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Importance of urban wildlife management in the United States and Canada

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Abstract. Urban wildlife management is growing in importance in the U.S. and Canada. This paper describes the archetypical history of wildlife population exploitation, recovery, impact management, and the anthropogenic root-causes for management of many species in urban environments. Although urban and traditional wildlife management situations differ in many ways, in both contexts, some species are welcome to co-exist with humans, while other species are considered intolerable. Management approaches and techniques tailored to urban situations are still in early days of development. Urban wildlife management issues tend to be “wicked problems” (problems where disparate human values lead to different interpretations of desirable outcomes and acceptable means of achieving them). People sharing the same space with each other and with wildlife inevitably perceive different impacts from wildlife. Experience has amply demonstrated the difficulty of finding a management response that is accepted across all segments of an urban community. Arguably, urban wildlife management ranks with species imperilment as one of the greatest conservation challenges of our time, but for a very different reason. The problems people experience with urban wildlife, if not curbed, could lead to popular backlash against wildlife and habitat conservation within or proximate to urban areas.

Key words: urban wildlife, wildlife management.

Wildlife management in urban and suburban environments is of growing importance across the United States (U.S.) and Canada. Urban development is a leading threat to wildlife conservation and biodiversity with the concern that urban and suburban areas (hereafter simplified to urban areas, for our purposes a location characterized by high human population density, including what are referred to as suburban, peri-urban, and exurban areas) are becoming places where human-wildlife coexistence is being contested. Relevant to wildlife management today, the Earth is becoming more urbanized, a trend that is projected to continue well into this century. This trend is being played out in the U.S. and Canada, with significant effects on wildlife management. Nearly 80 percent of the population of North America resides in urban areas and associated expansive human-built features. Thus, this is where most people reside, work, and recreate, and also

where many will gain first-hand experience with wildlife. Sometimes much to their surprise, such experience differs markedly from what people expect, especially if their expectations are based largely on depictions of human-wildlife interactions in entertainment media. The disparity between people’s expectations and actual experience, if occurring in the context of a problem, may result in strong reactions that can reproduce rapidly (e.g., an *individual’s* problems from a food-conditioned coyote quickly expand to become a *community* issue). This leads to demands for relief from such problems. In these increasingly common situations throughout the U.S. and Canada, the normal, measured approaches to wildlife management become embedded in local political whirlwinds. Dealing with controversy and conflict among people involved, more so than dealing with the wild animals in question, then becomes the wildlife management challenge (Decker

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et al. 2012a). Thus, once considered simply wildlife “nuisance and damage control” and largely ignored by mainstream professional wildlife management that was focused on “game” species and “endangered species” in “natural” or rural agricultural environments, urban wildlife management now captures a great deal of wildlife agencies’ attention (Adams et al. 2006).

Our purpose is to portray urban wildlife management, and briefly describe the historical developments that gave rise to the importance of urban wildlife management in the U.S. and Canada. An overview of wildlife management phases in the U.S. and Canada is presented to help understand the context for urban wildlife issues/concerns. Concerns are explained, in terms of wildlife impacts of interest to particular stakeholders in management, and to society overall. Further, the evolution of the approaches taken in urban wildlife management are described—the adaptive response of wildlife agencies over time to address the needs and expectations of people living in urban environments. While not presenting specific techniques to conserve wildlife in urban settings, the discussion concludes with some of the persistent challenges to human-wildlife co-existence in an urban environment.

We adopt Decker et al.’s (2012a) definition of wildlife management: “The guidance of decision-making processes and implementation of practices to influence interactions among people, and between people, wildlife, and wildlife habitats, to achieve impacts valued by stakeholders.” A stakeholder is any person or group significantly affected by or significantly affecting wildlife or wildlife management decisions or actions (Decker et al. 1996, 2012a). Stakeholders are people with various kinds of interests (i.e., stakes) in wildlife, human-wildlife interactions, and management interventions. Stakeholders found in urban areas may be individuals who are well organized into formal special-interest groups; individuals joined together in *ad hoc*, situation-specific grassroots groups; or simply a set of individuals who are unaffiliated and perhaps even unknown to one another yet have a similar interest or stake in a wildlife management issue. People, however, do not need to be organized or even aware they have a stake to be stakeholders in wildlife management.

Wildlife management is seldom an orderly, linear process that unfolds predictably over time (Decker et al. 2014). Urban wildlife management in practice typically is a “wicked” problem (Rittel and Webber 1973); that is, it is not only technically complex, but also has no single acceptable solution because multiple outcomes and strat-

egies of achieving those outcomes are desired by different stakeholders, based on their respective values (Leong et al. 2012). For this and other reasons, wildlife management is a multi-faceted endeavor, within which several nested sub-processes play out, often simultaneously. Wildlife management typically includes developing goals and policies, setting objectives, choosing and implementing actions, monitoring and evaluating outcomes, and then revisiting goals, policies, and objectives with new insights derived from evaluation. Involving partners (e.g., other agencies, nongovernmental organizations) and other stakeholders in the various facets of management, while necessary, contributes to the complexity of the endeavor.

Urban wildlife management takes place in an environment comprised of sociocultural, economic, political (both non-formal channels of influence as well as formal governance structure), and ecological components, referred to as a social-ecological system or as coupled human and natural systems (CHANS) (<http://chans-net.org/>). The human dimensions tend to be the prominent drivers of urban wildlife management, and they need to be well understood and integrated throughout all phases of the management process.

Wildlife management is expected to produce benefits for society (current and future generations), where benefits are the desired outcomes (i.e., positive impacts created or negative impacts reduced) experienced directly or indirectly by citizens as a result of management actions (e.g., benefits associated with citizens having improved knowledge of wildlife, preservation of biodiversity, provision of wildlife-dependent recreation opportunity, economic activity). Human experiences with wildlife and human interactions with one another about wildlife vary in intensity and duration, and can be of many kinds. These experiences typically produce a variety of effects, the most important of which (i.e., those typically generating strong stakeholder reactions and prompting management attention) are impacts (Riley et al. 2002). Impacts of concern in urban wildlife management may take numerous forms (e.g., economic benefits or costs; threats to or enhancement of human health and safety; ecological services wildlife provide; and physical, mental, and social benefits produced by recreational enjoyment of wildlife). Positive and negative impacts arise from all kinds of interactions between humans and wildlife or wildlife habitat, and among humans because of wildlife. Wildlife management attempts to enhance, regulate, or prohibit various experiences people might have with wildlife to

produce net positive impacts for people and sustain acceptance of the presence of wildlife in urban environments. The diverse benefits/outcomes that citizens expect of wildlife management in urban areas, as well as preferences for management methods, can be impossible to achieve simultaneously, perhaps even mutually exclusive, and lead to conflicts between stakeholders.

