GLOBAL URBANIZATION AND PROTECTED AREAS

Challenges and opportunities posed by a major factor of global change — and creative ways of responding

Ted Trzyna

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PREFACE

This is one of a series of reports on impacts of global change on protected areas commissioned by IUCN – The World Conservation Union as part of its Ecosystems, Protected Areas, and People Project. Online versions of this paper, including an executive summary, are posted on the Web sites of IUCN's Protected Areas Learning Network, http://www.parksnet.org, and the California Institute of Public Affairs, http://www.InterEnvironment.org/cipa/urbanization.org.

IUCN defines a protected area as "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means."

This paper is based primarily on numerous interviews and discussions with conservation and urban leaders over the past four years, both in the field and at various conferences. I have also drawn on recent and classic literature in conservation, urban studies, and other subjects. Although those who helped me are too numerous to list, I want to mention those most directly involved from mid-2005 to the end of 2006. Many of them are my associates in an initiative on cities and conservation centered in the Task Force on Cities and Protected Areas of the World Commission on Protected Areas of IUCN – The World Conservation Union (IUCN 2006a).

In general: John Davidson, Jeffrey A. McNeely, and Adrian Phillips, my close colleagues and mentors in IUCN's urban effort; and those who contributed articles to *The Urban Imperative* (Trzyna 2005a), an IUCN book based on a workshop at the Fifth World Parks Congress, held in Durban, South Africa, in 2003.

Participation in relevant workshops and conferences included events sponsored by the United Nations Environment Programme (UNEP) and the UN Human Settlements Programme (UN-HABITAT) in Havana, Cuba; the World Academy of Art and Science in Zagreb, Croatia; the University of Plymouth at Schumacher College in Dartington, England; ICLEI – Local Governments for Sustainability in Cape Town, South Africa; the Universidad Anáhuac de Xalapa in Xalapa, Veracruz, Mexico; and ICLEI again in Rome, Italy. In addition, I participated in two workshops cosponsored by the IUCN task force: Urban Nature 2006, in Cape Town, organized by the South African National Biodiversity Institute and the City of Cape Town; and a workshop on cities and biodiversity in Nairobi, Kenya, organized by UNEP, the Kenya Wildlife Service, and the IUCN task force.

In Kenya: Director Julius Kipng'etich, Paul Gaithitu, Anne W. Kahihia, Wilson Korir, and Gideon Amboga, all of the Kenya Wildlife Service; and Pedro da Cunha e Menezes, a Brazilian diplomat posted in Nairobi who is a Deputy Leader of the IUCN task force. Thanks to a very generous invitation from KWS, I visited the parks described below and conducted interviews in September 2006.

In South Africa: George Davis, South African National Biodiversity Institute; Tanya Goldman, Cape Flats Nature; Brett Myrdal, Manager, Table Mountain National Park. I visited the sites mentioned and conducted interviews in March 2006, as well as on previous occasions.

In the Californias: Joseph T. Edmiston, Executive Director, Santa Monica Mountains Conservancy; Michael Eaton and Scott Morrison, The Nature Conservancy; Pat Flanagan, Executive Director, Mojave Desert Land Trust; Superintendents Curt Sauer and Woody Smeck, U.S. National Park Service; Paul Smith, attorney, conservationist, and board chair of the organization I direct, the California Institute of Public Affairs. I have visited the areas mentioned on numerous occasions and participated in several transboundary meetings.

My thanks to all who helped me.

This paper was prepared under a contract between IUCN – The World Conservation Union and the California Institute of Public Affairs, with funding from the United Nations Global Environment Facility. I am solely responsible for the interpretations and conclusions in the paper, as well as any errors of fact.

Ted Trzyna
Oasis of Mara, Mojave Desert, California
1 January 2007

ABOUT THE AUTHOR AND SPONSORS

Author

For information about the author, see Note 1 on page 45, and the biography posted at http://www.InterEnvironment.org/cipa/ttbioshort.htm.

IUCN – The World Conservation Union

Founded in 1948, the World Conservation Union brings together States, government agencies, and a diverse range of nongovernmental organizations in a unique world partnership: over 1,000 members in all, spread across some 140 countries.

As a Union, IUCN seeks to influence, encourage, and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.

The World Conservation Union builds on the strengths of its members, networks, and partners to enhance their capacity and to support global alliances to safeguard natural resources at local, regional, and global levels. For further information: http://www.iucn.org.

California Institute of Public Affairs / InterEnvironment

Founded in 1969, CIPA works to improve policy-making on complex issues. Its main focus is on environmental policy in California and internationally. InterEnvironment is CIPA's international program. Most of CIPA's international work is done with and through IUCN. For further information: http://www.cipahq.org.

1. BACKGROUND

a. Urbanization as a factor of global change

Urbanization has long been one of the major forces shaping the world, and it will continue to be so. Few protected areas will not be affected by urbanization in some way.

Urbanization refers to the process by which rural areas take on urban characteristics. It also refers to more concentration of people in human settlements.

Currently, most attention to urbanization is focused on a United Nations estimate that, in 2007, 50% of the world's population will be living in cities, rising from about 30% in 1950. This figure is projected to reach 61% by 2030 (UN 2004).

Although these estimates are useful in drawing attention to the urbanization phenomenon, they are just that, estimates. They are based on national definitions of "urban" that use different criteria (UN 2005) and on numbers that sometimes derive from outdated or questionable census data.

Also, these are global figures. When the data are disaggregated by world region, they show marked differences in the level and pace of urbanization. In the Americas, Europe, and Oceania, the proportion of people living in urban areas is already over 70%. Although the figures for Africa and Asia are currently much lower, 39% and 37%, respectively, many cities in those regions will double their populations in the next fifteen years (UN 2004).

