



9. Recreationist-Wildlife Interactions in Urban Parks

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The mission of the Green Visions Plan for 21st Century Southern California is to offer a guide to habitat conservation, watershed health and recreational open space for the Los Angeles metropolitan region. The Plan will also provide decision support tools to nurture a living green matrix for southern California. Our goals are to protect and restore natural areas, restore natural hydrological function, promote equitable access to open space, and maximize support via multiple-use facilities. The Plan is a joint venture between the University of Southern California and the San Gabriel and lower Los Angeles Rivers and Mountains Conservancy, Santa Monica Mountains Conservancy, Coastal Conservancy, and Baldwin Hills Conservancy.

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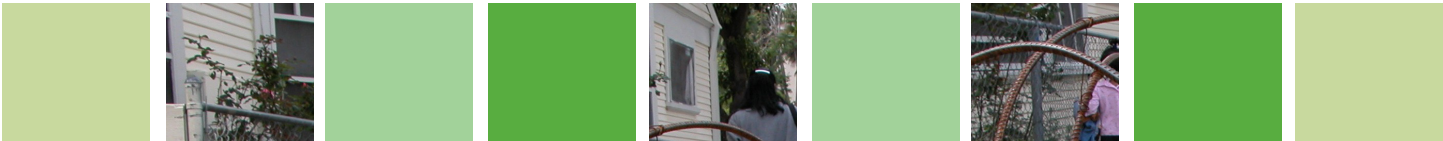
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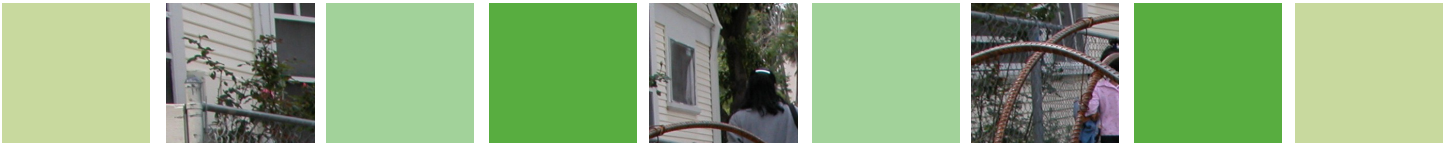
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EXECUTIVE SUMMARY

This report has been prepared for the Mountains Recreation and Conservation Authority (MRCA) and the Santa Monica Mountains Conservancy (SMMC). Its purpose is to examine the potential beneficial and detrimental human–wildlife interactions that would arise from habitat restoration in the upper Los Angeles River watershed.

With the acquisition and restoration of land for parks and wildlife reserves within Los Angeles comes the potential for a range of human–wildlife interactions, especially as wildlife re-enter the city. The increased presence of urban wildlife presents a complex mosaic of opportunities and constraints for both residents and wildlife alike. The challenge is to balance competing interests, educate residents about potential benefits and manage detrimental impacts in an ethical and ecologically sensitive fashion. Although there is a well established literature on human–wildlife interactions, originating largely from the disciplines of conservation biology, ecology, wildlife management, and the broader environmental studies and conservation literatures, little has been written about such interactions in the context of urban parks, a central focus of the conservancies' efforts in the upper Los Angeles River watershed.

The introduction of this report (Chapter 1) contextualizes the SMMC and MRCA's interest in urban park creation and restoration within the increasing interest in the ecology of cities and the growing understanding of cities as places for wildlife. Indeed, there is growing recognition that urban landscapes are complex ecological sites, not barren wastelands. It offers an overview of the issues that can arise between humans and wildlife when urban park spaces are restored to create wildlife habitat.

The body of the report is divided into two sections. Section I concerns interactions between humans and wildlife generally, discussing the positive and negative impacts of interactions on wildlife (Chapter 2) and on humans (Chapter 3). Chapter 4 identifies best practices to minimize the negative aspects of these interactions.

Chapter 2 chronicles the impacts on wildlife of various positive and negative interactions between park users and urban wildlife. Community groups, government services and departments, and non-profit organizations variously contribute to the creation of new habitat and the improvement of degraded habitat for wildlife. Food and other garbage discarded by recreationists may increase the reproductive rates, litter sizes, and body sizes of scavenging animals. Unfortunately, many park user interactions with wildlife fall on the negative side of the spectrum. Exploitation, disturbance, habitat modification and pollution are all common anthropogenic effects, causing results including but not limited to behavioral changes, reduced reproductive success, and habitat destruction.

Next, Chapter 3 addresses wildlife interactions with residents and park users. The benefits of animals in the city are rarely acknowledged. People may benefit from interaction with wildlife in numerous ways including increased residential property values, mental well being, stress relief, improved communication skills, affirmation of personal, spiritual, and aesthetic values, and economic benefits deriving from tourism and even increased agricultural productivity. The numerous negative impacts that wildlife have upon people include animal attacks on recreationists and on pets, the spread of disease, nuisance activities such as animals foraging through trash, harm to private property through nesting, erosion, garden damage, structural damage, vehicle collision, and unsightly and annoying instances of defecation on paved surfaces and automobiles. Many of these problems can be expensive — especially in the case of structural damage to vehicles and buildings.

Section I ends with Chapter 4, which discusses potential remedies for human–wildlife conflicts. A variety of possible solutions exist, including neighborhood outreach and education efforts, stringent parkspace ordinances, wildlife-friendly infrastructure, and zoning strategies. There is no singular, universal remedy for human–wildlife conflict situations; rather, one or several pathways to resolve conflicts must be chosen

and tailored to the particular situation.

In Section II, we develop a typology to describe how ecologically restored land functions in terms of increasing wildlife habitat connectivity, and apply this typology to the proposed projects for the upper Los Angeles River watershed. We then consider the potential increases and decreases in human–wildlife interactions that would result from these projects, with special attention to a case study (Pacoima Wash).

In Chapter 5 we introduce and discuss the general characteristics of park spaces that lend them to ecological restoration, including vegetative cover, size, and location within the landscape. Ecological restoration will likely increase the occurrences of human–wildlife interaction. The degree of such increase will depend largely on the park’s size, location, and restoration objectives. Generally, restoration of larger parks is preferred over smaller ones; however, small parks can constitute very important habitat in the urban matrix. Parks located closer to existing large habitat remnants have better chances of repopulation than parks relatively isolated by the urban matrix. Here, we also introduce a typology for understanding the potential restoration projects in the upper Los Angeles River watershed in terms of the connectivity that each restored park would create for wildlife. The placement of any park project within the typology is dependent upon interplay between project size, project location within the urban matrix, and project location relative to other expanses of habitat.

In Chapter 6, the conservancies’ potential restoration projects are placed within this typology, and each is considered in terms of surrounding land uses and human population density to produce an estimate of the potential for an increase or decrease in human–wildlife interactions. We then present a detailed case study of the implications of the restoration of Pacoima Wash.

The paper concludes by reiterating the promise of restoration projects as contributors to the vitality of the urban ecosystem. Wildlife will benefit from habitat restoration as their food, water, and shelter resources increase. Park users may experience more wildlife-viewing opportunities, and may enjoy a heightened sense of interspecies community, a decrease in stress levels, and even a rise in property values, among other benefits. Although habitat restoration may pose a number of conflict situations between park users and wildlife, these can be mediated by tools such as wildlife-friendly infrastructure, ordinances, zoning, and education efforts. Both the physical environment and human attitudes must shift to accommodate the increased presence of wildlife in the city that restoration will bring.

CHAPTER 1: INTRODUCTION

Cities are typically viewed as artificial entities — the opposite of nature (Cronon 1995; Haspel and Calhoon 1991; Spirn 1996). Yet over the past two decades, cities have been increasingly recognized for their complex ecologies. Rather than being barren or sterile “concrete jungles,” cities comprise an intricate matrix of disturbed and remnant landscapes and habitats (Rebele 1994). As the supply of wildlands dwindles, attention must be given to the many ways in which urban areas can be improved as wildlife habitat. The restoration of degraded landscapes and retrofitting of parklands can potentially increase the habitat value of urban environments. With such improvements, there should be a concomitant increase in the abundance of urban wildlife. This report has been prepared for the Santa Monica Mountains Conservancy (SMMC) and the Mountains Recreation and Conservation Authority (MRCA) to examine the potential detrimental and beneficial interactions between humans and wildlife arising from habitat restoration in the upper Los Angeles River watershed.

This paper is one component in a series of studies being undertaken as part of the Green Visions Plan for 21st Century Southern California. An important aspect of this plan is the identification of land for future acquisition as part of a regional vision for ecological restoration of critical wildlife habitats and creation of open space. With the acquisition and restoration of land for parks and wildlife within the region comes the potential for a range of human–wildlife interactions. Some of these will be conflictual in nature, especially as larger animals such as coyotes — with their propensity to eat pets, rummage through trash, and worry parents — re-enter the city. Proposals for new park space and the restoration of existing parkland and other urban green spaces should be cognizant of these issues so as to maximize the benefits of parks and connecting corridors for both people and animals. One of the biggest challenges in this process will be to change the public’s perception of urban wildlife as “problems” or “pests”, as a portion of the urban population finds urban wildlife to be unwelcome neighbors (Knight 2003).

Overview of the issues

Although there is a well established literature on human–wildlife conflict, originating largely from the disciplines of conservation biology, ecology, wildlife management, and broader environmental studies and conservation literatures, little has been written about such conflicts in the context of urban parks. Most literature focuses on human–animal relationships in large exurban parks or wilderness areas. Notable exceptions include studies of deer in Durand Eastman Park, New York (Curtis et al. 1993); raccoons in Rock Creek Park, Washington D.C. (Riley et al. 1998); raccoons, skunks and coyotes in the Ned Brown Forest Preserve, Chicago (Gehrt 2004); and dog–wildlife conflicts in the Berkeley Marina, California (Abraham n.d.). This may be because until very recently, urban environments were considered to be impoverished and useless ecological spaces (Gill and Bonnett 1973; Haspel and Calhoon 1990; Rebele 1994; Wolch et al. 1995). In many cases, this could not be further from the truth.

The inclusion of two United States cities in a long term ecological study network is an excellent example of the growing recognition that urban spaces are rich ecological landscapes. Baltimore, MD and Phoenix, AZ are the two urban systems chosen in the late 1990s to belong to the long term ecological research (LTER) site network. The LTER site network, supported by the National Science Foundation, was established in 1980 in order to investigate place-based ecological issues best studied over long periods of time. There are now over 25 LTER sites in the United States (LTER Network 2004). Researchers at most sites seek to understand two sets of variables that affect ecosystems: ecosystem patterns and processes constrained by biological and geophysical factors like climate, hydrology, and species pools; and human activities such as resource consumption, species introduction, and land-use change (Grimm et al. 2000). Findings from the Baltimore and Phoenix sites are already suggesting that cities should be viewed as complex ecosystems and not simplistically as artificial entities. Urban areas have a multitude of impacts on energy and nutrient cycling, heat storage, water storage and movement, and at the same time support

a diversity of plant, animal, and human life (Grimm et al. 2000).

In her insightful paper on green links and biodiversity, Schaefer (2003) notes that far from being sterile or barren landscapes, urban areas present an array of productive ecological spaces, albeit often highly fragmented and degraded (see also Rebele 1994). Urban habitats such as greenways, Schaefer argues, offer the opportunity to connect habitat fragments, linking isolated populations and adding ecological value to urban areas. Nonetheless, such connective corridors are plagued by a range of ecological impacts or edge effects that can compromise their integrity. Problems with urban habitat fragments include weed invasion, vulnerability to fire and increased risk of predation along fragment margins (Fernández -Juricic et al. 2004; Lepczyk et al. 2003; Miller and Hobbs 2000; Rebele 1994; Soulé 1991).

Moreover, as in natural ecosystems, urban wildlife communities fluctuate and evolve, sometimes creating conflicts with humans in the urban matrix (Savard et al. 2000). The interaction of wildlife and humans within the urban fabric presents a range of problematic issues ranging from the serious — attacks on humans and domestic animals, disease transmission, and damage to property like homes and cars — to the annoying, such as noisy howls and calls, scattered garbage, and bird droppings on park benches. And in reverse, anthropogenic activities and actions can negatively affect urban wildlife. Human infringement upon or presence in wildlife habitat may lead to habitat fragmentation and destruction, making populations more vulnerable to predation, vehicle collision, poisoning, and starvation. Exotic species introduced into ecosystems by humans can cause trophic level disturbances and more habitat destruction.

Human disturbance can also result in behavioral changes in wildlife, which may adopt an avoidance response to human activities. Disturbances by humans and companion animals that provoke escape responses can be extremely detrimental, hampering animals' reproductive success. Off-leash or otherwise unsupervised companion animals are also responsible for thousands of reptile and bird deaths through predation, and may spread diseases to park wildlife. At the other end of the behavioral spectrum, some species of wildlife exhibit attraction to humans. A number of urban wildlife species utilize human-generated garbage as a food source, and may even understand humans to be a source of food, when consistently exposed to recreationists who offer hand-outs. Substitute feeding can cause artificially high population densities, and can also result in individual animals boldly and even dangerously approaching humans and human habitations for food. Repercussions of wildlife feeding include population culls and the euthanasia of animals that get "too comfortable" in the city. Finally, urban wildlife are exposed to many of the same environmental ills that humans are — chronic air pollution, dirty streams, and abundant litter — and other sources of pollution, such as noise and light, also represent serious disturbances to wildlife, affecting foraging and breeding success in urban areas.

On the other hand, the presence of wildlife in urban ecosystems can positively impact urban dwellers' quality of life and educational experiences, and ultimately contribute to the preservation of biodiversity in less disturbed ecosystems (Savard et al. 2000). The presence of wildlife in urban areas contributes to aesthetic, emotional, psychological, and social experiences for urban dwellers. To some it is an utter delight to share space with wild creatures, and observing wildlife may constitute a relaxing and peaceful experience for viewers. The presence of wildlife in and near urban areas may provide for others a more practical benefit. Wild animals can be subjects to monitor or study as indicators of environmental quality. Some species perform tangible services such as pollination or mesopredator control. The existence of wildlife and natural habitats in urban areas contributes to increased property values, and local businesses stand to profit from tourist visits to nearby parks and reserves.

In turn, to reinforce and increase the benefits that humans reap from living with wildlife, and to recreate what land development has demolished, community groups, governments, and nonprofits restore,

augment, and conserve natural habitat in urban areas. And, urban wildlife are able to supplement their diets with leavings in garbage cans and compost piles.

Clearly the increased presence of wildlife in the city presents both constraints and opportunities for residents and wildlife alike. The challenge for habitat restoration projects like those to be undertaken by conservancies such as the SMMC and MRCA is to find a way to balance competing interests, educate residents about potential benefits, and manage detrimental impacts in an ethical and ecologically sensitive manner.

Why restoration matters

Urban parks can constitute invaluable habitats for species that otherwise could be lost from the urban ecosystem. Van Ommerson and Helmstetter (2004), for instance, have found strong correlations between native vegetation volume and total wildlife density, and between native vegetation volume and native bird density, in an urban Phoenix, Arizona park. Fernández-Juricic (2000) notes that vegetated streets have the potential to increase landscape connectivity for urban avian species.

Habitat patches such as urban parks with little or no connectivity suffer from a range of deleterious effects (Soulé 1991) yet they are often the only occurrences of urban nature. A conservation strategy in metropolitan areas must use a wide variety of tools, and well-managed small reserves can be very valuable for conservation in the urban matrix. They can act as corridors and stepping stones to improve connectivity for some species, and at the same time be crucial habitat patches for others. It is important to improve the connectivity between habitat patches to foster the movement of animals between fragments and to provide a greater range of opportunities for residents to experience nature in the city. These park-reserves must be created with both the local and landscape scales in mind as part of an overall strategy that includes reserves with different conservation roles, of different sizes, and with different habitats and uses. Flexibility, creativity and multipurpose are fundamental concepts in urban conservation.

Structure of the paper

The paper is divided into two sections. Following this introduction the first section chronicles the diverse types of interactions between park users and urban wildlife (Chapter 2). Here we discuss habitat restoration and resource provision that directly benefit wildlife. However, there are seemingly far more negative than positive impacts, largely because human interactions with wildlife produce a range of responses in both individual animals and groups of animals, through exploitation, disturbance, habitat destruction, and pollution.

The first section of the paper also addresses interactions of wildlife with residents and park users (Chapter 3). There is an equally complex set of issues pertaining to such interactions, and once again they are both positive and negative. Wildlife interactions with humans are generally largely framed within the context of economic costs and benefits and fail to account for intrinsic, spiritual and other indirect values. Oftentimes the benefits of animals in the city are hidden behind a cloak of unwieldy city ordinances, antiquated attitudes of residents and administrators and sensationalist reporting by the media of isolated instances of animal attack or pet predation. People benefit from interaction with wildlife in numerous ways including increased residential property values, mental well being, stress relief, improved communication skills, affirmation of personal values, and economic benefits deriving from tourism and agricultural productivity. The negative impacts that wildlife have upon people include animal attacks on individuals and pets, the

spread of disease, nuisance activities such as animals foraging through trash and harm to private property through nesting, erosion, garden damage and unsightly and annoying instances of defecation on paved surfaces and automobiles (Hoffman and Gottschang 1977; Riley et al. 1998).

Chapters 2 and 3 draw on both the larger body of literature about human–wildlife interactions in wilderness areas and exurban parks, and on the growing body of literature on urban parks and wildlife. Research on interactions at the urban fringe is in many ways useful for extrapolation about possible benefits and conflicts stemming from the increased presence of wildlife in urban parks, and is a necessary source to draw on at this point in time until the volume of publications about wildlife ecology in urban park spaces increases.

Chapter 4 addresses potential remedies for human–wildlife conflicts. Here we discuss the promise of and lessons from zoning, ordinances, conservation planning, wildlife-friendly design, community outreach, and immunocontraception to alleviate habitat destruction and other facets of human–wildlife conflict. The viability of most of these techniques is context-dependent. Municipal ordinances regulating park space activity are recommended in any situation, as is park user education. Zoning ordinances too can be an effective way to approach land-use issues, and can be applied within and beyond park boundaries — but as with municipal ordinances, will be subject to the approval of other governing bodies. The scale and necessity of changes to infrastructure is dependent upon the surrounding urban matrix; and the utility of immunocontraceptive techniques will depend on whether a fertility control program is available for the species in question.

In Section II, Chapter 5 addresses the characteristics of park spaces that lend themselves to ecological restoration. Important variables include park size, vegetation cover, situation within the urban matrix, and location relative to other open space. These all have implications for connectivity, edge effects, and human–wildlife/wildlife–human interactions. A typology for classifying land suitable for restoration in the upper Los Angeles River watershed, contingent upon the contribution to urban matrix permeability and habitat connectivity a restoration project would make, is presented in this chapter as well. Projects are classified according to interplay between project size; project location within the urban matrix; and project location relative to other expanses of habitat.

In Chapter 6, potential restoration projects are placed within this typology and labeled as prone to increases or decreases in potential for human–wildlife interaction. This involves understanding the nature of the project as determined by the analysis completed to place it within the typology, and factoring in surrounding land uses and human population density to estimate the degree of potential for increases or decreases in human–animal interactions. A general discussion of human–wildlife interactions and suggestions to resolve conflicts in each type of restored space follows the typology presentation. Finally, the Pacoima Wash restoration project is discussed in more detail, to describe predicted wildlife–park user interactions given its characteristics and to offer solutions to negative interactions expected to arise. This section is followed by our conclusion.

SECTION I

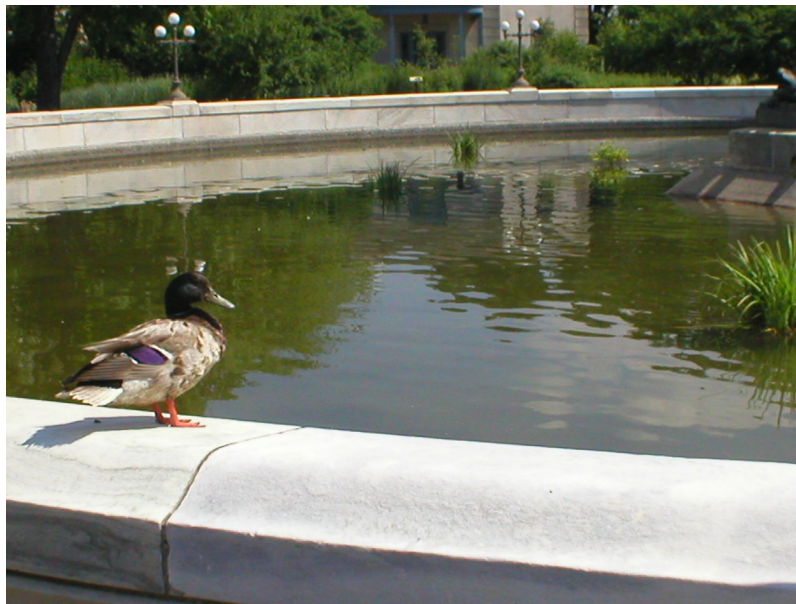
CHAPTER 2: PARK USER IMPACTS ON WILDLIFE

Positive aspects

The literature on park user–wildlife interactions suggests that there are a number of positive impacts that park users and managers may have on wildlife. Two groups of positive impacts are identified, the first pertaining to the provision and protection of natural habitat, and the second to increased food supplies.

Habitat creation, augmentation, restoration, and conservation

Urban environments may actually provide a greater diversity of opportunities for some species than wildland areas. For example, in their study of raptors, Mannan and Boal (2004) report that urban areas may offer increased prey (such as pigeons, rabbits and rats), alternative nesting sites, and greater stability of resources such as nesting materials. Other animals including skunks, raccoons, and coyotes may also prosper from increased habitat diversity found in urban areas. Rosatte et al. (1991) have found that vegetation density in parks can directly affect the population density of mesopredators such as skunks, raccoons, and foxes, which in turn can decrease predation from free ranging cats. Hoffman and Gottschang (1977) and Riley et al. (1998) have asserted that parks and adjoining residential areas offer a host of denning and foraging opportunities. Some rare native species can exist in areas of low-intensity development, including city parks, cemeteries, vegetated areas under large powerlines, and other public rights-of-way protected from development (McKinney 2002).



Mallard duck (*Anas platyrhynchos*) in an urban nature park
Credit: Mona Seymour

Such incidental opportunities may be supplemented through habitat creation and restoration in urban areas. The increase of native plant species, and even some ornamental species found in gardens, may be accompanied by an increase in insectivorous birds (Sears and Anderson 1991). Allowing ruderal areas to go undisturbed and enter a succession process is another avenue toward restoration, often resulting in an increase in total species diversity, and a reduction in non-native species diversity (McKinney 2002). Other approaches include conserving habitat swaths by fencing off areas for protection, and performing exotic plant weeding and revegetation.