Wildlife management often is interpreted as protection or manipulation of wildlife and habitats, plus regulation of wildlife use (e.g., for hunting, trapping, and wildlife viewing). These are parts of wildlife management, but not a complete picture of what wildlife managers do in practice. Wildlife management activities of these kinds often are necessary to achieve many of the outcomes desired by society, but wildlife management as a whole enterprise includes a broader array of necessary processes (e.g., informative communication, negotiation, development of strategic partnerships, and decision making). This more robust conceptualization of wildlife management is especially relevant in urban settings.

History: a social-ecological perspective

Modern wildlife management in the U.S. and Canada was born out of necessity to undo the damage that occurred throughout the 19th century that many species of North American wildlife suffered (Trefethen 1975; Dunlap 1988). Concern about the plight of wildlife came to a head in the late 1800s/early 1900s as severe declines were noted for several species and some extinctions occurred. Over-exploited species that were sought commercially for food, hides, fur, and plumage were the foci of early wildlife conservationists. High profile conservation activists effectively used public communication campaigns (e.g., George Bird Grinnell, Theodore Roosevelt, and others wrote for *Forest and Stream*; Ding Darling newspaper satirical cartoons, etc.) to raise awareness and influence public opinion. This in turn stimulated legislation that institutionalized policies to protect some species and manage others as renewable resources. Initially, most attention was given to protecting wildlife by curbing excessive exploitation and by providing safe places for them (e.g., refuges and preserves). Though promoted largely by elite urban dwellers, vital conservation efforts were overwhelmingly oriented to rural and wilderness environments, not urban environments. Conservation efforts were concerned mostly with “saving” species and habitats that were valued for their aesthetic qualities, or animals that were traditionally the quarry of hunters.

Urban human populations were of great interest in early wildlife conservation movement because that was where the money and the votes could be found to fund and effect conservation, and where the markets for game meat, fur, and plumage were located, but urban environments were of little concern as context for actual wildlife management. For most of those involved at the time, conservation of nature (or parts thereof, such as wildlife) needed to occur in what were considered natural areas. With few exceptions, that meant largely everything outside of the developed fringes of urban centers of the day.

Urban wildlife management was not regarded as a responsibility by many wildlife agencies until relatively recently. The convergence of two phenomena facilitated that change during the 1980s and 1990s. First, interest in wildlife among urbanites was demonstrated in national surveys in U.S. and Canada. Contemporary wildlife-use trend data demonstrates that millions of Canadians and Americans participate in bird watching, photography, and other forms of wildlife viewing, and they place a high value on wildlife, wildlife conservation, and outdoor recreation involving wildlife (Gray et al. 1993; Bowker et al. 1999; U.S. Census Bureau, Department of the Interior, Fish and Wildlife Service 2001; Cordell 2008; Cordell et al. 2008). According to the 2011 National U.S. Fish and Wildlife Survey, 90 million U.S. residents 16 years and older participated in wildlife recreation: 33.1 million people fished, 13.7 million hunted, and 71.8 million participated in at least one type of wildlife-watching activity including observing, feeding, or photographing fish and other wildlife in the U.S. (US Fish and Wildlife Service 2011). In addition, a move was afoot in the U.S. during the 1980s to raise funds at the federal level to support nongame and urban wildlife programs. The wildlife management establishment in the U.S., at least some segments of it, were seeing the potential that urban populations had for funding and political support of wildlife conservation programs.

The second phenomenon was itself a convergence of two forces. Human population growth was not uniformly distributed, causing human-wildlife interactions to vary within landscapes. The fastest growth rates occurred in urban areas of Southern and Western sections of the U.S. Basically, the urban-rural interface grew as urban areas expanded (development sprawled out into the countryside post World War II) and human-wildlife interactions grew as many species made come-backs, demonstrated adaptability to urban environments, and started to create impacts that became less tolerable either because of their

nature or extent. Urban ecosystems had become “out of balance” due to human interventions (e.g., human exclusion of predatory species, which created challenges when populations of some of the prey species that were considered to be tolerable grew and became overpopulated).

In the years since World War II, First World societies have been transitioning from rural, agricultural, to urban lifestyles (Adams et al. 2006). Hand-in-hand with increasing human populations and urbanization are all the associated decisions made with respect to land-development and infrastructure (e.g., electrical power and natural gas pipeline corridors) influenced by job markets, real-estate, house-hold preference, highway placement, and other variables (Alberti 2008). As a result of these human induced inter-related land-use changes, the landscape is increasingly shaped by extensive fragmentation of habitat, which is one of this century’s most substantial threats to wildlife populations and biodiversity (Wilcox and Murphy 1985; Hilty et al. 2006). These landscape alterations in turn have direct influences on juxtaposition of wildlife habitat with human land uses, creating a complex human-wildlife interface in and at the edges of urban areas.

Presently, many urban areas in North America are not defined by a single city center but rather by a series of extended suburban areas connecting to one another, stretching out across the landscape, and creating “the limitless city” (Gillham 2002). Suburbs are no longer easily defined as low-density residential housing surrounding city centers. Cities centered on large-scale factory production developed rapidly and over time, residents within these communities began to realize the negative environmental and social consequences of living in the city. In response to these polluted, noisy, and dirty city neighborhoods, many people gradually retreated to the urban-wildland interface (Gillham 2002; Squires 2002). During the last quarter of the twentieth century, suburbs grew, stretching out from city centers (Adams and Lindsey 2010). By the start of the twenty-first century, more people in North America lived and worked in suburbs than in city centers (Gillham 2002). This situation is a set up for more human-wildlife interaction.

