity and shape more desirable behaviors in wildlife. Providing equitable green space access and infrastructure, efficient waste management, sound housing integrity, and supporting ecocultural relationships with nature are a few of many justice-centered management strategies that can promote more positive perceptions of and interactions with urban wildlife (89). Justice-centered management efforts will, therefore, create a more resilient system by which humans and wildlife can coexist.

References

1. Lambert MR, Brans KI, Des Roches S, Donihue CM, Diamond SE. Adaptive evolution in cities: progress and misconceptions. Trends in Ecology and Evolution. 2021;36(3):239–57.
2. Soulsbury CD, White PCL. Human–wildlife interactions in urban areas: a review of conflicts, benefits and opportunities. Wildlife Research. 2015;42(7):541–53.
3. Cram DL, van der Wal JEM, Uomini N, Cantor M, Afan AI, Attwood MC, et al. The ecology and evolution of human-wildlife cooperation. People and Nature. 2022 Aug;4(4):841–55.
4. Harris NC, Wilkinson CE, Fleury G, Nhleko ZN. Responsibility, equity, justice, and inclusion in dynamic human–wildlife interactions. Frontiers in Ecology and the Environment. 2023. Available from: https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/fee.2603
5. Riley SJ, Decker DJ, Carpenter LH, Organ JF, Siemer WF, Mattfeld GF, et al. The essence of wildlife management. Wildlife Society Bulletin. 2002;30(2): 585–93.
6. Soga M, Gaston KJ. The ecology of human–nature interactions. Proceedings of the Royal Society B: Biological Sciences. 2020 Jan 15;287(1918):20191882.
7. DeStefano S, DeGraaf RM. Exploring the ecology of suburban wildlife. Frontiers in Ecology and the Environment. 2003 Mar;1(2):95–101.
8. Lukasik VM, Alexander SM. Human–coyote interactions in Calgary, Alberta. Human Dimensions of Wildlife. 2011 Mar 29;16(2):114–27.
9. Hunold C, Lloro T. There goes the neighborhood: urban coyotes and the politics of wildlife. Journal of Urban Affairs. 2022 Feb 7;44(2): 156–73.
10. Mormile JE, Hill CM. Living with urban baboons: exploring attitudes and their implications for local baboon conservation and management in Knysna, South Africa. Human Dimensions of Wildlife. 2017 Mar 4;22(2):99–109.
11. Treves A, Naughton-Treves L. Evaluating lethal control in the management of human–wildlife conflict. In: Woodroffe R, Thirgood S, Rabinowitz A (eds.) People and Wildlife, Conflict or Co-existence? Cambridge: Cambridge University Press; 2005. p. 86–106.
12. Loss SR, Boughton B, Cady SM, Londe DW, McKinney C, O'Connell TJ, et al. Review and synthesis of the global literature on domestic cat impacts on wildlife. Journal of Animal Ecology. 2022;91(7): 1361–72.
13. Murray MH, Sánchez CA, Becker DJ, Byers KA, Worsley-Tonks KEL, Craft ME. City sicker? A meta-analysis of wildlife health and urbanization. Frontiers in Ecology and the Environment. 2019;17(10):575–83.
14. Mateo-Tomás P, Olea PP, Sánchez-Barbudo IS, Mateo R. Alleviating human–wildlife conflicts: identifying the causes and mapping the risk of illegal poisoning of wild fauna. Journal of Applied Ecology. 2012;49(2):376–85.
15. Schell CJ, Stanton LA, Young JK, Angeloni LM, Lambert JE, Breck SW, et al. The evolutionary consequences of human–wildlife conflict in cities. Evolutionary Applications. 2021;14(1):178–97.
16. Shettleworth SJ. Cognition, Evolution, and Behaviour. New York: Oxford University Press; 2010.

17. Sih A, Ferrari MCO, Harris DJ. Evolution and behavioural responses to human-induced rapid environmental change. Evolutionary Applications. 2011;4(2):367–87.
18. Robertson BA, Rehage JS, Sih A. Ecological novelty and the emergence of evolutionary traps. Trends in Ecology and Evolution. 2013;28(9):552–60.
19. Shochat E, Warren PS, Faeth SH, McIntyre NE, Hope D. From patterns to emerging processes in mechanistic urban ecology. Trends in Ecology and Evolution. 2006;21(4):186–91.
20. Griffin AS, Netto K, Peneaux C. Neophilia, innovation and learning in an urbanized world: a critical evaluation of mixed findings. Current Opinion in Behavioral Sciences. 2017 Aug 1;16:15–22.
21. Grimm NB, Faeth SH, Golubiewski NE, Redman CL, Wu J, Bai X, et al. Global change and the ecology of cities. Science. 2008;319(5864):756–60.
22. Lee VE, Thornton A. Animal cognition in an urbanised world. Frontiers in Ecology and Evolution. 2021;9:633947.
23. Sol D, Lapiedra O, Ducatez S. Cognition and adaptation to urban environments. In: Szulkin M (ed.) Urban Evolutionary Biology. Oxford: Oxford University Press; 2020. p. 253–67.
24. Owen MA, Swaisgood RR, Blumstein DT. Contextual influences on animal decision-making: significance for behavior-based wildlife conservation and management. Integrative Zoology. 2017 Jan;12(1):32–48.
25. Immelmann K, Colin B. A Dictionary of Ethology. Cambridge, MA: Harvard University Press; 1989.
26. Levitis DA, Lidicker WZ, Freund G. Behavioural biologists do not agree on what constitutes behaviour. Animal Behaviour. 2009 Jul;78(1):103–10.
27. Audet JN, Lefebvre L. What's flexible in behavioral flexibility? Behavioral Ecology. 2017;28(4): 943–7.
28. Lea SEG, Chow PKY, Leaver LA, McLaren IPL. Behavioral flexibility: a review, a model, and some exploratory tests. Learning and Behavior. 2020 Mar 1;48(1):173–87.
29. Greggor AL, Clayton NS, Phalan B, Thornton A. Comparative cognition for conservationists. Trends in Ecology and Evolution. 2014;29(9):489–95.
