

# Urban Wildlife Conservation and Communication under COVID-19

Subjects: Biodiversity Conservation

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Most ecosystems are increasingly being degraded and reduced by human activities at the local and global scales. In contrast, urban environments are expanding as increasing portions of humanity move into cities. The relevance of urban wildlife consumption and the trade between urban and rural areas and among cities have received growing attention in light of the COVID-19 pandemic.

Keywords: urban ecology ; urban conservation ; urban vegetation ; public perceptions ; communication strategies

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## 1. Introduction

Cities first emerged thousands of years ago and, in recent decades, became the predominant human habitat <sup>[1]</sup>. Increasingly numerous and geographically widespread, they offer diverse habitats and species. Although urban plant diversity can decline as compaction increases, similar numbers of species may be found in adjacent urban and rural settings (e.g., <sup>[2]</sup>), though urban floras are more likely to have large non-native components. More floristically diverse urban landscapes support a greater diversity of animal species (e.g., <sup>[3]</sup>) and traits (e.g., <sup>[4]</sup>). Despite increasing attention, the biodiversity of cities, and especially the conservation value of urban ecosystems, remain poorly studied <sup>[1][5]</sup>. The value that cities provide to humans, especially in poorer countries, and their potential to contribute to improved human wellbeing and the potential of new technologies to change the nature of urban natural resource management are also often under-appreciated <sup>[6][7]</sup>. Likewise, the relevance of human socioeconomic factors to urban biodiversity patterns is understudied <sup>[8]</sup>. In contrast, the relevance of urban wildlife consumption and the trade between urban and rural areas and among cities have received growing attention in light of the COVID-19 pandemic. Likewise, urban ecology, with a focus on biogeochemical cycles, has recently received increased attention <sup>[9]</sup>.

Perry et al. <sup>[1]</sup> surveyed the literature on urban wildlife and their interactions with the human population and noted that human-wildlife interaction in urban settings may be divided into “good”—those that provide benefits to humans and/or wildlife—and “bad”—instances where the interaction is detrimental to at least one side. On the “good” side, for example, humans provide habitat for many other species by creating structures or providing food. For example, a picture in the Israeli newspaper Haaretz <sup>[10]</sup> shows a woman in Kiev, Ukraine, feeding street pigeons with bread bought during the ongoing war there, despite food shortages. Such positive interactions clearly can have large significance for people, but urban wildlife can also become a nuisance or carry diseases. How those trends, surveyed through 2017, would develop as urbanization continues, automation expands, and climate change worsens were open questions <sup>[1]</sup>.

## 2. Urban Biodiversity Conservation: An Update, with Particular Attention to COVID-19

### 2.1. Recent Work on Urban Wildlife

#### 2.1.1. Invertebrates

Urban wildlife studies have traditionally focused on vertebrates, though invertebrates are by far the more numerous on Earth. Human alterations to natural landscapes still allow us to receive benefits from invertebrates (e.g., ecosystem services of pollination and pest control) and provide opportunities for invertebrates to compete for resources (e.g., herbivory in agricultural crops and structural pests). Invertebrates such as mosquitoes and ticks also serve as vectors for disease-causing organisms and more directly impact human health. This has led to insects often being considered “pests”, though only approximately 10,000 insects of over one million described species deserve the title, even from an anthropocentric perspective, and many are beneficial to humans <sup>[11]</sup>. Some flagship insect species, such as the honeybee and the monarch butterfly, serve as conduits by which humans are linked to nature and conservation actions. Because

invertebrates have relatively small functional resource requirements, cities serve as refuges for some insects <sup>[12]</sup>. However, the impacts of urbanization are not limited to the terrestrial world. For example, aquatic insects with terrestrial life stages have been shown to be affected by characteristics of both riparian and upland landscapes, influencing stage development and dispersal <sup>[13]</sup>.