In these new urban settings, what once would be considered an individual homeowner’s problem with wildlife to be dealt with by her or him, often became a widespread community issue. Thus, rather than dealing with a wildlife problem oneself or hiring a private wildlife control service (pest control/exterminator) for individual assistance, communities were turning to local government and

state wildlife agencies for relief. Communities feeling collective impacts were willing to use political influence to gain agency attention. Especially in newly developed areas, where greenspace (e.g., golf courses) and natural areas (e.g., parks) were purposefully built into the residential and commercial landscapes, many species of wildlife found this built habitat, even if fragmented by some standards, to their liking and took up residence next to the humans who created the habitat. This was not a bad thing, in moderation. Wildlife were typically considered an amenity, adding value to humans’ living spaces. With greater affluence, people who already possessed material goods began to seek intangible products and/or experiences, such as opportunities for participation in wildlife activities (e.g., wildlife watching) near their homes.

Periods and phases of wildlife population exploitation, recovery, and impact management

Histories of population exploitation, recovery, and impact management have taken similar paths for many species of wildlife in the U.S. and Canada. We describe these and their anthropogenic root-causes generally here as background for understanding how the current situation emerged for many species needing management in urban environments and for anticipating which species are likely to need attention in the future. The generalization we present is an approximation we think helps one grasp the histories of many species. The fortunes of many wildlife species in the U.S. and Canada has three primary periods, all influenced by humans, indicated by our reference to “management” in each period: pre-management; population recovery management; and wildlife impact management (Fig. 1). Where nuanced shifts or phases occur within these periods they are pointed out.

No management or “Pre-management” Period (1500s to 1880s)

Human societies in North America that predate the Industrial Revolution have been characterized by primary dependence on wild, renewable natural resources (Decker et al. 2001). This situation is characteristic of the first phase within the “no management” period. During this period, fluctuations occur in wildlife populations; however, human impact from use of species directly or from habitat degradation from human land-use activities did not result in widespread threats to wildlife populations (Muth et al. 2001). This changed as human populations grew in number and spread across the landscape.

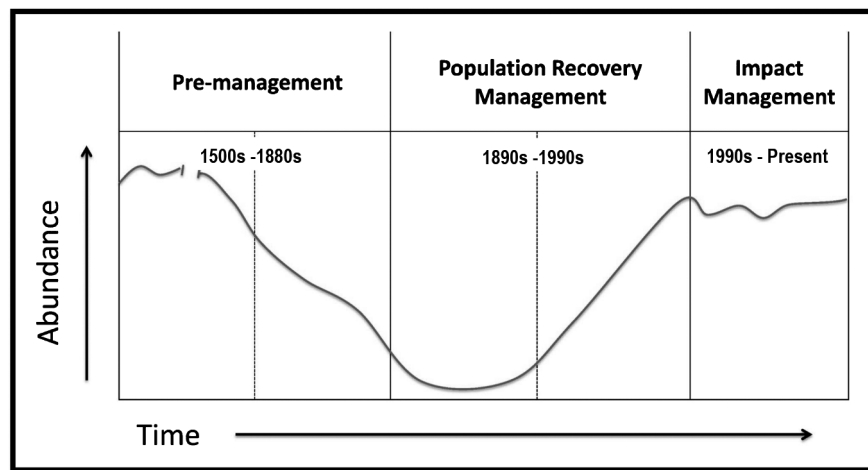


Fig. 1. Periods and phases of wildlife population exploitation, recovery, and impact management in North America.

The second phase of this “no management” period is when the overexploitation and collapse of many wildlife populations occurred in conjunction with expanding human population and technological innovations that allowed for more extensive and intensive pressures on wildlife. From greater land clearing and agricultural capabilities, to extensive removal of timber to build cities, to invention of new modes of transportation, to increased efficiency in traps and firearms, human impacts on wildlife magnified. These developments had deleterious effects on many species; entire communities of native plants and animals were altered, and sometimes lost. Westward migration of European Americans in the mid to late 1800s, driven by discovery of gold in California and prospects of acquiring lands for farms and ranches, created human population pressures that adversely affected wildlife. This phase is marked by availability of technology to harvest wildlife that was far ahead of regulations and enforcement to prevent over-exploitation of wildlife populations (Adams et al. 2006). Wildlife were killed for food, material, and because they competed with humans (competed with grazing cattle, ate crops, preyed on livestock and threatened humans directly).

“Population Recovery Management” Period (1890s to 1990s)

Population Recovery Management has two phases. First is the “stalled decline and redirect” phase. During this phase—the late 19th century for many wildlife species—wildlife populations continued to wane, but the public’s concern about such declines was growing. The concern gave rise to the North American conservation movement, major components of which were sustaining

wildlife populations by restricting extraction (adopting an agricultural paradigm of “harvesting the surplus”) and promoting a philosophy of sportsmanship and fair chase that added social norms to constrain use (Muth et al. 2001; Adams et al. 2006). These efforts were translated into laws that regulated take of wild animals for sport. But additional laws also curtailed commercial use of wildlife, essentially ending hunting to supply commercial markets. These acts all had a decidedly rural-wilderness orientation to them, and the focus was on law enforcement to protect the wildlife resource—the animals. In the U.S. the Lacey Act essentially terminated commerce in wildlife, except for regulated fur harvest. For people living in northern areas of Canada, the Migratory Birds Convention of 1917 was particularly restrictive; it classified many traditionally hunted bird species as nongame and outlawed shooting in the spring (Muth et al. 2001).

Phase two of this period was characterized by “rebounding populations.” It is marked by the inception of scientific wildlife management. Many notable actions occurred during this phase, including the implementation of habitat and species restoration programs. In 1937 the U.S. Congress addressed wildlife restoration and management needs when passing the Federal Aid in Wildlife Restoration Act (aka Pittman-Robertson Act). Furthermore, the wildlife management profession was launched, curricula were established at universities, and research was undertaken to support wildlife restoration goals with science and trained professionals to get the job done. During this period, too, recreational values gradually replaced subsistence as the primary motivation for hunting in most areas of the U.S. Providing diverse recreational hunting experiences became one of the primary

objectives of wildlife management (Muth et al. 2001).