30. Sol D. Revisiting the cognitive buffer hypothesis for the evolution of large brains. Biology Letters. 2009;5(1):130–3.
31. Allman J, McLaughlin T, Hakeem A. Brain weight and life-span in primate species. Proceedings of the National Academy of Sciences of the United States of America. 1993;90(1):118–22.
32. Schlaepfer MA, Runge MC, Sherman PW. Ecological and evolutionary traps. Trends in Ecology and Evolution. 2002 Oct;17(10):474–80.
33. Jones J. Habitat selection studies in avian ecology: a critical review. The Auk. 2001;118(2):557–62.
34. Blumstein DT. Habituation and sensitization: new thoughts about old ideas. Animal Behaviour. 2016;120:255–62.
35. Bejder L, Samuels A, Whitehead H, Finn H, Allen S. Impact assessment research: use and misuse of habituation, sensitisation and tolerance in describing wildlife responses to anthropogenic stimuli. Marine Ecology Progress Series. 2009 Dec 3;395: 177–85.
36. Berger J. Fear, human shields and the redistribution of prey and predators in protected areas. Biology Letters. 2007 Dec 22;3(6):620–3.
37. Bleicher SS. The landscape of fear conceptual framework: definition and review of current applications and misuses. PeerJ. 2017 Sep 12;5:e3772.
38. Hoppitt W, Laland K. Social Learning: an introduction to mechanisms, methods, and models. Princeton, NJ: Princeton University Press; 2013.
39. Barrow E. Animal Behavior Desk Reference. Boca Raton, FL: CRC Press; 1995.
40. van Horik JO, Madden JR. A problem with problem solving: motivational traits, but not cognition, predict success on novel operant foraging tasks. Animal Behaviour. 2016;114:189–98.
41. Chow PKY, Uchida K, Von Bayern AMP, Koizumi I. Characteristics of urban environments and novel problem-solving performance in Eurasian red squirrels. Proceedings of the Royal Society B: Biological Sciences. 2021;288(1947):1–9.
42. Uexküll J. Umwelt und Innenwelt der Tiere. Berlin: Springer; 1909.
43. Lowry H, Lill A, Wong BBM. Behavioural responses of wildlife to urban environments. Biological Reviews. 2013;88(3):537–49.
44. Sol D, Lapiedra O, González-Lagos C. Behavioural adjustments for a life in the city. Animal Behaviour. 2013;85(5):1101–12.
45. Ritzel K, Gallo T. Behavior change in urban mammals: a systematic review. Frontiers in Ecology and Evolution. 2020 Nov 16;8:576665.
46. Athreya V, Odden M, Linnell JDC, Karanth KU. Translocation as a tool for mitigating conflict with leopards in human-dominated landscapes of India. Conservation Biology. 2011 Feb;25(1):133–41.
47. Teyssier A, Rouffaer LO, Saleh Hudin N, Strubbe D, Matthysen E, Lens L, et al. Inside the guts of the city: urban-induced alterations of the gut microbiota in

a wild passerine. Science of the Total Environment. 2018;612:1276–86.

48. Murray MH, Kidd AD, Curry SE, Hepinstall-Cymerman J, Yabsley MJ, Adams HC, et al. From wetland specialist to hand-fed generalist: shifts in diet and condition with provisioning for a recently urbanized wading bird. Philosophical Transactions of the Royal Society B: Biological Sciences. 2018;373(1745):20170100.
49. Geffroy B, Samia DSM, Bessa E, Blumstein DT. How nature-based tourism might increase prey vulnerability to predators. Trends in Ecology and Evolution. 2015;30(12):755–65.
50. Sayol F, Sol D, Pigot AL. Brain size and life history interact to predict urban tolerance in birds. Frontiers in Ecology and Evolution. 2020;8(Mar):1–9.
51. Preiszner B, Papp S, Pipoly I, Seress G, Vincze E, Liker A, et al. Problem-solving performance and reproductive success of great tits in urban and forest habitats. Animal Cognition. 2017 Jan;20(1): 53–63.
52. Audet JN, Ducatez S, Lefebvre L. The town bird and the country bird: problem solving and immunocompetence vary with urbanization. Behavioral Ecology. 2016;27(2):637–44.
53. Mazza V, Guenther A. City mice and country mice: innovative problem solving in rural and urban noncommensal rodents. Animal Behaviour. 2021 Feb;172:197–210.
54. Klump BC, Major RE, Farine DR, Martin JM, Aplin LM. Is bin-opening in cockatoos leading to an innovation arms race with humans? Current Biology. 2022 Sep;32(17):R910–11.
55. Klump BC, Martin JM, Wild S, Hörsch JK, Major RE, Aplin LM. Innovation and geographic spread of a complex foraging culture in an urban parrot. Science. 2021 Jul 23;373(6553): 456–60.
56. Barrett LP, Stanton L, Benson-Amram S. The cognition of "nuisance" species. Animal Behaviour. 2019;147:167–77.
57. Ham C, Donnelly CA, Astley KL, Jackson SYB, Woodroffe R. Effect of culling on individual badger *Meles meles* behaviour: potential implications for bovine tuberculosis transmission. Journal of Applied Ecology. 2019;56(11):2390–9.
58. Woodroffe R, Donnelly CA, Jenkins HE, Johnston WT, Cox DR, Bourne FJ, et al. Culling and cattle controls influence tuberculosis risk for badgers. Proceedings of the National Academy of Sciences of the United States of America. 2006 Oct 3;103(40): 14713–17.
59. Haniza MZH, Adams S, Jones EP, MacNicoll A, Mallon EB, Smith RH, et al. Large-scale structure of brown rat (*Rattus norvegicus*) populations in England: effects on rodenticide resistance. PeerJ. 2015 Dec 7;3:e1458.
60. Gese E. Demographic and spatial responses of coyotes to changes in food and exploitation. In: Nolte DL, Fagerstone KA (eds.) Proceedings of the 11th Wildlife Damage Management Conference. Bethesda, MD: Wildlife Damage Management Working Group; 2005. p. 271–85. Available from: https://digitalcommons.unl.edu/icwdm_wdmconfproc/131/
61. Stanton LA, Bridge ES, Huizinga J, Johnson SR, Young JK, Benson-Amram S. Variation in reversal learning by three generalist mesocarnivores. Animal Cognition. 2021;24:555–68.