In recent years, several studies have been devoted to urban invertebrates and conditions that enhance their diversity, including the roles of beneficial insects that provide ecosystem services <sup>[14]</sup> and supporting the initial prediction. The city is increasingly viewed as a complex entity that includes both vertebrate and invertebrate ecological components <sup>[15]</sup> and intermingled humans and their activities. For example, invertebrates provide food for wildlife and support ecosystem services such as pollination provides a value of USD \$57 billion annually in the U.S. <sup>[16]</sup>. Similarly, the structure of the urban landscape influences the composition of insect functional groups, which in turn provide added monetary value <sup>[17]</sup> <sup>[18]</sup>. Conservation and restoration of natural resources such as native soils in order to promote urban pollinators may also benefit nearby gardens and other green spaces <sup>[19]</sup>, and replacing closely mowed lawns with longer grassy vegetation leads to “substantial biodiversity benefit”, including an increase in self-dispersed plant species, a positive response in soil microbiome, and an increase in invertebrate taxa <sup>[20]</sup>. This has led to some cities declaring months in which no mowing of residential lawns would occur <sup>[21]</sup>. What is gradually emerging is a move from a conflict-only perception of urban invertebrates (focusing, for example, on cockroaches) to a more nuanced view that acknowledges that such conflict exists, but that there are also benefits, some of them substantial and multifaceted. Unfortunately, invertebrate biodiversity continues to diminish in urban settings <sup>[22]</sup>, a loss primarily abetted by apathy toward this important component of ecosystems. Whereas ecology journals have shown an increase in studies of community ecology, including in urban settings, the term “urban” did not emerge as important in entomological journals <sup>[23]</sup>.

In what is becoming a common approach in other taxa as well, citizen monitoring has been used to integrate academia and the public in conducting citizen science invertebrate surveys <sup>[24]</sup>. During the COVID-19 pandemic, educators charged with innovating distance education sought to promote interactions in nature in response to student isolated and mental health challenges. For an example, Schirmel <sup>[25]</sup> engaged life science students to become “citizen scientists”, documenting and comparing insect and plant communities across habitats. In support of such efforts, online biodiversity programs such as iNaturalist assist in linking remote and online student learning with local nature.

### 2.1.2. Vertebrates

The interactions of humans with urban vertebrates were extensively reviewed relatively recently <sup>[1]</sup>. Because of their relatively large size and the carnivorous habits of many vertebrates, they are often hard to miss, and their presence in an urban setting is commonly seen as troublesome. One traditional way to reduce such conflict has been through legislation, and this remains common. For example, Clayworth <sup>[26]</sup> reported on the ongoing process of passing a resolution banning wildlife feeding in the city of Des Moines, Iowa, USA. Originally including feral cats and any species “not normally domesticated”, the ban was narrowed to only include waterfowl and deer after residents complained that the definition of “wild animal” was too broad and would have prohibited feeding species liked by many, such as squirrels and alley cats. Extending a trend to also look at the positive aspects of the urbanization/wildlife interface, Cooper et al. <sup>[27]</sup> recently showed that secondary cities offer a better habitat for wildlife than do large cities such as Los Angeles, and Dunn et al. <sup>[28]</sup> concluded that urban species residing in gray zones—areas high in built structures and low in vegetation—have a greater potential for evolutionary innovations to emerge than those residing in the green habitats more traditionally studied.

Even more common than legislation is lethal control, although that option is increasingly opposed by animal rights proponents and others <sup>[29][30]</sup>. As lethal options become less acceptable in all but the most extreme cases, managers are increasingly forced to develop ways to foster human–wildlife coexistence, emphasizing the need for effective communication with the human population <sup>[31]</sup>.

## 2.2. Progress on Automation in Urban Conservation Management

Novel opportunities for human-wildlife conflict have emerged with the increasing incorporation of drones and other automatic devices in urban environments <sup>[6]</sup>. The predictions they made have had relatively little time to be tested, but there have already been some surprises. For example, Evans <sup>[32]</sup> recently reported on urban ravens (*Corvus coronoides*) disrupting drone delivery of coffee in Canberra, Australia. Of course, the lockdown and global disruption caused by the COVID-19 pandemic have also changed the landscape, at least temporarily. Such uncertainty has led Yigitcanlar et al. <sup>[33]</sup> and Galaz et al. <sup>[34]</sup> to call for extreme care in implementing novel technologies that entail “the risk of creating new urban problems and/or intensifying the old ones instead of alleviating them”, a concern we certainly share under the precautionary principle.