Note that the focus during the “Population Recovery Management” period remained largely on habitats, wildlife populations, and consumptive wildlife activities in rural/wilderness areas. Urban and rural-urban fringe issues were not center-of-the-plate, and not even on the plate of most state wildlife management agencies during this phase. Thus, the norms and conventions of wildlife management philosophy and practice, respectively, developed with a bias toward wildlife and wildlife use in quasi “natural” conditions, not the human-dominated environments of urban and suburban places. Furthermore, the paradigm of wildlife management developed to respond to scarcity with an emphasis on production and fair allocation of opportunity to harvest “surplus” animals from managed populations. This is a paradigm ill-suited to urban wildlife management situations.

“Impact Management” Period (1990s to present)

Currently we are in a period of “Impact Management” (Riley et al. 2003; Enck et al. 2006), where the pervasive problem for wildlife management is seeking a socially and ecologically sustainable relationship between humans and wildlife, an aspiration we will discuss in our conclusion. Impact management focuses on desired conditions for wildlife and for human-wildlife interactions across the landscape, including urban environments. It also refers to human-human interactions about wildlife or wildlife management, which often give rise to conflict requiring management attention.

The concern about impacts of restored wildlife species started in the rural and wilderness environments that have been the focus of wildlife management for decades—ungulates damaging crops and snow geese damaging the tundra on breeding grounds are well known contemporary examples. However, impact management has also been recognized as especially relevant for urban situations where human-wildlife interactions are growing and impacts are increasingly considered intolerable/unacceptable to communities experiencing them.

Urban wildlife management responses

As the definition of wildlife management presented earlier indicates, human values are at play not only in decision-making processes about goals and objectives, but also in selection of “... practices to influence interactions between people, wildlife and wildlife habitats, and among people about wildlife, to achieve impacts valued

by stakeholders” (Decker et al. 2014). Thus, wildlife management is largely an attempt to enhance, regulate, or prohibit various interactions people might have with wildlife in order to influence direct impacts they experience and other values they associate indirectly with wildlife, such as biodiversity. In urban situations, however, the emphasis often is on problems, and usually these are of people’s own making.

In Canada, for example, residents providing artificial food sources to urban wildlife remains an ongoing issue (McCance et al. 2015). This social behavior leads to habituation and food conditioning. Habituation of wildlife, resulting in the lack of an animal’s behavioral fear response to the presence of humans after repeated non-consequential encounters, can create uncertain and risky situations that lead to negative human-wildlife interactions and thus human-wildlife conflict (Hudenko 2012). Human decisions and behaviors influence whether habituation and human-wildlife interactions will result in negative outcomes for both people and wildlife (Hudenko 2012). Through this social behavior, the nature of human-wildlife contact is defined, urban wildlife movement is influenced, and the risk of human-wildlife conflict is increased.

In addition to mental cognitions and social behavior, animals evoke strong human emotions that can influence human behavior toward wildlife (Hudenko 2012). Human-wildlife interactions are typically emotionally-charged events that can be both positive and negative in nature. Thus, human emotions toward wildlife play a role in influencing human behavior toward wildlife and human-wildlife interactions (Jacobs 2009; Hudenko 2012; Jacobs et al. 2012).

Management response

As reported earlier, prior to the last few decades of the twentieth century, urban wildlife management was not in the mainstream of professional wildlife management. Relatively speaking, management approaches and techniques tailored to urban situations are still in early days of development. In fact, urban wildlife management was viewed more as wildlife “damage control.” With this perspective prevailing, it is not surprising that practices developed throughout the 1900s in rural areas for game management and wildlife damage control were applied in urban situations, rather than starting from the different mindset of managing human-wildlife interactions. Thus, tools and tactics for managing urban wildlife issues do

not have a long history of refinement. For many years, game management and damage control strategies and techniques designed for landscape-level and/or rural and wild land application have been applied. Managers have discovered that such strategies and techniques are often impractical in urban areas, as they frequently are inadequate or unacceptable to urban residents. In urban settings, management needs to consider not only wildlife populations, but also people's expectations for various kinds of interactions between humans and wildlife, including the nature of management responses.

Human dimensions tend to be the prominent drivers of urban wildlife management, and they need to be well understood and integrated throughout all phases of the management process. Key among the human traits to be understood are perceptions of impacts arising from the presence of wildlife, often expressed as benefits and costs people associate with wildlife. People express their desires for wildlife management in terms of impacts—benefits sought or costs avoided. The diverse benefits or outcomes that citizens expect of wildlife management in urban areas, as well as stakeholder preferences for management methods, can be impossible to achieve simultaneously.

Management of wildlife issues in highly modified urban environments as it has thus far evolved exhibits four traits; two relate to overall approach (stakeholder

engagement and community-based co-management) and two relate to class of actions (individual incident mitigation and population reduction techniques).

The need to develop effective responses to urban wildlife issues has given rise to new approaches to stakeholder engagement in governance of wildlife in these environments. Creation of new venues for stakeholder input in the U.S. was necessitated by their absence at the community level and the lack of capacity on the part of state wildlife agencies in urban areas (Raik et al. 2008). As the need for community-based co-management of wildlife was recognized, new methods for collaboration and new modes of wildlife governance in urban areas have been developed that rely on different kinds of stakeholder engagement. For example, six approaches, or models, of community-based white-tailed deer management have been described (Decker et al. 2004; Table 1). In addition to stakeholder engagement and co-management innovations, techniques for wildlife population control that include nonlethal tools (e.g., sterilization, egg oiling) and novel lethal strategies and tools (e.g., bait and shoot, capture and euthanize), have been explored (DeNicola et al. 1997; Smith et al. 1999; Conover 2002; Adams et al. 2006).

Techniques for managing urban wildlife

Many of the implements used to manage game species

Table 1. Models of community based white-tailed deer management (based on Decker et al. 2004)

Model type	How are wildlife management decisions made?	Most important interventions
Community vote	By popular vote at town meeting	Education and learning, inventory/assessment
EIS ¹ /public consultation	EIS process, plus other forms of citizen participation with local and national stakeholders (including local and state government)	Informative communication, inventory/assessment
Agency partnership	By park director, with input from a multi-agency deer management work group (county, state, and federal stakeholders)	Education and learning, wildlife agency flexibility
Homeowner's association	By vote of the governing board of homeowners' association	Education and learning, inventory/assessment
Citizen action	By approval of county legislature, considering recommendations from a CTF ² and coordination with city and town officials	Stakeholder involvement, wildlife agency flexibility
	By vote of village board, with consideration of recommendations made by a CTF	
	By vote of board of freeholders, with consideration of CTF recommendations	
Citizen-agency partnership	By vote of board of freeholders, with consideration of CTF recommendations	

¹ EIS: Environmental Impact Statement. ² CTF: Citizens.