In addition, there are pronounced differences among countries within these world regions. In Africa, for example, the degree of urbanization ranges from under 15% in Burundi and Malawi, to over 85% in Libya. In the Americas, it ranges from under 40% in Haiti and Guatemala, to over 85% in Argentina, Chile, Uruguay, and Venezuela.[2]

In the first three decades of the 21st century, the world's urban population is projected to increase from 2.9 billion to 5 billion. Almost all of this increase will be absorbed by urban areas of less developed regions. Based on current trends, most of these new urban dwellers will live in overcrowded slums, often situated on marginal and dangerous land, without sanitation or easily accessible access to clean water. According to the Cities Alliance, a World Bank-based partnership of official development agencies and global associations of local authorities, "ignoring this policy challenge risks condemning hundreds of millions of people to an urban future of misery, insecurity, and environmental degradation on a truly awesome scale" (CA 2004).

Contrary to a commonly held belief, "megacities" (urban agglomerations of 10 million inhabitants or more) account for less than 4% of the world's population. Most urban dwellers live in settlements with fewer than half a million inhabitants. Some of the world's fastest growing cities have between 1 and 5 million people or are much smaller (UN 2004). In this paper, the word "cities" includes smaller as well as larger human settlements. Even villages can have significant impacts on ecologically sensitive protected areas. (See Note 3 for definitions of urban terms.)

Much has been written about why the world is urbanizing. The reasons are complex. Rural-to-urban migration and international migration account for most urbanization, but migration from cities to rural areas that then become urbanized also occurs. Wars can bring people into cities, but they can also have the opposite effect, depending on where people feel safer. Natural disasters can cause people to move out of cities, but those people may then contribute to urban growth elsewhere.

b. Uncertain consequences of climate change

To these already significant trends must be added the consequences of climate change. Two of these deserve special mention: rising sea levels, and more frequent and more intense weather events.

Rising sea levels, combined with storm surges, will force migration to higher ground. Roughly a billion people live at sea level or just a few meters above it (Mastny 2006), and many of the world's cities are situated in coastal lowlands. As conditions worsen, where will these people go? How will their resettlement, guided or unguided, affect protected areas?

Rising sea levels will also submerge low-lying coastal protected areas in and near cities, making nature less accessible to urban residents and resulting in increased use of inland protected areas.

The UN's Intergovernmental Panel on Climate Change projects a rise in global sea level of up to 88 cm between 1990 and 2100 (IPCC 2001a), with regional variations. However, other scenarios are much less optimistic, such as the "abrupt climate change" scenarios set out by the U.S. National Research Council (2002). The cities most immediately vulnerable to sea-level rise are Asian megacities sitting on subsiding river delta land. However, many other coastal cities throughout the world are vulnerable to flooding from storm surges, and will become uninhabitable well before they disappear underwater because of waterlogging and saltwater intrusion (IPCC 2001b). More than words can tell, an online interactive map produced by the University of Arizona (2006) shows in graphic detail the inundations that would occur with one- to five-meter rises in global sea levels.

Another consequence of climate change is more frequent and more intense weather events. Such events demonstrate the value of protected areas to cities. During a 24-hour period on 26-27 July 2005, an unprecedented monsoon rainstorm dumped almost a meter of rain on Mumbai, India, a city on the Indian Ocean that ranks sixth among the world's urban agglomerations, with a population of 19.8 million. Severe flooding resulted, and over a thousand people lost their lives. But loss of life and property damage could have been much greater had it not been for 104-sq-km Sanjay Gandhi National Park, which lies entirely within the city limits. The heavily forested park absorbed much of the rainfall (Sahgal 2005).

c. What is "urban"?

A final general point about urbanization: The urban-rural distinction is becoming less meaningful. For centuries, city and countryside have been seen as opposites. Now, in much of the world, differences between urban and rural communities are becoming

blurred as advanced technologies and the global economy penetrate areas formerly considered remote, and urban and rural areas become more linked and interdependent. Steve Bass (2004) of the UK's Department for International Development calls for "Ditching the Dichotomy" in terms of development strategies and points out that it has become hard to even define the terms "urban" and "rural."

d. Cities and larger ecosystems: The context

The Task Force on Cities and Protected Areas of IUCN's World Commission on Protected Areas has arrived at some general conclusions about connections and disconnections between cities and larger ecosystems (IUCN 2006b) that are useful context for this paper:

- Cities depend on a multitude of goods and services from their surrounding regions, and increasingly from ecosystems far removed from the cities themselves. These ecosystem services are cogently described in *Ecosystems and Human Well-being: Synthesis* (MA 2005), a report of the Millennium Ecosystem Assessment.

- Cities can relieve pressure on rural and natural areas by concentrating human populations; achieving economies of scale in such areas as energy, housing, transportation, and solid waste reuse and recycling; and providing services such as health and secondary and higher education. On the other hand, cities are centers of consumption of resources and can cause harm to their surroundings through sprawl; depleting such resources as water and forests; and generating solid, liquid, and gaseous wastes. This consumption and pollution often also imposes burdens on distant ecosystems. These complex relationships are discussed in detail in the "Urban Systems" chapter of another volume of the Millennium Ecosystem Assessment (McGranahan, Marcotullio, et al. 2005).

- Nature is essential to people's well-being. Most importantly, children need direct experience of nature for healthy intellectual and emotional development. This has been well-documented (Kahn and Kellert 2002, Louv 2005). Natural areas in and near cities are anchors to the Earth; they provide opportunities for exercise, education, and renewal. Nature is important even for the poorest of the urban poor.

2. HOW URBANIZATION AFFECTS PROTECTED AREAS

a. Forms of urbanization

Urbanization that affects protected areas takes several forms that are not mutually exclusive:

Urban sprawl: Building over unprotected rural land between a city and a protected area, sometimes surrounding it. The prime examples given below are from Kenya (Nairobi National Park) and the Californias (particularly the border area and Joshua Tree National Park).

Ribbon development: Building along roads radiating from cities, often a precursor to urban sprawl. The main examples are from the Californias (again, the border area and Joshua Tree National Park).