62. Young J, Schultz J, Jolley B, Basili N, Draper J. Social learning of avoidance behaviors: trap aversion in captive coyotes. Animal Behavior and Cognition. 2022 Aug 1;9(3):336–48.
63. Conover M. Resolving Human–Wildlife Conflicts: the science of wildlife damage management. Boca Raton, FL: CRC Press; 2001.
64. Cunningham CX, Nuñez TA, Hentati Y, Sullender B, Breen C, Ganz TR, et al. Permanent daylight saving time would reduce deer-vehicle collisions. Current Biology. 2022 Nov;32(22):4982–8.e4.
65. Quigley H, Herrero S. Characterization and prevention of attacks on humans. In: Woodroffe R, Thirgood S, Rabinowitz A (eds.) People and Wildlife, Conflict or Co-existence? Cambridge: Cambridge University Press; 2005. p. 27–48.
66. Peterson AC, Ghersi BM, Campanella R, Riegel C, Lewis JA, Blum MJ. Rodent assemblage structure reflects socioecological mosaics of counter-urbanization across post-Hurricane Katrina New Orleans. Landscape and Urban Planning. 2020;195(Mar):103710.
67. Camacho-Rivera M, Kawachi I, Bennett GG, Subramanian SV. Associations of neighborhood concentrated poverty, neighborhood racial/ethnic composition, and indoor allergen exposures: a cross-sectional analysis of Los Angeles households, 2006–2008. Journal of Urban Health. 2014 Aug;91(4): 661–76.
68. Lamb CT, Mowat G, McLellan BN, Nielsen SE, Boutin S. Forbidden fruit: human settlement and abundant fruit create an ecological trap for an apex omnivore. Journal of Animal Ecology. 2017;86(1): 55–65.

69. Fehlmann G, O'riain MJ, Fürtbauer I, King AJ. Behavioral causes, ecological consequences, and management challenges associated with wildlife foraging in human-modified landscapes. BioScience. 2021 Jan 11;71(1):40–54.
70. Scholz C, Firozpoor J, Kramer-Schadt S, Gras P, Schulze C, Kimmig SE, et al. Individual dietary specialization in a generalist predator: a stable isotope analysis of urban and rural red foxes. Ecology and Evolution. 2020 Aug;10(16): 8855–70.
71. Newsome SD, Garbe HM, Wilson EC, Gehrt SD. Individual variation in anthropogenic resource use in an urban carnivore. Oecologia. 2015 May 12;178(1): 115–28.
72. VerCauteren KC, Dolbeer RA, Gese EM. Identification and management of wildlife damage. In: Silvy NJ (ed.) The Wildlife Techniques Manual. Baltimore, MD: Johns Hopkins University Press; 2010. p. 232–69.
73. Greggor AL, Berger-Tal O, Blumstein DT. The rules of attraction: the necessary role of animal cognition in explaining conservation failures and successes. Annual Review of Ecology, Evolution, and Systematics. 2020;51:483–503.
74. Snijders L, Greggor AL, Hilderink F, Doran C. Effectiveness of animal conditioning interventions in reducing human–wildlife conflict: a systematic map protocol. Environmental Evidence. 2019 Jun;8(S1):10.
75. Theimer TC, Clayton AC, Martinez A, Peterson DL, Bergman DL. Visitation rate and behavior of urban mesocarnivores differs in the presence of two common anthropogenic food sources. Urban Ecosystems. 2015;18:895–906.
76. Lambert MR, Nielsen SN, Wright AN, Thomson RC, Shaffer HB. Habitat features determine the basking distribution of introduced red-eared sliders and native Western pond turtles. Chelonian Conservation and Biology. 2013 Jul;12(1):192–9.
77. St. Clair CC, Backs J, Friesen A, Gangadharan A, Gilhooly P, Murray M, et al. Animal learning may contribute to both problems and solutions for wildlife–train collisions. Philosophical Transactions of the Royal Society B: Biological Sciences. 2019 Sep 16;374(1781):20180050.
78. Babi⊠ska-Werka J, Krauze-Gryz D, Wasilewski M, Jasi⊠ska K. Effectiveness of an acoustic wildlife warning device using natural calls to reduce the risk of train collisions with animals. Transportation Research Part D: Transport and Environment. 2015 Jul;38:6–14.
79. Shimura M, Ushiogi T, Ikehata M. Development of an acoustic deterrent to prevent deer-train collisions. Quarterly Report RTRI. 2018;59(3):207–11.
80. Found R, St. Clair CC. Personality influences wildlife responses to aversive conditioning: elk personality and response to management. Journal of Wildlife Management. 2018 May;82(4):747–55.
81. Found R, Kloppers EL, Hurd TE, St. Clair CC. Intermediate frequency of aversive conditioning best restores wariness in habituated elk (*Cervus canadensis*). PLoS ONE. 2018 Jun 25;13(6):e0199216.
82. Found R, St. Clair CC. Influences of personality on ungulate migration and management. Frontiers in Ecology and Evolution. 2019;7(Nov):438.
83. Steen KA, Therkildsen OR, Karstoft H, Green O. An adaptive scaring device. International Journal of Sustainable Agricultural Management and Informatics. 2015;1(2):130–41.
84. Vantassel S, Groepper S. A survey of wildlife damage management techniques used by wildlife control operators in urbanized environments in the USA. In: Angelici FM (ed.) Problematic Wildlife: a cross-disciplinary approach. Cham, Switzerland: Springer International; 2016. p. 175–204.
85. bin Shabib R, bin Shabib A. Buildings for the birds [Internet]. The Common Table; 2022 Jan 27. Available from: https://thecommontable.eu/buildings-for-the-birds/
86. Doorn AC, O'Riain MJ. Nonlethal management of baboons on the urban edge of a large metropole. American Journal of Primatology [Internet]. 2020 Aug [cited 2023 Jan 13];82(8):e23164. Available from: https://onlinelibrary.wiley.com/doi/10.1002/ajp.23164
87. Kaplan BS, O'Riain MJ, van Eeden R, King AJ. A low-cost manipulation of food resources reduces spatial overlap between baboons (*Papio ursinus*) and humans in conflict. International Journal of Primatology. 2011 Dec;32(6):1397–412.