(e.g., traps, firearms, etc.) at the traditional landscape scale are similar for urban wildlife, but the applications often are different because of the context. In many instances laws and regulations that allow for equitable and fair distribution of game harvest or harvest of scarce wildlife (e.g., bag limits, elements of fair chase) are impediments or even counterproductive to overabundant wildlife management and impact management in urban areas. This is especially the case when the goal for wildlife damage management is removing as many target animals as quickly and efficiently as possible until impacts of concern are reduced to a tolerable level. Urban wildlife management typically includes population management or individual animal removal (lethal and nonlethal), modifying animal behavior (e.g., fencing, netting, repellents, scare devices, etc.), and changing human behaviors (e.g., reducing wildlife habituation or food attractants, etc.).

In urban areas, overabundant wildlife are often seen as a nuisance, pest, or threat to human health and safety. It is acceptable to many homeowners to kill and dispose of animals causing damage to their property (e.g., squirrels or raccoons in an attic) or creating health and safety concerns (e.g., wildlife carrying zoonotic diseases in their yard, or attacking their pets), but many others in their community may oppose such actions. Public attitudes toward wildlife vary widely by species and context, complicating management actions (Kretser et al. 2009).

One of the important challenges for professionals managing urban wildlife is avoiding the devaluation of charismatic species (e.g., *America's Pest Problem: It's Time to Cull the Herd*, Time Magazine, December 2013). For many people, Canada geese are no longer the harbingers of spring and fall eloquently described by Aldo Leopold (Leopold 1949), but instead are perceived as noisy, ill-tempered birds that foul municipal parks and ponds, golf courses and athletic fields. The beautiful white-tailed deer is no longer the exciting animal that thrilled people, even with fleeting sightings, just a generation earlier. Hundreds of thousands of white-tailed deer are hit by motorists each year, and more than 200 people lose their lives in deer-vehicle collisions annually in the U.S. (Sullivan 2011). Rare and relished a half century ago, today white-tailed deer are referred to by some as rats with hooves. Many stakeholders are unhappy with the high costs and other negative impacts associated with common wildlife species—their tolerance threshold has been reached or exceeded. As more people view wildlife as pests, support for conservation and habitat management can be expected to dwindle (Decker et al. 2011, 2012b; Siemer

et al. 2014; Buttke et al. 2015).

Urban wildlife management may be conducted by state or federal agency staff, or more frequently by private wildlife control operators (WCOs). With reduced agency staff and budgets, an ongoing shift toward privatization of wildlife impact mitigation has been occurring in urban areas. The wildlife control industry is growing, and professional groups such as the National Wildlife Control Operators Association (NWCOA) have emerged to help network these commercial actors in urban wildlife management. Several states now require licensing of WCOs who remove animals for profit; this trend is likely to continue in the future. The National Wildlife Control Training Program was developed as a basic course to provide new WCOs with the skills needed for licensing in several states (e.g., New York, Delaware, Oklahoma). NWCOA certified the course and is providing training for WCOs in states that currently do not require licensing. The industry is promoting increased oversight and standardization for WCO training across the country.

WCOs usually handle the most common nuisance species (e.g., squirrels, raccoons, bats, skunks, rats, mice, etc.; Table 2) that do not require special permits or expertise. Control methods vary depending on species biology, the situation involved, likelihood of successfully managing the problem, and cost. Excluding animals from structures and sanitation (nonlethal methods) are the best long-term solutions for many wildlife problems. WCOs typically focus on individual animal removal (lethal and nonlethal means), modifying animal behavior (e.g., exclusion, repellents, etc.), and traps or toxicants (lethal methods) to control rats and mice.

State or federal agency staff usually retain the responsibility to manage migratory wildlife and most game species. Special permits and training are required to handle large animals (e.g., black bears, moose, white-tailed deer), and immobilization may involve the use of controlled substances not generally available to WCOs. Trapping, tagging, and relocation of large mammals are often regulated and handled by the state wildlife agency. Migratory birds fall under both federal and state jurisdiction per the Migratory Bird Treaty Act. Removing birds other than exotic species (e.g., starlings, pigeons, and house sparrows) or those that routinely damage crops (e.g., crows and blackbirds) involves both state and federal permits. In the U.S., bird management at sensitive areas such as airports is usually handled by USDA-Wildlife Services biologists, but there is an increasing trend toward privatization of these services.

Table 2. Common techniques for managing problem wildlife using urban areas in the U.S.

Common management techniques	Species
Egg oiling/puncturing	Canada geese
Exclusion/check-valves/one-way doors	Bats, rats, mice, squirrels, skunks, raccoons, woodchucks
Fencing/plant guards	Beavers, deer, elk, rabbits, raccoons, skunks, woodchucks, voles
Frightening devices	Crows, Canada geese, gulls
Hunting/shooting	Canada geese, crows, coyotes, deer, elk, bears, rabbits, raccoons, squirrels, woodchucks
Repellents	Deer, elk, rabbits, woodchucks, voles
Rodenticides	Mice, rats, voles
Sanitation/remove food attractants	Bears, coyotes, mice, rats, squirrels
Trapping	Beaver, coyotes, foxes, mice, moles, rats, raccoons, skunks, squirrels, woodchucks
Water-level control devices	Beaver

Urban wildlife management case studies

The emergence of community-based approaches to urban deer management

The need to manage negative impacts associated with populations of white-tailed deer in urban areas has become prevalent across the U.S. Though most urban residents value the presence of deer, many residents and local leaders also harbor concerns about deer-vehicle collisions, transmission of tick-borne illnesses to people and pets, damage to landscape plantings, and loss of plant and animal diversity in natural areas. Controlling deer numbers in urban areas is difficult because a substantial proportion of the local population may not be vulnerable to management actions (e.g., state regulations regarding minimum distances from occupied dwellings for discharging guns and bows make some lands unavailable for hunting, landowners may not allow hunting due to concerns about hunter behavior, residents' concerns about animal welfare or human safety vis-à-vis use of guns and archery equipment may lead to closure of public lands to deer management). In response to this challenge, local leaders and wildlife professionals are working together to

develop community-based approaches to local deer management in urban areas.