### 2.3. Second-Order Impacts of COVID-19

The global direct impacts of COVID-19 have been extensive and multifaceted. Recent work has also begun exploring second-order impacts (e.g., [35][36]), and their implications for human-wildlife interactions have been speculatively compared to those of war [37]. During the pandemic-caused “anthropause”, human activity patterns drastically changed in many cities, whether because of mandated or self-enforced mobility restrictions. People increased their use of urban green spaces, with some notable differences between demographics [38]. Many news stories showed wild animals claiming empty urban places [39][40], either because of reduced competition from humans or, such as hungry monkeys being unruly in Lopburi, Thailand [41], because resources regularly provided by humans were withdrawn. These were somewhat reminiscent of reports on how wildlife has proliferated in the city of Chernobyl, Ukraine, following the nuclear disaster and the removal of human presence (e.g., [42]). However, the irruption of the pandemic is still quite recent and ongoing, so peer-reviewed evaluations have been relatively few. Zellmer et al. [43] provided a perspective on the questions being raised and tools that might be available to answer them. Their key questions had to do with measuring changes to the urban environment (e.g., noise and human activity levels) and their effect on other urban taxa, and whether differences in policy approach to the pandemic will affect those [43]. They suggested a multi-city approach that relies on a combination of citizen science and automated technology such as trail cameras.

The pandemic has led to a heightened public awareness of nature [44]. Abd Rabou [45] reviewed reports from the media and social media, found dozens of species mentioned from around the world, and collated photos of wildlife active in urban settings from a variety of sources. His conclusions were three-fold: first, COVID-19 created opportunities for wildlife to expand their activity in areas made quiet by the reduction in human behavior and, in some cases, showed much increased reproductive success; second, more action is needed to reduce the illegal trade in wildlife, much of it ending up in urban areas, that has likely led to the current pandemic in conjunction with high rates of global mobility; and third, that in the poorer areas worst economically hit by the global downturn, “poaching and hunting of wildlife have increased”. Support for that final conclusion also comes from recent work in Mexico [46]. Abd Rabou [45] also collated reports of COVID-19 infecting pets and wild animals. Le Page [47] summarized recent studies on this, noting that the virus is now “rife among the 30 million white-tailed deer in North America”, raising concern about the “risk of deer infecting other species, and also of new variants emerging in other animals and jumping back to people”. In Chile, anecdotal observations of güiña (*Leopardus guigna*) and southern river otter (*Lontra provocax*) provide evidence of increased activity during the pandemic [48]. Similarly, Shome et al. [49] report the presence of many species of birds in Jamalpur, Bangladesh. However, no conclusive support exists in either study for the hypothesis that these reflect the effects of the shutdown [48].

Wearing face masks on urban streets had no effect on flight initiation distance (FID) of European urban birds [50] but did affect FID in desert-dwelling Nubian ibex (*Capra nubiana*) in Israel [51]. In Spain, bird activity documented in an ongoing citizen science project did not increase during the lockdown, but the authors did note an increase in bird detectability associated with a change in activity times [52]. iNaturalist citizen-science data from North American cities likewise provided a mixed picture, with most species of mammalian predators showing little change in documented behavior, whereas other taxa increased their urban range [53]. Although mountain lions (*Puma concolor*) expanded into previously unexplored regions of the Los Angeles area in the United States, they reduced their activity levels [54]. Similarly, a diverse set of data allowed Manenti et al. [55] to identify increases in the species richness of some taxa in locations where human activity declined, but also that the lockdown hampered or prevented some ongoing conservation efforts in Italy.