88. Fehlmann G, O'Riain MJ, Kerr-Smith C, King AJ. Adaptive space use by baboons (*Papio ursinus*) in response to management interventions in a human-changed landscape. Animal Conservation. 2017;20(1):101–9.
89. Schell CJ, Dyson K, Fuentes TL, Des Roches S, Harris NC, Miller DS, et al. The ecological and evolutionary consequences of systemic racism in urban environments. Science. 2020;369(6510): eaay4497.
90. Hope D, Gries C, Zhu W, Fagan WF, Redman CL, Grimm NB, et al. Socioeconomics drive urban plant diversity. Proceedings of the National

Academy of Sciences of the United States of America. 2003;100(15):8788–92.

91. Des Roches S, Brans KI, Lambert MR, Rivkin LR, Savage AM, Schell CJ, et al. Socio-eco-evolutionary dynamics in cities. Evolutionary Applications. 2021 Jan 1;14(1):248–67.
92. Fidino M, Lehrer EW, Kay CAM, Yarmey NT, Murray MH, Fake K, et al. Integrated species distribution models reveal spatiotemporal patterns of human–wildlife conflict. Ecological Applications [Internet]. 2022 Oct [cited 2023 Jan 13];32(7):e2647. Available from: https://onlinelibrary.wiley.com/doi/10.1002/eap.2647
93. Brownlow A. An archaeology of fear and environmental change in Philadelphia. Geoforum. 2006 Mar;37(2):227–45.
94. Anguelovski I. From toxic sites to parks as (green) LULUs? New challenges of inequity, privilege, gentrification, and exclusion for urban environmental justice. Journal of Planning Literature. 2016 Feb;31(1):23–36.
95. Murray MH, Buckley J, Byers KA, Fake K, Lehrer EW, Magle SB, et al. One Health for all: advancing human and ecosystem health in cities by integrating an environmental justice lens. Annual Review of Ecology, Evololution, and Systematics. 2022 Nov 2;53:403–26.
96. Monchanin C, Blanc-Brude A, Drujont E, Negahi MM, Pasquaretta C, Silvestre J, et al. Chronic exposure to trace lead impairs honey bee learning. Ecotoxicology and Environmental Safety. 2021 Apr;212:112008.
97. Berg EL, Pedersen LR, Pride MC, Petkova SP, Patten KT, Valenzuela AE, et al. Developmental exposure to near roadway pollution produces behavioral phenotypes relevant to neurodevelopmental disorders in juvenile rats. Translational Psychiatry. 2020;10(1):289.
98. Serieys LEK, Lea AJ, Epeldegui M, Armenta TC, Moriarty J, Vandewoude S, et al. Urbanization and anticoagulant poisons promote immune dysfunction in bobcats. Proceedings of the Royal Society B: Biological Sciences. 2018;285(1871):20172533.
99. Adamkiewicz G, Zota AR, Fabian MP, Chahine T, Julien R, Spengler JD, et al. Moving environmental justice indoors: understanding structural influences on residential exposure patterns in low-income communities. American Journal of Public Health. 2011 Dec;101(S1):S238–45.
100. Casey JA, Morello-Frosch R, Mennitt DJ, Fristrup K, Ogburn EL, James P. Race/ethnicity, socioeconomic status, residential segregation, and spatial variation in noise exposure in the contiguous United States. Environmental Health Perspectives. 2017 Jul 24;125(7):077017.
101. Donley N, Bullard RD, Economos J, Figueroa I, Lee J, Liebman AK, et al. Pesticides and environmental injustice in the USA: root causes, current regulatory reinforcement and a path forward. BMC Public Health. 2022 Dec;22(1):708.
102. Sugden S, Murray M, Edwards MA, St. Clair CC. Inter-population differences in coyote diet and niche width along an urban–suburban–rural gradient. Journal of Urban Ecology. 2021 Jan 22;7(1): juab034.
103. Feng AYT, Himsworth CG. The secret life of the city rat: a review of the ecology of urban Norway and black rats (*Rattus norvegicus* and *Rattus rattus*). Urban Ecosystems. 2014;17(1):149–62.
104. Schulte-Hostedde AI, Mazal Z, Jardine CM, Gagnon J. Enhanced access to anthropogenic food waste is related to hyperglycemia in raccoons (*Procyon lotor*). Conservation Physiology. 2018;6(1):1–6.
105. Hungerford LL, Mitchell MA, Nixon CM, Esker TE, Sullivan JB, Koerkenmeier R, et al. Periodontal and dental lesions in raccoons from a farming and a recreational area in Illinois. Journal of Wildlife Diseases. 1999;35(4):728–34.
106. Sugden S, Sanderson D, Ford K, Stein LY, Cassady C, Clair S. An altered microbiome in urban coyotes mediates relationships between anthropogenic diet and poor health. Scientific Reports. 2020 [cited 2022 Feb 23];10:22207. Available from: https://doi.org/10.1038/s41598-020-78891-1
107. Savard JPL, Clergeau P, Mennechez G. Biodiversity concepts and urban ecosystems. Landscape and Urban Planning. 2000 May;48(3–4): 131–42.
108. Nielsen AB, van den Bosch M, Maruthaveeran S, van den Bosch CK. Species richness in urban parks and its drivers: a review of empirical evidence. Urban Ecosystems. 2014 Mar;17(1):305–27.
109. Møller AP. Urban areas as refuges from predators and flight distance of prey. Behavioral Ecology. 2012 Sep 1;23(5):1030–5.
110. Ryan AM, Partan SR. Urban wildlife behavior. In: McCleery RA, Moorman CE, Peterson MN (eds.) Urban Wildlife Conservation: theory and practice. Boston, MA: Springer US; 2014. p. 149–73.
111. Knapp S, Aronson MFJ, Carpenter E, Herrera-Montes A, Jung K, Kotze DJ, et al. A research agenda for urban biodiversity in the global extinction crisis. BioScience. 2021 Mar 1;71(3):268–79.