In generic terms, community-based deer management is a cyclical process with four recurring phases: problem definition, decision-making, implementation, and adaptation. In the problem definition phase, deer-related concerns become so prominent that community leaders typically identify a committee to gather information (e.g., through public comment events and surveys of community residents), carefully assess the communities' situation, and formally define the problem. Communities that believe they have a deer management problem sufficient to require management often create a group that is sanctioned to consider management alternatives and recommend actions. The community or its appointed officials use information from the deliberative body to make decisions and set a course of action. The community nearly invariably next develops a deer management plan, which includes deer management goals. Typical goals include reducing the local deer population and maintaining the population at a lower density (such goals assume that lowering deer numbers will lead to reduction in negative impacts associated with deer). Following implementation of management actions, ideally the community enters an evaluation phase, where it tracks a set of indicators of change to assess progress toward established management goals. As communities learn by doing, they may go through subsequent management cycles, leading to adaptations in management decisions or actions.

Communities that set a goal of reducing the local deer population can use some form of deer reproductive control, managed local deer hunts, or carefully controlled deer culls to achieve their goal. These techniques can be illustrated with examples from two small adjacent communities in central New York State: the Village of Cayuga Heights and the Village of Lansing.

The Village of Cayuga Heights developed a deer management plan with three objectives, to be achieved in sequential phases. Phase I called for surgical sterilization of at least 60 does within a two-year period. Surgical sterilization was used in Phase I given there was not political support for culling when the project started. Surgical sterilization of deer takes a great deal of expertise and coordination (with local police and other entities) to handle and efficiently remove hundreds of deer from communities, even if only a few square miles in size. The Village hired a private consultant (White Buffalo) to implement phase I. During 2012 and 2013 White Buffalo staff captured and sterilized 137 does (98% of female

deer in the Village). Phase II called for a deer cull over bait to further reduce the deer population. The same firm was hired to implement Phase II. In 2015, a total of 48 deer were removed through the cull (it took two years to lay the groundwork necessary to implement the cull).

Sometimes communities enlist professional expertise to help them organize groups of volunteer shooters to remove deer either with controlled local deer hunts, or under special deer damage permits. In the Village of Lansing, New York, volunteer shooters with archery equipment removed deer from private lands using state-agency-issued Deer Management Assistance Program permits. This community-based effort grew from a single property in 2007, to more than 30 properties in 2014. The program expanded because landowners accepted the presence of shooters who were restricted to archery equipment, and the fact that all the deer meat would be donated to and consumed by needy families. A spotless safety record increased program awareness and drew in several neighboring landowners. Although the Village of Lansing does not allow recreational hunting, Village Trustees sanctioned this special program for deer removal. A Cornell University faculty member coordinated shooters and property owners involved using a web-based program for scheduling stand use and reporting deer removed.

Community-based deer management initiatives have a mixed record of success. In some cases community disagreements over management actions have led to court battles, community acrimony, and fluctuation in political will; implementing a program can take years and cost hundreds of thousands of dollars. In other cases, communities have moved forward, sustained management strategies have been implemented, and reduction in negative impacts has been demonstrated. Local leaders and wildlife professionals need to create several conditions in order to achieve successful community-based deer management initiatives.

Community representatives (e.g., elected officials, a sanctioned deer committee) need to take communication actions to increase residents' knowledge and awareness of a deer management issue and the steps their community leaders are taking to address the issue. Local leaders need to engage all affected stakeholders in their community, to gather informed input for decisions, involve community residents in fair, just, and inclusive decision-making processes, and often, to help in implementing deer management actions. Elected officials need to create strong political support to overcome challenges to the

action plan selected by the community, and to garner and sustain funding for management actions.

Community residents and community leaders need to become active learners who make comparisons, seek out patterns, and draw inferences from the overall body of information developed during the problem definition, decision-making, implementation, and evaluation phases of the process. Wildlife agencies can serve communities as a source of technical expertise on deer, deer management, and effects of deer on other wildlife and the natural environment. They usually provide assistance with permits necessary to allow for local deer management actions to occur. State wildlife agencies also need to demonstrate regulatory flexibility, because laws or regulations may have to be modified to accommodate the specialized approaches requested by urban communities (e.g., baiting, use of lights at night, etc.).

Elk management in Banff National Park, Canada

High elk concentrations in the Banff townsite over the last two decades years have resulted in serious ecological impacts, such as vegetation degradation and upsets in predator/prey relationships, and growing public safety concerns. In 1992, a community-based Elk Advisory Committee was formed to consult with Parks Canada regarding elk management actions to reduce human-elk conflicts. During the first five years, the Elk Advisory Committee focused on educational programs, areas for preventative closures, and guiding some research projects. In 1999, Parks Canada and the Elk Advisory Committee implemented the Banff National Park Elk Management Strategy (Parks Canada, webpages accessed November 29, 2015). This strategy took an adaptive management approach to urban Elk Management with two key goals: the restoration of natural ecological processes on lands adjacent to the town; and the reduction of elk-human conflicts (Parks Canada, webpages accessed November 29, 2015).

The primary objectives of the Elk Management Strategy were to: restore wildlife corridors; reconnect predators and prey; reduce elk-human and wildlife-human conflict; reduce the elk population in specific areas; increase elk wariness and migratory behaviour; restore willow/aspen indicator communities; and reduce artificial elk attractants. As part of the Strategy, a total of 212 habituated "townsite" elk were trapped and re-located out of the Bow Valley between 1999 and 2002 (Parks Canada, webpages accessed November 29, 2015). Once these elk were removed, managers implemented an aversive con-

ditioning program on the remaining elk in the herd to increase the wariness of elk toward humans, restore their migratory behaviour, and teach them to avoid the town-site. The Elk Management Strategy preliminary results were positive given their public safety targets were met, with reports of aggressive elk incidents declining from 106 in 1999 to only 19 in 2003 with only one contact charge in 2003 compared to an average of seven per year from 1995 to 1999 (Parks Canada, webpages accessed November 29, 2015). Other results included the restoration of a corridor allowing for improved predator access to prey, an increased proportion of migrant elk, and improved elk wariness levels following aversive conditioning trials. The elk population target outlined in the Elk Management Strategy was achieved with less than a dozen habituated elk continuing to frequent the town-site regularly. The willow vegetation indicators have responded to reduced herbivory. Overall, the preliminary results have indicated the importance of the limiting effects of wolves on elk as essential to maintaining the integrity of the park ecosystem (Parks Canada, webpages accessed November 29, 2015).