Urban intensification and infill: Examples are from Kenya (Lake Nakuru National Park), Cape Town, the Californias (Santa Monica Mountains National Recreation Area), Hong Kong, and Tarawa in Kiribati.

Coalescing "megapolitan" regions: These are large-scale polycentric networks of metropolitan and smaller urban areas (note that a megapolis is not the same as a megacity or a megalopolis[3]). The example, with an explanation, is from the Californias (The desert: Protected areas in a coalescing megapolis).

Tourism developments: These are often enclaves, usually beach resorts, that cater almost exclusively to visitors from other countries. Examples are given from Kenya (Mombasa Marine National Park) and Cape Verde.

Second-home and retirement developments: To date, most of these have catered to people within countries, for example, in the "Sunbelt" of the USA, or in countries relatively nearby, for example Spain and Portugal for Northern Europeans, and Mexico and the Caribbean for North Americans. However, cheap air travel and political change are opening up new possibilities. An example is given from Cape Verde.

Growing gateway communities: The example is from the Californias (Yosemite National Park).

Growing settlements within protected areas: The example is Yosemite.

Informal settlements: The main examples are from Cape Town.

Transboundary urbanization: The example is from the Californias (the border area).

b. Impacts of urbanization

Impacts of urbanization on protected areas include:

Fragmentation of habitat: Examples are given from Kenya (Nairobi National Park), South Africa (Edith Stephens Wetland Park), and the Californias (the border area and Joshua Tree National Park).

Edge effects: The results of disturbance of the natural ecosystem along an abrupt transition with developed or disturbed land. These effects occur in virtually all protected areas in urban and urbanizing environments.

Water quantity: Urbanization can result in too little or too much water in protected areas. Examples are given from Kenya (drawing down of the aquifer in Nairobi National Park) and South Africa (flooding of the Edith Stephens Wetlands Park).

Water pollution: The prime examples are from Kenya (Lake Nakuru National Park), the Californias (Tijuana Estuary in the border area), and Kiribati (Tarawa).

Air pollution: The main example is from the Californias (Sierra Nevada parks).

Solid waste: The example is from the Californias (Joshua Tree National Park).

Noise: The example is from the Californias (The desert: Protected areas in a coalescing megapolis).

Light pollution: The example is from the Californias (Joshua Tree National Park).

Human-wildlife conflicts: These range from deer grazing on garden flowers to predators killing humans and livestock. The examples are from Kenya (Nairobi National Park) and the Californias (Santa Monica Mountains National Recreation Area).

Introduction of exotic invasive species: The examples are from Cape Town (Table Mountain National Park), the Californias (Joshua Tree National Park), and Australia.

Fire along the wildland-urban interface: This can be natural, accidental, or intentional. Examples are given from Cape Town (Table Mountain National Park) and the Californias (Santa Monica Mountains National Recreation Area).

Crime: Criminal activity in protected areas in or near cities ranges from vandalism, theft of park property, and incidental poaching to large-scale poaching, arson, mugging, and murder. In some cases, international criminal syndicates are involved. Examples are given from Cape Town (Table Mountain National Park) and the Californias (the border area).

Minor problems with urban visitors: These include such problems as over-visitation and collection of plant material such as firewood, wildflowers, and medicinal herbs. These problems are found in virtually all urban and peri-urban protected areas in both developing and industrialized countries.

3. CASE STUDIES

a. Introduction

The forms and impacts of urbanization, and responses to them, are best understood in the context of the environments, institutions, economies, and population trends of specific countries and regions. Following are three case studies: of protected areas in Kenya; South Africa; and the Californias, a binational region including parts of Mexico and the USA. Brief notes illustrate special problems and/or innovative solutions from Australia, Brazil, Cape Verde, China, and Kiribati.

I want to emphasize that the case studies do not attempt to give the full stories behind the examples I describe, just enough to put them in context.

In choosing countries and areas for case studies, I wanted to include (1) places I recently visited where I have had opportunities to see what is happening on the ground and meet face-to-face with local residents, leaders, and experts; (2) a range of biomes, including areas of high biodiversity value; (3) different socioeconomic situations; and (4)

places that illustrate different forms and impacts of urbanization, and the conclusions I have drawn from my research.

b. Kenya

Introduction

Kenya's current population of 34.7 million is projected to grow to 64.8 million by 2050. Its per capita income is equivalent to U.S. $1,170. About 36% of the population is urban.

Kenya's three largest cities, Nairobi, Mombasa, and Nakuru, all include important protected areas within their boundaries. This paper focuses on two of these, Nairobi and Lake Nakuru national parks, with notes on a third complex, the Mombasa Marine National Park and Reserve. All are managed by the Kenya Wildlife Service.

Tourism is the second largest contributor to Kenya's economy, after agriculture. It accounts for 12% of the country's GDP and 21% of foreign exchange earnings. National parks account for 75% of tourist earnings, which are expected to grow 4.5% to 5% per year (KWS 2005, 16).

Nairobi National Park

Nairobi National Park was established in 1946 as Kenya's first national park. It covers 117 sq km.[5] The park (designated as an IUCN Category II protected area[6]) lies within the city of Nairobi, separated from built-up areas by an electrified fence. It is in the tropical grasslands and savannas biome at an altitude of between 1,540 and 1,780 m. Open grass plains with scattered acacia shrubs are predominant, with part of the area covered by highland dry forest. A river lined by riparian forest runs along the park's southern boundary, which is unfenced.

Nairobi is the only city in the world with a major wildlife park next door. The park has an impressive array of species, including black rhinoceros (*Diceros bicornis,* listed by IUCN as Critically Endangered)*,* lion, leopard, hyena, cheetah, buffalo, eland, wildebeest, zebra, hippopotamus, giraffe, and diverse birdlife. However, the populations of most of these species are much smaller than in the late 1970s, perhaps down as much as 75% overall.