One of the most effective (and, in the long run, inexpensive) habitat conservation strategies is to preserve as much remnant native habitat as possible. Urban parks and other developed areas that retain pre-

development vegetation can sustain native birds, mammals, and plants at levels of species richness that increase with the area of the native habitat patches. Planners and developers must also pay attention to the greater matrix in which the native habitat remnants are embedded: if the land surrounding the remnants is highly disturbed, the native habitats suffer from more and more intense edge effects than if the surrounding land is at a low level of development (McKinney 2002).

Environmental engineering projects such as sustainable drainage systems can provide good urban wildlife habitat, especially if built in conjunction with appropriate landscaping and native vegetation. Ponds, wetlands, and swales provide habitat for waterbirds, amphibians, and invertebrates as they manage runoff (Wright 2003). In general, urban open space, unpaved areas, and green cover not only provide habitat for wildlife, but also absorb stormwater runoff, take up pollutants such as ozone, particulates, and carbon dioxide from the air, moderate wind, and reduce urban heat island effects and hence energy demands (Nowak et al. 2000; Luley 1998). Open space and green cover are, essentially, a part of the city's infrastructure.

Increased food supply

The feeding of wildlife by park users may have short-term benefits including enhanced reproductive success (Orams 2002). Despain et al. (1986) found that grizzly bears in Yellowstone National Park that exploited human food waste averaged larger body sizes, higher reproductive rates, and larger litter sizes prior to the closure of park garbage dumps. According to Brittingham (1991), the use of bird feeders has a positive impact on bird populations and there is little evidence to suggest that birds become dependent on feeders.

Fedriani et al. (2001) found that coyote densities in the Santa Monica Mountains were highest in the most developed portions of the mountains, and that anthropogenic food sources such as trash, fruit, and pets may constitute up to 25% of the coyotes' diets in these areas. Similar trends were noted for skunks and raccoons by Hoffman and Gottschang (1977) and Riley et al. (1998), who found that these animals prospered around anthropogenic food sources.

Prange et al. (2004) found that raccoons in an urban and a suburban open space had smaller and more stable home ranges than raccoons in a rural open space, due to abundant and fairly reliable anthropogenic food sources. Consequently, urban and suburban raccoons lived at higher densities, and experienced increased survival, higher annual recruitment, and higher site fidelity than their rural counterparts.

Negative Aspects

Unfortunately there is a much larger array of negative human impacts on wildlife. Knight and Cole (1995b) note that humans affect wildlife in four possible ways — disturbance, habitat modification, exploitation, and pollution. Disturbance may be either unintentional (accidentally scaring a nesting bird) or intentional (deliberately frightening a deer to get a good photograph). Habitat modification typically results from vegetation clearing or damage, the introduction of invasive plant species, or the release of predators or competitors. Knight and Cole state that exploitation results in the death of the animal as a direct result of human interaction, including hunting, trapping, fishing or collection. Pollution may occur in a variety of forms including noise pollution, light pollution, visual intrusion, and air, water and soil contamination through activities such as pesticide application, dumping of trash, or contaminants from storm water runoff. Many of the impacts we discuss below fall neatly into Knight and Cole's (1995b) framework. In addition to these effects, the urban setting of park spaces may pose other threats to wildlife. Mannan and Boal (2004) cite several hazards that the urban matrix poses to raptors, including electrocution from overhead powerlines, poisoning from insecticides or rodenticides, collision with vehicles, and collision with

glass windows. Klem (1991) has documented that bird collisions with glass windows of buildings cause millions of avian deaths in the United States each year. Disease is also a hazard, and may be due to transmission resulting from high concentrations of wildlife around food sources, or to ingesting prey such as pigeons that may have a range of avian diseases not found in wildland species.

Disturbance and destruction in habitat fragments

Perhaps the greatest impact of people on wildlife in urban areas is habitat loss (Tigas et al. 2002). This is especially the case in southern California which is not only a global biodiversity hotspot, but where urban development has destroyed hundreds of thousands of acres of unique habitat (Rideout 1993; Soulé 1991). The conservancies, in a sense, seek to inject habitat fragments into the urban matrix, which carries many of the same implications for wildlife as exurban fragmentation. Generally speaking, populations in habitat fragments are exposed to a heightened degree of edge effects like noise and exotic predators, due to the higher perimeter-to-surface area ratio that characterizes habitat fragments.

Habitat destruction has many faces, with trampling of vegetation by recreationists and introduction of invasive species including weeds, insects and exotic animals (Wolch et al. 1995) being most relevant to urban parks and open space. Recreation in habitat fragments can lead to serious ecological disturbance including soil compaction, reduced infiltration, increased erosion, and changes in soil moisture, temperature, and fertility with concomitant changes in soil flora and fauna. Impediment of interactions between soil, microbiota, and vegetation caused by soil compaction can result in a decrease in primary productivity (Cole and Landres 1995).

The alteration or destruction of park habitat by users may also foster increased bird predation. This may occur due to vegetation trampling by recreationists or their pets or through the removal of cover during trail construction, which also increases edge effects such as weed invasion (Miller and Hobbs 2000). Miller and Hobbs found that the establishment of greenway trails increased nest predation by birds, mice, raccoons, red foxes, and squirrels. Knight and Cole (1995b) cite evidence of avian and mammalian predators following human scent trails to bird nests, and Gutzwiller (1995) has noted that recreationists disrupt species interdependencies and alter the composition of guilds. He asserts that recreational activities alter species richness, abundance and composition.

Species that are able to survive and even prosper in the mosaic of urban habitat fragments are opportunistic and highly adaptable. These characteristics oftentimes bring adaptive species into conflict with urban residents. Habitat fragmentation forces animals such as coyotes and bobcats to search for food amidst trash or to include domestic animals in their diet. Though adaptable, these species are often less able to coexist with humans than are “less-threatening” species like raccoons (Riley et al. 2003). Individuals located in habitat fragments are also more prone to disturbance and may shift their foraging behaviors to nocturnal patterns. Habitat fragmentation also brings animals into more frequent contact with vehicles and with toxins, such as rodenticides (Riley et al. 2003).

Release of exotic species

Next to habitat fragmentation and degradation, the biological invasion of alien species of flora and fauna currently constitutes the most serious threat to urban biodiversity in the United States. The over 50,000 alien species in the United States cause upward of \$138 billion of damage to agricultural and industrial infrastructure, and disturb the intricate processes of both urban and wildland ecosystems (Pimentel et al. 2000). When compared to the estimated cumulative \$97 billion in damages derived from invasive species during the 85 year period from 1906–1991, the \$138 billion annual estimate illustrates the staggering impact of the rapidly growing exotic animal trade, increased demand for agricultural production, and the globalization of the world economic market (OTA 1993).

Introduced species have serious environmental and ecological impacts. Recreation causes disturbances that favor the establishment of exotic flora, which has implications for the dietary and shelter needs of native species. For instance, differences between resident bird populations in native and exotic Canadian grasslands were attributable to differences in habitat structure and food supply (Cole and Landres 1995). Invasive plants encounter few predators in new environments and may subsequently gain dominance over native plants that serve as a significant source of food to native herbivores (Vitousek and D'Antonio 1997).

The inadvertent or intentional release of non-native fauna into parks can result in the establishment of populations of feral species. Parrots, cats, fish, and reptiles can all take their toll on native species through trophic level disturbance and habitat destruction. Alien fauna represent a new component to a native assemblage of southern California species, whether predator, prey, and/or competitor, resulting in disruption to the species composition of an emerging park ecosystem. Non-natives may enter into direct competition for resources with native species and outcompete their native counterparts. Other species in higher trophic levels feel the repercussions of this relationship as a native prey species disappears; and lower trophic levels may lose a natural predator or grazer (Cole and Landres 1995). For instance, in southern California, Garrett et al. (1997) recorded the exploitation of tree seeds, flowers, and fruits by different species of naturalized parrots. They found that several species of parakeets and Amazon parrots include acorns from native oak species in their diets, and that six parakeet and parrots species consume native sycamore seeds. Garrett et al. predict that some of the naturalized species may enter into substantial competitive relationships with native bird species for food resources in the future.

A well-known example of invasive species disturbance to a park ecosystem is the explosion of the cane toad population in Australia. Introduced from Central and South America in 1935 as a biological control mechanism against beetle pests infesting sugarcane fields, the venomous cane toad became a major pest itself, heavily impacting the region's ecology. The recent arrival of cane toads in Kakadu National Park is linked to a decline in native park predators. With no natural predators of the cane toad in Australia, there is currently no far-reaching means of population control available (AGDEH 2004).

Substitute feeding

Orams (2002) has catalogued a wide range of issues associated with human feeding of wildlife. Substitute feeding can create wildlife dependencies on park visitors. Animals may alter their foraging behaviors in favor of easier food sources such as trash left by visitors or food provided directly by park users. This can create problems with artificially high population levels, and the risk of population crashes if food sources are suddenly removed as a result of declining park visitation (Orams 2002). Consumption of human waste food may impair the health of individual animals, and also negatively impact their natural foraging or predatory behavior (Grace 1976). Populations that become too reliant on human handouts may quit their natural roles in a forest or park ecosystem, whether they be pollinators, seed dispersers, or predators (Knight and Temple 1995a). Some individuals dependent upon substitute feeding may damage property in search of unnatural food sources (Peine 2001). Other problems include habituation to human contact, intra and inter-species aggression, and animal injury and disease (Orams 2002; Burns and Howard 2003). A dependency upon handouts can result in the relocation or culling of "problem" animals or populations that become too aggressive or too large (Conover 1999; Schullery 1980).

Urban areas also create ideal conditions for rabbits, rats, squirrels, seagulls, crows and other highly adaptable species. This makes them attractive to opportunistic predators such as coyotes and bobcats, potentially bringing them into conflict with urban residents and recreationists (Tigas et al. 2002). Opportunistic species such as crows and raccoons that are attracted to garbage left behind by recreationists may prey upon native species to supplement their diets (Garber and Burger 1995). Seagull populations have been reported to have dramatically increased in North America in recent decades, due to easy access to food from landfills and a range of nesting sites such as rooftops, parks, golf courses

and airfields (Belant 1997).

Behavioral changes in wildlife

Wildlife respond to human presence in three ways: attraction, avoidance, and habituation (Knight and Temple 1995a). Attraction behavior results from positive experiences with humans, and avoidance behavior from negative experiences. Habituation means that wildlife simply become accustomed to the presence of humans, through neither positive nor negative experiences with them (Knight and Temple 1995a). Vaske et al. (1995) note that animal responses to human intrusion or disturbance are not uniform even within species, and are multifaceted. Behavioral changes may be short term or long term, occur at the individual level or at the population level (Knight and Cole 1995b), and, importantly, may carry over into individual or species-level ecologies.

Factors to be taken into consideration include the type of park use, frequency of park use, and behavior of park users (Vaske et al. 1995). Different wildlife species have different tolerance levels — some are detrimentally affected by small impacts whereas others, particularly opportunistic species such as crows, squirrels, seagulls, skunks, raccoons and foxes (Rosatte et al. 1991), may profit from increased human interactions. Outcomes will depend on the time and place of interactions, issues of seasonality such as breeding cycles, and the duration, intensity and predictability of interactions. Outcomes will also be a function of the type of animal involved, the health of the animal, body size, behavioral adaptability, group size, age and sex (Knight and Cole 1995a).

Species attracted to human-disturbed landscapes include but are not limited to crows, coyotes, foxes, skunks, raccoons, opossums, pigeons, sparrows, and Norway rats. McKinney (2002) distinguishes between urban adapters, species adapted to forest edges and open spaces but able to exploit anthropogenic resources; and urban exploiters, species extremely or completely dependent upon anthropogenic resources. These species are often implicated as antagonists in “nuisance” situations, as they infringe upon “human” spaces. Though these animals benefit from urban food sources and shelters, their constant presence in or near to urban areas means that individuals are more at risk of being trapped and euthanized by animal control personnel, and of being injured or killed in vehicle collisions. Further, dependence on anthropogenic resources makes these species vulnerable to population fluctuations, if for some reason their food source is terminated (Orams 2002). However, populations of urban exploiters are generally quite resilient.

Various wildlife species, when harassed by recreationists, undergo significant changes in habitat use, nesting behavior, and territoriality as part of their avoidance behavior (Knight and Temple 1995a). Human disturbance can cause temporary avoidance behaviors including nest abandonment and food habit changes. Longer-term changes can include the abandonment of preferred foraging grounds and changes in food sources (Knight and Cole 1995b). Other animal behavioral responses to humans include altered foraging strategies



Mountain lion (*Puma concolor*) emerging from den
Credit: United States Fish and Wildlife Service (Larry Moats)

(Moulton and Adams 1991). Haspel and Calhoun (1991), Tigas et al. (2002), and others have found that some animals become more nocturnal in the presence of humans, as a strategy to avoid contact. For example, Tigas et al. found that coyotes and bobcats were less active during the day in fragmented habitat patches compared to unfragmented areas, had smaller home ranges, and supplemented their diet with anthropogenic sources (see also Rosatte et al. 1991). Van Dyke et al. (1986) discovered that mountain lion activity near areas of human presence peaked after sunset and was concentrated during night hours, in contrast to the activity of mountain lions in non-disturbed areas, which peaked at sunrise and sunset.

Avoidance responses have repercussions past behavioral changes. Human disturbance can result in physiological repercussions for many animals, such as elevated heart rates. Longer physiological changes include altered energy budgets because of increased energy expenditure for escape or decreased energy intake due to foraging interruptions; this can result in decreased reproductive capacity (Knight and Cole 1995b). Other animals react to frightening situations with a passive defense response or freezing mechanism. A variety of behavioral and physiological effects can occur, including decreased heart rates, body temperature, and oxygen consumption. For instance, the heartbeat of willow grouse hens, normally 120 to 140 beats per minute (bpm), dropped to 20 bpm when approached within two to four meters by a human or a dog (Gabrielson and Smith 1995).

Avoidance responses also affect wildlife at the population and community levels. Family units that scatter upon anthropogenic disturbance events experience a loss of social structure if family members are terminally separated from the group, which negatively impacts group cohesiveness and future reproductive activity (Anderson 1995). Avoidance responses can alter community dynamics as well. Human disturbance can alter competitive relationships by inducing some species to flush from a food resource more readily than others, allowing the less fearful species to exploit the resource to the detriment of the more cautious species. Facilitative relationships may be disrupted if human disturbance causes a facilitating species to avoid its natural hunting or foraging grounds. For instance, if bald eagles are constantly frightened away from salmon carcasses, they will not tear through the salmon skin, and then crows and gulls will not be able to feed from the fish (Gutzwiller 1995).

Wildlife may learn to essentially ignore humans if anthropogenic stimuli are predictable and nonthreatening. Knight and Temple (1995a) mention Geist's (1978) suggestion that habituation of wildlife to human activity may in fact be a positive behavioral change, in that it may be the avenue to peaceable co-use of wildlands by both humans and animals. Habituation does not suggest however that animals have lost the capacity to fear human activity — several studies show that species otherwise habituated to human stimuli will flush at unexpected disturbances (e.g., gunshots, off-trail hikers) (Geist 1978; Owens 1977). A caveat to the value of wildlife habituation to humans is the behavior of humans themselves — in order to achieve habituation in wildlife, human visitors to parks will have to restrain themselves from throwing rocks at ground squirrels and refrain from feeding the raccoons.

Disturbance of breeding or roosting birds

Another impact of park users on wildlife is associated with the disturbance of nesting or roosting birdlife. Hiking, backpacking, cross-country skiing and other non-motorized recreational uses primarily affect reproductive success through the redistribution of avian populations. Avian populations are also displaced by rock climbers, who use ledges that serve as ideal nest sites (Knight and Cole 1995b). Fernández-Juricic et al. (2004) recently found that birds are less prone to disturbance if recreationists remain on designated trails, and that birds roosting higher in the tree canopy are less prone to disturbance than ground foraging or low canopy birds.

Wildlife viewing, a seemingly unobtrusive category of recreational use, can significantly affect avian populations. Wildlife viewers often target populations during breeding time. For example, Bolduc and

Guillemette (2003) reported that the timing and frequency of recreational and research visitation to the nesting sites of shoreline birds were crucial determinants of nest failure, with disturbances occurring early in the period of incubation more likely to result in nest failure. Moreover, wildlife viewers often concentrate on rare bird species (Knight and Cole 1995b). The situation worsens when viewing crosses the line into harassment. Some recreationists have reduced reproductive success by trampling, handling, and removing eggs and nestlings.

Recreational activities can cause temporary wildlife displacements, also called “flushes.” Birds often perceive visitors as threats and demonstrate escape behavior. This can result in a decline in the reproductive success of intolerant species which seem to be more susceptible to disturbance than opportunistic or habituated species (Fernández-Juricic et al. 2004). Burger (1995) reported that some species of foraging birds may spend up to half their time avoiding human contact — a significant investment of time resources that alters reproductive behavior and physical fitness. Birds foraging with a brood of chicks must also exert more energy to protect and relocate chicks that scatter in response to recreational activities. Human disturbance can directly lead to increased predation by altering the behavior of avian parents. When an adult leaves the nest to defend its chicks against a perceived human threat, the chicks are left defenseless against heat, stress, and other natural predators (Burger 1995).

Disturbance also significantly affects breeding avian populations by altering nest selection and flight patterns. Reproductive success is reduced when avian species are forced to seek new habitat (Burger 1995). When an intolerable level of disturbance forces species out of their familiar habitat they must survive and reproduce with unknown amounts of food, shelter and access to other vital natural resources. Moreover, reduction in environmental complexity and the depletion of habitat can reduce the abundance of avian populations (Cole and Landres 1995). HaySmith and Hunt (1995) note that migratory birds are the most susceptible to anthropogenic disturbance and the least tolerant of frequent disturbance, whereas resident species such as herons, egrets and pelicans readily habituate to humans.

Pet predation and disturbance

Humans are not the only source of wildlife disturbance. Knight and Cole (1995b) note that companion animals startle wildlife as well, impacting both individuals and populations. Individual impacts include increased heart rates, stress, reduced vigor due to interrupted foraging behavior, increased energy

expenditure as a consequence of fleeing intruders, nest abandonment, decreased reproduction, and avoidance behaviors. Entire populations of particular species may learn to avoid areas subject to ongoing disturbance by humans and their pets by relocating elsewhere. This in turn affects the viability of breeding populations through increased competition, aggressive behavioral responses, reduced access to breeding sites and increased predation (Knight and Cole 1995b).

In her investigation of the interactions between dogs and wildlife in San Francisco parks, Abraham (n.d.) found that off-leash dogs startled nesting birds and disrupted the behaviors of raptors. Dogs wandering off defined trails into adjoining vegetation



Cyclist and dog in the Puente Hills, California
Credit: Jennifer Mapes

caused avian flushes. Abraham cites a study by Jones and Stokes (1977) which revealed that dogs have a serious impact on nesting birds and may result in reduced reproductive success. A number of studies suggest that the presence of a dog and a recreationist produces a greater response (e.g., flush distance, distance moved) in a variety of wildlife species than does a solitary pedestrian (Miller et al. 2001; Mainini et al. 1993; Yalden and Yalden 1990; MacArthur et al. 1982, 1979).

Attacks on reptiles by pets are also a problem. For example, Shine and Koenig (2001) have documented dog and cat attacks on snakes and small reptiles as a prominent cause of urban reptile mortality. As with vehicle collisions, such attacks are also seasonal in nature reflecting hibernation patterns and periods of increased activity as reptiles search for potential mates in the spring or neonates disperse in the summer.

Lepczyk et al. (2003) have identified urban cats as a significant factor in declining urban bird populations. They state that even a low estimate of birds killed by cats is cause for concern. Based on research in Michigan, they found that the 656 free ranging cats in their study area killed between 16,000 and 47,000 birds during the breeding season and calculated that the cats killed one bird per day per kilometer.

Lethal control, culling, and attacks on wildlife

Another concern concomitant with the reintroduction or increased presence of animals in the city is the lethal control of wildlife deemed to be a nuisance. In their study of raccoons in Rock Creek Park in Washington D.C., Riley et al. (1998) reported that a substantial number of deaths of animals that they tracked with radio collars were caused by trapping and euthanizing by animal control agencies because some raccoons were regarded as a public nuisance. Mosillo et al. (1999) also reported that one of their raccoon subjects in a translocation study was trapped and shot as nuisance wildlife on private property, and suspected that four more were killed by local homeowners. Belant (1997) has reported that common management practices for controlling nuisance populations of urban seagulls involve shooting, poisoning, and egg destruction. Control of nuisance birds can decimate entire breeding colonies in just one to two years.

In their examination of cougars in southern California, Gullo et al. (1998) reported that residents often responded in a reactionary way to the presence of these animals in their neighborhoods and that the media have portrayed the big cats as 'serial killers', 'killing machines' and a 'menace'. The animal control response has invariably been to shoot rather than to attempt to relocate these impressive predators, and hunting permits have been seen as a legitimate form of control. As remaining habitat is further diminished, remnant habitat patches in the form of parks and green space will become increasingly important for cougars' survival, yet at the same time will further exacerbate instances of conflict.

One issue less frequently reported in the literature is the proliferation of herbivores following the extirpation of top order predators or after predator culling. For example, in many urban areas of the United States deer have become a "pest" species, browsing in gardens, spreading disease and colliding with automobiles. Another often overlooked consequence of predator diminishment or removal is that herbivores such as deer can dramatically alter understory vegetation to the detriment of birds, small mammals and reptiles (Rutberg et al. 2004).

Park users sometimes can be directly implicated in the death of resident wildlife. A very harmful impact of park users on wildlife is direct injury caused by attacks upon animals. The injury of wildlife through spearing, clubbing, being shot by arrows, air-rifles or firearms, or other such forms of human attack is a serious concern. Though not widespread, instances of such attacks may leave animal victims permanently disabled or dead.

Vehicle collisions

Roadways constitute significant barriers to migration, dispersal, foraging, and genetic exchange for wildlife species, and many animals that attempt to surmount these barriers fall victim to motor vehicle collisions (Aresco 2005). Ruediger (2004) has recently cited evidence that a high percentage of large predators such as cougars and wolves are killed by vehicle collision each year in the United States. Knight and Cole (1995b) cite examples of declining wolf populations in national parks due to motorists intentionally or unintentionally running over wolves. Groot Bruinderink and Hazebroek (1996) have extensively documented the incidence and costs of ungulate collision with motor vehicles in the United States and Europe. They found that a relatively high proportion of the spring population of roe deer and wild boar were killed in vehicle collisions and attributed the collisions to poor driver education and excessive vehicle speeds. Moreover, they noted that the presence of water and grasses on road verges may increase the risk of vehicle collision. Clevenger et al. (2001) note that collisions are more likely to occur at the ends of highway mitigation fencing and at major drainages. Importantly, Groot Bruinderink and Hazebroek (1996: 1063) assert that vehicle collisions exhibit a seasonality, wherein “road kills are often associated with breeding activities and dispersal”. A similar pattern was noted by Shine and Koenig (2001) in their study of reptile deaths in urban Australia.