112. Moorman C. Managing urban wildlife habitat at the local scale. In: McCleery RA, Moorman CE, Peterson MN (eds.) Urban Wildlife Conservation: theory and practice [Internet]. Boston, MA: Springer US; 2014 [cited 2023 Jan 14]. p. 303–21. Available from: https://link.springer.com/10.1007/978-1-4899-7500-3_14
113. Hale R, Swearer SE. When good animals love bad restored habitats: how maladaptive habitat selection can constrain restoration. Journal of Applied Ecology. 2017 Oct;54(5):1478–86.
114. McKinney ML. Urbanization, biodiversity, and conservation. BioScience. 2002;52(10):883–90.
115. Goddard MA, Ikin K, Lerman SB. Ecological and social factors determining the diversity of birds in residential yards and gardens. In: Murgui E, Hedblom M (eds.) Ecology and Conservation of Birds in Urban Environments [Internet]. Cham, Switzerland: Springer International Publishing; 2017 [cited 2023 Jan 14]. p. 371–97. Available from: https://link.springer.com/10.1007/978-3-319-43314-1_18
116. Litteral J, Shochat E. The role of landscape-scale factors in shaping urban bird communities. In: Murgui E, Hedblom M (eds.) Ecology and Conservation of Birds in Urban Environments [Internet]. Cham, Switzerland: Springer International Publishing; 2017 [cited 2023 Jan 14]. p. 135–59. Available from: https://link.springer.com/10.1007/978-3-319-43314-1_8
117. Panlasigui S, Spotswood E, Beller E, Grossinger R. Biophilia beyond the building: applying the tools of urban biodiversity planning to create biophilic cities. Sustainability. 2021 Feb 24;13(5):2450.
118. Wilkinson CE, McInturff A, Kelly M, Brashares JS. Quantifying wildlife responses to conservation fencing in East Africa. Biological Conservation. 2021 Apr;256:109071.
119. Osipova L, Okello MM, Njumbi SJ, Ngene S, Western D, Hayward MW, et al. Fencing solves human-wildlife conflict locally but shifts problems elsewhere: a case study using functional connectivity modelling of the African elephant. Journal of Applied Ecology. 2018 Nov;55(6):2673–84.
120. McInturff A, Xu W, Wilkinson CE, Dejid N, Brashares JS. Fence ecology: frameworks for understanding the ecological effects of fences. BioScience. 2020 Nov;70(11):971–85.
121. Ward MP, Schlossberg S. Conspecific attraction and the conservation of territorial songbirds. Conservation Biology. 2004 Apr;18(2):519–25.
122. Nisbet I. Disturbance, habituation, and management of waterbird colonies. Waterbirds. 2000;23(2):312–32.
123. Lepczyk CA, Aronson MFJ, Evans KL, Goddard MA, Lerman SB, MacIvor JS. Biodiversity in the city: fundamental questions for understanding the ecology of urban green spaces for biodiversity conservation. BioScience. 2017 Sep;67(9):799–807.
124. Jokimäki J, Kaisanlahti-Jokimäki ML, Suhonen J, Clergeau P, Pautasso M, Fernández-Juricic E. Merging wildlife community ecology with animal behavioral ecology for a better urban landscape planning. Landscape and Urban Planning. 2011 Apr;100(4):383–5.
125. Robertson BA, Blumstein DT. How to disarm an evolutionary trap. Conservation Science and Practice. 2019;1(11):e116.
126. Greggor AL, Trimmer PC, Barrett BJ, Sih A. Challenges of learning to escape evolutionary traps. Frontiers in Ecology and Evolution. 2019 Oct 25;7:408.
127. Riley SPD, Brown JL, Sikich J, Schoonmaker C, Boydson E. Wildlife friendly roads: the impacts of roads on wildlife in urban areas and potential remedies. In: McCleery RA, Moorman CE, Peterson MN (eds.) Urban Wildlife Conservation: theory and practice. Boston, MA: Springer US; 2014. p. 323–60.
128. Shilling F, Waetjen D, Longcore T, Vickers W, McDowell S, Oke A, et al. Improving light and soundscapes for wildlife use of highway crossing structures. Davis, CA: UC Davis Institute of Transportation Studies; 2022 [cited 2023 Jan 14]. Available from: https://escholarship.org/uc/item/4vk0m9cs
129. Glista DJ, DeVault TL, DeWoody JA. A review of mitigation measures for reducing wildlife mortality on roadways. Landscape and Urban Planning. 2009 May;91(1):1–7.
130. Carlen EJ, Li R, Winchell KM. Urbanization predicts flight initiation distance in feral pigeons (*Columba livia*) across New York City. Animal Behaviour. 2021 Aug;178:229–45.
131. Bowers MA, Breland B. Foraging of gray squirrels on an urban–rural gradient: use of the GUD to assess anthropogenic impact. Ecological Applications. 1996 Nov;6(4):1135–42.
132. Reilly CM, Suraci JP, Smith JA, Wang Y, Wilmers CC. Mesopredators retain their fear of humans across a development gradient. Behavioral Ecology. 2022 Apr 18;33(2):428–35.
133. Clucas B, Marzluff JM. Attitudes and actions toward birds in urban areas: human cultural differences influence bird behavior. The Auk. 2012;129(1):8–16.

134. Gaynor KM, Hojnowski CE, Carter NH, Brashares JS. The influence of human disturbance on wildlife nocturnality. Science. 2018;360(6394):1232–5.
135. Nickel BA, Suraci JP, Allen ML, Wilmers CC. Human presence and human footprint have non-equivalent effects on wildlife spatiotemporal habitat use. Biological Conservation. 2020;241(Jan):108383.
136. Wilmers CC, Nisi AC, Ranc N. COVID-19 suppression of human mobility releases mountain lions from a landscape of fear. Current Biology. 2021 Sep;31(17):3952–5.e3.
137. Duarte MHL, Vecci MA, Hirsch A, Young RJ. Noisy human neighbours affect where urban monkeys live. Biology Letters. 2011 Dec 23;7(6):840–2.