The park has had about 100,000 visitors a year since the 1950s. In addition, a Safari Walk and Wildlife Conservation Education Centre at the main entrance receive many visits from students, teachers, and the general public.

The main threat to Nairobi National Park from urbanization is urban sprawl. Pollution and human-wildlife conflicts are also significant.

According to census figures, the population within the city's municipal boundaries grew from 119,000 in 1948 to 2.14 million in 1999. Today, the number of people in the metropolitan area is estimated at between 3-4 million.

Heavy industry, as well as residential and commercial development, extends right up to the park fence. Along the park's northeastern boundary there are tanneries, a steel

works, a cement plant, and a chemical factory that dumps industrial waste into a river and discharges toxic pollutants into the air.

South of the park is another kind of problem related to urbanization. An extensive area vital for animal migration and dispersal is gradually being subdivided and fenced into small parcels. Country estates and shantytowns have arisen as both rich and poor want to escape urban congestion. There are sheep and goat farms. Eucalyptus groves have been planted (the wood is grown for power poles and fence posts). Plastic greenhouses have been erected for flower production (Kenya has become Europe's major supplier of fresh-cut flowers). All these uses depend on wells for their water supply and are gradually drawing down the aquifer, which affects indigenous plant life and watering holes for wildlife within and outside the park.

Large herbivores moving through this migration route are followed by lion and other predators that also attack livestock. Although there is a program to compensate owners of livestock killed by wild predators, some owners have taken direct action. In 2004, 11 of Nairobi National Park's 18 lions were found dead from poisoning; however, the lion population had recovered by 2006. There have been many similar incidents in the past (Frank et al. 2006).

Kenya has a sound legal framework for land-use planning and regulation, at least on paper, but geographer R.A. Obudho (1997), who has written extensively on Nairobi, points out that the process is "fraught with corruption" and regulations are ignored. Although the city has "extensive development control powers . . . these have not been effectively enforced." Recent discussions with conservationists in Nairobi confirm this.

Kenya ranks high, 142 on a scale of 163, on the most recent Corruption Perceptions Index compiled by Transparency International, the global anti-corruption NGO. Its national affiliate, Transparency International Kenya, publishes its own annual Kenya Bribery Index (TI 2006). In recent years, corruption has become a major political issue in Kenya, getting prominent attention in the country's press.

Responding to this concern, President Mwai Kibaki announced in September 2006 the establishment of an autonomous Nairobi Metropolitan Region Development Board "for the proper planning and administration of the city of Nairobi." Among the board's responsibilities will be coordinating planning and environmental management and "enforcing compliance" (KBC 2006).

The Kenya Wildlife Service is taking a proactive stance in working to control land development within the larger ecosystem in which Nairobi National Park is embedded. Its main tool is public awareness. Nationally, KWS is giving higher priority to education and established a new education department in 2005 that has seven regional offices.

In the area surrounding Nairobi National Park, KWS also collaborates with other agencies such as the Ministry of Lands, which is formulating a master plan for the area. In addition, KWS is involved in programs that encourage landowners south of the park to keep animal migration and dispersal routes open; this requires much patience and confidence-building.

There is definitely a positive side to having a national park within the boundaries of an important city. Nairobi is not only the capital of Kenya but the most populous urban center in East Africa and a regional business and media center. It also has the largest concentration of diplomats in sub-Saharan Africa, due to the presence of a number of international organizations, including the world headquarters of both the United Nations Environment Programme (UNEP) and the United Nations Human Settlements Programme (known as UN-HABITAT).

For these diplomats and international officials it is easy to go out to the park in the late afternoon for a "game drive." In so doing, they learn about the natural environment, and many of them join or contribute money to the Friends of Nairobi National Park or other conservation NGOs.

Lake Nakuru National Park

Lake Nakuru National Park (IUCN Category II) is renowned for its huge numbers of lesser flamingo *(Phoeniconaias minor)*, as many as 1.5 million at a time, covering the shores of Lake Nakuru in solid pink. The park is in the tropical grasslands and savannas biome and lies 140 km northwest of Nairobi at an elevation of around 1,800 m. First established as a bird sanctuary in 1960, it became a national park in 1968 and was later expanded to its present size of 188 sq km. The lake is on the Ramsar List of Wetlands of International Importance under the Convention on Wetlands (Ramsar 2006). It is the only Kenya national park that is entirely fenced in.

Lake Nakuru has no outlet. It sits at the lowest point of a watershed of 1,800 sq km, fed by the Njoro, Makalia, and Enderit rivers, as well as rainfall and springs along its shoreline. The lake's inflow is balanced by evaporation.

The lake is shallow. Although it potentially has a surface of 62 sq km, its depth has been quite variable due to poorly understood interactions among hydrology, meteorology, and geology. Periodically, it dries up entirely, most recently in the late 1950s. Lake Nakuru is one of a series of shallow alkaline lakes in the Eastern Rift Valley whose food chains are based on populations of algae and fish that can survive under only very specific conditions. Any changes in water level or composition have drastic impacts on their ecosystems (KWS 2003, 27).

In addition to flamingo, the park has many other species of birds and mammals, including hippopotamus, zebra, buffalo, white rhinoceros, and Rothschild's giraffe. The park area surrounding the lake includes patches of marsh and grassland alternating with rocky hills, stretches of acacia woodland, and what is claimed to be the largest euphorbia forest in Africa (of the candelabra tree, *Euphorbia ingens,* which here reaches a height of 15 m). The park receives about 300,000 visitors a year, of whom half are Kenyan, including 100,000 students.

The main threats to the park from urbanization relate to reduced water quantity and quality. The level of water in the lake has drastically receded in recent years, perhaps due to a combination of natural and human causes, and it has become a sump for silt and waste. However, these problems have rural, as well as urban, sources.