Barnyard geese (*Anser anser*) cross an urban road
Credit: Rivers and Mountains Conservancy

Vehicle collision is an especially pertinent concern when considering urban park creation and restoration, given the prevalence of highways and surface streets in the southern California landscape. Tigas et al. (2002) have found that coyotes and bobcats move between habitat patches by following steep hills, canyons, riparian areas, golf courses and utility easements, and tend to avoid human contact wherever possible. However, moving between habitat patches also necessitates road crossings, making animals prone to vehicle collision. Ruediger (2004) has noted that highways cause problems for large predators by constricting home ranges, disrupting seasonal movements, and acting as barriers to population dispersal. This assertion resonates with the findings of Tigas et al. (2002), who report that vehicle collision was a significant source of mortality for both bobcats and coyotes. Mountain lions also appear to be very vulnerable to vehicle collision (Papouchis 2004). Indeed, Gullo et al. (1998) have noted that cougar collisions have increased in past decades in southern California as habitat remnants are encroached upon

by urban development. Smaller mammals are affected by vehicle collision in urban areas as well. Out of twelve domestic and wild animal species, ground squirrels, opossums, and jackrabbits had the highest number of kills per kilometer on suburban roadways in California's Central Valley (Caro et al. 2000). Lewis et al. (1993) found vehicle collision to be the most significant cause of mortality in red foxes in urban Orange County.

Birds are also vulnerable to collision (Mannan and Boal 2004) though more frequently with aircraft than with automobiles (Conover 2002; HaySmith and Hunt 1995). Reporting on research on seagulls in urban environments, Belant (1997) noted that gulls comprised 30% of bird collisions with aircraft in the United States and are estimated to cause \$40 million in annual aircraft damage costs. Conover (2002) reports that over 8,000 collisions between birds and civilian aircraft occur each year in the United States. The restoration of beaches, wetlands and other gull habitats in proximity to airports can bring gulls into conflict with aircraft.

Disease

Another area where park users may impact non-human species is through the spread of diseases. Once again, this may be a direct or indirect result of users' actions. Disease may be spread through a variety of vectors including pet droppings, contact between pets and wildlife, fungus spread on footwear or automobile tires of park users, or through the release of exotic species. Another source of disease transmission may occur when animals gather in high densities at sites of opportunistic feeding such as trash cans or bird feeders (Brittingham 1991). Riley et al. (1998) have noted that in urban parks the density of animals such as raccoons greatly exceeds densities in wildlands, as parks contain a ready supply of food and den sites and provide opportunities for foraging in park-adjacent neighborhoods. Moreover, urban parks offer wildlife a refuge from hunting and vehicle traffic, often resulting in higher densities of animals, which may render animals more prone to epizootic transmission and mortality.

The home range of some animals like raccoons puts them into contact with domesticated species such as cats and dogs. According to Meltzer and Rupprecht (1998) dogs in the United States may be an important source of transmission of rabies to wildlife. Pets are a ready reservoir for a range of diseases easily transmitted to coyotes, raccoons, skunks, bobcats and other urban wildlife, including canine distemper, rabies, feline panleukopenia, canine hepatitis and adenovirus (Rosatte et al. 1991). Wildlife in the most popular national parks face the particular danger of exposure to pets from widely different geographic regions that visit with their owners; park wildlife is thus exposed to an assortment of geographically localized diseases. Visitors' dogs likely represent the most significant disease risk for canids such as coyotes, wolves, and foxes in larger wilderness parks (Aguirre et al. 1995).

Pollution

Human activity has unleashed a variety of negative environmental effects on parklands. Some, like global warming and air and water pollution, are far more widespread than the park environments they affect; but others, like trash, noise pollution, and light pollution, are localized problems.

Poisoning of wildlife and their environments may result from pollutants released into the air, water, and soil. For instance, rats exposed to ambient particulate matter, a specific air pollutant that includes soot, smoke and dirt derived from cars and factories, demonstrate cardiac arrhythmia (Su et al. 2004). Chronopoulos et al. (1997) studied the concentrations of lead and cadmium — two metals that are toxic to plants and animals — in soils and plants at urban parks in Athens, Greece. In urban environments, car fumes and tire wear are the main sources of lead and cadmium, respectively. The authors found the highest concentrations of cadmium and lead in soil and plants situated at the periphery of the parks. The pollutants associated with urban runoff are another concern for wildlife health. Nitrogen, phosphorous, and a number of metals related to automobile operation, as well as an assortment of antifreeze, fecal

matter, and garbage items leach, flow, and blow into park waterways and water tables (Tourbier 1994).

Noise and light pollution also represent serious threats to urban park and open space populations. Noise pollution oftentimes forces animals to alter their foraging, nesting and reproductive behaviors. Radle (1998) suggests that there is a broad consensus that noise can affect wildlife physiology and behavior, and that chronic noise stress can have negative effects on animals' energy budgets, reproductive success, and long-term survival. Bowles (1995) has suggested that wildlife responses to noise are influenced by several variables including the source of the noise, the intensity of the noise, the attenuation or decay factor, the frequency and duration of the noise, background noise levels, and habituation. Moreover, wildlife may exhibit a range of responses to noise including avoidance, attraction, reproductive decline, increased susceptibility to predation, increased energy expenditure, stress, decreased resistance to disease, and abandonment of offspring (see, e.g., Harrington and Veitch 1991).

Light pollution is another significant disturbance factor with which urban wildlife must cope. It is important to understand that "light pollution" refers not only to artificial sky brightness, but also to the haze that artificial lighting casts downward across terrestrial ecosystems. Migratory disorientation can be attributed both to artificial sky brightness and to ecological light pollution, but the latter class of light pollution is directly linked to a number of ill effects. Longcore and Rich (2004) have identified a range of direct impacts that lighting has on terrestrial wildlife including increased predation, territorial singing, reduced egg laying, collision, reduced reproductive success, reduced nesting, foraging competition and disruption of communication. They predict that future research will confirm the disruptive role that artificial night lighting has in natural ecosystems.

CHAPTER 3: WILDLIFE IMPACTS ON PARK USERS

Positive aspects

The benefits that urban wildlife confer upon humans are generally poorly recognized, though over the past decade, there has been a growing recognition that people need animals — especially urban residents who are oftentimes divorced from direct experiences with nature. The benefits that urban wildlife provide to people include economic benefits, recreational benefits, aesthetic benefits, scientific benefits, and ecological benefits (Conover 2002). For example, writing about birds of prey in urban areas, Mannan and Boal (2004) assert that these species provide aesthetic value experience through observation and photography, and educational value, especially for children who have grown up in cities (see also Gray 1993).

Economic benefits

The restoration of natural habitat and the concomitant use of the habitat by wildlife may in many situations result in economic benefits to residents and businesses, including increased real estate values (Orams 2002). Thorsnes (2002) suggests that scenic views, immediate access to recreational space, and direct wildlife observation opportunities are primary factors that push lot prices. Analysts have looked at the impact of access to environmental amenities such as parks, open spaces, and wetlands on housing prices, usually employing hedonic modeling techniques.

Lutzenhiser and Netusil (2001) examined the impact of different types of parks (together with golf courses and cemeteries) on home prices in Portland, Oregon, finding that natural area parks and specialty/facility parks had positive and significant effects on property values. Geoghegan (2002) showed that in Howard County, Maryland, permanent open space (e.g., parks, conserved lands) increased nearby residential land values over three times as much as an equivalent amount of developable open space (e.g., private forest land and agricultural land). Ready and Abdalla (2003) described the distance-decay of impacts of land use on residential property values in Berks County, Pennsylvania, finding that within 400 meters of a house, open space had the largest positive impact on house price, as compared to the impacts of residential, commercial, and industrial space.

Besides urban parks and open space, some studies have measured the effect of urban greenway trails. A review by Crompton (2001) on greenway impacts on property values included a Wisconsin study that compared prices for trailside versus other lots in the same housing development (Green Bay-Brown County Planning Commission, 1997, as cited in Crompton 2001). The commission found a 9% increase in value for trailside properties, which also sold faster. Recently, Nicholls (2002) evaluated the impact of the Barton Creek Greenbelt (Austin, Texas) on three adjacent neighborhoods. Her study (as cited in Nicholls 2004) showed that two of the neighborhoods benefited from the greenbelt with a total increase of \$13.64 million in property value. The greenbelt contributed 6% to 12% of total value for properties immediately adjacent to it. The third neighborhood was not impacted by the greenbelt, which may be due to the nature of the greenbelt in that area: it was less appealing for either viewing or recreation.

Bin and Polasky (2002) suggest that amenity values of wetlands include pollution and noise buffering, enhanced views, open space, and opportunities to watch wildlife and wildfowl. Mahan et al. (2000) used a hedonic property price approach to evaluate how residential property values in Portland, Oregon are affected by proximity to and size of wetlands. They found that reducing the distance from a home to a wetland by 1,000 feet increased the value of that residence by \$436. Similarly, increasing the size of the nearest wetland by one acre increased residential property value by \$24. The type of wetland — open water, scrub-shrub, emergent vegetation, or forested— does not appear to matter (but see Doss and Taff 1996). A study by Lupi et al. (1991) found that increases in wetland acreage positively affect property values more dramatically in locations where wetland acreage is low than in places where acreage is high, holding housing density constant. And, increases in wetland size are more valuable in areas with higher

housing density. The results of Mahan et al. (2000) also indicate that proximity to streams positively impacts property value. Decreasing the distance between a residence and a stream by 1,000 feet yields a property value increase of \$259. Streiner and Loomis (1995) estimate that urban stream restoration projects result in property values increasing by between three and 13% over the average local property price.

Psychological, social, and aesthetic values of wildlife

Stephen Kellert has provided one of the most extensive reviews of human attitudes towards wildlife, identifying 10 attitudes descriptive of wildlife values possessed by Americans (Kellert 1980). Eight of these attitudes relate to positive or appreciative feelings toward, or satisfying interactions with, wild animals. Outdoor sport and recreation, nature studies, and ecotourism factor heavily into common behavioral expressions of people who harbor positive attitudes toward wildlife. As nature becomes reestablished in the city through urban park and open space creation, the social, psychological, and aesthetic values of wildlife will hopefully come to be recognized by a larger audience of recreationists.

Those with naturalistic, humanistic, and aesthetic attitudes are the most in line with the non-consumptive recreational opportunities such as hiking, camping, and wildlife viewing that are widely available in southern California. People with a naturalistic attitude orientation are most strongly interested in backcountry use, nature observation, and other outdoor wildlife-related recreation opportunities. Those with humanistic and aesthetic attitudes may be more drawn to wildlife tourism. People with moralistic attitudes are primarily concerned with the ethical treatment of animals. These people are likely to appreciate wildlife for their existence and ethical values.

Scientific attitudes toward wildlife often lead people to study and observe the physical and biological characteristics of wildlife. People with ecologic attitudes are often interested in ecosystem-level relationships between species and the natural environment, and support conservation efforts. Both of these attitudes imply emotional detachment from wild animals, and the perception of wildlife as subjects to study and understand.

People with dominionistic attitudes tend to benefit from interactions with wildlife that involve sporting events or trophy hunting; those with utilitarian attitudes often seek out wildlife for meat or other bodily products. This type of person has an extractive relationship with nature, and their values are affirmed by direct, consumptive, or spectator interactions with animals. The scale and purpose of many urban park restoration efforts may not translate into chances for these people to express these particular values, however.

Also among the benefits that wildlife provide to humans, Butler et al. (2003) assert that communication skills and socialization benefits occur when people talk about their interactions with wildlife. Wildlife lovers form social and educational groups, interacting with each other in the form of fanciers clubs and informal newsletters (Lipske 1997). For instance, the National Audubon Society has over 500 chapters in the United States, which arrange bird walks and other events for members (National Audubon Society 2004).

Goode (1990) and Hilliard (1991) have suggested that urban wildlife has enormous aesthetic and psychological value to people who live in cities and do not have ready access to wildlands. For example, Gehrt (2004) asserts that animals such as skunks, raccoons and coyotes add aesthetic value to urban landscapes. Lee and Miller (2003) recorded almost seventy percent of respondents to an elk management survey as enjoying just knowing the fact that elk are in their vicinity. The spontaneous motion of wild animals may inspire spiritual, artistic or creative responses in urban residents and provide relief from the mundane city (Gray 1993).

Daigle et al. (2002) and Hunt and Ditton (2001) have asserted that wildlife interactions with recreational fishers, hunters and outdoor enthusiasts result in a sense of achievement, reduced stress and increased wellbeing. Heatwole and West (1985) tout fishing as both therapeutic and environmentally educational for the urban public. Non-extractive interactions with wildlife, such as photography and observation, are important experiences to urban and rural residents alike (Butler et al. 2003).

Scientific and educational benefits

Valuing wildlife for scientific reasons involves an interest in the physical attributes and biological functioning of animals (Kellert 1980). Gray (1993) has noted that urban wildlife provide considerable scientific value. By studying the health of animals in urban areas, which are highly disturbed environments, scientists can gain important insights into the function of ecosystems and perturbations resulting from the introduction of exotic species or anthropogenic stress. Conover (2002) echoes the value of using some wildlife species as indicators of environmental quality and health.

Scientific interests in wildlife align closely with the educational values of wildlife. The observation and examination of natural processes fuels cognitive development, and the natural world has long provided an accessible and stimulating context for intellectual growth (Kellert 2004). Kellert (1985) suggests that children who have personal experiences with natural environments are likely to become more environmentally concerned and active. Schicker's (1988) research on schoolchildren indicates that children generally place a high value on outdoor play space that allows for exploration, investigation, and tactile experiences, which implies that children have some level of intrinsic interest in wildlife that should be fostered. She recommends that children be exposed to the natural world at an early age to ensure wildlife awareness and appreciation. Countrywide schoolyard restoration efforts (as described by Rivkin 1997) are spreading in an effort to expose children to plants and animals that they otherwise may not come into intimate contact with. Rivkin suggests that childhood experiences in natural settings incite development of environmental values, and also that learning in a sensory, physical, natural environment with moving animals and growing plants contributes to children's physical, cognitive, and emotional development. In addition, many adults actively seek out wildlife for viewing or enjoy incidental sightings. Such would-be viewers have strong expectations about the educational value of wildlife, anticipating that they will have the chance to observe and learn about wildlife behavior (Daigle et al. 2002).

Ecological benefits

There are a number of ecological benefits related to an increased urban wildlife presence. They include seed dispersal of endemic plant species, which assists in native revegetation; a reduction in pest species such as rats through increased predation; predatory regulation of mesopredators such as foxes and even removal of mesopredators like free-ranging cats; and an increase in genetic diversity as new animals move into formerly isolated populations (see, e.g., Gehrt 2004; Soulé 1991). Conover (2002) states that wildlife species' ecological value stems from their important role in maintaining a functioning ecosystem. Species with established roles in ecosystems contribute to the health of ecosystem processes.

Henke and Bryant's (1999) research is illustrative of the ways in which an assemblage of species maintains a functioning ecosystem. Over eight consecutive seasons, Henke and Bryant removed 354 coyotes, which regulate microherbivore and mesopredator populations, from two 5,000 square hectare sites to determine the effects of keystone predator removal on shrubland and grassland ecosystems. Effects of this cull included increases in rodent density and biomass, jackrabbit density, and badger, bobcat, and gray fox relative abundance; and a decline in rodent species richness and diversity. Increases in rodent and lagomorph numbers are worrisome because these herbivores can enter into forage competition with range animals, and may consume more of the annual primary plant production than is sustainable. The slight increase in mesopredator abundance can influence populations of ground-nesting birds, as mesopredators are known to consume eggs and chicks (Henke and Bryant 1999; Soulé 1991).

Animals also provide what have been termed nature's services (Abramovitz 1998). As the traditional view of urban parks — canopy trees and lawn — is replaced by alternative conceptions such as nature parks and community gardens, urban wildlife come to play a greater role in providing beneficial services to park users. Some of these benefits include the pollination of fruit trees and other crops in community garden plots and indeed in residential gardens.

Negative Aspects

As with user interactions with wildlife, there are also numerous problems associated with wildlife interactions with users. These usually attract the most attention as they incur economic costs. Such problems include the spread of disease, attacks on humans or their pets, or damage to private property (Bryant and Ishmael 1991; Gray 1993; Quinn 1991). Some of these negative interactions are discussed in greater detail below.

Disease

Meltzer and Rupprecht (1998) have noted that rabies in wildlife presents a threat to public health. For example, Gehrt (2004) states that raccoons and skunks are reservoirs of diseases such as leptospirosis and parasites, which are easily transmitted to humans. The United States Centers for Disease Control and Prevention now lists a potentially fatal type of roundworm carried by urban raccoons as an emerging infectious disease (Johnson 2004). Some California ground squirrel populations are reservoirs for fleas that harbor the bacterium that causes bubonic plague in humans; the disease is transmitted through flea bites (Conover 2002).

Although animals are well-recognized disease vectors, transmission pathways may not be immediately evident. For example, Knight et al. (2003) have noted that habitat generated by the construction of storm water treatment wetlands is often associated with a concomitant increase in mosquitoes and insect-borne viral infections. Other impacts, such as the contamination of human drinking water supplies, are more obvious. The connection between seagulls and *Salmonella spp.*, *E. coli*, *Clostridium sp.*, *Listeria spp.* and *Campylobacter spp.*, has been noted as a serious cause of disease for humans, especially through the contamination of drinking water supplies (Belant 1997). Conover et al. (1995) note that feeding wildlife increases the chance of disease transmission to humans, by virtue of spatially concentrating animals and humans.

Animal attack

One of the most prominent negative impacts of wildlife–human interactions within urban areas is animal attack on residents. Burns and Howard (2003), Jones and Neelson (2003), Warne and Jones (2003), and Wolch et al. (1995) have all catalogued instances of wildlife attacks on residents and recreationists. In southern California, animals that pose the biggest risk to humans include mountain lions, coyotes, and venomous snakes (Conover 2002; Fitzwater 1989). Although recent attacks on mountain bikers by cougars have received widespread media coverage, snakebites are a greater cause for concern — and Conover (2002) has observed that most snakebites occur in urban areas where people are less careful. Conover et al. (1995) list attacks on humans by alligators, bears, Canada geese, coyotes, mute swans, and raccoons that resulted from the animals approaching humans for food.

Predation of pets and livestock

Another common cause of complaint about urban wildlife is the predation of pets by animals such as mountain lions, bobcats and coyotes (Fitzwater 1989; Mapstow 1989; Tigas et al. 2002). Coyotes in southern California have been implicated in the consumption of domestic cats, an abundant food source in residential areas within the Santa Monica Mountains (Fedriani et al. 2001). Dogs that are brought along

to parks or onto hiking trails are at risk of being bitten by rattlesnakes, especially since not all owners take their dogs to negative reinforcement training classes, which teach dogs to avoid snakes (Martín 2005).



Coyote (*Canis latrans*)

Credit: United States Fish and Wildlife Service (John and Karen Hollingsworth)

A related problem is the predation of livestock and poultry by raccoons, skunks, opossums, foxes and coyotes (Fedriani et al. 2001; Fitzwater 1989). In the United States, coyotes were held accountable for almost 61% of the 273,000 sheep and lamb losses to predators in 1999 (USDA 2002). Phillips and Schmidt (1994) warn about the losses that red and gray foxes cause for poultry farmers, and also state that lambs and piglets are target prey.

Damage to private property

Damage to private property caused by urban wildlife is a vexing management issue. Wildlife, through behaviors such as foraging, nesting, and denning, harm or destroy private property. Examples include birds and raccoons nesting in chimneys or under eaves, raccoons and rodents damaging roofing insulation and electrical wiring, bird guano clogging drains and damaging automobile paintwork, birds nesting in air conditioner ducts, and damage to gardens through browsing of deer, bears, raccoons, and squirrels (Peine 2001; Belant 1997; Bryant and Ishmael 1991; Hadidian et al. 1991; Rosatte et al. 1991; Fitzwater 1989). Other damage includes skunks and raccoons burrowing underneath houses (Rosatte et al. 1991).

In addition, recreational facilities such as golf courses may be damaged through the browsing of herbivores such as deer and Canada geese and the burrowing of animals such as moles, raccoons, squirrels and gophers into greens and fairways (Rutberg et al. 2004; Fitzwater 1989). Reforestation efforts may be stunted by pocket gophers, which feed on tree seedling roots and stems (El Hani et al. 2002). Loss of commercial crops to wildlife is particularly difficult to cope with, as integrated pest management strategies grow more and more expensive and do not represent cure-alls (Marsh 1998).

A significant source of damage to private property is wildlife collision with motor vehicles. Conover (2002) reports that in the United States, the annual number of vehicle collisions with ungulates (deer, elk, moose) is approximately 1.5 million, causing millions of dollars in automotive damage, 29,000 injuries, and 200 deaths.

Nuisance activities

A variety of negative impacts associated with wildlife can potentially result from urban habitat restoration and park creation efforts. For instance, Bin and Polasky (2002) suggest that wetland restoration may directly result in the increase of nuisance animals in a neighborhood, and also that insects and undesirable odors will be ushered in. Feeding and loafing are two activities that can translate into nuisances for park users and residents. Opportunistic species such as gulls, crows, squirrels and the like can create problems for park users through defecation on park benches and other facilities. In a study of gull abundance, Belant (1997) noted that defecation and other general nuisances were a real concern in gull-human interactions. Gorenzel and Salmon (1992) report an increase in complaints to public agencies about the fouling of vehicles, walkways, buildings, and yards beneath urban crow roosts; callers also voiced concern about health hazards associated with the droppings. Bats are also implicated in fecal contamination (Mapstow 1989).

An issue that is infrequently reported in the literature is the disturbance of urban residents by animal vocalizations. Some residents are offended by birds such as the northern mockingbird, which rouse them from their sleep, and regard bird calls as a source of annoyance (Fitzwater 1989; Kay and Patterson 1991). Early morning crow vocalizations annoy urban residents (Gorenzel and Salmon 1992) as does evening chatter from roosting naturalized parrot flocks (M. Seymour, pers. obs.). Other animal noises such as coyote howls may also annoy some city dwellers (Fitzwater 1989) as may raptor vocalizations associated with breeding, mating or the rearing of offspring (Mannan and Boal 2004). Accounts of performances at the Hollywood Bowl being disrupted by coyote howls may be hard to believe now, but they were common when coyotes were more prevalent in the area (Gill and Bonnett 1973). It is likely that the restoration of parks could increase animal noises in surrounding neighborhoods, bringing wildlife into conflict with residents.