138. Bates AE, Primack RB, Biggar BS, Bird TJ, Clinton ME, Command RJ, et al. Global COVID-19 lockdown highlights humans as both threats and custodians of the environment. Biological Conservation. 2021 Nov;263:109175.
139. Goumas M, Boogert NJ, Kelley LA. Urban herring gulls use human behavioural cues to locate food. Royal Society Open Science. 2020;7(2):191959.
140. Liu J, Dietz T, Carpenter SR, Alberti M, Folke C, Moran E, et al. Complexity of coupled human and natural systems. Science. 2007;317(5844):1513–16.
141. Clucas B, Marzluff JM. Coupled relationships between humans and other organisms in urban areas. In: Niemelä J (ed.) Urban Ecology: patterns, processes, and applications. Oxford: Oxford University Press; 2011. p. 135–47.
142. Kellert SR. American attitudes toward and knowledge of animals: an update. In: Fox MW, Mickley LD (eds.) Advances in Animal Welfare Science 1984 [Internet]. Dordrecht: Springer Netherlands; 1985 [cited 2023 Jan 14]. p. 177–213. Available from: https://link.springer.com/10.1007/978-94-009-4998-0_11
143. Dickman AJ, Hazzah L, Carbone C, Durant SM. Carnivores, culture and "contagious conflict": multiple factors influence perceived problems with carnivores in Tanzania's Ruaha landscape. Biological Conservation. 2014 Oct;178:19–27.
144. Reiter D, Brunson M, Schmidt R. Public attitudes toward wildlife damage management and policy. Wildlife Society Bulletin. 2023;27(3):746–58.
145. Koval MH, Mertig AG. Attitudes of the Michigan public and wildlife agency personnel toward lethal wildlife management. Wildlife Society Bulletin. 2004 Mar;32(1):232–43.
146. Lischka SA, Teel TL, Johnson HE, Reed SE, Breck S, Don Carlos A, et al. A conceptual model for the integration of social and ecological information to understand human-wildlife interactions. Biological Conservation. 2018 Sep;225:80–7.
147. Carter NH, Riley SJ, Liu J. Utility of a psychological framework for carnivore conservation. Oryx. 2012 Oct;46(4):525–35.
148. Ngo KM, Hosaka T, Numata S. The influence of childhood nature experience on attitudes and tolerance towards problem-causing animals in Singapore. Urban Forestry & Urban Greening. 2019 May;41: 150–7.
149. Young JK, Coppock DL, Baggio JA, Rood KA, Yirga G. Linking human perceptions and spotted hyena behavior in urban areas of Ethiopia. Animals. 2020 Dec 15;10(12):2400.
150. Wilcoxen TE, Horn DJ, Hogan BM, Hubble CN, Huber SJ, Flamm J, et al. Effects of bird-feeding activities on the health of wild birds. Conservation Physiology. 2015;3(1):cov058.
151. Kumar N, Jhala YV, Qureshi Q, Gosler AG, Sergio F. Human-attacks by an urban raptor are tied to human subsidies and religious practices. Scientific Reports. 2019;9:2545.
152. Saraswat R, Sinha A, Radhakrishna S. A god becomes a pest? Human-rhesus macaque interactions in Himachal Pradesh, northern India. European Journal of Wildlife Research. 2015 Jun;61(3): 435–43.
153. Peterson MN, Birckhead JL, Leong K, Peterson MJ, Peterson TR. Rearticulating the myth of human–wildlife conflict. Conservation Letters. 2010 Apr;3(2):74–82.
154. Redman CL, Grove JM, Kuby LH. Integrating social science into the Long-Term Ecological Research (LTER) Network: social dimensions of ecological change and ecological dimensions of social change. Ecosystems. 2004;7(2):161–71.
155. Dickman AJ. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. Animal Conservation. 2010;13(5):458–66.
156. Siex KS, Struhsaker TT. Colobus monkeys and coconuts: a study of perceived human–wildlife conflicts. Journal of Applied Ecology. 1999 Dec;36(6):1009–20.
157. Wilkinson CE, Brashares JS, Bett AC, Kelly M. Examining drivers of divergence in recorded and perceived human-carnivore conflict hotspots by integrating participatory and ecological data. Frontiers in Conservation Science. 2021 Jul 20;2: 681769.

158. Draheim MM, Parsons ECM, Crate SA, Rockwood LL. Public perspectives on the management of urban coyotes. Journal of Urban Ecology [Internet]. 2019 [cited 2022 Jul 10];5(1):juz003. Available from: https://academic.oup.com/jue/article/doi/10.1093/jue/juz003/5424021
159. Basak SM, Hossain MS, O'Mahony DT, Okarma H, Widera E, Wierzbowska IA. Public perceptions and attitudes toward urban wildlife encounters – a decade of change. Science of the Total Environment. 2022 Aug;834:155603.
160. White J, Kemmelmeier M, Bassett S, Smith J. Human perceptions of an avian predator in an urban ecosystem: close proximity to nests increases fondness among local residents. Urban Ecosystems. 2018;21(2):271–80. Available from: https://link.springer.com/10.1007/s11252-017-0713-y
161. Boso À, Álvarez B, Pérez B, Imio JC, Altamirano A, Lisón F. Understanding human attitudes towards bats and the role of information and aesthetics to boost a positive response as a conservation tool. Animal Conservation. 2021 Dec;24(6):937–45.
162. Rigolon A. A complex landscape of inequity in access to urban parks: a literature review. Landscape and Urban Planning. 2016 Sep;153:160–9.
163. Warkentin T. Cultivating urban naturalists: teaching experiential, place-based learning through nature journaling in Central Park. Journal of Geography. 2011 Nov;110(6):227–38.
164. Larson LR, Cooper CB, Stedman RC, Decker DJ, Gagnon RJ. Place-based pathways to proenvironmental behavior: empirical evidence for a conservation–recreation model. Society & Natural Resources. 2018 Aug 3;31(8):871–91.
165. Poessel SA, Gese EM, Young JK. Environmental factors influencing the occurrence of coyotes and conflicts in urban areas. Landscape and Urban Planning. 2017 Jan;157:259–69.