The park lies within the municipality of Nakuru, a governmental and agricultural center that serves a large area of the Rift Valley. According to census figures, the population within the city's boundaries grew from 47,000 in 1969 to 219,000 in 1999. Current estimates for the metropolitan area range up to 500,000, with an annual increase of around 10%.

The lake receives treated water from the sewage works of Nakuru, as well as raw sewage from houses unconnected to the sewer system. Although most larger factories have their own waste treatment systems, many smaller facilities such as car-repair shops and textile-dying plants dump industrial wastes into pits that drain into ground water. The largest single source of pollution in Lake Nakuru is urban runoff from the first major rains of two wet seasons, the so-called "first flush." This runoff includes oil, grease, and toxic chemicals from motor vehicles; viruses and bacteria from leaking septic tanks; sediments from new construction; and plastic bags.

Urban pollution is exacerbated by sediment and agricultural chemicals flowing into the rivers from outlying areas of the watershed. Kenyan conservationist Ramesh J. Thampy writes that during the 20th century Lake Nakuru's watershed was "transformed from a sparsely settled and heavily forested area teeming with wildlife to one that is heavily settled, extensively cultivated, and urbanized." Although destruction of habitat and wildlife started with European farmers and ranchers in the first half of the century, government resettlement schemes initiated shortly after independence in 1963 resulted in a surge in human population and replacement of natural vegetation by small-scale subsistence farms. Rains on exposed soils have resulted in Lake Nakuru receiving greatly increased sediment and nutrient loads. "The depletion of natural ground cover is also thought to have altered the hydrological regime" of the watershed and "resulted in diminished surface flow into Lake Nakuru." In addition, deforestation and climate change have resulted in less rainfall (Thampy 1996).

Forests continue to be converted to small-scale agriculture. As recently as 1970, nearly half the watershed was forested; now it is less than 15%. A recent study of the part of the watershed drained by the Njoro River found that between 2000 and 2005 the number of cattle rose by over 250%, and the number of sheep rose by about 200% (SUMAWA 2005).

In 2005-2006, more than 30,000 lesser flamingo have been found dead at Lake Nakuru. Similar mass die-offs occurred there in 1993, 1995, and 1997, and have also occurred at other Rift Valley lakes. Since 2004, the species has been classified as Near Threatened by IUCN (2006c), because it depends on a small number of unprotected breeding sites. In September 2006, thousands of lesser flamingo appeared for the first time at small Lake Oloiden, southeast of Lake Nakuru. The causes of the deaths and unusual migration are unclear, although changes in lake ecology due to pollution and alien flora and fauna are suspected.

In October 2006, two dozen flamingo experts from around the world came together in Nairobi to discuss an action plan to protect the lesser flamingo. Their recommendations are being submitted to the African-Eurasian Migratory Waterbird Agreement (AEWA 2006), the largest such agreement concluded under the framework Convention on Migratory Species of Wild Animals (Koenig 2006).

The plight of Lake Nakuru is receiving much attention from Kenyan and international conservation organizations and development agencies. So far, efforts have concentrated on monitoring, research, and strategizing. Numerous conservation measures have been put forward, but implementation has been slow (Ramsar 2005). Proposed solutions include restoring ground cover in the watershed, reforming soil management practices, cutting back on use of agrichemicals, and improving the handling of urban waste. These are daunting tasks, particularly upstream, where in some rural areas average earnings are less than the equivalent of U.S. $1 a day. Efforts to evict squatters from protected forest land have been opposed by human-rights groups and some elected officials.

The Kenya Wildlife Service is working with municipal officials on a strategic plan for Nakuru and to improve water supply and sewage connections. It is encouraging the Kenya Forest Department to protect watershed lands under its authority, but that department has very limited resources. KWS is also trying to raise public awareness locally of the importance of the national park, especially among political and business leaders and schoolchildren. It has helped organize a local business association, works with a citizens' group called Friends of Lake Nakuru, and supports neighborhood associations that plant trees and sponsor clean-up events. At the park's main gate, adjoining the urbanized area of Nakuru, an education center and a strip of lawn are open without payment of an entrance fee, and two buses take city residents on free visits to the lake itself. Local leaders are invited to special events in the national park. For example, in September 2006, a "Cycle with Rhinos" bicycle race was followed by a picnic, awards, and speeches by civic leaders and a Member of Parliament.

However, the contrasts between the city and the national park are striking. Commercial buildings and public housing line the park fence. Within the crowded urban area there is little green space; the only city park, Nyayo Gardens, across from a leading tourist hotel, is a haven for drug addicts. The air is full of diesel exhaust and smoke from charcoal cooking fires. And Nakuru continues to grow.

If Lake Nakuru continues its decline, the flamingos may go elsewhere. If they do, tourism in Nakuru will die, and so will the numerous businesses and jobs that depend on it.

One possible solution is for the national government to create a regional development board for the Nakuru region such as the one it is setting up for Nairobi. That board would not only have authority to oversee environmental management and enforce compliance with laws, but could put unemployed people to work on environmental improvement projects. Another, more radical, solution would be for KWS itself to take over management of the Lake Nakuru watershed. A national Environmental Management and Coordination Act, drafted in collaboration with the United Nations Environment Programme and enacted in 1999, provides a legal and institutional framework for much stronger action to protect the country's natural resources (UNEP 1999).

A fundamental cause of the problems faced by both Nairobi and Lake Nakuru national parks is rural-to-urban migration. Reversing this flow depends on wealth creation in rural areas. A number of projects sponsored or endorsed by the Kenyan government are

working to do this. An example is the Village Transformation Scheme, centered on reforestation (Tuller 2006).