The foraging of animals upon household waste is an ongoing problem in many urban areas (Hester 1990). The list of animals involved is numerous and includes bears, coyotes, raccoons, seagulls, and crows. Not only does animal foraging spread waste in an unsightly fashion, it can also be a source of disease (Fitzwater 1989; Tigas et al. 2002) and lead to considerable clean-up costs. For example, Gehrt (2004) has reported that in Chicago, skunks alone cause over \$1 million dollars per annum in property damage and clean-up costs.

CHAPTER 4: POTENTIAL SOLUTIONS AND BEST PRACTICES

All situations of human–wildlife conflict, no matter the geographic location, species involved, or interests at stake, share one common thread: it is human thoughts, decisions, and actions that determine the course and the nature of the resolution (Manfredo and Dayer 2004). Here we discuss a variety of potential solutions and best practices to attenuate or prevent recreationist–wildlife conflict.

Zoning

Zoning ordinances divide communities into use districts, such as residential, commercial, and conservation, and prescribe the land uses and levels of development allowed and prohibited in each district (McElfish 2004). Because this report focuses on urban park and open space creation and restoration, types of zoning that guide greenfield development plans are irrelevant. However, other zoning ordinances that restrict land use and future development density and design can play a critical role in the conservation of smaller-scale urban wildlife habitat. For instance, zoning ordinances can reconcentrate certain types of development away from sensitive habitat patches within a zoning district (McElfish 2004).

The Great Barrier Reef Marine Park in Queensland, Australia provides an instructive example about zoning for very specific land uses within park. Zoning maps of the park delineate, for instance, conservation zones, scientific research zones, habitat protection zones, and buffer zones. Certain recreational, tourist, scientific, and extractive activities are either allowed, prohibited, or sanctioned only by permit in each of these zones. The park’s presentation of these zoning rules to the public is notable — zoning maps are provided online on the park website, and the splashpage advises viewers to study the color-coded zoning map before visiting the park, in order to understand what activities they may engage in, and in which zones (Great Barrier Reef Marine Park Authority 2004). The new Forest Plans released for Angeles, Cleveland, Los Padres, and San Bernardino National Forests in southern California incorporate similar zoning tactics, which define management emphases and allowable recreational, development, and economic activities in each land use zone (USDA 2005a; see also, e.g., USDA 2005b).

Overlay zones are a type of zone that can be superimposed upon areas within established zoning districts or spanning a number of districts that need additional regulations regarding land use. The local government with jurisdiction over the zoning districts does not have to amend the zoning ordinance that defines land uses and development intensities for the districts, but rather places additional requirements on specific areas within larger districts (McElfish 2004). Overlay zoning is useful for conservation planning in that it can superimpose more stringent land use rules across, for instance, a wetland area within a zoning district, and allow medium-density residential development density to remain across the rest of the district. Marin County, CA has established a Bayfront Conservation Zone which includes tidal and seasonal marshes, grasslands overlying historic marshlands, lagoons, and wetlands. The county adopted a zoning overlay district in unincorporated bayfront areas that places an additional regulation on land use and development, namely that planners and developers must conduct an environmental assessment of existing conditions prior to preparing any development plans (County of Marin 2005).

Performance zoning may be another key to protecting natural areas and parkspaces. This type of zoning sets up standards that development must meet, but in contrast to a typical zoning ordinance that prescribes what the land may and may not be used for, performance zoning ordinances allow a measure of creativity, permitting developers to build the desired forms at the desired densities as long as the construction meets the performance standards. For instance, performance standards may include impervious surface minimization, inclusion of native vegetation, and passages for wildlife (McElfish 2004), all of which are important characteristics for areas surrounding restored urban park space which may be prone to redevelopment. This sort of zoning seems to be a logical choice for cities that are unwilling to zone a swath of land as a conservation overlay zone because they want to (re)develop it.

Ordinances

A number of municipal and county governments across the United States have enacted ordinances that directly or indirectly address many of the issues detailed in Chapters 2 and 3. Adopting ordinances with clear and specific standards that are supported by community and political leaders and understood by the public is an effective step toward achieving positive relationships between park users, wildlife, and wildlife habitats (McElfish 2004). The following ordinances are examples of existing municipal and county parks and recreation ordinances that may serve as models for jurisdictions in need of a more structured set of park regulations. All codes, except where noted, can be found in American Legal Publishing's online code library (<http://www.amlegal.com/library/>). Table 1, located after this list of ordinances, suggests how these codes can address a number of the conflicts discussed in Chapters 2 and 3. Particular types of interactions and activities that may occur in urban park spaces are grouped together in the left-hand column of the table, and conflicts that may be generated by some of these activities are listed across the top row of the table. Letters in the table refer to the list of ordinances below, all of which regulate park user behavior and activities.

A. "It shall be unlawful for any person to feed any wildlife or feral animals in a park" (Brooklyn Park, MN §95.05.B4).

B. "No person shall ... remove or have in his [or her] possession the young of any wild animal or the eggs or nest or young of any reptile or bird" (Voorhees Township, NJ §97.22.B).

C. "It shall be unlawful for any person to [k]ill, trap, hunt, pursue or in any manner disturb or cause to be disturbed, any species of wildlife ..." (Carver County, MN §91.07.B1).

D. "It shall be unlawful to carry or discharge into any county park, trail or open space area firearms or projectile weapons or explosives of any kind including, but not limited to fireworks, BB guns, pellet guns, air guns, crossbows, longbows, slingshots or other device capable of causing injury to persons or animals ..." (Santa Fe County, NM §92.06).

E. No person shall "[b]uild or attempt to build a fire, except in such areas and under such regulations as may be designated; no person shall drop or throw or otherwise scatter ... flammable material within any park or on any highways, roads or streets abutting or contiguous thereto ... [l]eave a picnic area before the fire is completely extinguished ..." (Voorhees Township, NJ §97.29C,D).

F. No person in a city park or recreation area shall "[d]eface, destroy, tamper with, injure or remove any city property, including, but not limited to furniture, structures, vegetation, signs or soils" (Shorewood, MN §902.02.3).

G. It shall be unlawful for any person to "[i]ntentionally remove, alter, injure or destroy any tree, other plant, rock, soil or mineral" (Carver County, MN §91.07.A1).

H. "When walking or riding a vehicle, horse or other animal on a designated hiking trail, walking trail or designated recreational area, no person shall leave the hiking trail, walking trail or designated recreational area without the permission of the Director" (Mason, OH §963.05.f).

I. "No person in a park shall climb or rappel any rock escarpment or other natural features" (Mason, OH §963.05.e).

J. No person shall "[r]elease any insect, fish, animal or other wildlife or introduce any plant, chemical or other agent potentially harmful to the vegetation, water supply or wildlife of the area" (Shorewood, MN

§902.03.5).

K. “[R]adios, tape players or televisions [must be] tuned so that the sound does not carry more than 10 (ten) feet from the speaker” (Walnut Creek, CA §11-1.501).

L. “Existing Artificial Light fixtures shall be repositioned, modified, replaced, or removed so that the point source of light or any reflective surface of the light fixture is not directly visible from the [area of concern]” and so that this area is “not directly or indirectly illuminated” (Sarasota County, FL §54-756.1.a,b; see entire ordinance, drafted for protection of beach areas, at www.municode.com).

M. “Any light source permitted by this Code may be used for lighting of outdoor recreational facilities ... provided [a]ll fixtures used for event lighting shall be fully shielded as defined in Section 2.2 of this Code, or be designed or provided with sharp cut-off capability, so as to minimize up-light, spill-light, and glare ... under no circumstances shall any illumination of the playing field, court, or track be permitted after 11:00 p.m. ...” (A model lighting ordinance from the New England Light Pollution Advisory Group [NELPAG], n.d., §2.5.A.a,b)

N. Look out for the International Dark-Sky Association’s (IDA) model lighting ordinance, currently in development. Notably, it will include descriptions of five zones on a scale from dense urban to natural environment and outline what constitutes appropriate lighting in each zone (IDA 2005).

O. “All residential refuse containers that receive garbage and/or refuse edible by wildlife must either be wildlife-resistant or wildlife-proof or be kept within a fully enclosed and secured structure” (Avon, CO §8.32.030a). This can be extended to park space garbage containers as well.

P. “It shall be unlawful for any person to [p]lace any debris or other pollutant in or upon any city lands or any body of water in or adjacent to a park or any tributary, stream, storm sewer or drain flowing into such waters ... [d]ischarge waste water or any other wastes in a park ... [r]elease a pesticide in or upon any park lands...” (Brooklyn Park, MN §95.05.D1-3).

Q. “No person shall [b]ring into, dump in, deposit or leave within the public park or recreational area any empty bottles, broken glass, ashes, paper boxes, cans, dirt, rubbish, waste, garbage or refuse or other trash. In addition, no such refuse or trash shall be placed in any waters in or contiguous to any park or recreational area or left anywhere on the grounds thereof. All such refuse and/or trash shall be placed in the proper receptacles where those are provided ... [or] shall be carried away from the park by the person responsible for its presence and properly disposed of elsewhere” (Voorhees Township §97.23.B).

R. “No person in a city park or recreation area shall [b]ring any dog, cat or other animal unless caged or kept on a leash not more than six feet in length” (Shorewood, MN §902.03.2).

S. “It shall be unlawful for any person to [a]llow any dog, cat or other pet to enter a beach area, nature center area, refuge area ... or other “no pet” designated areas within a park” (Carver County, MN §91.06.B2)

T. Sherbrooke Council, Victoria, Australia: cat curfew bylaw requiring owners to confine domestic cats at night (Hartwell 2003).

U. Local council, Halls Gap, Victoria, Australia: cat-free zones, wherein residents cannot acquire new cats, though they may keep the ones they have (Anderson 1994).

V. “Every person who owns or harbors any dog over the age of four months in the city shall have such dog vaccinated against rabies by a duly licensed veterinarian ...” (Los Angeles, CA §53.51).

W. “No person in a city park or recreation area shall [p]ermit any domestic animal to defecate in or upon public property. The owner ... shall be responsible for immediately cleaning up any feces of the animal and disposing of the feces in a sanitary manner” (Shorewood, MN §902.03.7).

Wildlife-friendly design practices

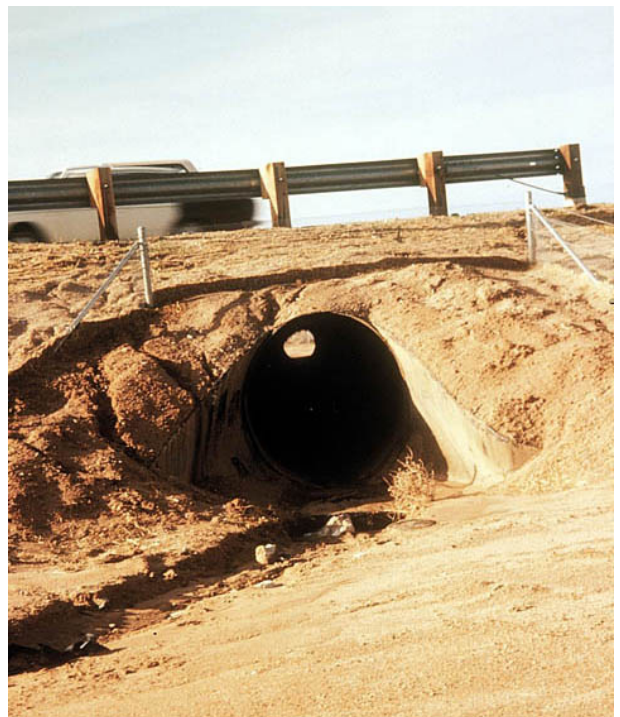
Wildlife-friendly design encompasses a variety of landscaping and construction techniques that can be used to defray negative human impacts on wildlife. Here we discuss design practices for urban settings that can help avert vehicle collisions with wildlife; contain wildlife within certain areas or exclude them from others; and lessen the disturbance that light pollution causes for species of wildlife.

Roadway underpasses, overpasses, and fencing barriers are construction techniques frequently used in the United States, Europe, and elsewhere to reduce roadway mortality of local wildlife species. Other structures not constructed with wildlife crossing utilization in mind, such as drainage culverts and underpasses for surface roads that cross beneath highways, experience incidental use by wildlife. Jaeger and Fahrig (2004) suggest that fencing used in combination with an overpass or any type of underpass is the best rule of thumb to employ when planning additional infrastructure, especially if little is known about the population ecology of local species. Fencing alone will be beneficial only if there is evidence that traffic mortality plays a critical role in the population decline of a species or if members of a population rarely or never successfully cross a road; otherwise fencing may inhibit growing populations from dispersing across roads to access resources.

Ng et al. (2004) found that a variety of southern California fauna, including coyotes, mule deer, reptiles, and small mammals, utilize existing underpasses and culverts as road-crossing passageways. They suggest that animal-proof fencing be erected to funnel wildlife toward culverts and underpasses (see also Haas 2000). Animal-proofing a fence involves ensuring that smaller mammals, amphibians, and reptiles cannot squeeze through or dig under a fence, by installing mesh, solid sheeting, or a concrete retaining wall along the fence bottom and below the ground surface (MAPC 2005). Fencing should lean slightly away from the road to thwart climbing animals' attempts to cross over the fence (Aresco 2005).

The presence of coyotes, mountain lions, deer, and other animals with jumping abilities requires a fence of at least seven to 10 feet in height (MAPC 2005). Drift fencing, or fencing that spans a length of a road and curves away from the road for many meters at both fence-ends, has been used successfully in combination with existing culverts to reduce road-kill rates (e.g., Aresco 2005 for turtles and other reptiles). This fencing technique should help combat the high mortality rates at the ends of roadway mitigation fencing noted by Clevenger et al. (2001). In addition to structural measures like drift fencing, Clevenger et al. suggest installing speed bumps or other traffic-calming devices near fence ends. Finally, fencing should be interspersed with underpasses or overpasses as frequently as possible: Aresco (2005) attributed the mortality of turtles found dead behind highway fencing over a three-year period to predation ($n=92$) and to overheating ($n=3$); presumably, long stretches of fencing can create a sink for slow-moving prey species.

Likelihood of use of culverts, underpasses, and overpasses are species-specific to some degree, and can vary according to passage length, width, height, surrounding habitat, and amount of human activity nearby (Ng et al. 2004; Clevenger and Walther 2000). Passages surrounded by natural habitat, as opposed to developed or



Underpass used by tortoises, rodents, and other small wildlife species

Credit: United States Department of Transportation – Federal Highway Administration (William Boarman)

landscaped habitat, are recommended for coyotes, bobcats, and mountain lions, whereas raccoons are far more likely to use passages surrounded by developed land. Mid-sized mammals including skunks, opossums, and raccoons tend to use longer passages (Ng et al. 2004). Large carnivores, though, may be inhibited by long, low-ceilinged passages (Clevenger and Waltho 2000). Coyotes and gray foxes use more open passages (wider and/or higher) with greater frequency (Haas 2000). It appears that mule deer also require more open passages and shorter passages, probably will not use culverts, and may prefer passages bordered by natural habitat (Ng et al. 2004). Human activity near passages may also diminish their utility value for deer; in fact, ungulate requirements for passages are perhaps the most stringent (Rodriguez et al. 1996). Coyotes and raccoons are tolerant of high human activity levels near passages (Ng et al. 2004); snake and lizard use of culverts is also linked positively with human activity (Rodriguez et al. 1996). Rodents appear to prefer culverts less than two meters wide (Rodriguez et al. 1996). Clevenger and Waltho (2000) suggest that predator-prey relationships may be partially responsible for prey species' avoidance of underpasses or culverts that possess dimensions conducive to use by carnivores.

To construct a set of passages that accommodate as many species as possible, careful planning should incorporate pertinent design features into a series of passages, each of which accommodates the ecological needs of a subset of animals. If possible, passages should be placed in known travel routes, instead of drastically redirecting movement; this is particularly important for species with low mobility and would address yet another species-specific ecological need (MAPC 2005). Ng et al. emphasize that both ends of the passage should open onto suitable habitat for crossing species if such a structure is to be a valuable feature. To suit species that cannot tolerate human activity near a passage, restrictions should be placed on land use within a radius of the passage entrance (Clevenger and Waltho 2000). Finally, Riley et al. (2003) suggest that animals that are familiar with a portion of an urban landscape may learn to safely navigate roads within their home ranges. Appropriate passage dimensions, locations, and surrounding habitats would thus hopefully contribute to animals' development of the ability to safely cross roadways near restored urban parks.

Fencing techniques to keep animals off roadways are also useful to restrict animal movement between park space and urban space. The same design rules apply — fences should be at least seven feet high, reinforced at the bottom, and slanted inward. Chain link fencing material will be less obtrusive in the landscape; however, sacrificing a pleasant view and lining the fencing with dense vegetation or soil berms may reduce the amount of automobile and neighborhood noise that filters into wildlife habitat, and planting unpalatable vegetation along the fence may dissuade some species from attempting to cross the fence (MAPC 2005). Vegetative barriers probably should not be used in lieu of fencing because they are more permeable.

Artificial sky brightness is another wildlife-related topic that has garnered considerable attention and fledged “dark-sky” movements across the United States. To reduce artificial sky lighting, Lockwood (2004) suggests reducing bulb wattage; directing light downward; shielding the light by installing cutoff lighting, which directs light to the sides of and beneath a fixture; and lowering the height of light poles. However, as discussed earlier, light that is directed downward to combat artificial sky brightness results in a greater number of negative impacts on many terrestrial and aquatic wildlife species. Ecological light pollution has received comparatively little attention, probably because ecosystem-level effects of this type of pollution are largely unknown (Bird et al. 2004). Hence, there is little information on the appropriate lighting fixtures to install in areas utilized both by humans and by a particular wildlife species, and we look to future research for answers to what appears to be somewhat of a species-specific problem. For instance, as a result of research on ecological light pollution and sea turtle nesting behavior, Florida beaches may be lighted only by either low-pressure sodium vapor lights or by incandescent yellow bug lights, both types of long-wavelength lighting with different spectral properties (Witherington and Martin 2000 in Bird et al. 2004). However, Bird et al. found that the local population of Santa Rosa beach mice

foraged at a higher proportion of resource patches under the bug lights than under the sodium vapor lights, and those that foraged under bug lights harvested fewer seeds than in areas with zero artificial lighting. This reveals that both types of turtle-friendly lighting do impact mouse foraging behavior, and do so differently, perhaps because mice assess higher predation risks under the alternate lighting scenarios.

In order to incorporate wildlife-friendly lighting into park design, wildlife biologists will need to study the effects of various types of lighting on a palette of local species. Longcore and Rich (2004) advise ecologists to measure illumination in photons per square meter per second and in wavelengths per square meter per second, in order to ascertain a measurement that is meaningful in terms of discussing effects on wildlife. Luminance or brightness of light and sudden changes in illumination are other factors of concern. In the interim, we suggest that residential areas be regulated to reduce the amount of light that spills over into adjacent open spaces, and that any lighting installed in park spaces be dimmed.

Restricting recreational activity

Knight and Temple (1995b) advise that managing recreation in ways that allow park users and wildlife to coexist is generally a more realistic approach than instituting park closures and excluding humans from wildlife viewing and other recreational activities, as may happen in situations concerning endangered or sensitive species. In cases of urban park restoration, where recreational space and wildlife habitat are both strong priorities, the former management approach is indeed the more realistic of the two.

Creating buffer zones and steering human activity away from sensitive wildlife habitat are common methods of spatial restriction. Buffer zones are often established by determining flush distances or flight distances for the population in question; these distances can vary over the course of a day or a year (Knight and Temple 1995b). Vegetative barriers can be used to steer human activity away from sensitive wildlife habitat, along with trail design and access restrictions. Briffett (2001) suggests that bike and walking paths be routed away from places where birds are (expected to be) nesting. Thick brush, thorn hedges, ditches, steep grades, and boulders are recommended both to steer recreationists away from sensitive habitat and to keep them on trails to prevent erosion or vegetation trampling (Carr and Lane 1993; Agate 1996; Briffett 2001; Cole 1993). Limiting the number or location of access points to a recreational area can also be effective in funneling human activity away from more sensitive areas (Briffett 2001).

Limiting the visual exposure of wildlife to recreational activity can be complementary to the creation of barriers that steer park users away from sensitive habitat. Wildlife are sometimes less affected by human activity when they are visually shielded from it; however, the optimal location of the animal, the barrier, and the activity relative to each other varies by species (Knight and Temple 1995b). Skagen et al. (1991) found that avian scavengers prefer to feed away from vegetation shields because these may hinder their detection of predators. Thus, if the shield is closer to the activity than to the animal, the animal may be able to utilize habitat closer to the disturbance. White-tailed deer, however, were found to take shelter *within* a vegetative shield, watching recreational activities without fleeing (Richens and Lavigne 1978).

Depending on resident species ecologies, recreational activity could be restricted temporally. Knight and Temple (1995b) suggest that periods of critical resource use by wildlife are best accommodated by park closure during those hours. For example, they cite Knight et al.'s (1991) findings that wintering populations of bald eagles primarily feed in the mid- and late-morning hours — restricting recreationists' morning access to parklands during several months of the year is proposed as a compromise. Restricting access during an entire breeding season is another valuable strategy to consider.

Restrictions on the nature of recreational activities is another management strategy. Waterfowl, for

instance, are especially wary of activities associated with loud noise and rapid movement (Knight and Temple 1995b). If a park hosts a population of waterfowl unhabituated to human presence, restricting football and soccer games on adjacent lawns may be in the birds' best interest. Cole (1993) suggests that some recreational activities can be discouraged by failing to provide the appropriate facilities. He also suggests zoning by activity type, to limit potentially destructive activities like dog walking to carefully selected portions of a park. Briffett (2001) advises managers to analyze patterns of use violations, to determine whether recreationists are disregarding activity rules to the degree that managers should consider creating an area dedicated to that particular activity in order to steer violators away from more sensitive habitat.

Simply limiting visitor numbers (Garber and Burger 1995) or the number of available parking spaces (Cole 1993) are other ways to reduce the amount of park users. Garber and Burger (1995) witnessed the extirpation of two robust wood turtle populations over one decade on lands that were opened to human recreation, estimating that every 19 annual permits issued to recreationists resulted in the death or removal of one turtle, and consequently warn against allowing more recreationists into a park than a resident wildlife population can bear.

Wildlife-friendly residential design and neighborhood outreach

The management of wildlife outside of park lands — for instance, in neighborhoods proximate to parks or other public land — is an important component of the larger realm of habitat conservation and wildlife survival. As Kilvington et al. (1998) state, urban restoration and conservation entail a two-way relationship between humans and wildlife, wherein wildlife have value for the community, and are also dependent on the community for continued existence. Indeed, as more parkland is added to urban areas, residents should understand not only that they may expect to encounter wildlife more often, but that the manner in which their yard spaces and other public and private areas are landscaped can help (or sometimes hurt) these animals' existences.