166. Drake D, Dubay S, Allen ML. Evaluating human–coyote encounters in an urban landscape using citizen science. Journal of Urban Ecology. 2021 Jan 22;7(1):juaa032.
167. Breck SW, Poessel SA, Mahoney P, Young JK. The intrepid urban coyote: a comparison of bold and exploratory behavior in coyotes from urban and rural environments. Scientific Reports. 2019;9(Feb):2104.
168. Brooks J, Kays R, Hare B. Coyotes living near cities are bolder: implications for dog evolution and human-wildlife conflict. Behaviour. 2020 Mar 20;157(3–4):289–313.
169. Henger CS, Herrera GA, Nagy CM, Weckel ME, Gormezano LJ, Wultsch C, et al. Genetic diversity and relatedness of a recently established population of eastern coyotes (*Canis latrans*) in New York City. Urban Ecosystems. 2020 Apr;23(2):319–30.
170. Wurth AM, Ellington EH, Gehrt SD. Golf courses as potential habitat for urban coyotes. The Wildlife Society Bulletin. 2020 Jun;44(2):333–41.
171. Gámez S, Harris NC. Living in the concrete jungle: carnivore spatial ecology in urban parks. Ecological Applications [Internet]. 2021 Sep [cited 2022 Jul 14];31(6):e02393. Available from: https://onlinelibrary.wiley.com/doi/10.1002/eap.2393
172. Thompson CA, Malcolm JR, Patterson BR. Individual and temporal variation in use of residential areas by urban coyotes. Frontiers in Ecology and Evolution. 2021 Jun 1;9:687504.
173. Gilbert-Norton LB, Shahan TA, Shivik JA. Coyotes (*Canis latrans*) and the matching law. Behavioural Processes. 2009 Oct 1;82(2):178–83.
174. Stanton LA, Bridge ES, Huizinga J, Benson-Amram S. Environmental, individual and social traits of free-ranging raccoons influence performance in cognitive testing. Journal of Experimental Biology. 2022 Sep 15;225(18):jeb243726.
175. Van Bourg J, Young JK, Alkhalifah R, Brummer S, Johansson E, Morton J, et al. Cognitive flexibility and aging in coyotes (*Canis latrans*). Journal of Comparative Psychology. 2022 Feb;136(1):54–67.
176. Poessel SA, Mock EC, Breck SW. Coyote (*Canis latrans*) diet in an urban environment: variation relative to pet conflicts, housing density, and season. Canadian Journal of Zoology. 2017 Apr;95(4):287–97.
177. Murray M, Cembrowski A, Latham ADM, Lukasik VM, Pruss S, St Clair CC. Greater consumption of protein-poor anthropogenic food by urban relative to rural coyotes increases diet breadth and potential for human–wildlife conflict. Ecography. 2015 Dec;38(12):1235–42.
178. Breck S, Poessel S, Bonnell MA. Evaluating lethal and non-lethal management options for urban coyotes. In: Timm RM, Baldwin RA (eds.) Proceedings of the 27th Vertebrate Pest Conference [Internet]. Davis, CA: Universty of California Davis; 2016 [cited 2022 Jul 14]. p. 103–11. Available from: https://escholarship.org/uc/item/0g83m9km
179. Murray MH, Hill J, Whyte P, St. Clair CC. Urban compost attracts coyotes, contains toxins, and may promote disease in urban-adapted wildlife. EcoHealth. 2016 Jun;13(2):285–92.
180. Wald DM, Jacobson SK, Levy JK. Outdoor cats: identifying differences between stakeholder beliefs, perceived impacts, risk and management. Biological Conservation. 2013 Nov;167:414–24.

181. Nattrass N, O'Riain MJ. Contested natures: conflict over caracals and cats in Cape Town, South Africa. Journal of Urban Ecology. 2020 Jan 1;6(1):juaa019.
182. Loss SR, Will T, Marra PP. The impact of free-ranging domestic cats on wildlife of the United States. Nature Communications. 2013 Jun 26;4(1):1396.
183. Bonnell MA, Breck SW. Using resident-based hazing programs to reduce human-coyote conflicts in urban environments. Human–Wildlife Interactions. 2017;11(2):5.
184. McLellan BA, Walker KA. Efficacy of motion-activated sprinklers as a humane deterrent for urban coyotes. Human Dimensions of Wildlife. 2021 Jan 2;26(1):76–83.
185. Sponarski CC, Miller CA, Vaske JJ, Spacapan MR. Modeling perceived risk from coyotes among Chicago residents. Human Dimensions of Wildlife. 2016 Nov;21(6):491–505.
186. Sampson L, Van Patter L. Advancing best practices for aversion conditioning (humane hazing) to mitigate human–coyote conflicts in urban areas. Human–Wildlife Interactions. 2020;14(2): 166–83.
187. Alexander SM, Quinn MS. Portrayal of interactions between humans and coyotes (Canis latrans): content analysis of Canadian print media (1998-2010). Cities and the Environment. 2011;4(1):1–24.
188. Draheim MM, Crate SA, Parsons ECM, Rockwood LL. The impact of language in conflicts over urban coyotes. Journal of Urban Ecology. 2021;7(1):juab036. Available from: https://doi.org/10.1093/jue/juab036
189. Davidson GL, Raulo A, Knowles SCL. Identifying microbiome-mediated behaviour in wild vertebrates. Trends in Ecology and Evolution. 2020 Nov 1;35(11):972–80.
190. Jones TB, Evans JC, Morand-Ferron J. Urbanization and the temporal patterns of social networks and group foraging behaviors. Ecology and Evolution. 2019;9(8):4589–602.
191. Prange S, Gehrt SD, Hauver S. Frequency and duration of contacts between free-ranging raccoons: uncovering a hidden social system. Journal of Mammalogy. 2011;92(6):1331–42.
192. Hirsch BT, Prange S, Hauver SA, Gehrt SD. Raccoon social networks and the potential for disease transmission. PLoS ONE. 2013;8(10): 4–10.