The success of the Elk Management Strategy is attributed in part to the collaboration of the Elk Advisory Committee as well as the network of community partners. Project updates and new initiatives were reviewed and discussed twice annually with a group of park staff and interested stakeholders, including representatives from the Town of Banff, Banff Centre, Banff Springs Hotel & Golf Course, Town of Canmore, Banff - Lake Louise Hotel/ Motel Association, Banff - Lake Louise Tourism Bureau, Bow Valley Naturalists, Central Rockies Wolf Project and the public (Parks Canada, webpages accessed November 29, 2015).

Urban goose management, Winnipeg, Canada

The City of Winnipeg, like many other urban centers, has a variety of green spaces (lawns, parks, golf course, cemeteries, and agricultural croplands) integrated within the city's developed landscape. These green spaces, in combination with conventional retention ponds, provide ideal habitat for migratory geese, free from predation and hunting, attracting large numbers of both resident and non-resident birds. Increasing urban goose populations has led to increasing human-geese conflict, decreasing Winnipeg residents' tolerance for urban geese.

Geese nesting or feeding in an urban area can cause significant damage and are associated with risks to human health, safety, and property. Goose fecal matter pol-

lutes lawns and playgrounds, making them unusable to school children and residents, and degrades water quality on urban lakes and reservoirs, increasing community concerns for human health. Large numbers of geese around Winnipeg roadways has increased the numbers of vehicle collisions as well as citizen concerns over the dangers associated with large numbers of geese around arriving and departing aircraft near Winnipeg's International Airport.

At the peak of fall migration, the Canada goose population in Winnipeg exceeds 120,000 birds. Given the increasing number of geese within the City of Winnipeg, an Urban Goose Working Group was established in 2011, as a collaborative partnership between the Government of Canada, the Province of Manitoba, the City of Winnipeg, and the Winnipeg Airport Authority (City of Winnipeg, webpages accessed November 29, 2015). The primary goal of the Urban Goose Working Group is to reduce risks to human health and safety caused by geese in the City of Winnipeg.

Since 2011, the Urban Goose Working Group has been working to reduce the number of geese nesting and feeding within the City of Winnipeg, thereby mitigating human-geese conflict. Resident urban goose counts, goose fecal counts near retention ponds, and population reduction strategies (egg removal) have been undertaken. Studies have been conducted to determine urban goose habitat use to identify where geese may have the greatest impact on their surroundings. These studies highlight the importance of vegetation height as a factor in the number of geese residing near a pond, as ponds with naturalized vegetation were associated with lower goose fecal counts (City of Winnipeg, webpages accessed November 29, 2015). Retention ponds with vegetation buffers surrounding them, in comparison to those with mown grass to the water's edge, differed in the number of geese present with the latter being associated with more geese. The Urban Goose Working Group investigations reveal the importance of vegetation management as part of the solution to reducing issues related to Canada geese in urban environments. Further, the Urban Goose Working Group researchers are examining the association between geese and grasses with readily available fescue varieties that are infected with endophyte fungus, suggesting this relationship may prove to be a promising part of urban goose management. Geese have been shown to avoid feeding in areas where endophyte-infected grass are present (City of Winnipeg, webpages accessed November 29, 2015). Efforts to date show the numbers of nesting geese along

primary roadways in Winnipeg and the airport have been reduced and the Urban Goose Working Group has gained a better understanding of urban goose habitat use within the city.

The City of Winnipeg Urban Goose Working Group, after over a decade in operation, remains an effective collaborative partnership, across three levels of government, engaged in on-going research initiatives into the location and movement of geese within the city along with the persistence of urban goose population reduction measures.

Persistent and emerging challenges in urban wildlife management

Naiveté, experience, and education

Decades of social, technological, and ecological change in the U.S. and Canada have created a seeming paradox in the relationship between urban residents and wildlife. Collectively human residents of urban areas are spending less time outdoors and are growing more detached from nature and wildlife (Louv 2008; Sterba 2012). Yet, even as those trends have emerged, populations of a few adaptable species (e.g., deer, beaver, coyote, black bear, Canada goose) have rebounded in urban areas, leading to increased levels of human-wildlife interaction and conflict. Though urban residents may experience frequent superficial wildlife interactions (e.g., seeing common birds and mammals), they often have limited knowledge of wildlife (Adams et al. 1987; Penland 1987; VanDruff et al. 1994). Low levels of wildlife-related knowledge and experience can contribute to naiveté about these animals, unrealistic expectations about impacts of living with them, and misperceptions about the feasibility of management options in urban contexts. Not recognizing the complexity of urban wildlife issues, some urban residents may harbor unrealistic expectations for low-cost, “quick-fix” solutions. This “wicked” situation aggravates the severity of contention in many urban wildlife management issues (Sterba 2012).

People develop beliefs about wildlife-related risks through personal experience, interpersonal communication, and exposure to mass media. Of particular concern in urban contexts is the role of mediated information on wildlife-related risk perceptions. A body of research suggests that communication through mass media plays an important role in how risks are framed and socially constructed (Kasperson et al. 2003). Media effects vary across individuals and contexts (Scheufele and Tewksbury 2007). But it is reasonable to assume that, for residents

who lack first-hand experience on which to base their perceptions, beliefs about the benefits and risks of living with urban wildlife, as well as management expectations and preferences for management actions, will be influenced by conventional and social media representations of wildlife-related risks. Wildlife professionals’ concerns about reliance on media for development of risk perceptions are rooted in the knowledge that messages can be manipulated by special interests, and with the advent of social media, can be forwarded by any number of sources who have little accountability for accuracy or even truthfulness (McGarity and Wagner 2008; Fenton 2010). This presents a large challenge for urban wildlife management and almost assures controversy.