Landowners can supplement habitat restoration efforts on public parklands and provide wildlife habitat by landscaping their own properties with native vegetation. Landscaping with native flora contributes to a larger vision — that of connectivity for wildlife through densely urbanized portions of a city. Fernández-Juricic (2000), for instance, describes wooded streets as being structurally similar to corridors, in that they are vegetated landscape elements connecting urban parks. Though he found that wooded streets contained only 56% of the avian species richness found in nearby parks, vegetated streets still have the potential to increase landscape connectivity, particularly if the streets share the level of vegetative complexity found in the local parks. Research by Palmer and Dann (2004) suggests that participation in structured native landscaping programs may result in reciprocal benefits both for participants and wildlife, as participants are likely to have positive attitudes toward wildlife and be more tolerant of negative impacts of wildlife; have increased knowledge about wildlife; and engage in long-term wildlife habitat maintenance and improvement.

Kilvington et al.'s (1998) pilot study of an urban restoration initiative in Christchurch, New Zealand warns of a potential difficulty in encouraging residents to plant native vegetation. She and her colleagues found that citizens who had only vague understandings of environmental health issues and urban ecosystems tended to rely on personal aesthetic or cultural preferences when asked their opinion on revegetating the city with native rather than exotic flora. This experience points to the importance of actively educating neighborhoods near parks about the ecological contributions they have the power to make. Part of this education effort may include the creation of a native planting demonstration project to serve as a model for neighborhood members to follow in their own yards.

Indeed, education about wildlife and natural habitats is a vital tool in leading urban residents to understand the functions and needs of other species that share the southern California landscape with them. Though not a panacea for human–environment problems, education at the very least promotes awareness about human–wildlife conflicts and resolutions. School-based environmental education programs are especially appropriate when restoration efforts take place nearby. Queensland, Australia students (ages eight–17) who visited natural areas as part of their schools' environmental education programs indicated pre-visit that they were particularly interested in learning about different wildlife species and how to help them. Post-visit data showed that seeing and interacting with animals proved to be the most enjoyable feature of the outdoor experience. These students also reported changes in their environmental knowledge, attitudes, and intentions, including newfound respect for forest ecosystems, anger about pollution, realization that humans must care for wildlife, and understanding that one should not frighten wildlife or pick plants (Ballantyne and Packer 2002).

Beside nature-based excursions or outdoor classrooms, there has also been a surge in the creation of schoolyard habitats, constructed in an effort to reconnect urban students with nature and to take natural science study beyond the classroom and textbooks (e.g., Foss 2004; Rivkin 1997; Trank 1997). And in a classroom setting, Manaster (2003) suggests that exploring the ecological, sociological, economic, and political dimensions of urban wildlife with students is an instructive way to encourage students to consider social issues from multiple perspectives.



Birdwatching at San Luis National Wildlife Refuge, California
Credit: United States Fish and Wildlife Service

There are other opportunities to create, augment, or adopt educational programs outside of school that bring information about wildlife and habitat issues to a broader demographic in useful, accessible ways. One alternative is to partner with a variety of community programs run by local museums, land conservancies, grassroots organizations, or nonprofit foundations. These programs provide meaningful, relevant knowledge about wildlife and wildlife habitats in local parks or other public open spaces via workshops, lectures, videos, outdoor excursions, and more. Ballantyne and Packer (2002) believe that combining observation with instruction is an especially powerful educational strategy, after their own research that documented the enthusiasm of primary and secondary students for seeing, interacting with, and learning about different wildlife species. Schicker (1986) also notes that enrollment in natural history courses such as those offered through local museums will probably result in increases in children's knowledge and interest about wildlife, and in more positive attitudes toward wild animals. Education

efforts for any age group should ideally make people aware of the link between their behavior and specific ecological problems; demonstrate the appropriate behavior that will subvert the problem; and encourage a sense of commitment in people to avoid causing those problems (Cole 1993).

Finally, communication between community members and project developers is another important form of outreach. Local responses can help evaluate the progress and benefits of the restoration project (Purcell et al. 2002; Casagrande 1997). Casagrande (1997) also suggests collaboration between developers and the community in the project planning stages. This interaction among interest groups before the project breaks ground can be particularly useful in fleshing out local concerns about human–wildlife interaction levels. Gauging residents' apprehensions about wildlife can lead into a discussion of legal or urban infrastructure that would address these concerns in a manner acceptable to community members.

Immunocontraception

Another potential solution to human–wildlife conflict is immunocontraception. Immunocontraceptive techniques work to control fertility by stimulating the production of antibodies to destroy proteins and hormones essential to reproduction. When the immune system detects a foreign substance, it attacks the substance with antibodies; when the immune system detects a familiar substance, it is unresponsive. By coupling one type of an animal's self reproductive antigens (hormones and proteins) with a foreign protein, and administering this conjugated protein to the animal, the animal's immune system reacts by producing antibodies to destroy this conjugation. These antibodies will also destroy the self reproductive antigen naturally occurring in its body, and this will induce infertility (Miller et al. 1998).

This technique could be used in southern California to target burgeoning urban populations of deer, birds, coyotes, and rodents implicated in nuisance activities and disease transmission (Miller et al. 1998). By lowering the fertility of these populations, it may be possible to limit the damage caused by these animals. Before beginning an immunocontraception campaign, parties should consider whether they are able to expend the time, effort, and money necessary to achieve a population-level effect with immunocontraception methods; and whether this control method is consistent with community values, current control practices, and needs (Rudolph et al. 2000). It is important to note that results for a particular immunocontraception technique are species-specific (Nash et al. 2004; Fagerstone et al. 2002), and will depend upon biological factors as well as the mating system, site fidelity, dispersal rate, and scale of individuals' movements within a population's geographic range (Porter et al. 2004; Twigg et al. 2000). Additionally, immunocontraceptive treatments have been developed and tested unevenly across species, so immunocontraception is a better or more reliable management strategy for some species and not others.

Two general delivery systems exist for administering immunocontraception: non-disseminating (bait) and self-disseminating micro- or macroparasites (vector) (Barlow 2000). In non-disseminating systems, individual animals must consume bait containing an immunocontraceptive drug in order to be treated; alternatively, an animal may be injected with the drug by dart, needle, or biobullet. Baits do not disseminate an immunocontraceptive agent throughout a population; they only affect the animal that consumed the bait. Immunocontraceptives applied via bait may result in one or two years of infertility, dependent upon the length of time that sufficient antibodies exist to destroy the targeted self reproductive antigen (Miller et al. 1998).

Virus-vectored immunocontraception (VVIC) does disseminate an immunocontraceptive agent, and Courchamp and Cornell (2000) believe that VVIC would almost always be a more effective and time-efficient method of inducing sterility than the use of baits. A genetically engineered infectious vector is introduced to individuals in a population, and is transmitted to other conspecifics through mating activity.

One release of VVIC may impact a population for a longer period of time than one application of bait because the vector offers the possibility of multiple infection cycles (Barlow 2000). The effectiveness of VVIC over a large geographical area for any species will depend upon, among other things, the distance that breeding individuals tend to roam from their core population or home range to mate with members of the opposite sex (Ji et al. 2000). Individuals infected with an immunocontraceptive virus are ideally rendered permanently infertile (Hood et al. 2000); though, individuals that recover reproductive capacity seemingly could become re-infected through mating activity.

Research indicates that immunocontraception techniques are plausible solutions to coping with populations of species found in the upper Los Angeles River watershed. Here we discuss the promise of immunocontraception for reducing populations of California ground squirrels, coyotes, mule deer, and feral cats.

Nash et al. (2004) investigated the efficacy of gonadotropin-releasing hormone (GnRH) immunocontraception for controlling urban populations of California ground squirrels. Reducing GnRH levels leads to the reduction in the release of the hormones that control the functions of the testes and ovaries, which results in gonad atrophy and infertility. However, modification of hormonal systems may impact territorial defense, aggression, pair-bond formation, and scent-marking behavior, resulting in unexpected population dynamics (Asa et al. 1990; Asa 1995 in Bromley and Gese 2001). The results of Nash et al.'s two-year study show that administering a single injection of GnRH vaccine to ground squirrels is over 90% effective in inhibiting reproductive functions for at least 1.5 years. They determined that by the second year of the project there was a 66% reduction in the number of juveniles born per adult, as compared to the ratio at a non-treated control site. Nash et al. recommend this control method for areas that are accessible to humans, for the purpose of injection administration; and that have little squirrel immigration. They advise that males and females be immunized prior to mid-November in order for the vaccine to be in effect for the first breeding season, because there is a time delay post-injection for reproduction function inhibition.

A handful of researchers have contributed to development of immunocontraception for coyotes. DeLiberto et al. (1998) have tested the promise of porcine zona pellucida (PZP) application to inhibit reproduction in coyotes. This involves inducing a female to produce antibodies that bind to the zona pellucida (ZP), which is a glycoprotein layer on the surface of an egg. Incoming sperm must bind to a receptor on the ZP and break the ZP down with an enzyme in order to enter the egg. The antibodies bound to the ZP block the sperm from binding to and breaking down the ZP (Dunbar and Schwoebel 1988 in Miller et al. 1998). DeLiberto et al.'s results indicate that PZP vaccinations of 300 µg, followed one month later by a 200 µg booster, and thereafter by annual 45 µg PZP boosters will reduce mean litter size. They achieved complete infertility in female coyotes that were vaccinated with 300 µg and then boosted four and six weeks later with 200 µg, but this frequency of treatment is probably unrealistic for management.

Southern California hosts populations of mule deer, on which significantly less immunocontraceptive research has occurred in comparison to white-tailed deer. However, Baker et al. (2000) achieved fertility control in captive mule deer for one breeding season using a GnRH agonist. This involves rendering pituitary gonadotroph cells unresponsive to GnRH, which normally triggers the production of reproductive hormones in those cells. As long as agonists are continuously infused into the body, gonadal function will be hindered, meaning that the effectiveness of this method depends upon technology that will enable a long-acting, slow-release agonist formulation (Fagerstone et al. 2002). Baker et al. used subdermal implant technology to suppress the secretion of luteinizing hormone from the pituitary gonadotroph cells in female mule deer for one breeding season, and witnessed no negative behavioral or physiological side effects. A number of immunocontraceptive treatments, including ZP vaccination (e.g., Rudolph et al.

2000) and GnRH vaccination (e.g., Miller et al. 2000) have been tested successfully on white-tailed deer, suggesting that they may be effective on other members of the *Odocoileus* genus, but because results are species-specific, there is no guarantee for its success in mule deer.

Levy et al. (2004) investigated the potential of GnRH immunocontraception for male cats. They concluded that the technique has promise but needs more research and development, because at all three GnRH dosage levels some cats were rendered sterile for one year, and other cats at those dosages produced low antibody titers. Levy et al. also endorse GnRH methods because they block production of estrogen and testosterone, which “contribute to objectionable behavior and medical diseases” in felines (1128).

Unfortunately, there seems to be a gap in research on immunocontraception for raccoons and opossums, which is surprising because the species found in southern California are often implicated as nuisances and disease vectors. There is little research on immunocontraception for red foxes, though Bradley et al. (1997) published on their ongoing attempts to develop a vaccine, and Saunders et al. (2002) believe that reproductive control is feasible for fox populations. Saunders et al. surgically sterilized female red foxes via tubal ligation, which is analogous to immunocontraceptive methods like ZP treatment that keep hormonal systems intact; the team found no worrisome behavioral differences or significant survival differences between control and treatment groups.

HCPs and NCCPs

Potential conflicts arising from urban habitat restoration efforts, particularly stemming from the competing interests of adjacent landowners and park visitors, are in some ways similar to issues that larger-scale conservation planning endeavors in California have experienced. Both habitat conservation plans (HCPs) under the federal Endangered Species Act (ESA) and Natural Community Conservation Plans (NCCPs) under the state Natural Community Conservation Planning Act of 1991 have been utilized in the state over the past decades. HCPs mitigate the population-level effects of private land development upon federally listed endangered or threatened species (Beatley 1995). NCCPs are the proactive cousin of HCPs, seeking to delineate, conserve, and manage large swaths of plant and wildlife habitat in order to avoid endangerment of a number of species not yet listed as threatened or endangered under the ESA (Porter 1995).

These plans tend to cover larger land areas than do the conservancies' proposed projects. Typically, HCPs and NCCPs are deployed to manage hundreds or thousands of acres, while many of the conservancies' proposed projects are around 15 acres in size. However, general lessons (rather than solutions) can be drawn from the larger-scale planning efforts, concerning ecosystem health and accommodating recreation. The San Diego Multiple-Species Conservation Plan (MSCP), for instance, has been criticized in the past for failing to coordinate a species and ecosystem health monitoring program across the subregion (California Research Bureau, 2001). As Samson and Knopf (1996) suggest, continuous monitoring is vital to understanding the repercussions of land development on species and ecosystem health; similarly, consistently monitoring the effects of recreational use on urban park wildlife and flora is an important aspect of restoration. The California Department of Fish and Game (2003) emphasizes that planners should set clear and measurable biological goals to avoid problems concerning consistent monitoring that earlier large-scale planning efforts faced.

The direct management of recreationists' use of reserve land is a related issue that some local conservation plans have addressed, especially important here because the activities of recreationists in urban parklands has significant impact on the status of wildlife and vegetation. The Palos Verdes Peninsula subregional plan is an especially valuable one to look at for these purposes, as many of the parcels incorporated into this plan are the size of the conservancies' proposed projects and are situated in

developed areas. For instance, the City of Rancho Palos Verdes and a local land conservancy will develop a public use plan to address trail use, lighting, parking, impacts on adjacent neighborhoods, and other issues arising from dedication of the reserve. This use plan will be sensitive to the effects of active and passive recreation on habitat and covered species, limiting the creation of passive recreational areas with picnic tables, toilets, and garbage cans to near reserve boundaries, to avoid placing facilities in the interior of a sensitive resource area (URS 2004).

In a more general sense, the California Department of Fish and Game (2003) has emphasized the importance of establishing relationships early on with all parties that will potentially be affected by a conservation plan, in order to begin dialogues about expected benefits and inconveniences. Beside local governments and large landowners, this includes contacting nearby home owners, recreationists, and other organizations that use the land. This advice has very practical application to urban park restoration efforts as community meetings are opportune forums for discussions of residents' and recreationists' attitudes about an increased wildlife presence, about possible conflict mitigation measures, and about native planting projects.

SECTION II

CHAPTER 5: URBAN RESTORATION AND CONSERVATION

Urban parks can play an important role in nature conservation, but their management and expectations must be different from those of parks located in rural landscapes or in areas with low population densities. Urban parks are usually smaller, surrounded by a high population density matrix, and possess internal fragmentation, intense edge effects, and heavily-altered ecologies. In the past, these characteristics were a disincentive for conservationists to work in such parks. In the last 15 years, however, there has been a shift in attitudes toward these areas, and metropolitan reserves are increasing in number as planners recognize their importance for environmental education (Savard et al. 2000; Heywood 1996; Goode 1990), human well-being (Maller et al. 2002), and conservation biology (Stenhouse 2004).

Although parks' conservation and restoration value should be assessed individually, there are some general park characteristics that are associated with higher value for restoration and conservation in urban areas. Size, vegetation cover, location in the urban matrix and landscape, and park age are proven to be important features. Given the current situation in the upper Los Angeles River watershed, where riparian habitats have been all but completely destroyed in the urban matrix, restoration projects involving riparian habitat are of particular importance. However, a balance should exist regarding the types of native habitats being restored. Non-riparian habitats are also important and lacking in the area, and certain species that benefit directly from riparian habitat restoration might also need other habitat types for their survival.

Size

Park size is an important consideration for reserves in general. Due to the intense modification of the environment in the urban matrix, size becomes an important factor in protecting sensitive species from edge effects. In urban areas, patch size has been positively associated with insect diversity and density (Faeth and Kane 1978; Watts and Larivière 2004); preservation of forest types (Levenson 1981); and bird and amphibian diversity (Vizyova 1986; Donnelly and Marzluff 2004; Fernández-Juricic and Jokimaki 2001). Even at the garden scale, studies have shown that size plays an important role in vegetation cover and diversity (Smith et al. 2005). Although *ceteris paribus* a big park is preferred over a smaller one, relatively small parks are very important, particularly in a landscape as fragmented and disturbed as the urban matrix where they can simultaneously act as permanent habitat, stepping stone, and corridor.

The SLOSS (Single Large or Several Small) debate is sometimes fueled by evidence from studies on small urban reserves, and these discussions are likely to continue (Lahti and Ranta 1985; 1986; Wilcox and Murphy 1985; Murphy and Wilcox 1986). Studies discussing the importance of small reserves for conservation range from arguments favoring a network of small reserves over a single large reserve in a fragmented landscape (Baz and Garcia-Boyer 1996), to studies highlighting the significant positive impact of small remnants (Turner and Corlett 1996; Abensperg-Traun and Smith 1999; Schwartz and van Mantgem 1997; Lomolino 1994), and studies showing no significant effect on species richness (Honnay et al. 1999; Oertli et al. 2002).

Size is a major consideration when assessing parks for conservation in the urban matrix. Effort should of course be made to maintain and restore existing bigger parks; this, however, should not be detrimental to the work needed in acquiring and/or restoring relatively small parks. There is sufficient evidence to show that these parks can play a vital role in the overall conservation strategy at both the local and ecosystem levels.

Vegetation cover

When assessing urban parks for conservation value it is important to study their vegetation structure, complexity, and cover percentage. Although different habitats naturally have different vegetation complexity and cover, studies have shown a positive relationship between complexity and cover and species diversity. Land vertebrate species diversity is positively related to percentage of vegetative cover (Vizyova 1986). Bird diversity is significantly influenced by density of shrub layer (Tilghman 1987), and can also be increased with increased habitat complexity (Melles et al. 2003). Beetle composition is also influenced by vegetation structure (Watts and Larivière 2004, Webb et al. 1984).

Given that “urban stands tend to have lower stem densities, unless those stands are old-growth remnants in large parks or former estates” (Lawrence 1995), it is important to identify and conserve parks with relative vegetation complexity, and increase this complexity in restoration efforts. “Trees of different ages as well as multiple layers of vegetation are the most simple and direct tools to increase the suitability of urban parks due to higher availability of food, shelter and breeding substrates” (Fernández-Juricic and Jokimaki 2001: 2033). This last quote underscores the importance of vegetation complexity and highlights the importance of recognizing that certain non-invasive exotics can play an important role for many native species. An effective conservation strategy in the urban matrix should be pragmatic, assessing the function many of these exotics perform in the landscape and not dismissing their contribution because they are not native.

Vegetation cover and complexity can also play an important role for connectivity at the matrix level. At the street level it can increase connectivity (Fernández-Juricic 2000). At the garden level we know that richness increases with garden area and age (Smith et al. 2005), which is important to consider since Szacki et al. have found that “some built-up areas are more similar to natural habitats than many areas recognized in physical plans as ‘green’ ones” (1994: 51–52).

Vegetation cover and complexity should be considered main elements when assessing the value of parks for conservation. Moreover, these elements are perhaps the most important ones when working in the urban matrix. Good vegetation management can increase percolation rates through the matrix for some species and create suitable habitat or stepping stones for others.

Landscape and connectivity

“It is essential to consider landscape factors in the management of urban biodiversity” (Savard et al. 2000: 136). A park’s location in the landscape and within the urban matrix will affect both the park itself and its role in the conservation strategy of the landscape as a whole. Moreover, the local and regional scales are not independent. Local scale management at the park level will influence the impact these parks have at the landscape level, and management of the matrix and regional parks will influence local parks. Well-managed local parks can help some species traverse the urban matrix, contributing to the diversity of regional parks. Regional parks can function as sources of species to newly restored areas in local urban parks. Composition of the matrix itself is another important factor when dealing with approaches at a local level. Factors including population density, housing type, and neighborhood age can affect the matrix’s vegetation composition, which is related to species diversity, density, and connectivity.

Urban parks located in proximity to larger habitat remnants can receive populations from those larger patches. Studies on mammals, insects, and birds support the importance of landscape resources in determining species richness in urban areas (Dickman 1987, Dickman and Doncaster 1989, Owen 1978; Melles et al. 2003; however, see Clergeau et al. 2001). It is therefore important to prioritize conservation

and restoration of parks located close to existing larger patches, but consideration of diversity of habitat types should also be a top priority in order to cover a broader range of species and protect habitat types that might be isolated but unique.

Urban parks' locations can also be important in the assessment of their value for connectivity, either as stepping stones, corridors, or as part of an overall strategy to increase matrix permeability. Dickman (1987) recommends a system of small habitat patches in the city, and a similar recommendation is made by Baz and Garcia-Boyer (1996) for highly fragmented habitats. However, interactions between urban development patterns and ecosystem dynamics are not yet well understood (Alberti 2005); therefore, a strategy that includes a variety of tools is recommended. In order to assess potential tools it is important to study the various characteristics of the urban matrix and its effect on different species. Housing density, for example, can sometimes explain the variation in species density (Germaine et al. 1998). This and other characteristics of the matrix need to be well understood in order to work on the improvement of connectivity beyond parks and reserves, at the neighborhood level.

Parks themselves are in turn affected by the composition and arrangement of the surrounding habitats. Studies by Szacki et al. (1994) show that in built-up areas vegetation and garden management can increase the permeability of the matrix. Even very small islands or fencerows can “help maintain a mix of exotic, pioneer, and terminal plant community components and can function as stepping stones between larger forested areas” (Levenson 1981). At this same scale level, vegetation complexity of corridors such as wooded streets can improve regional connectivity (Fernández-Juricic 2000). Habitat complexity can be the most effective strategy to turn small parks into high quality stepping stones (Fernández-Juricic and Jokimaki 2001; Rosenberg et al. 1997).

Although size, location, and vegetation structure are good general guidelines to assess parks' potential for conservation in urban areas, it is important to highlight that all species experience and utilize landscapes in a different way, and that habitat quality is very species-specific (Young and Jarvis 2001: 656). The particular assemblage of species that inhabits a restored park is dependent upon the habitat that has been created, as well as on the surrounding urban matrix. Further, the objectives of each park need to be clearly specified to meet the needs of expected wildlife inhabitants and of users and park managers. Having said this, it should be emphasized that parks cannot be managed in a vacuum; rather, they and their objectives must be planned and managed with the municipal and regional scale in mind. Without this landscape framework conservation opportunities might be lost by not understanding the interrelationship of urban parks and of these parks with the local and regional landscapes.

Typology of parks

Taking the above literature into consideration, we suggest a basic typology of *connective corridors*, *stepping stones*, and *urban islands* for understanding the values and functions of park spaces in terms of the contribution of a restored park to urban matrix permeability and habitat connectivity. A park would be placed into the typology according to the interplay between park size; park location within the urban matrix; and park location relative to existing expanses of habitat at the fringe of and outside of the urban matrix. The size of a park must be considered relative to the degree of the park's isolation from connectors and other expanses of habitat. Park location within the urban matrix refers to its location in relation to obstacles (e.g., highways, roads), connectors (e.g., railroad tracks, vegetative cover, water courses), and to features that can act both as connectors and as habitat (e.g., golf courses, other urban parks). Finally, park location relative to existing habitat generally refers to larger parks and wilderness areas situated at the terminus of the urban matrix and may also include significant native habitat patches within the matrix. Then, all of these factors, along with land use and human population density

surrounding the park, influence the types and degrees of potential human–wildlife and wildlife–human interactions in and around urban parklands.