193. Westall TL, Cypher BL, Ralls K, Wilbert T. Observations of social polygyny, allonursing, extrapair copulation, and inbreeding in urban San Joaquin kit foxes (*Vulpes macrotis mutica*). The Southwestern Naturalist. 2019 Oct 7;63(4):271.
194. Vlaschenko A, Kovalov V, Hukov V, Kravchenko K, Rodenko O. An example of ecological traps for bats in the urban environment. European Journal of Wildlife Research. 2019 Apr;65(2):20.
195. Strasser EH, Heath JA. Reproductive failure of a human-tolerant species, the American kestrel, is associated with stress and human disturbance. Journal of Applied Ecology. 2013 Aug;50(4):912–19.
196. Frigerio D, Pipek P, Kimmig S, Winter S, Melzheimer J, Diblíková L, et al. Citizen science and wildlife biology: synergies and challenges. Ethology. 2018 Jun;124(6):365–77.
197. Ostermann-Miyashita E, Pernat N, König HJ. Citizen science as a bottom-up approach to address human–wildlife conflicts: from theories and methods to practical implications. Conservation Science and Practice [Internet]. 2021 Mar [cited 2023 Jan 14];3(3):e385. Available from: https://onlinelibrary.wiley.com/doi/10.1111/csp2.385
198. Lasky M, Parsons A, Schuttler S, Mash A, Larson L, Norton B, et al. Candid critters: challenges and solutions in a large-scale citizen science camera trap project. Citizen Science: Theory and Practice. 2021 Feb 26;6(1):4.
199. Swanson AC, Conn A, Swanson JJ, Brooks DM. Record of an urban ringtail (*Bassariscu astutus*) outside of its typical geographic range. Urban Naturalist Notes. 2022;9(4):1–6.
200. Carter NH, Linnell JDC. Co-adaptation is key to coexisting with large carnivores. Trends in Ecology and Evolution. 2016 Aug;31(8):575–8.
201. König HJ, Kiffner C, Kramer-Schadt S, Fürst C, Keuling O, Ford AT. Human–wildlife coexistence in a changing world. Conservation Biology. 2020 Aug;34(4):786–94.
202. Collins MK, Magle SB, Gallo T. Global trends in urban wildlife ecology and conservation. Biological Conservation. 2021 Sep;261:109236.
203. Parker SS. Incorporating critical elements of city distinctiveness into urban biodiversity conservation. Biodiversity and Conservation. 2015 Mar;24(3):683–700.
204. Xie S, Wang X, Zhou W, Wu T, Qian Y, Lu F, et al. The effects of residential greenspace on avian biodiversity in Beijing. Global Ecology and Conservation. 2020 Dec;24:e01223.
205. Cox DTC, Hudson HL, Plummer KE, Siriwardena GM, Anderson K, Hancock S, et al. Covariation in urban birds providing cultural services or disservices and people. Journal of Applied Ecology. 2018 Sep;55(5):2308–19.
206. Ilham K, Rizaldi, Nurdin J, Tsuji Y. Status of urban populations of the long-tailed macaque (*Macaca fas-*

cicularis) in West Sumatra, Indonesia. Primates. 2017 Apr;58(2):295–305.

207. Sha JCM, Gumert MD, Lee BPY-H, Jones-Engel L, Chan S, Fuentes A. Macaque–human interactions and the societal perceptions of macaques in Singapore. American Journal of Primatology. 2009 Oct;71(10):825–39.
208. Chen M, Tan ADJ, Quek WL, Chahed H. A proposal for a technology-assisted approach to wildlife management in Singapore. Pacific Conservation Biology [Internet]. 2022 [cited 2022 Jul 15];29(1):1–16. Available from: http://www.publish.csiro.au/?paper=PC21055
209. Hinchcliffe DL, Young RJ, Teixeira CP. Callout analysis in relation to wild birds in a tropical city: implications for urban species management. Urban Ecosystems. 2022 Jun 21;25(6):1643–52.
210. Charles KE, Linklater WL. Selection of trees for sap-foraging by a native New Zealand parrot, the Kaka (*Nestor meridionalis*), in an urban landscape. Emu - Austral Ornithology. 2014 Dec;114(4): 317–25.
211. Crenshaw K. On Intersectionality: essential writings. New York: The New Press; 2017.
212. Baruch-Mordo S, Breck SW, Wilson KR, Broderick J. A tool box half full: how social science can help solve human–wildlife conflict. Human Dimensions of Wildlife. 2009 Jun 3;14(3):219–23.
213. St John FAV, Edwards-Jones G, Jones JPG. Conservation and human behaviour: lessons from social psychology. Wildlife Research. 2010;37(8): 658–67.
214. Baruch-Mordo S, Breck SW, Wilson KR, Broderick J. The carrot or the stick? Evaluation of education and enforcement as management tools for human-wildlife conflicts. PLoS ONE. 2011 Jan 12;6(1):e15681.
215. Johnson HE, Lewis DL, Lischka SA, Breck SW. Assessing ecological and social outcomes of a bear-proofing experiment. Journal of Wildlife Management. 2018;82(6):1102–1114.
216. Athreya V, Thakur S, Chaudhuri S, Belsare A. Leopards in human-dominated areas: a spillover from sustained translocations into nearby forests? Journal of the Bombay Natural History Society. 2007;104(1):45–50.
217. Massei G, Quy RJ, Gurney J, Cowan DP. Can translocations be used to mitigate human–wildlife conflicts? Wildlife Research. 2010;37(5):428–39.
218. Resende PS, Viana-Junior AB, Young RJ, Azevedo CS. What is better for animal conservation translocation programmes: soft- or hard-release? A phylogenetic meta-analytical approach. Journal of Applied Ecology. 2021 Jun;58(6): 1122–32.
219. Athreya V, Odden M, Linnell JDC, Krishnaswamy J, Karanth U. Big cats in our backyards: persistence of large carnivores in a human dominated landscape in India. PLoS ONE. 2013 Mar 6;8(3):e57872.
220. Bhatia S, Athreya V, Grenyer R, MacDonald DW. Understanding the role of representations of human–leopard conflict in Mumbai through media-content analysis. Conservation Biology. 2013 Jun;27(3): 588–94.