

## Human–wildlife interactions in urban ecosystems

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The growth of urban areas is occurring at an unprecedented scale. Urban areas account for a proportionally small area of the world's terrestrial surface (Grimm *et al.* 2008), yet by 2030, ~80% of the global population is expected to live in urban areas in the developing world (UNFPA 2007). As a consequence, for much of the global population, the only ecosystem with which they will interact directly is the urban ecosystem. There is no simple definition of what the urban ecosystem is. Urban environments comprise a complex matrix of green (vegetation), blue (lakes and rivers) and built-up spaces, with a mixed community of plants, animals and humans. Despite being of huge significance, urban ecosystems remain one of the most understudied and poorly understood ecosystems in the world (Martin *et al.* 2012).

Wildlife has been part of urban ecosystems since records began. Wildlife and humans in urban areas inevitably interact, but the nature of these interactions can vary greatly and give rise to a gamut of emotions, ranging from wonder and enjoyment to fear and loathing. Given the background of an urbanising human population, we need to understand the science of these interactions much better. We also need to learn how best to manage human–wildlife interactions in urban areas, especially when and how we should intervene, so that their positive effects can be maximised, and their detrimental impacts (both to humans and wildlife) can be minimised.

This Special Issue of *Wildlife Research* has assembled eight papers that address the context, impact and value of interactions between humans and wildlife in urban ecosystems. Soulsbury and White (2015) provide an overview of wildlife in urban areas, including drawing focus on the nature and type of human–wildlife interactions. Their overarching review highlights the fact that humans and wildlife have interacted in urban areas for a long time, both positively and negatively. There is a clear imbalance in the literature that perhaps stems from the ease with which negative interactions, known as human–wildlife conflict, can be quantified. The review gives a more balanced view, by drawing focus on the more poorly understood benefits of human–wildlife interactions and well as emphasising that human–wildlife interactions are a two-way process. The review concludes with strong push for more research into urban wildlife benefits and their importance to human society.

The high density of humans and their associated activities have important roles in determining not only the species able to

occupy the urban ecosystem but also the behaviour of the individuals of those species that are able to co-exist with humans. A series of papers across a broad range of taxa examine this. Clucas and Marzluff (2015) compared cities on two differing continents and found that similar factors were acting as filters on bird species richness. In particular, species that used bird feeders were favoured, demonstrating how human interactions, and particularly our desire to interact with wildlife, can ultimately shape the surrounding urban biodiversity. At the same time, selection can act within species. Vine and Lill (2015) compared the behaviour of urban and exurban little ravens and found that urban birds were bolder, indicating how the birds had adapted to the frequent human interactions. Lastly, some animals interact with the urban environment we have created and much less with ourselves. Often urban areas are thought to be detrimental to many wildlife populations (though see Iossa *et al.* 2010). Ancillotto *et al.* (2015) found that urban development was beneficial to Kuhl's pipistrelle bats (*Pipistrellus kuhlii*), with bats in urban areas giving birth earlier and having more pups than bats in surrounding rural areas, probably as a result of access to permanent water sources and artificial lighting. Taken together, these three papers demonstrate how urban wildlife is shaped by human influence, via direct interactions such as feeding (Clucas and Marzluff 2015), indirectly through our behaviour and presence (Vine and Lill 2015) or through the changes brought about by urbanisation (Ancillotto *et al.* 2015). Humans therefore have a significant role in determining the structure and functioning of urban ecosystems.

As Soulsbury and White (2015) discuss, there has long been a tendency for research to focus on the conflicts resulting from human–wildlife interactions. Understanding how and why these conflicts occur is of great importance, and relies significantly on the participants in the conflict. Individual tolerance to different levels and types of conflict vary substantially, whilst the species involved also play a role. Teixeira *et al.* (2015a) examined reptile–human conflict in the city of Belo Horizonte in Brazil. Unsurprisingly, snakes were the subject of higher rates of callouts from pest control agencies compared with other taxa, with callouts most frequent in wealthier, more educated regions of the city. In contrast, Teixeira *et al.* (2015b) found little conflict between humans and black tufted marmosets (*Callithrix penicillata*), and noted that most human–marmoset interactions were sought deliberately by humans. In fact, it is likely that most