In this chapter we describe the attributes of each of the three typology categories. This includes a broad discussion of expected recreationist–wildlife interactions in and around urban islands, stepping stones, and corridors, and of solutions for negative interactions. These general guidelines may be more applicable to particular park spaces and less representative of others, as multiple place-based variables — such as municipal laws and population densities — affect actual interactions.

Creating a typology to classify park lands in a way that makes sense of interactions between recreationists and wildlife is complex because different species relate to the landscape in different ways; what constitutes a corridor for one species can be an urban island for another. This becomes more complex when we account for the influence of the urban matrix on the projects: the same-sized park in different surroundings can be a stepping stone or an urban island, and even in one location a park can act as stepping stone for a species with enough mobility to penetrate the matrix and as an island for one with less mobility. In Chapter 6, we apply this basic typology to a number of the potential projects that may be undertaken by the Santa Monica Mountains Conservancy and the Mountains Recreation and Conservation Authority.

Connective corridors: Connective corridor projects involve restoration of sites that will create or increase connectivity with existing habitat patches or large reserves. These can be corridors along creeks, rivers, floodways, washes and canyons, or they can be more ‘urban’ corridors located in abandoned tracks or rights of way, or even greening of street corridors.

Connective corridor or greenway projects generally offer the best situation for southern California wildlife out of the three habitat creation and restoration options. They provide wildlife with a strip of connective habitat between larger reserves or open spaces, meaning that forays into surrounding neighborhoods are not necessary as long as the corridor contains ample shelter, food, and water for wildlife. Animals that do not need to disperse into residential neighborhoods are at a lower risk of being implicated as nuisances or being involved in vehicle collisions. However, the accuracy of this prediction depends on the activities of the humans living in these adjacent neighborhoods. If residents fail to comply with ordinances that restrict the anthropogenic provision of resources, a restored connective greenway will not necessarily be attractive enough to induce wildlife to remain within its bounds. Open garbage receptacles, outdoor housecats, and unfenced koi ponds virtually guarantee wild visitors to residential backyards. Generally speaking, corridor projects through denser neighborhoods will result in a greater volume of wildlife interactions with humans, and whether these interactions are positive or negative will largely depend upon whether residents adjust their practices accordingly. Narrow greenway projects will probably result in more wildlife entering surrounding neighborhoods than wider projects, because wildlife traversing the narrow linkage may be more likely to stray from the thin expanse of habitat and examine the adjacent neighborhoods for food resources. Moreover, inner city corridors will have less wildlife traffic, and probably involving smaller species, than corridors connecting the mountains to inner city parks.

The existence of a greenway also allows wildlife to leave areas plagued by edge effects such as noise or light pollution, and to avoid predators, visitors, or other disturbances, by traveling through an expanse of native habitat rather than through city streets. Some corridors may be bisected by roads, though, creating a very dangerous situation for wildlife species passing through. In these cases, overpasses or underpasses should be planned in concert with fencing. Wider corridors are preferable over narrow ones to decrease edge effects on corridor users; however, any size corridor is prone to considerable edge effects because corridor length results in a high ratio of perimeter to surface area. Overlay zoning for the

immediately surrounding neighborhoods could be considered to decrease localized edge effects that may induce wildlife to leave restored greenways.

For recreationists, greenways may hold advantages over stepping stone projects and urban island projects including greater opportunities for wildlife-viewing and educational events, which can provide aesthetic experiences, social encounters, stress relief, and a greater appreciation of local ecology. Property value hikes could be an important result of greenway habitat restoration. Restored greenways offer clear ecological benefits in that species passing through the linkage may perpetuate the restored habitat through seed dispersal activities and predation of nonnative faunal species that colonize it. Other ecosystem services include pollination of native plants and trees in the greenway and perhaps of residential garden plants as well. Habitat restoration also may provide a noise and pollution buffer for adjacent neighborhoods. Another important benefit that open space users and nearby residents may derive from the greenway revolves around knowing that a very functional stretch of habitat has been restored; this may bring various psychological and mental benefits to users.

Stepping stones: These are patches in relative isolation to other patches or large reserves that provide habitat for species that move through the urban matrix from one patch to another.

Generally speaking, stepping stones contribute to connectivity in a way that urban islands do not. However, whether a park is considered a stepping stone or an urban island will depend as much on the park and its context as on the species being considered. Stepping stones can be useful both for sedentary species and for animals with larger home ranges, enabling the latter species to move between stepping stones in pursuit of food, shelter, and reproductive opportunities. Larger stepping stones, or those with a higher surface area to perimeter ratio, are preferable to protect wildlife against edge effects; however, species using stepping stones in an urban matrix are likely to be relatively tolerant of disturbance. Vehicle collisions are still of concern here though, as stepping stones imply some level of animal dispersal. If drainage culverts of appropriate dimensions for resident wildlife do not already exist under major roads, culvert or underpass construction is suggested. Additionally, landowners between stepping stone patches should be encouraged to landscape with native vegetation and to otherwise provide green cover for dispersing or roaming animals, to augment their passage between stepping stones.

For some species that use stepping stones as part of a movement corridor, stepping stone projects are expected to have high potential for wildlife interactions with humans. For other species, stepping stones will generate activity similar to that in an urban island, because they will use the stone as a longer-term habitat and disperse through urban neighborhoods only when population densities require them to colonize another area. Densely-populated neighborhoods with existing green coverage and diverse vegetation structure represent a higher potential for conflict, as the amount of incentives for scavenging is higher. Therefore, preventative ordinances and conflict avoidance education are recommended for residential tracts situated near stepping stones and urban islands. In fact, before engaging in a stepping stone or urban island project, a survey of surrounding neighborhoods to determine the receptivity of residents to an increased wildlife presence and associated regulations may be judicious. Overlay zoning could be implemented to address park space disturbances originating only from proximate developed areas.

Park users and local residents can reap important benefits from wildlife use of stepping stone spaces and neighborhoods. Among other things, the movement patterns that stepping stone projects facilitate may increase understanding among urban residents that the city is in fact a complex ecosystem, home to two-legged, four-legged, and winged commuters. Increased exposure to wildlife may yield a set of aesthetic, social, and psychological benefits for humans and park users. As suggested above, residents who are

so inclined can engage in creation of mini-habitats in their yards to augment the effectiveness of stepping stone projects; they may then experience feelings of satisfaction in their ecological contribution and in subsequent backyard wildlife viewing opportunities. Finally, property abutting stepping stone projects may rise in value.

Urban islands: As stated above, the degree of patch isolation is relative to the species. However, some areas are isolated enough that only extremely adaptable species can populate them. These areas, which still represent functional habitat for many wildlife species, will be referred to as urban islands.

Urban island projects are the most size-dependent of the three project types, with reference to human–wildlife interactions. Such projects represent a habitat gain for wildlife species, though an urban island project is less valuable to terrestrial species with low mobility than is a corridor project or a project located in the proximity of existing large habitat remnants. Animals residing in urban islands are especially vulnerable to anthropogenic disturbances because they are unable to temporarily relocate to a nearby patch of habitat; if a disturbance flushes an animal from the island, it is forced to spend time in suboptimal habitat conditions (i.e., the surrounding developed landscape) until conditions in the island return to amenable. Indeed, wildlife that colonize or remain in an urban island are more vulnerable to a range of negative user–wildlife interactions. Disturbances may include park activity by humans and domestic animals; exotic species that colonize park space and compete with or prey upon resident species; and edge effects such as noise pollution. We expect higher population densities in surrounding neighborhoods to produce higher levels of noise and light pollution. Overlay zoning could be used here to impose specific requirements about noise, lights, and other disturbances originating from surrounding neighborhoods.

If animals are forced out of an urban island due to disturbance or a resource shortage, with no nearby refuge to flee to, we predict that vehicle collisions and animal control service involvement (sometimes leading to euthanasia) will increase. Larger patches will reduce the need for some species to use the surrounding matrix, and moreover, bearing in mind the SLOSS discussion above, larger patches can provide habitat for more and larger species. Therefore, despite the importance of small reserves, larger urban islands will be more valuable as habitat than smaller ones. However, larger patches can provide appropriate habitat for species with larger body sizes, increasing the possibility of contact between those species and humans.

Benefits that park users and residents gain from an urban island restoration project include recreational space in a park-impoverished area, which along with providing aesthetic and other benefits, may also positively impact property values adjacent to the project. Though wildlife-viewing opportunities may not be as dramatic as those that a greenway or stepping stone project would bring, wildlife species would colonize even a small island and offer opportunities for education about the role of wildlife in urban ecosystems. Residents in surrounding neighborhoods should be educated about the positive impact they could have on urban island-dwelling wildlife by gardening with native vegetation and otherwise providing vegetative cover in their yards — this could effectively diminish the problems we may see if smaller urban islands experience periodic bouts of disturbance. And in turn, creating backyard habitat will provide wildlife-viewing opportunities for residents.

Finally, we expect human behavior to be the most important variable in determining user–wildlife and wildlife–user interactions, regardless of the type of park and park size. We expect behavioral changes in wildlife to be dependent upon park visitor volume, which may or may not be positively correlated to residential density surrounding the park. Higher visitor volumes may result in more substitute feeding, which unfortunately creates an attraction response in many wildlife species. Ideally, park wildlife would not develop an affinity for visitors because park users, nearby residents, and/or local government

agencies may result to culling campaigns or other inhumane control practices to remove wildlife that become nuisances or dangerous in their food-seeking activity. And, higher concentrations of animals resulting from artificial food sources will translate to higher probability of interspecies and intraspecies disease transmission. Additionally, we suggest that disease transmission potential may be more related to the type of habitat restoration planned: for instance, wetland restoration may increase the chance of mosquito presence, which act as vectors for viruses such as West Nile Virus. Higher visitor volumes also mean increased possibility of wildlife disturbance, unless visitors' movements and activities within parks are restricted and regulated. All negative scenarios discussed above, regardless of type of park or park size they were linked with, can be ameliorated if humans exhibit the appropriate behavior toward wildlife.

CHAPTER 6: PARK PROJECT CLASSIFICATION

The range of potential projects that may be undertaken by the Santa Monica Mountains Conservancy and the Mountains Recreation and Conservation Authority is broad; however the projects discussed in this chapter are limited to those in the upper Los Angeles River watershed. Because project funding would come through Proposition 50, the projects must incorporate stormwater infiltration, wetland creation, and riparian habitat restoration. Additionally, the conservancies would like to provide trail access wherever possible, increase the amount of native habitat in urban areas, increase habitat connectivity, and provide open space to communities with little green space. This chapter first characterizes the list of sites for potential development according to the basic typology outlined at the end of Chapter 5, to make sense of the human–animal interaction issues. Following this, we further examine the Pacoima Wash project, taking a closer look at the implications of restoration for human–wildlife interaction.

Classifying projects

Here we categorize the array of potential projects in the upper Los Angeles River watershed as greenway, stepping stone, or urban island by the methods described in “Typology of parks” in Chapter 5, and judge each project for its potential to increase or decrease human–wildlife interactions. Some projects may fall under more than one typology category, dependent upon the species in question. An example is the Aliso Creek Powerline project, which can potentially provide increased connectivity as a greenway, but could also act as a stepping stone and be functional habitat for many species. As we mention in Chapter 5, it would be problematic to affix a single label to any project since different species use the land in different ways and the surrounding urban matrix may help or hinder permeability for different species. Therefore, it is important that we analyze information such as project size and characteristics of the surrounding matrix when judging each project for its human–wildlife interaction potential.

Typology chart and project analysis

Unless otherwise stated, we base our classification and analysis of each project on the assumption of ‘finished’ restoration projects, that is restored to historical conditions. This final state may take a few years to achieve and the surrounding matrix may change before completion of the restoration process. We do not, however, account for potential changes outside of the project lands.

As we discussed in Chapter 5, projects are classified as corridor, stepping stone, or urban island according to interplay between project size; project location within the urban matrix; and project location relative to expanses of habitat at the fringe of and outside of the urban matrix. Placement within the typology is contingent upon the contribution of a restored park to habitat connectivity. In order to identify missing linkages within the urban matrix, we created a GIS model based on the habitat requirements and dispersal ability of several focal species, selected for their particular habitat requirements. Vegetation information for the model comes from the Normalized Difference Vegetation Index (NDVI). The focal species used for the model are the coyote, California quail, loggerhead shrike, and acorn woodpecker and they all share the characteristic of being relatively urban tolerant. The coyote was selected as an urban keystone species. The quail was selected for chaparral and coastal sage scrub habitats, the shrike for grassland and scrub habitats, and the acorn woodpecker for oak woodlands; each of these species is moderately tolerant of urbanization but primarily found within its native habitat. This model shows all of the restoration projects as well as all viable patches of habitat in the watershed for each of these four species. Using each species’ dispersal distance, we ran a program that drew connections between habitat patches and projects that were within that species’ dispersal distance. This indicated to us whether or not a project provided connectivity between existing habitat patches for the focal species whose native habitat was the same as that which the project should be restored with. The use of focal species is further described in Martino et al. (2005) and the model characteristics can be found in Lam, Martino and Longcore (unpub. data). In addition to the connectivity analysis, placement in the typology

was contingent on how each project's size and location within the urban matrix contributes to the habitat needs and dispersal ability of the four focal species. Finally, we used aerial photography to look at urban matrix features surrounding the project, for particular features that may hinder or help connectivity.

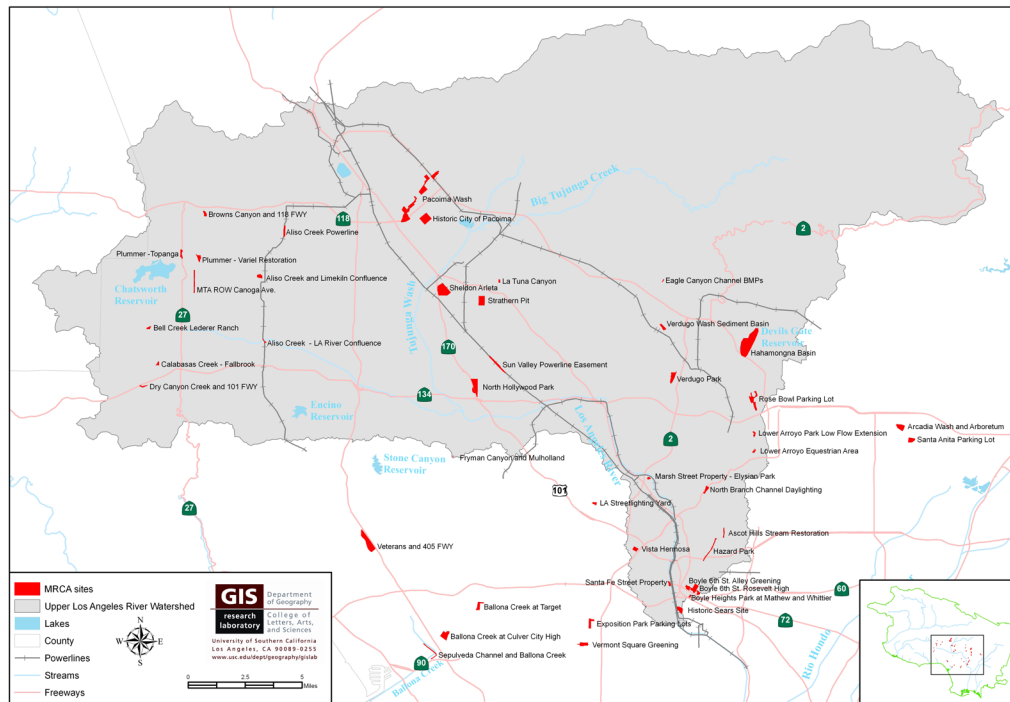


Figure 1. Potential projects in the upper Los Angeles River watershed

Then, to understand the projects in terms of human–wildlife interactions after each has been placed into the typology, land use and human population density surrounding the project must be considered. This involves understanding the nature of the project as determined by the analysis completed to place it within the typology, and factoring in the surrounding landscape — dense residential neighborhoods? Industrial area? Bordered by golf courses? — to estimate the degree of potential for increases or decreases in human–animal interactions. We used aerial photography and NDVI as an approximate measure of residential density and land use. The result is the classification of each project as bringing about a high, medium, or low potential for increase or a potential for decrease in human–wildlife and wildlife–human interactions.

Table 2 shows the list of potential projects in the upper Los Angeles River watershed placed within the typology we developed (see also Figure 1). Projects are presented as per their potential importance as corridors, stepping stones, or urban islands; their size; and their effect on urban matrix permeability. Projects are grouped in the left-hand column according to their implications for human-wildlife interaction potential — that is, the likelihood that these interactions will occur, or increase if they are already occurring. The number of x's signify the project's potential value for each typology category and for relative permeability, with more x's signifying more value. In the size columns, more x's signal extremity. Below the table a brief description of how we reached the conclusions for each project is provided.

Table 2. Typology of habitat restoration projects

	Typology			Size			Increases Relative permeability	
Project	Crdr	S.Stn	U.Isl	Lrg	Mdm	Sml	Y	N
High potential for increased interaction								
Aliso Creek Powerline	xx	xx			x		xx	
Pacoima Wash	xx		xxx	xxx			xx	
Sun Valley Powerline Easement	xx	xx	x	x			x	
Medium potential for increased interaction								
Calabasas Creek/ Fallbrook		x	x			x	x	
Browns Canyon at 118 FWY	x		x		x		xx	
Low potential for increased interaction								
Topanga Canyon and Plummer		xxx	xx		x		x	
Plummer Variel Restoration		x	x		x		x	
Dry Canyon Creek and 101FWY		xx	x			xxx	x	
Strathern Pit		x	xx	xx			xx	
MTA Right of Way Canoga Avenue	x				x		xx	
Aliso Creek - LA River Confluence		x				xxx		x
Verdugo Wash Sediment Basin	xx	xxx	x		x		xx	
Verdugo Park	xxx	xxx		x			xx	
Potential for decreased interaction								
Sheldon Arleta		x	xxx	xxx			x	x
La Tuna Canyon		x	x			xx	x	x

Aliso Creek Powerline

15.720 acres

- This project is relatively large in size; however, as with the MTA Right of Way Canoga Avenue project, its shape makes it less valuable as urban island. In this case however, the project is located along a canal (Aliso Creek), making it an important corridor enhancer and stepping stone for species using the canal as corridor.
- The project is within dispersal distance of coyote (if we account for the probable use of the canal) and loggerhead shrike habitats.

Pacoima Wash (more detailed analysis below)

Approximately 206 acres

- The Pacoima project is one of the most extensive. It is adjacent to existing habitat, and it is within dispersal distance of existing habitat for coyotes, loggerhead shrike, acorn woodpeckers and quail. Therefore its restoration potential is high and although it is an island, it is very close to existing habitat and if properly restored it can be considered an extension of important existing habitat (thus its rating as a highly important urban island). Moreover, given its shape and location, it significantly extends into the urban matrix, giving it some typical characteristics of an urban island such as edge effects and human–wildlife interaction potential.
- In terms of connectivity, it will represent a valuable corridor into the urban matrix, but it does not extend far enough to the south to offer connectivity to existing parks and other proposed projects that could be connected through Pacoima Wash or Pacoima Diversion. If the spreading grounds further south were to be restored, the project would be an excellent stepping stone and corridor for many species, increasing connectivity between existing habitat to the north of the wash and the spreading grounds to the south.

Sun Valley Powerline Easement

31.636

- Although this area is relatively isolated from existing habitat, its location within the easement gives it potential to assist the corridor and function as stepping stone to some species using the corridor. The increase in relative permeability for many species will depend on the existence and removal of fences from the easement.

Calabasas Creek Fallbrook

6.293 acres

- Located relatively close to existing large habitat areas, it could act as a stepping stone for loggerhead shrike, quail and coyote between potential habitat restoration sites of Bell Creek Lederer Ranch and Dry Canyon Creek at 101HWY. The connection between Calabasas and Dry Canyon has more potential due to the potential connectivity provided by Calabasas creek.

Browns Canyon and 118 FWY

11.453 acres

- Adjacent to existing large patches of well preserved habitat.
- It is identified as coyote habitat.
- Very close to identified quail habitat, but not likely to increase connectivity to any existing habitat.
- Not identified as loggerhead habitat, but important for its connectivity (Figure 2).

Given its location and size, and depending on restoration measures, it has the potential to be an urban island for acorn woodpecker. No important effect in connectivity except for what was pointed out for acorn woodpecker (Figure 3). Coyotes are probably already using the area as an underpass to Highway 118.

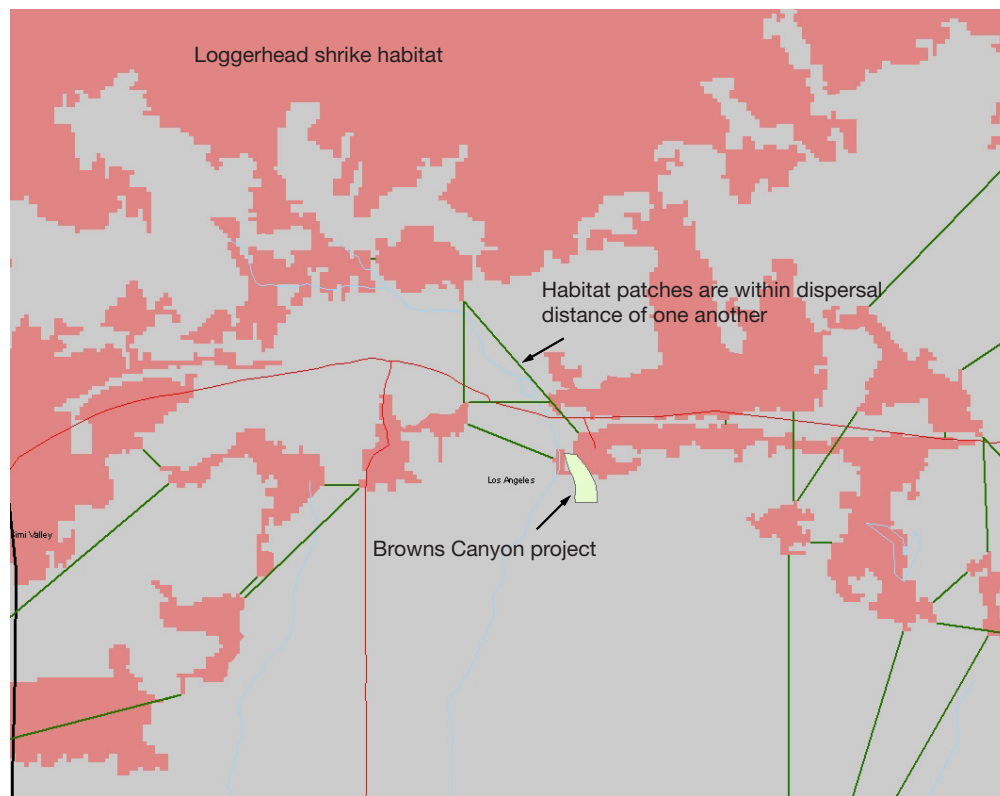


Figure 2. Browns Canyon project site (yellow) and modeled loggerhead shrike habitat (red). Green lines connect each shrike habitat to the nearest habitat within the average dispersal distance of the species, indicating the potential for movement between habitats. Light red lines indicate freeways.