Finally, reduced traffic resulted in a reduction in roadkills in some urban and non-urban settings and species but not in others, perhaps because increased animal activity in response to decreased traffic sometimes made animals more susceptible to remaining vehicular motion [56][57][58][59].

## 3. Urban Vegetation: Benefits, Constraints, and Effects on Urban Wildlife

Plants are important constituents that provide ecosystem services such as heat mitigation, cooling, and filtration of pollutants and particulate matter in urban landscapes. Urban plants provide habitat and food sources for wildlife and contribute to human well-being. Urban green (typically parks) and gray (often vegetation associated with denser construction) areas provide substantial urban plant biodiversity, encompassing both native and non-native species [60][61]. They include a variety of vegetated areas, including remnant natural areas; managed areas such as parks, home gardens, and yards; heavily maintained “terraformed” areas and green roofs; bioswales and rain gardens; and unmanaged brownfields and vacant lots. However, non-native vegetation often has negative impacts on native vegetation and urban wildlife [62].

Urban areas can provide substantial plant biodiversity, but greater abundance and species richness do not always equate to suitable quality habitat for urban wildlife. Between 30% and 50% of urban plant species are non-native [61][63][64][65]. Non-native plant species abundance and richness increase in more urbanized environments [66], a process driven by human-mediated trade and transport, whether that be unintentional or intentional [67]. Non-native plant species also tend to be more tolerant of the altered soil structure, hydrology, and microclimates characteristic of urban areas and benefit from reduced pressure from competing species and natural enemies (i.e., pests, herbivores) [66]. Effects of alien vegetation on urban wildlife range from positive, to negative, to negligible [62][68]. Generally, native plant species benefit urban wildlife, with native animal species benefiting (e.g., greater abundance, diversity, occupancy, and richness) more frequently from native than exotic plant species [62]. Non-native animals tend to benefit more from introduced plant species. Wildlife responses to plants' "nativeness" are complex, however. Requirements for habitat and food resources are highly variable across species, and the provision of necessary resources is ultimately more important than plant origin [69][70]. The ability of wildlife to acclimate to suboptimal resources thus plays a major role in determining species' success in urban environments. Additionally, even if an urban space contains primarily native plant species, native wildlife abundance and richness may be low due to competition with better-adapted nonnative biota.

Four primary vegetational factors shape urban habitat use by wildlife: (1) plant community composition, (2) plant species richness, (3) vertical and horizontal vegetation structure, and (4) plant community successional stage [71]. Urban vegetation management (e.g., pruning, mowing, removal of dead or diseased vegetation) directly alters vertical and horizontal vegetation structure but also affects vegetative species recruitment and age structure. Because each animal species has a unique set of requirements, it is important for cities to use a "differential management" approach that aims to balance traditional intensive horticultural and landscape management practices with more natural, environmentally friendly practices such as varying mowing heights and decreasing mowing frequency [72]. In 2004, the city of Paris started using a "differential management" program in which gardeners and park managers could choose to apply a variety of practices from a set of guidelines. This resulted in management variance across a network of interconnected habitat patches. Public gardens using enough differential management practices to become certified as "biodiversity-friendly" had greater bird and pollinator richness than non-certified public gardens. Wild plant and butterfly diversity also increased in certified gardens [72]. Green spaces, nature, and biodiversity are valued by city dwellers [73]. This became particularly apparent during the COVID-19 pandemic [39]. During lockdowns associated with the pandemic, urban outdoor recreation activities were reported to increase [74][75]. Similarly, survey respondents reported that having indoor plants in their households during the pandemic benefited their emotional welfare [76]. More than half of respondents reported taking more care of houseplants while being confined, and more than 60% communicated a desire to take more time caring for houseplants once normality resumed. The extent to which citizens experience and benefit from biodiversity in urban green spaces is debated. For example, Dallimer et al. [77] found inconsistent relationships between actual plant, butterfly, and bird species richness and the psychological well-being of urban greenspace visitors. However, for many urban residents, visiting urban green spaces is the primary or even sole means of encountering biodiversity. Urban green spaces thus provide residents opportunities to connect with nature, view ecological processes in person, and potentially become better capable of making decisions about conservation initiatives and policies in and away from the urban setting. Though humans value urban green spaces and the plant and animal resources they provide, increasing the availability of urban vegetation and habitat may increase human-wildlife conflict. Areas with "good" habitats have a greater abundance and occupancy of wildlife, which in turn results in increased potential for human-wildlife interactions. The vegetative composition and structure of urban green spaces can ameliorate desired interactions or exacerbate negative interactions. For example, increasing tree density in parks should decrease human-squirrel interactions [78]. Low tree density results in fewer places for arboreal wildlife to take refuge and increases their exposure to humans. Finally, the abundance of vegetation may decrease urbanites' sense of safety, especially at night [79].