negative impacts experienced by humans in relation to human–wildlife interactions arise from interactions that are deliberately sought out by humans, and only a small minority result from accidental encounters. As Soulsbury and White (2015) highlight, human–wildlife conflict in urban areas is complex. This is because the conflict can range in severity from minor to major, from often to very infrequent, and the participants themselves can be passive or deliberately seek interaction. With such a diverse and complex issue, management and mitigation of conflict are challenging. Education about urban wildlife is often seen as extremely important, both in terms of avoiding or reducing conflict but also for promoting its appreciation and conservation (Dearborn and Kark 2010).

Not all human–wildlife interactions result in conflict and, in fact, the benefits that human–wildlife interactions can bring are increasingly recognised. Soulsbury and White (2015) summarise the range of key benefits that wildlife bring to urban areas. A key theme drawn from this paper is the myriad of ecosystem services provided by urban wildlife. Ecosystem services are the benefits provided by ecosystems that contribute to making human life both possible and worth living, and are normally categorised as provisioning (e.g. supply of food, fish and timber), regulating (e.g. purification of water, regulation of waste, control of pests and disease) and cultural (e.g. recreation, aesthetic value). The paper by Yirga *et al.* (2015) highlights the important role that spotted hyenas have for waste disposal in Ethiopia. However this relationship is far from simple. The lack of alternative prey items in the area means that hyenas are almost totally reliant on human waste to survive. This complex relationship highlights how the specific properties of the urban ecosystem can give rise to unexpected mutualistic relationships. Previous work has similarly shown the importance of vultures for human society via their role in carcass disposal, with poisoning-induced declines in Indian white-backed (*Gyps bengalensis*) and long-billed vultures (*Gyps indicus*) leading to a build-up of rotting carcasses in and around urban settlements. In this case, the decline in vultures has led to concomitant increases in undesired mammalian scavengers and a heightened risk of disease (Prakash *et al.* 2003). Soulsbury and White (2015) highlight other examples where urban wildlife contributes to ecosystem services, such as the control of insect pests and pollination. As already discussed, the benefits of urban wildlife are poorly understood, and there is a real need to understand how urban wildlife contributes to urban ecosystem services.

Perhaps the most poorly understood benefit, yet potentially one of the most important, is the contribution of wildlife to cultural ecosystem services, the non-material benefits people obtain from ecosystems, which include ‘cultural diversity, spiritual and religious values, knowledge systems, educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, recreation and ecotourism’ (MEA 2005). As discussed by Soulsbury and White (2015), there is evidence accumulating that shows that wildlife and the desire to interact with urban wildlife has considerable physical and mental health benefits to the human population. Hobbs and White (2015) provide an example of this, reporting on the experiences of people in a deprived urban area of participating in a citizen science project, with benefits to both the individuals involved but also

potentially extending across the community. There is limited, but growing, evidence that wildlife has an important role in providing cultural ecosystem services in the urban ecosystem. What is clear, is that targeted research specifically addressing this topic is desperately needed and requires a multidisciplinary approach to fully quantify the benefits.

The consequences of human–wildlife interactions, both positive and negative, have important implications for future interactions between humans and nature, especially in the context of increasing urbanisation, the growing enthusiasm for green infrastructure within cities and the inherent curiosity of the human psyche. The papers in this Special Issue provide an overview and some specific examples relating to some of these consequences. However, much research remains to be done, especially in terms of understanding the behavioural, psychological and sociological mechanisms behind the interactions, how outcomes in terms of benefits and costs vary as a consequence of these, and how we can design our urban environments to maximise positive interactions and minimise the risks of negative ones. Addressing these questions will require the contributions of scientists beyond the traditional wildlife-related disciplines, extending to sociology, psychology, landscape architecture, planning and public health. Given the continuing rise in the global urban population, further research in these areas is critical if we are to minimise the negative consequences of human–wildlife interactions in urban areas, but especially to reap the diverse functional and cultural benefits that such interactions can bring.

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