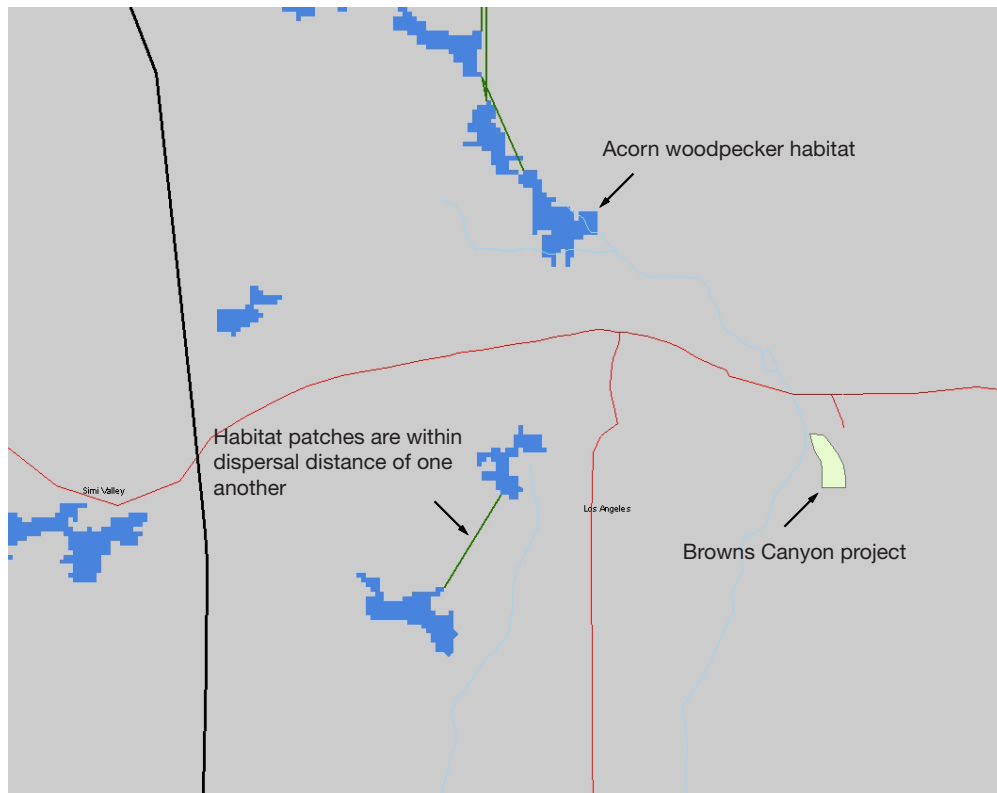


Figure 3. Browns Canyon project site (yellow) and modeled acorn woodpecker habitat (blue). Green lines connect each acorn woodpecker habitat to the nearest habitat within the average dispersal distance of the species, indicating the potential for movement between habitats. Light red lines indicate freeways.

Topanga Canyon and Plummer

13.395 acres

- Very close to existing large patches of well-preserved habitat.
- Identified as coyote habitat.
- Neither habitat nor connectivity for quail or acorn woodpecker. Because it is within dispersal distance for loggerhead shrike, and very close to existing habitat for this species, it is reasonable to think that there is potential for shrike to become established in the area if properly restored.

Could be a potential stepping stone from existing adjacent habitat to Plummer Variel restoration project to the east. However, the space between the two is an industrial area with very little green coverage.

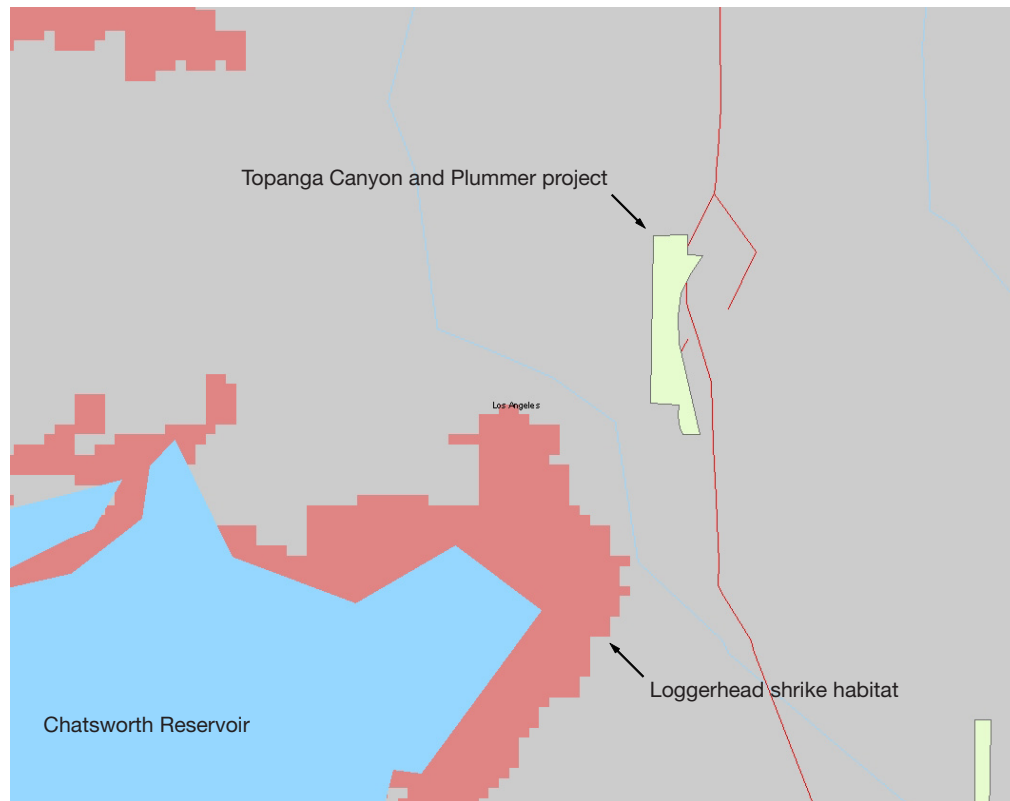


Figure 4. Project site at Topanga Canyon and Plummer (yellow) in relation to modeled Loggerhead Shrike habitat (red). Green lines connect each shrike habitat to the nearest habitat within the average dispersal distance of the species, indicating the potential for movement between habitats. Light red lines indicate freeways and blue is the Chatsworth reservoir.

Plummer Variel Restoration

18.053 acres

- Close to existing large patches of relatively well preserved habitat.
- This project is within dispersal distance of coyote habitat; however the matrix between source areas and the project is relatively impermeable. With respect to connectivity, the project has the advantage of being adjacent to Browns Creek channel, which could connect, through Browns Creek and then Santa Susana Creek, to the MTA row Canoga Avenue project. However, a more direct link to the latter would be straight from suitable habitat using Santa Susana Creek. Therefore its value as stepping stone is relatively low.
- Its value as urban island is higher, despite being surrounded by a relatively impermeable matrix, due to its proximity to existing habitat for quail, coyote, and loggerhead shrike. Coyote and shrike are within dispersal distance to existing habitat and quail are within dispersal distance of a potential stepping stone (Topanga Canyon and Plummer).



Figure 5. Relationship between Topanga-Plummer project site (yellow polygon to west) and Plummer Variel project site (yellow polygon to east). Background is aerial photograph.

Dry Canyon Creek and 101FWY

4.255 acres

- Despite its size this area has relative value as an urban island due to its location within dispersal distance of present habitat for our four focal species, and proximity to existing large habitat. It also holds relative value as a stepping stone due to its location next to Calabasas creek. More information on present and potential uses is needed to assess the impact on relative permeability and to be more confident regarding human–wildlife increase or decrease interaction potential.

Strathern Pit

61.883 acres

- Depending on the type of habitat it is restored to and on the matrix between the areas, this area could function as stepping stone for loggerhead shrike and coyotes which have habitat 1.5 kilometers south from the site, and also potentially to the Sheldon Arleta project.
- Given its size, location, and current and potential use, we classify it as relatively high in urban island value and with potential to increase permeability in the area.

MTA Right of Way Canoga Avenue project

16.086 acres

- Close to existing large patches of relatively well preserved habitat.
- Although the project is of similar size to the ones described above, we classify it as low value as an urban island due to its shape. Its elongated shape and location in a relatively low green coverage area (according to NDVI) makes it very likely to be susceptible to intense edge effects.
- Its value as a corridor could be relatively high because it covers more than 1.5 kilometers, but it is in between industrial areas and not connecting existing or potential habitat; therefore we classify it as low for corridor value. However, because it is long and in a low green coverage area we rank it as relatively high for increase in relative permeability.

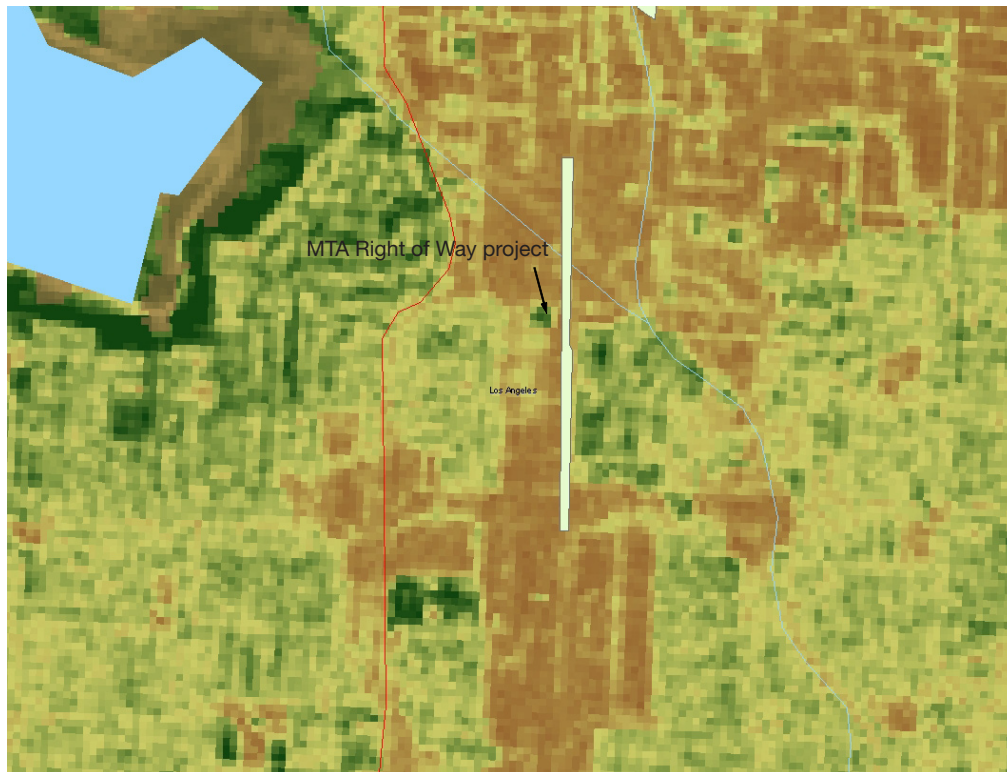


Figure 6. MTA Right of Way project site (yellow polygon) in relation to vegetation density as measured by the Normalized Difference Vegetation Index (NDVI). Darker shades of brown indicate less vegetation, while darker shades of green indicate more vegetation.

Aliso Creek and Limekiln Confluence

16.253 acres

- Relatively far from existing large patches of well preserved habitat. However, it is within distance of existing loggerhead shrike habitat and downstream from existing coyote habitat, so the potential exists for coyotes to reach this area using Aliso Creek. The location in the landscape combined with its size make it potentially valuable as an urban island. Although it has little value as corridor, it could potentially have an important effect increasing permeability in latitudinal movement. It is located in a relatively low green coverage area that divides higher green coverage areas to the north and south (see Figure 7). Therefore we classify it as increasing relative permeability.

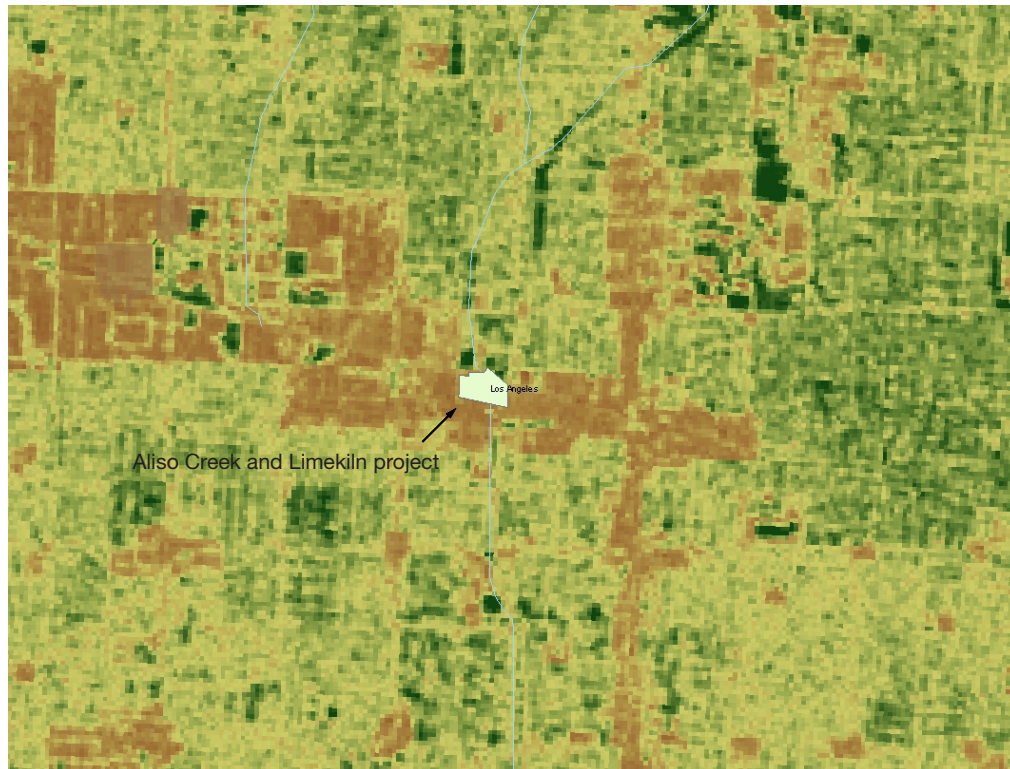


Figure 7. Aliso Creek and Limekiln project site (yellow polygon) in relation to vegetation density as measured by the Normalized Difference Vegetation Index (NDVI). Darker shades of brown indicate less vegetation, while darker shades of green indicate more vegetation.

Verdugo Wash Sediment Basin

16.118 acres

- This park is located adjacent to a large expanse of existing habitat and is presently habitat for coyote, quail and loggerhead shrike. It is also adjacent to acorn woodpecker habitat. It is a potentially important stepping stone for species using Verdugo Wash as a corridor, particularly due to its location between a potential barrier to the north and the existing golf course to the south.
- Although permeability will quite likely be increased, interactions are not likely to increase much since most of the neighborhoods located close to this area are already adjacent to existing habitat.



Figure 8. Verdugo Wash Sediment Basin project site (yellow polygon) over aerial photography showing a golf course to the south and native hillside vegetation to the north and west.

Verdugo Park

39.311 acres

- This project is of vital importance to connect habitat northwest and southeast of it. Quail, coyote, and loggerhead shrike could potentially benefit from the proposed reintroduction of natives in the area (see Figures 9 and 10).
- Although an overpass or underpass may be needed for many species, this project can contribute to a very much needed increase in connectivity for the area.

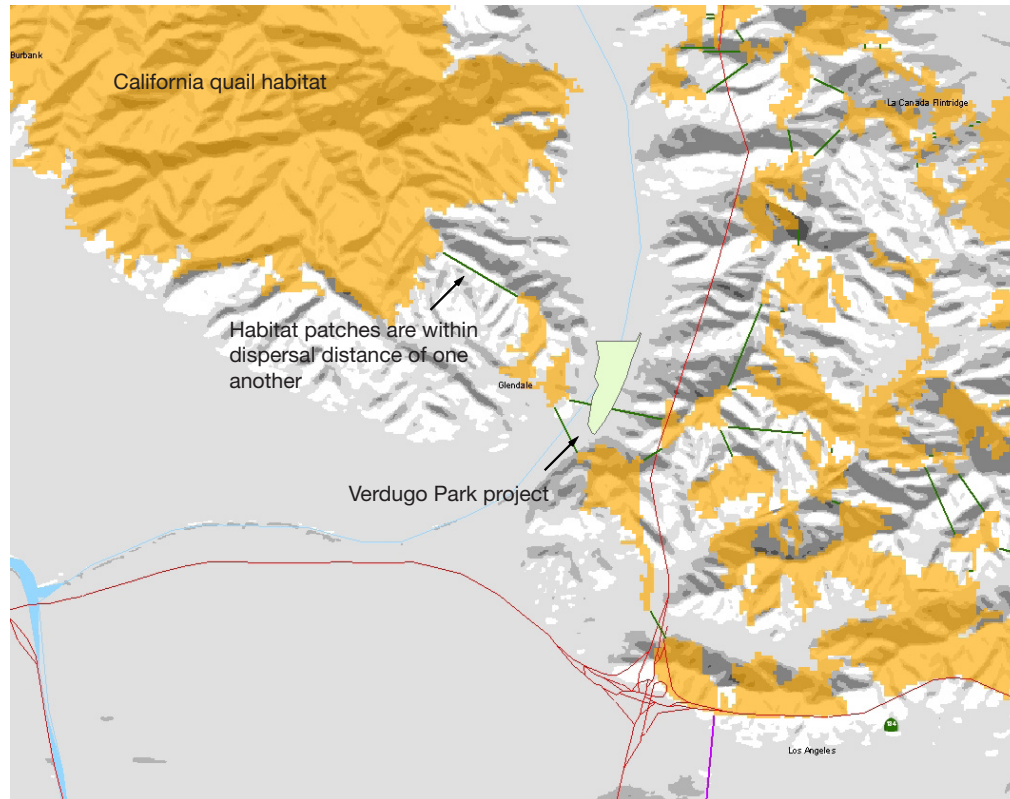


Figure 9. Verdugo Park project site (yellow polygon) in relation to habitat modeled for California quail (orange). Green lines connect each quail habitat to the nearest habitat within the average dispersal distance of the species, indicating the potential for movement between habitats. Red lines indicate freeways. Shaded topographic relief is included to illustrate the location of the project site between mountainous regions.

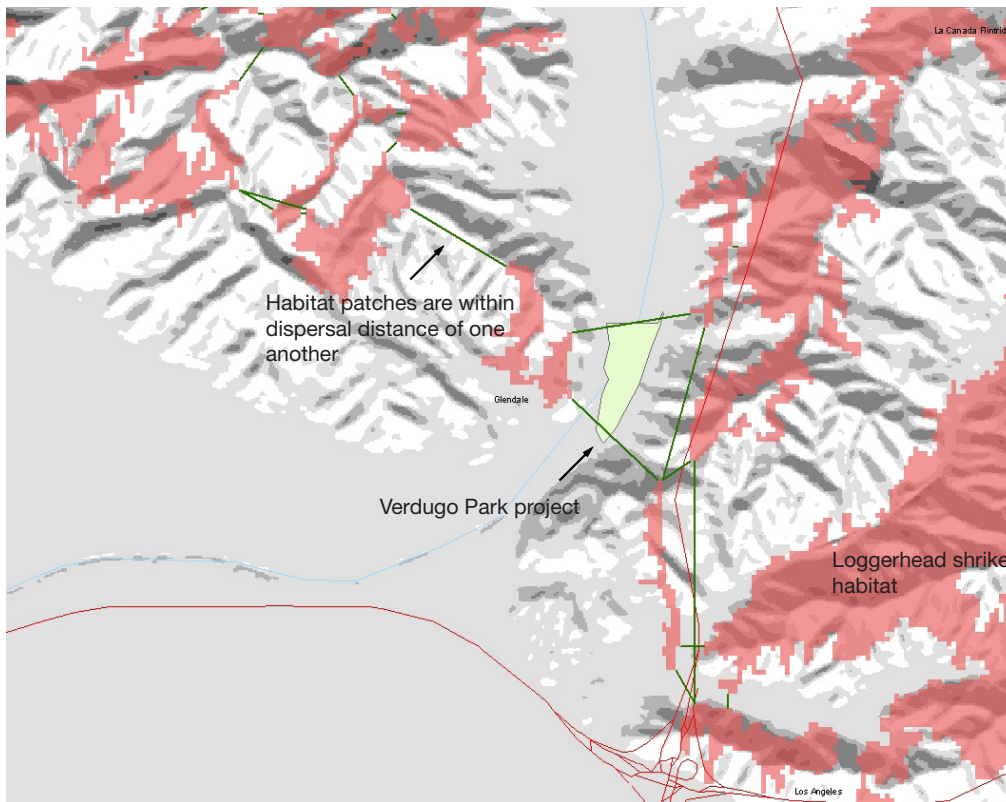


Figure 10. Verdugo Park project site (yellow polygon) in relation to habitat modeled for loggerhead shrike (red). Green lines connect each shrike habitat to the nearest habitat within the average dispersal distance of the species, indicating the potential for movement between habitats. Red lines indicate freeways. Shaded topographic relief is included to illustrate the location of the project site between mountainous regions.

Sheldon Arleta

128.127 acres

- This combined recreational–restoration project is located in relative proximity to an existing large expanse of habitat to the north, and this expanse of habitat could be connected for some species through Tujunga Wash. Although potential habitat to the south is not close to this site, it still can be used as stepping stone by some species.
- Due to its size, and potential for repopulation through the wash from the relatively close existing habitat, and given that our model predicts that it could be habitat for coyote and loggerhead shrike, we rank it high in its value as an urban island.
- If the project brings down existing fences, provides more vegetation cover, and diversifies vegetation structure it could potentially increase permeability. However, if those actions are not taken, and recreational activity is intense, permeability could also decrease. Because of our initial assumption of assessing the parks as expected at the end of the restoration process, we will classify it as increasing permeability.