The ability of urban plants to provide essential ecosystem services must also be considered in the context of climate change. Impervious surfaces such as roads and rooftops absorb solar radiation and emit heat, creating urban heat islands that are significantly warmer than surrounding rural areas. Urban parks and preserves may form "cool islands", which are buffered from heat- and pest-related stress and, in turn, help mitigate the surrounding urban heat island effects [80]. Urban trees shade buildings, sidewalks, and the sides of roadways, moderating radiant heat and improving outdoor human and animal thermal comfort [81]. Woody and herbaceous vegetation provide natural air cooling through transpiration. Urban plants filter air as well, absorbing pollutant gases and trapping particulate matter [82][83]. Rain gardens and bioswales reduce stormwater runoff by slowing flow and increasing infiltration while also filtering out pollutants. Urban plants are often under abiotic stress and may suffer severe pest infestations. Warmer temperatures may benefit urban arthropod pests by either directly increasing their survival or fecundity or by indirectly increasing host plant stress, making plants more suitable for infestation and subsequent loss of ecosystem services [84]. The urban heat island effect is associated

with reductions in soil moisture and increases in vapor pressure deficit, which may reduce plants' photosynthetic rates and water use efficiency [85].

## 4. Urban Wildlife and the Media

### 4.1. How People Perceive Wildlife

As encounters of humans with wild animals are becoming more common in urban settings, public scrutiny of urban wildlife and coverage in the popular media are also increased [86][87]. Abundant research has shown that public opinions and views are influenced by media frames (e.g., [88][89][90]). Often, the media will also help set the public agenda [91]. This includes influencing attitudes about wildlife and conservation outcomes and policies [92]. Thus, media coverage of human-wildlife interactions results from the overlap between the activities of humans and other species but also helps set public perceptions of those interactions [93]. Indeed, "it is equally important for biologists and ecologists to understand the social context of media and learn to communicate their conservation messages through them to gain public support for effective management [93] (p. 346). Gore and Knuth [94] explored the effect of a communication campaign about wildlife-related risks and found that news exposure influenced the level of public acceptance of risks from black bears. They also highlighted the importance of media effects for wildlife professionals. More recently, Wang et al. [95] studied the interaction of news agenda and public agenda as they relate to COVID-19 and found dynamic and reciprocal interactions on social media.

Since "[a]nimals doing what animals do normally are topics not well-suited for the average newspaper or TV newscast" [96] (p. 399), the stories that emerge are unlikely to always be positive in nature or suggest benefits to wildlife presence in the human arena. After all, the classic aphorism exemplifying newsworthiness in journalism states, "if a dog bites a man is not news, if a man bites a dog, it is news". This suggests that the essence of the news story is in its reversed relationship between animals and humans. Popular press stories can be categorized into three main types:

I. **Wild animals who break into human settings.** Three subcategories have been found:

- *Aggression*, such as stories of wild boars in Barcelona (see I.1 below) or Israel; bears in Colorado or Romania; bites from raccoons or coyotes; etc. In these types of stories, the media often presents animals as wilder or more aggressive than they really are, reinforcing the idea that they should be chased, relocated, or killed. Most of the time, this occurs without saying much about human responsibility (e.g., do not feed the bears). These stories also include the ones about animals who ended up somewhere where they are not native/usually seen.
- *Non-aggression*, such as wild turkeys reported roaming the paths of Harvard University (see I.2 below). These are typically funny, "Disney"-type stories where cute animals such as deer harmlessly walk near people.
- *Nuisance*, species that live in urban areas and become an irritation, such as rats or pigeons. Periodically an irruption is reported where they are "suddenly" seen "everywhere".