Mombasa Marine National Park and Reserve

Off Mombasa, Kenya's main coastal city, the park (IUCN Category II) covers 10 sq km and the reserve (IUCN Category VI) another 200 sq km of the Indian Ocean, protecting the beach, a lagoon, an extensive coral reef, and open sea. Since these areas were established in 1988, enforcement by KWS has reduced over-fishing and coral trampling, so much so that surveys conducted 10 years later found major increases in fish size, abundance, and diversity; coral cover; and nesting by sea turtles (Bryant et al. 1998). The commercial fishing industry has been very supportive. However, KWS has less control over pollution from the city and the numerous resort hotels that line the beaches up and down the coast. These establishments cater mainly to cost-conscious package tourists from Europe, many of whom never venture to the country's great wildlife parks in the interior. To stay competitive, some hotels cut their costs by dumping waste into the sea, waiting for darkness and a receding high tide to do so. KWS is aware of this and intends to enforce the law.

Web sites

East Africa Wildlife Society: http://www.eawildlife.org
Kenya Wildlife Service: http://www.kws.org (includes links to pages on all national parks)
Lakes of the Rift Valley Project: http://www.kenya-rift-lakes.org

c. SOUTH AFRICA'S CAPE REGION

Introduction

The Cape Floristic Region, which covers some 78,000 sq km of South Africa's Western Cape Province, is the smallest of the world's six so-called floral kingdoms. The region has some 9,600 species of indigenous plants, of which 7% are endemic (found nowhere else) and 1,406 are listed as facing a high risk of extinction. Like the California Floristic Province described below, it is one of 34 global biodiversity "hotspots" identified by Conservation International (2006).

In the Cape region, the main threats to biodiversity from urbanization are within the city limits of Cape Town, which also happens to include some of the richest biodiversity in the region. Cape Town includes Table Mountain National Park, described below, and several reserves managed by the South African National Biodiversity Institute, one of which is described below. In addition, the city government administers 22 municipal protected areas and has adopted a comprehensive Biodiversity Strategy (Katzschner et al. 2005).

The population of metropolitan Cape Town has grown rapidly. In 1946, it was about 500,000; now it is estimated to be 3.5 million. Most of the growth is from migration from other parts of South Africa and, more recently, other African countries. Although South Africa's per capita income is equivalent to U.S. $12,129, there are wide disparities

between rich and poor. Among the country's major cities, Cape Town has the widest such disparities.

The Cape Floristic Region is one of five regions of the world with Mediterranean-type climates characterized by mild, rainy winters and hot, dry summers. Per unit of area, they face greater immediate threats than any other species-rich regions on earth (Rundel 2002, IUCN 2006d). The other such regions are in parts of Australia and Chile; the California Floristic Province of Mexico and the USA (the subject of another case study in this paper), and in and around the Mediterranean Basin.

The main threats from urbanization to protected areas in Cape Town are urban infill and encroachment from informal settlements. Crime is also a serious problem. At the edges of the city, and further afield, second-home, retirement, and tourism development is increasing.

Table Mountain National Park

Table Mountain National Park (IUCN Category II) is the most visited of the 22 protected areas administered by South African National Parks. It covers some 250 sq km of land and 1,000 sq km of sea and coastline around the Cape Peninsula. It includes Cape Town's iconic Table Mountain, which rises 1,100 m above the ocean, and the Cape of Good Hope, which 500 years ago English navigator Sir Francis Drake called "The fairest cape in the whole circumference of the Earth."

The park was established in 1998 out of a mosaic of lands owned by various public authorities. It is fragmented by privately owned land and bordered by some of the wealthiest residential areas of the city as well as seven "townships" (shantytowns). It is an "open-access park" with only three managed pay points. Visits are estimated to be 4 million annually, with one million paying visitors. The park is one of eight sites that comprise the Cape Floral Region Protected Areas World Heritage Site, established in 2004 (UNESCO 2006a).

Manager Brett Myrdal (2006) sees linking the park to the local economy as his main challenge. Tourism is the "lead sector of Cape Town's economy," and the park "protects the backbone" of that economy. The park commissioned the University of Cape Town to do a study of the park's environmental, economic, and social contributions to the city (Standish and Boting 2006).

There is a major emphasis on reaching out to the poor. Employment and life-skills training is provided to people from neighboring shantytowns. Land was released for housing to reverse incursions from townships, and the park has a partnership with the city to manage low-income public housing on the park's urban edge.

When it was established, the main threats to the park were from invasive species of alien plants and animals. However, invasives are now largely under control thanks to much labor-intensive work paid for by a national employment program and international sources.

Now, the major threat to the park is crime. Although not all crime is committed by residents of neighboring shantytowns, and certainly very few shantytown residents are

criminals, employing such residents for short-term tasks such as fence-building, trail maintenance, and clearance of invasive plants has had the perverse effect of showing them where to hide and what there is to take. The crimes committed are mainly limited to pickpocketing, breaking into visitors' cars, or stealing park property, but there have also been violent assaults on hikers (IOL 2006). Such incidents are tragic in themselves but, once they get reported in the international press, they can have devastating consequences for places like Cape Town, whose economies are so dependent on foreign tourism. In response to rising crime, the park is deploying dog patrols and visitor safety officers, and closed-circuit television is being installed in high-use areas.

Fire in this ecosystem is a natural phenomenon needed periodically to maintain biodiversity. However, fire is always a problem along any wildland-urban interface. In the Cape region, it is an increasing threat because of arson and climate change (the climate is becoming warmer and drier).

There is crime of a different sort along the coast, poaching of beige abalone (*Haliotis midae*), a shellfish locally called perlemoen. Although some commercial harvesting of this species of abalone is permitted, most of it is taken illegally, frozen or dried, and exported, almost entirely to China, where it commands high prices for its supposed aphrodisiac qualities. Although local divers harvest the abalone, this lucrative trade is controlled by a crime syndicate based in China which is also involved in selling illegal drugs in South Africa. The urban location makes both illegal activities harder to detect. Park and other government officials try to control abalone poaching, and confiscate hundreds of thousands of specimens each year. However, some local conservationists believe more could be done by listing the species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora, known as CITES (WWF-SA 2003). Discussions are ongoing.