La Tuna Canyon

3.565 acres

- Currently an open area, this site will be turned into a neighborhood park and water infiltration area.
- It is located very close to coyote habitat and within dispersal distance for this species, quail and loggerhead shrike. The value as urban island is low due to its size, but its proximity to existing large habitat and adjacent to the channel give it some value as an island and a stepping stone. Depending upon the design of the park permeability may decrease or increase — a similar case to Sheldon Arleta.

The Pacoima Wash restoration project

Here we discuss human–wildlife interactions that may result from restoration of the Pacoima Wash, which has a high potential for increases in human–wildlife interactions. With a heightened presence of wildlife in the area, there are many opportunities for positive interactions between recreationists and wildlife, but we should also be aware of potential conflicts. Taking into consideration the physical dimensions of the wash, the level of urbanization surrounding it, its situation within the urban matrix, and its proximity to other habitat, we anticipate user–wildlife and wildlife–user interactions and a series of complementary solutions to possible conflicts.

Pacoima Wash geography, demography, and restoration goals

The Pacoima Wash begins northeast of the City of San Fernando, below the Pacoima Reservoir in the San Gabriel Mountains. From the reservoir, it winds south into urbanized City of Los Angeles lands, through an intermittent lake or marsh south of the El Cariso County Golf Course, back into developed City of Los Angeles lands, through urban San Fernando, and into urban Los Angeles. The wash passes under the Interstate 5 and Highway 118 intersection; its spreading grounds are south of this intersection and from here it splits into two channels, one flowing to the southwest and the other to the southeast. The wash is a tributary of the Los Angeles River watershed.

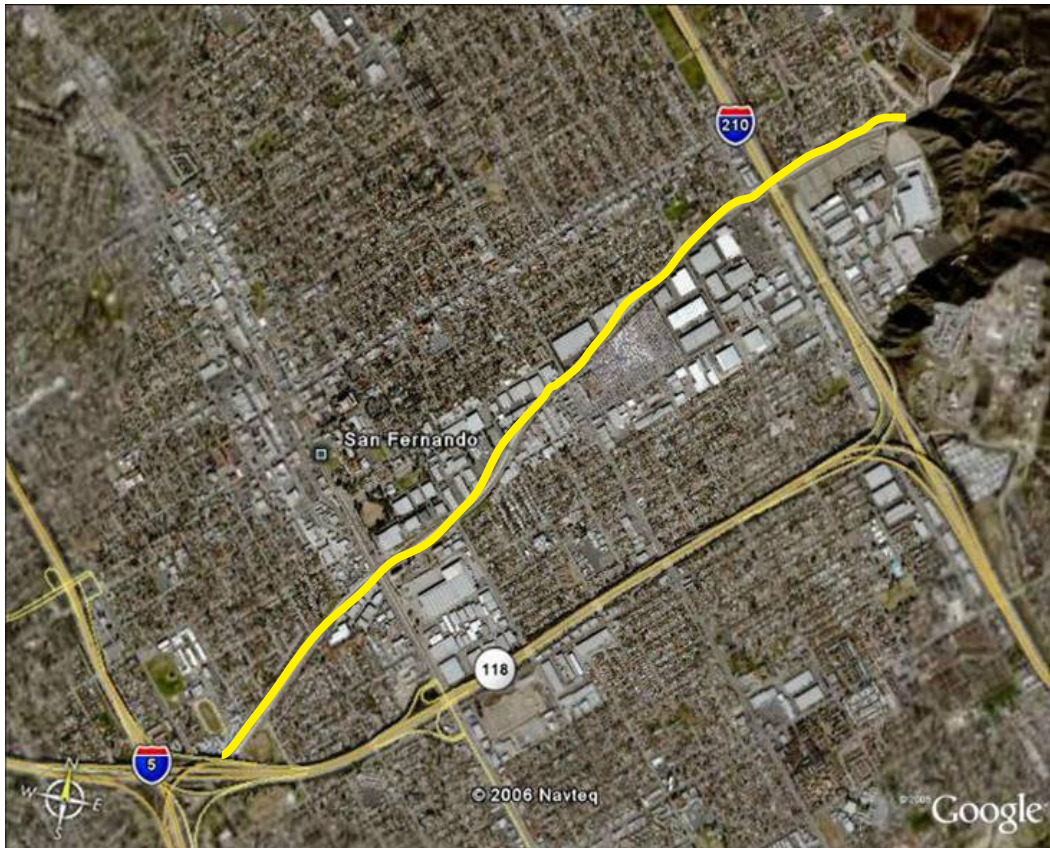


Figure 11. Target portion of the Pacoima Wash shown in yellow

The conservancies' plan for the wash concerns the acquisition and restoration of wash-adjacent properties over a three mile portion of the wash, beginning in Angeles National Forest and ending above the intersection of the 118 and 5 freeways near Richie Valens Park. The end product is to be a series of linear parks composed of restored habitat and trails for walkers, joggers, and bikers. The park will also provide recreationists with direct access to trails leading into the Angeles National Forest.

The wash lies in a densely-populated region of Los Angeles County. The population is predominantly Latino, and a full third of area residents are 16 years of age or younger. Anticipated park users include neighborhood residents and schoolchildren. There should be a high level of visitation to the wash from children and teenagers because of the elementary, middle, and high schools that are in close proximity to the wash. Recreationists from outside of the community are also anticipated because of the size of the project and the access it will provide into the mountains. Local wildlife are expected to benefit from the wash project as well. The restoration of riparian and wetland habitat, and the heightened use of the Pacoima Wash by recreationists and commuters, will allow and entice certain wildlife species to visit the restored wash and the surrounding neighborhoods with greater frequency.

Table 3. Profile of the area surrounding the Pacoima Washⁱⁱⁱ.

	Area within ¼ mile of the Pacoima Wash	Area within ½ mile	Area within 2 miles
Population density per square km	3,081	3,096	2,871
Average median income	\$24,529.08	\$23,389.76	\$24,681.42
Race			
Hispanic	85.5%	84.47%	75.92%
White	9.54%	9.40%	13.21%
Black	2.69%	3.58%	4.80%
Asian	1.54%	1.75%	5.20%
American Indian and Alaskan Native (AIAN)	0.51%	0.51%	0.45%
Native Hawaiian and Other Pacific Islander (NHOPI)	0.04%	0.04%	0.10%
Other	0.21%	0.19%	0.34%
Age			
To 17	33.96%	34.01%	33.49%
17–64	59%	58.92%	59.06%
65 and up	7.04%	7.07%	7.46%

User–wildlife and wildlife–user interactions

The restored wash is expected both to provide recreationists from surrounding communities with a new place to cycle, walk and jog, and also to be a valuable wildlife corridor into the urban matrix. Thus we can expect that the wash will be a space shared by both human and wildlife visitors. Additionally, the restored wash would offer little connectivity to other native habitat, and so it is possible that animals that follow the wash down into the urban matrix will disperse through residential neighborhoods. All of this is expected to result in a high potential for increases in human–wildlife interactions, both positive and negative in nature.

Native wildlife species will benefit from the restoration of native wetland and riparian habitats along the wash. Because the restoration project involves a long, relatively narrow strip of land, individual species' home range needs will determine whether the restored habitat in the midst of the dense urban landscape

will be of sufficient size to settle. A wider variety of species will benefit from the expected increase in food supply around the wash, however. With revegetation efforts, native herbivores will find more food resources in the wash, and with increased human traffic, wildlife living in and passing through the wash will probably be supplied with cast-off food items such as candy bars and sandwiches. The densely populated neighborhoods surrounding the wash will also offer dietary supplements, to be found in unlocked garbage cans, dumpsters, gutters, and rubbish piles.

Increased presence of wildlife in and around the Pacoima Wash may result in a larger negative array of anthropogenic effects for the animals themselves, though. The same substitute feeding that may enable the animals to expend less energy foraging and birth more young could lead these animals to desert their roles as predators or scavengers, experience health problems from consumption of unnatural food, and develop a dependency upon and even an affinity for humans and residential neighborhoods. Pacoima Wash wildlife may exhibit an attraction response toward wash visitors or neighborhood residents, and if animals in and around the wash begin to loiter around garbage cans or approach humans for food (or to do so more frequently than occurs presently), the likelihood that animal control will be called in to relocate or dispatch the offending animal increases.

Since the restored wash will be narrow, the disturbance of breeding birds and other animals is of concern — there is no buffer between core habitat and recreational and residential areas. Further, the wash will experience high loads of human traffic, presumably seven days per week, as schoolchildren traverse it during the weekdays and walkers, joggers, and cyclists utilize the paths in high volumes on weekends. Predation upon birds and smaller mammals by roaming neighborhood dogs and cats is another potential problem.

Finally, because the wash is surrounded by roads, vehicle traffic will constitute a threat to wash wildlife, as will pollution. Exhaust emissions from passing cars, traffic noise, and metal-laden runoff all make their ways into the wash's ambient environment. Light pollution from the surrounding urban matrix may have a negative impact on wash animals as well.

Humans visiting and living near the wash would benefit from its restoration in several ways. First, wash restoration represents an increase in public open space for the surrounding neighborhoods. Residents and park users possessing naturalistic, humanistic, and aesthetic attitudes toward wildlife should enjoy the viewing opportunities associated with an increased wildlife presence. Those with scientific attitudes may view the greening as a chance to study the biology of the wildlife attracted to the wash, while visitors and residents with ecologicistic attitudes will probably appreciate the incremental return of native habitat and native creatures to the upper Los Angeles River watershed, perhaps experiencing a sense of justice as the restoration effort brings back what development obliterated. Indeed, monitoring the health of individual animals and of the wash ecosystem could be an important study used to encourage more restoration efforts, and to guide forthcoming efforts away from any pitfalls this project should experience. The increased presence of both native and nonnative fauna may render the San Fernando and Los Angeles neighborhoods places of increased spirituality, beauty, aesthetic importance, and/or well-being. And for some, the presence of wildlife will provide valuable instances of communication, social bonding, and education as humans witness a strangely “foreign” native ecosystem permeate their densely urbanized neighborhoods. Property owners adjacent to the wash may experience more tangible benefits, in a property value hike resultant from the restoration of wetland and riparian habitat and from the proximity to a park space.

Little research has been done on the attitudes of United States urban Latino populations toward wildlife, so unfortunately there is little to say about how habitat restoration and an increased presence of wildlife may particularly benefit the Latino majority surrounding the wash. However, surveys of Latino voters in

California find them to hold strong environmental values. Moreover, recent research by Van Velsor (2004) indicates that access to and immersion in natural areas, involvement in wildlife-related activities, and positive encounters with a variety of wildlife species are among the factors that will foster appreciation in Latino and African American teens for the multiple values of wildlife. Restoration thus offers exciting opportunities for hands-on environmental education activities that would benefit Latino youth and, subsequently, wildlife. Wolch and Zhang (2005) have found that Latinas are likely to express support for environmental stewardship, human-wildlife coexistence, and animal rights and welfare; and to value animals and nature for spiritual and aesthetic reasons. And, Latinos are likely to benefit from purely recreational aspects of the project by gaining park space to use for active recreation as well as social, passive, family-group activities (Gobster 2002).

Negative aspects of increased wildlife presence in and around Pacoima Wash include some safety issues and a bevy of possible nuisance activities. Safety concerns stem from the possibility of wildlife becoming attracted to humans and approaching park users for food. Since coyotes and other omnivorous species are expected to utilize wash habitat, domestic cats, small dogs, and other small companion animals will be at risk of predation. Because we expect raccoons and skunks to exist in the wash, disease is another possible safety concern.

Neighborhood residents and park users will probably experience a variety of “nuisance” situations related to a heightened wildlife presence, such as increased volume of bird droppings and noisy roosting and mating calls. Unsecured garbage cans in the park and in surrounding neighborhoods may be overturned or rummaged through by coyotes, raccoons, and crows, spreading waste in an unsightly and perhaps unsanitary fashion. Property owners who fail to maintain their yards and structures may find wildlife burrowing, nesting, or otherwise seeking shelter in their buildings and yards. Respondents in Van Velsor’s (2004) study of urban Latino and African American youth expressed fear of and anxiety about opossums, raccoons, and snakes, which will likely benefit from restoration and increased use of the wash.



An opossum (*Didelphis virginiana*) travels through a backyard in urban Los Angeles

Credit: Jason Byrne

Given these possible negative wildlife-human interactions, a degree of apprehension amongst residents may be expected. However, perceptions after restoration are prone to change. Casagrande (1997) refers to Steinke’s (1986) study of a salt marsh restoration project in Fairfield, CN, wherein residents complained of negative experiences such as the migration of snakes and rats from the marsh to their yards. Several years later though, residents’ perceptions had changed drastically, becoming mostly positive and including an increase in appreciation of wildlife.

Solutions

Because Pacoima Wash will exist as a narrow strip of habitat once restored, it may necessarily remain a human-dominated landscape. However, there are measures that can be taken to improve the chances of

harmonious coexistence with wildlife in the wash.

Zoning and ordinances

The wash project may be a candidate for wildlife management overlay zoning, emphasizing that a project of this size in a densely urbanized area may need to rely heavily on regulatory solutions. Because the wash is so narrow, disturbance of wildlife is of primary concern. A possible solution is the creation of an ordinance to include in the zoning overlay that closes the wash to the public twice weekly to reduce inevitable visitor disturbances to park wildlife ecology. Restricted entrance could be applied solely in the breeding season, or could be a year-round rule. This type of “rest and recovery” period represents an attempt to simulate an undisturbed natural habitat for wildlife that have moved into the basin.

A zoning overlay can also effectively address problems stemming from elements that cross property boundaries, such as noise and light. Within the wash, this could be addressed by the installation of lighting fixtures that express low levels of illumination, low levels of luminance, and that surge and ebb incrementally; and park noise volume restrictions could be outlined. However, noise and light pollution will also come from the surrounding neighborhoods into the wash. Lighting restrictions within the overlay district could include requiring street lighting illumination and luminance volumes to be dimmed until research has been produced that addresses the needs of the particular wildlife species that take up residence in the wash. Installing shields or baffles on street lights, electric business signs, and any other night-lighting fixtures that throw light on the wash is an alternative or supplemental option. Since the wash is intersected by several roads, traffic noise will be a perpetual problem, but decibel and/or temporal restrictions on residential and commercial noise may be a feasible addition to overlay zone mandates.

There are a number of other ordinances that would be appropriate for the Pacoima Wash, which could be included in the zoning overlay package, or could be proposed as individual municipal ordinances. To help prevent conflicts inside of the wash, park space ordinances restricting users from feeding wildlife and from littering should be enacted in order to stymie the development of attraction behavior in wildlife. Citywide codes prohibiting the feeding of wildlife and requiring all garbage cans to have animal-proof lids should be adopted to govern the surrounding Los Angeles and San Fernando neighborhoods. Other ordinances should prohibit wash visitors from disturbing restored portions of the wash, forbidding the removal or destruction of any plants or wildlife therein, and disallowing the release of any exotic flora or fauna. Domestic animals should be regulated by leash laws to minimize disturbance of fauna in the wash, and cat curfews could be considered if the wash witnesses an influx of reptiles and birdlife. An important point here is that because the wash runs through both the City of Los Angeles and the City of San Fernando, both jurisdictions would need to agree to adopt the zoning overlay and/or individual ordinances, in order to assist the ecological success of restoration project.

Building barriers and creating linkages

As suggested above, the ability of the restored wash to provide permeability but not connectivity may result in animals dispersing through nearby neighborhoods. Potential conflicts could be diffused by the construction of barriers to contain wildlife in the wash. Because we anticipate coyote movement through the wash, fencing would have to be as high as seven feet above ground.

An alternative to walling off the park in order to contain wildlife visitors within the wash is to consider projects that would enable the Pacoima Wash to function as a connective corridor to another patch of habitat in the upper Los Angeles River watershed. Namely, the restoration of the Pacoima Spreading Grounds to the south of the portion of the wash that will be restored would increase connectivity between the San Gabriel Mountains and the spreading grounds. This would render the wash an important stepping stone and connective corridor, and wildlife that follow the restored wash down from the north may be less likely to disperse into the surrounding neighborhoods.

An adjunct recommendation to linkage construction is that vegetative restoration in Pacoima Wash be delayed until a linkage between the wash and other habitat exists. Withholding vegetation effectively denies shelter, cover, and forage to the species that would otherwise travel down the wash to a dead end; this tactic should decrease the number of animals that follow a vegetated path to its urbanized end and then disperse into the surrounding neighborhood or suffer high mortality rates. Constructing the bikeway and other human facilities could be the first task undertaken, allowing recreationists and schoolchildren functional use of the wash. Concurrently, the substrate could be shaped and primed for restoration. Later, once a linkage is completed, vegetation can be reintroduced, and wildlife can utilize what will have become a true linkage.

Community education and outreach

Lastly, educational approaches are a promising way to prevent or diffuse situations of interspecies conflict. The several potential conflicts that we mention above, including aggression, predation of pets, disease, and general nuisance activity, can all be addressed with preemptive education measures. A series of presentations open to neighborhood residents and park users could touch on wildlife ecology, the nature of interactions that residents and recreationists can expect with wildlife species, and ways to humanely prevent or end said interactions.

Guided tours of the wash offered to residents and users would be another forum through which to disseminate knowledge about wash wildlife, the project, and its larger implications for urban ecology. Print literature may be another valuable medium here. There is no shortage of pamphlets describing local wildlife species and tactics to avoid conflict with them, such as those published by local animal shelters, humane societies, governments, and nonprofits. Distributing literature on wildlife and wildlife conflicts door-to-door would provide an immediate resource for any residents and local park visitors who might encounter uncomfortable wildlife situations. To reach Pacoima Wash users from further away, a series of ecological interpretive signs could be posted throughout the wash, describing the ecologies of wildlife species that one may encounter in the wash and the optimal way to conduct oneself around them.

Communication with local residents and business owners could be another important component of the Pacoima Wash project, particularly given that we predict a high potential for increase in human–wildlife interactions and that we have suggested sets of ordinances and design practices that would impact the aesthetics of the wash and the activities and practices of nearby property owners. Sustained communication with property owners and recreationists could include feedback on the efficacy and desirability of the laws and design features that were enacted, as well as local perceptions of wildlife values and restoration success (Casagrande 1997).

CONCLUSION

Very little has been said about human–wildlife interactions in the parks literature. This is surprising. There are clearly many issues to address if we want to consider parks not just as recreational entities, but also as potential areas for ecological restoration. Part of the issue will be overcoming the public’s perceptions of what a park should be like (see Gobster 2002, Gobster and Hull 2000). Part of the issue will be modifying the visiting public’s behavior at parks and around wildlife, as ecological restoration brings in potential liability issues for park managers. Though there are infrastructural and landscaping solutions that directly address the numbers and behaviors of wildlife, the success of joint restoration–recreation efforts will turn on managing humans in order to manage wildlife. Since human attitudes toward wildlife vary according to race, age, education, location (Kellert 1980), exposure to cultural messages about animals, experience with animals (Lerner and Kalof 1999), and type of animal (Knight et al. 2003), this is no small task. Thus, both education that seeks to change attitudes and regulations that direct human behavior will be instrumental in managing for human–wildlife conflicts that urban park habitat restoration may generate. Nonetheless, benefits of restoration clearly outweigh costs, especially given the movement towards nature parks as noted by Cranz and Boland (2003) and the growing decline in suitable habitat for wildlife. A range of best practices and land use management techniques will provide flexibility in restoring the region’s parkland.

The conservancies’ list of potential restoration projects in the upper Los Angeles River watershed represents an exciting effort to embrace the ecological vitality of urban areas. Restoration will bring about a cadre of positive and negative interaction possibilities for both recreationists and wildlife in and around these projects. Habitat restoration will not only result in more living space for southern California wildlife, but also in more recreational space for urban residents, with associated opportunities for wildlife viewing and education, and in ecological benefits such as a chance to improve stormwater infiltration. Various negative aspects of recreationist–wildlife relationships, including pollution, disease, and behavioral changes, can be tempered through application of appropriate solutions, including regulatory ordinances and zoning, education, and wildlife-friendly infrastructure. Southern California, with its extreme mixture of dense urbanization and “untouched” wildlands, may be able to reconcile some of the tensions between the growing human population and the fragmented natural landscape through the reimagination of urban parklands as places both for restoration and recreation.

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ⁱ Australia recently witnessed a similar situation with a population of dingoes on its tourist destination of Fraser Island (Burns and Howard 2003). The federal government ordered a population cull after two dingoes killed a child visiting the island in 2001. Thirty-one dingoes were taken in response to this incident (the first reported fatality involving Fraser Island dingoes), leading a number of stakeholders to call the mandate irrational and claim that humans, not dingoes, needed to be managed. Up until that point, dingoes had been managed by culling individual animals that exhibited problem behavior. Anecdotal evidence throughout the paper suggests that Fraser Island residents and tourists were guilty of actions that may have caused dingoes to lose fear of humans and cultivate attraction behavior, such as hand-feeding the dogs and even allowing them in their cars. Human behavior, volume of island visitors, and paucity of natural food sources available to dingoes were all important variables in this situation, and a reactionary measure such as an immediate cull directed at dingoes not involved in the attack failed to capture the scope of issues that lead to the child's death.

ⁱⁱ We suggest monitoring the subsequent activities of wildlife around any infrastructure modifications and installations to determine their efficacy and whether any adjustments are necessary. Ng et al. (2004) used remotely triggered cameras that responded to body heat or motion to track rates and times of underpass usage by southern California wildlife species. Claridge et al. (2004) provide a detailed description of their wildlife-monitoring technology in New South Wales's Kosciuszko National Park. Infrared digital cameras (Digicam DC110s, which are designed specifically for remote field recording of animal behavior) mounted in environmental housing were used to capture target species images. The cameras are capable of producing high quality images of both nocturnal and diurnal animals, which is necessary for wildlife monitoring in southern California as well. Passive infrared motion sensors were preferable to active infrared sensor beams because animals tended to investigate the active sensor system and jostle the setup. Finally, this camera system allows investigators to program the camera's surveillance system such that it activated according to the size, speed, and direction of target species. This is a less-important feature for investigators who are monitoring multiple species, however. A comparable system could be installed along fencing barriers to learn whether some animals are able to slip through or jump over the barricades; and cameras could be installed at and inside of existing or newly built underpasses to determine whether they are in fact effective passages and for whom. Of course these would also monitor human activity in park spaces, revealing whether visitors are in fact abiding by any park usage restrictions.

ⁱⁱⁱ The table was produced with data from the 2000 Census. Tracts surrounding the wash were buffered at $\frac{1}{4}$, $\frac{1}{2}$, one, and two miles, and population for portions of tracts was calculated from coverages to find total population of the buffered area. From this, population density and age and racial percentages were produced. To calculate average median income, population was used as a proxy for number of households, and tracts and portions of tracts were normalized according to population count within each tract or tract portion. We assumed an even distribution of all variables across each tract.