These categories extend into popular culture as well, with movies such as *Jaws* and *The Birds* emphasizing the potential for wildlife aggression in or near urban settings, *Ratatouille* showing the potential for nuisance.

I.1. An example: Shakira and the wild boars (*Sus scrofa*). In the second half of 2021, singer Shakira visited Barcelona, Spain. The presence of boars (*Sus scrofa*) in the city is not new, but populations have grown and become increasingly habituated in recent decades [66]. In September, Instagram posts described how "two wild boars ... attacked me in the park were taking my bag to the woods with my phone in it. They've destroyed everything." The story was widely reported in outlets such as BBC, CNN, El País, Fortune, HuffPost, LA Times (Spanish and English versions), NBC, The Hill, Vanity Fair, and the Washington Post, among others (e.g., [97]). One of the more lurid titles read, "Boar-celona! Shakira clashes with purse-snatching hogs as the feral pigs upend European city life" [98]. Another referred to them as "a bullet-proof and puncture-proof plague". Luckily, as some of the stories put it, the singer and her son "survived" the "attack." Across multiple news stories and countries, the wild boars were similarly personified and vilified as thieves and bullies.

I.2. Another example: Thanksgiving turkeys. Also in 2021, turkeys (*Meleagris gallopavo*), once common in North America but greatly reduced by overhunting in the late 1800s and early 1900s [99], appeared in the news around the Thanksgiving holiday when they are a traditional food. Greatly increased populations following protection have spread to cities, where they are not hunted and where their presence is a source of both amusement and annoyance [100][101]. Hutton's [100] story begins, "There's a violent gang stalking urban America. In New Hampshire a motorcyclist crashed

after being assaulted. In New Jersey, a terrified postman rang 911 after a dozen members attacked at once. In addition, in Michigan, one town armed public workers with pepper spray". Smith was less alarmed: "Across the nation, from the riverbanks of the University of Minnesota to the forests of the University of California, Santa Cruz, wild turkeys have gone to college. And they seem to like it. Maybe too much". Other stories fell somewhere in between.

II **Domestic animals** are typically covered when they escape (e.g., the escape of three captive-kept zebras (*Equus zebra*) in Maryland, USA, in late 2021 <sup>[102]</sup>) or when there is an entertaining aspect, as with most dog stories. Aggressive domesticated animals also sometimes appear—for example, feral dogs (e.g., the Romanian press is full of stories where stray dogs bit or even killed people <sup>[103]</sup>). Stories focusing on domestic animals also feature in many movies, such as *Beverly Hills Chihuahua*, focusing on "cute" features. There are many other examples, but domestic animals will not be covered here further.

III **Animals that are not typically covered** but appear in stories about diseases, viruses, and pandemics caused by human consumption of animals (e.g., swine flu, avian flu, etc.). These animals are present in the news when the consequences of industrialization are negative, as in disease outbreaks. This is a somewhat gray area in the sense that media will mention the underlying human causes, but at the same time, animals are seen as the source of the aggressions (sickening people). Examples here abound: the avian flu, the swine flu, mad cow disease, and of course, COVID-19.

## 4.2. Importance of Urban Culture to Wildlife Conservation

Most coverage of urban wildlife in the popular media is negative. If the goal is to improve public perceptions and willingness to share the urban environment with other species and perhaps even encourage activities that create wildlife-friendly habitats, then some kind of countermeasure is needed. In addition, although much wildlife interaction (e.g., hunting, birdwatching) occurs outside of cities, "the city is the centre of decision-making for wildlife management as the headquarters location for various government agencies" <sup>[96]</sup>. Thus, activities that modify public opinions within cities can have much wider impacts on wildlife conservation.

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