Possibly this situation will abate over time as urban residents gain experience with wildlife. Unrealistic expectations about management may be replaced by practicable approaches, but the time frame for this transition seems very long—apparently multi-generational. Thus, managers sometimes place their hope in “education” of the masses as a surrogate for first-hand experience living with wildlife. Education sometimes is regarded as an accelerant of change in people’s understanding and expectations about urban wildlife management. Unfortunately, evaluation of public education and awareness programs regarding wildlife behavioral ecology and management in urban contexts (or any other contexts, really) is scarce. Some evaluation of educational interventions aimed at modifying human behavior to reduce negative impacts with wildlife (e.g., Gore et al. 2008) do not provide evidence for a hopeful outlook on the effect of education. Nevertheless, it is reasonable to believe that consistent, long-term communication about wildlife-related risks in urban situations is important for guiding public perceptions (Morgan et al. 2002; Shanahan et al. 2012).

Wildlife in its place and a space for wildlife

Though not unique to urban situations, managers should be mindful that humans have distinct spatial orderings with respect to animals, situating them as either “in or out of place” based on the traditional geographic boundaries humans have established with relation to the “proper” places animals should physically occupy (Emel and Wolch 1998; Gullo et al. 1998; Lynn 1998; Brownlow 2000; Jones 2000; Philo and Wilbert 2000; Wolch et al. 2000). These human-constructed spatial orderings of animal geography situate wild animals in relation to space, place, environment, and landscape. Humans have identified boundaries upon which some

animals are welcomed to occupy space within our daily lives while others are clearly thought to be “out of place” (Philo and Wilbert 2000). This spatial ordering phenomenon has significant implications for urban wildlife management. Management is often undertaken to maintain space-place boundaries humans seek for wildlife, and the fact that these are not uniformly delineated (boundaries not agreed upon) by humans, even neighbors, creates contention. Given concerns for environmental integrity, environmental ethics, and reconnection with nature, spatial profiling of wild animals is a multi-dimensional issue (Calarco 2008). Uncovering cognitive bases for the relationships between animals and humans, which remain deeply complex and shifting, requires multidisciplinary attention (Michaelidou et al. 2002). Farm animals, laboratory animals, wild animals, zoo animals, domestic pet animals, all become defined by cultural space, with humans categorizing animals and situating them as either “in or out of place” (Philo 1998). There is a growing pragmatic need to focus on this phenomenon (Jones 2000).

Increasingly, scholars are deconstructing these spatial orderings and challenging the wild/domestic dichotomy (Clement 2007), along with conventional notions of inclusion and exclusion (Philo 1998). Investigations into human-animal relations have given rise to new terms of reference such as anthrozoology, zoopolis (Emel and Wolch 1998), zoontologies (Wolfe 2008), zoographies (Calarco 2008) and to the study of urban animal ecology. Given the rapid rate of human population growth and urbanization that occurred in the twentieth century, the importance of considering “letting animals back in” is being considered (Emel and Wolch 1998), as is exploring the idea of urban “shared spaces” designed for species co-existence (Emel and Wolch 1998; Gullo et al. 1998; Jones 2000; Philo and Wilbert 2000). It is becoming increasingly critical for urban spaces to be designed for the co-existence of both human and non-human species (Beatley 2011). In aiming for this, however, urban wildlife management must lend itself to the process of articulating management objectives and actions that consider perspectives across multiple disciplines and involve stakeholders at all levels of management action (Michaelidou et al. 2002). Such considerations have implications for “ecological” and “social” carrying capacities—or better yet, for an integrative notion of “social-ecological” carrying capacity.

Conclusion

Urban wildlife management issues in the U.S. and Canada tend to be “wicked problems” (problems where disparate human values about the situation lead to different interpretations of desirable outcomes and acceptable means of achieving them). In the U.S. and Canada, and likely the case all over the world, people in the same geographic area—that is, people sharing the same space with each other and with wildlife—will inevitably perceive different impacts from human-wildlife co-existence in that space. In the U.S. and Canada, case after case has amply demonstrated this phenomenon, making difficult the discovery of a solution or objective for a management response that is socially accepted across all affected subcultures and or socio-economic segments of society. This makes the plausibility of co-existence between wildlife and human populations in urban contexts all the more challenging.

Nevertheless, the odds of improving the situation can be enhanced if conditions that are required to achieve co-existence are created. These may include:

- Create reasonable expectations regarding:
 - wildlife behavior with respect to people, their pets and their property;
 - acceptable human interactions with wildlife (an urban analog of ethical norms akin to the fair chase ethos created among hunters a century or more ago);
 - a new norm for boundaries of space and place for wildlife in the urban landscape;
 - the required nature of on-going management effort to ensure that a favorable (net positive) balance is achieved among the negative and positive impacts of human-wildlife co-existence.
- Improve individual and social (or collective) efficacy of community-based co-management efforts. That is, ensure capacity of co-management efforts can deliver adequate effectiveness of individuals, communities, agencies dealing with wildlife issues, such that societal confidence in maintaining a net positive balance in impacts of human-wildlife co-existence is reinforced.
- Develop and deliver effective educational and informative communication to improve risk perceptions held by urban residents vis-à-vis wildlife (these are directed toward cognition and skill change [self-efficacy improvement]).

Finding solutions to urban wildlife issues will take time and persistent effort. Furthermore, there is some

urgency to the search, at least in the U.S. and Canada, where we believe urban wildlife management ranks with species imperilment as one of the greatest conservation challenges of our time, but for a very different reason. Whereas endangered species conservation captures people's imaginations (and political and monetary support), urban wildlife management in the U.S. and Canada heretofore has not. We worry that the problems people experience with urban wildlife, if permitted to routinely and widely exceed tolerance thresholds of individuals and communities (i.e., persist as "nuisance" or "pest" control), could possibly lead to popular backlash against wildlife and habitat conservation within or proximate to urban areas. In a world where urban areas are growing in physical size and population, where concerns are instantly communicated globally, and where uninformed opinions can be shared and adopted with relative ease, the possibly of devaluing wildlife should give pause to anyone concerned about wildlife conservation.

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