TMNP's primary partner is Cape Town's municipal government. The park seeks to help the city meet its own objectives, while the city provides funding and in-kind support. The park is also reaching out to civil society groups, including through an advisory forum that has working groups on different issues.

Myrdal and his colleagues want to have the Cape Town community as a whole understand that the park is "an essential part of Cape Town's urban economic engine," and that "urban protected areas are not 'a lost space for development' but an 'asset for the cities that have them, offering potential competitive advantage over other cities."

Edith Stephens Wetland Park

Edith Stephens Wetland Park is one of several small nature reserves on the Cape Town lowlands known as the Cape Flats. Once a mosaic of dunes and marshes, the flats are now fragmented by industry, farming, and high-density residential neighborhoods. These neighborhoods include shantytowns without proper supply of water, electricity, or sanitation. In them, unemployment rates are over 40%, and up to 75% of residents live below South Africa's poverty line, which is equivalent to about U.S. $1.50 a day.

Still, there remain some 1,800 indigenous plant species on the flats, 76 of them endemic to the area. The Stephens Park, now nearly 40 ha in extent, was created in 1955 by what has become the South African National Biodiversity Institute (SANBI) to

protect an aquatic fern, *Isoetes capensis,* that occurs only at this site, as well as several other threatened plants. Now nearly surrounded by urban development, the park could have been regarded as a problem. Instead, SANBI saw it as an opportunity.

The park is the base for Cape Flats Nature, a partnership of five organizations: SANBI and Cape Action for People and the Environment, both of them units of the national government; the City of Cape Town; and two NGOs. Founded in 2002, Cape Flats Nature works at several sites on the flats by "building bridges between people and nature; demonstrating benefits from conservation for the surrounding communities, particularly areas where incomes are low and living conditions are poor; and encouraging local leadership for conservation action." It catalyses on-the-ground conservation management; facilitates access to "outdoor classrooms" for curriculum-based environmental education; encourages use of urban natural areas for recreation and teaching about traditional healing practices; and contributes to job creation through clearing of invasive plant species and encouraging local economic development (CFN 2006). In an article in *The Urban Imperative,* SANBI's George Davis (2005) describes the social and environmental context of Cape Flats Nature, how the initiative evolved, and lessons learned. The most critical lesson, he believes, has been the importance of identifying, supporting, training, and encouraging conservation leadership within local communities.

Behind the scenes in Cape Town, there are controversies over places like the Edith Stephens Wetland Park. These controversies reflect a division in the conservation movement between those who support investing money to save highly endemic species in what are sometimes called "postage-stamp" or "flowerpot" reserves, and those who argue for concentrating on protecting large-scale landscapes, where natural ecosystems demonstrably have a better chance of surviving global change.

Adam Welz (2006), a graduate student at the University of Cape Town, thinks both small- and large-scale protected areas are important in such urban contexts. The reserves on the Cape Flats, as well as private gardens and other patches of ground planted with indigenous species, are key to movement of insects and birds needed for pollination. Cape Town, he thinks, is a good place to experiment with making the "urban matrix more permeable and hospitable to wild species." One problem, he says, is that "maps of green and white don't account for the middle mix." He draws on the work of Michael Rosenzweig, author of *Win-Win Ecology* (2003, 1), who promotes "reconciliation ecology" as an alternative to "reservation ecology" and "restoration ecology." Reconciliation ecology tries to construct new ecological niches to replace those human activity has destroyed.

Some argue that plant species endemic to small areas of the Cape Flats could easily be wiped out by drought or by winter floods that have become more intense as natural and agricultural land has been converted to urban uses. But in the case of the Stephens Park, and many similar small urban nature reserves around the world, this is almost beside the point. Their function is not only protecting species but reconnecting people to nature. There are many reasons for reconnecting people to their natural heritage. In Cape Town, most of these have to do with the well-being of local people. However, those interested in large-scale conservation, including protected areas far from any city, should take note of another reason: Table Mountain National Park is clearly visible from the Cape Flats, but most people living on the flats never go there. However, they do

vote for members of parliament who make important decisions about all of South Africa's protected areas.

Two other Cape Town initiatives must be mentioned. At its headquarters in the Kirstenbosch National Botanical Garden, the South African National Biodiversity Institute has built a three-story Centre for Biodiversity Conservation which houses offices of South African conservation groups, the world headquarters of the Global Invasive Species Programme, and branches of such international organizations as IUCN, TRAFFIC, and Conservation International, as well as meeting rooms. The idea is that proximity promotes communication and synergy.

In addition, an urban biosphere reserve has been proposed for Cape Town (Stanvliet et al. 2004); this concept is described under São Paolo below.

Web sites

Botanical Society of South Africa: http://www.botanicalsociety.org.za
Cape Action for People and the Environment: http://www.capeaction.org.za
Cape Flats Nature: http://www.capeflatsnature.org
South African National Biodiversity Institute: http://www.sanbi.org
South African National Parks: http://www.sanparks.org

d. THE CALIFORNIAS (MEXICO-USA)

Introduction

"The Californias" refers to the state of California in the USA and the states of Baja California and Baja California Sur in Mexico. Together, as the crow flies, they stretch 2,500 km along the Pacific Ocean, with the Mexican portion forming a long peninsula separated from the mainland by the Sea of Cortés.

This case study concentrates on the U.S. state of California and the northern part of the Mexican state of Baja California. Both states are divided between Mediterranean-type ecosystems along the coast, and desert ecosystems in the interior. Like South Africa's Cape Floristic Region, described above, these Mediterranean-type ecosystems, which comprise the California Floristic Province, are one of 34 global biodiversity "hotspots" identified by Conservation International (2006).

The rate and scale of population growth in the U.S. state of California is like that found in many developing countries. It has risen from 1.5 million in 1900 to an estimated 37 million in 2006, and is projected to increase to 65 million by 2050. This rate of growth is without parallel in any area of similar size in the world (411,000 sq km, roughly the size of Sweden or Zimbabwe). It is almost entirely a product of immigration from other U.S. states and other countries. About 94% of the population is urban (CDOF 2005). Over 55% of California is in protected areas (Trzyna 2001, 4).

Baja California's current population is 3.5 million. Immigration from other Mexican states and Central America has been a major factor in its growth. The population is 91.6% urban. A relatively small part of the state is in protected areas, mostly in the desert or well to the south of the border.

Protected areas along a troubled border

The international boundary is a straight line running eastward from the Pacific Ocean across rugged mountains and canyons and down a steep escarpment to the desert floor. The focus in this paper is on the Mediterranean-type ecosystem west of that escarpment. It is a region very rich in biodiversity, including numerous endemic plant and animal species. The Biodiversity Research Center of the Californias at the San Diego Natural History Museum monitors these species in a binational context.

On the north, U.S., side of the boundary, San Diego County has 3.1 million people and is projected to grow to 3.8 million by 2030. South of the border is the municipality of Tijuana, which has 1.8 million people and is projected to grow to 3.2 million by 2040. (In 1950, San Diego County had 556,000 people; Tijuana had only 65,000.)

There is wealth and poverty on both sides of the line, but the difference in per-capita income across an international border is unparalleled anywhere in the world. According to 1999 data, the Tijuana municipality had a per-capita gross regional product equivalent to U.S. $6,800, while San Diego County's was $29,488, a ratio of 4.34:1 (Kada and Kiy 2004). Much of Tijuana's growth is in hillside shantytowns that, once built, are protected from demolition by Mexican law (Ouroussoff 2006).

There are also cultural and language differences. Mexico is Spanish-speaking and has a distinct form of Latin American culture; California's dominant culture is English-speaking but the state is increasingly multi-cultural; it has no ethnic majority.

If economic, cultural, and language differences were not enough, the challenges of creating and managing protected areas in this fast-growing binational urban complex are exacerbated by illegal immigration and drug trafficking. Organized crime in Tijuana is "out of control," its mayor recently said; Tijuana's rate of kidnappings ranks among the world's worst (Enriquez and Marosi 2006). There is also political tension between the two countries over border matters. Currently, this focuses on U.S. plans to build a triple fence, 3 m high, along its side of the border in an attempt to stop illegal immigration and smuggling. The fence would interfere with wildlife migration and water flow.

Tijuana River National Estuarine Research Reserve

At the ocean between San Diego and Tijuana, just north of the border, is the 10-sq-km Tijuana River National Estuarine Research Reserve (IUCN Category IV), owned and managed by several national, California state, and local government agencies. The primary land managers are California State Parks and the U.S. Fish and Wildlife Service. The property is a Ramsar site (Ramsar 2006).

The reserve is dominated by coastal salt marshes, dunes, riparian corridors, and coastal tablelands. Overall, this estuary is relatively intact compared to others in the southern part of California. However, the Tijuana River, which feeds it, flows through the Mexican cities of Tecate and Tijuana before entering the U.S. about eight km east of the ocean. Almost three-quarters of its watershed lies within Mexico.

Major challenges in managing this reserve relate to sewage and urban runoff from Tijuana and Tecate. This pollution also affects ocean water quality; it flows northward in

the strong California Current, joining more urban outflow from San Diego and Los Angeles. Those using southern California's beaches, all of them protected areas, are seriously affected by sewage from both countries. Bacterial pollution sickens as many as 1.5 million swimmers and surfers annually in the region and results in millions of dollars in health-care costs (Polakovic 2006). To deal with the Tijuana estuary problem, the U.S. government, with funds from both national governments, built a sewage treatment plant on the U.S. side of the border to treat effluent from Tijuana; however, the plant, which opened in 1997, can handle only half of the effluent generated by Tijuana and meets only a minimal, primary-stage, standard for treatment.

In addition, sedimentation from the stripping of vegetation from Tijuana hillsides adjacent to the reserve has filled in parts of the marsh. Invasive species are a serious problem, as they are in most California wetlands. Of most concern is tamarisk (*Tamarix* spp.), which forms three-meter-high thickets. Previously restricted to freshwater areas, it has only recently adapted to salt marshes and has the potential to change the physical structure and food web of such ecosystems.

The reserve is responding to these challenges by carefully monitoring water quality, vegetation, and wildlife; restoring filled marshes; and controlling invasive plant species as best it can (NOAA 2005). The reserve also has an active educational program linked to local school systems, and participates in a binational exchange that connects students in schools in Mexico and the U.S. by computer to exchange real-time information from monitoring flights of migratory birds along North America's Pacific Flyway.

There are numerous binational organizations — official, quasi-official, and unofficial — coping with cross-border environmental problems. One of them is the Border 2012 Tijuana Watershed Task Force, whose participants are national, state, and local government agencies in both countries, as well as NGOs and universities. Among its aims are protection of the estuary and undeveloped parts of the catchment. Its main tangible product to date is a bilingual atlas (Wright, Vela, et al. 2005), which covers physical, biological, and human aspects of the watershed in detail. The process of producing the atlas was an important step in itself; it required communication and consultation that eventually led to collaboration. The process also forced task force members to look beyond political boundaries and their compartmented responsibilities to see the watershed as a system of interacting components.

Urbanization is moving inland along both sides of the border. Little land on the Mexican side is protected. On the U.S. side, there are several national, state, and local protected areas, but they are physically and administratively fragmented. Good opportunities still exist to protect substantial areas along both sides of the border, and connect existing reserves, but authorities have been slow to act.

To move decision-makers toward a coordinated conservation strategy and action, Mexican and U.S. NGOs have launched Las Californias Binational Conservation Initiative. Las Californias ("The Californias") focuses on biodiversity conservation in an area that includes, but goes well beyond, the Tijuana River watershed. It is led by Pronatura, a major Mexican NGO, and The Nature Conservancy, a major U.S.-based NGO that has offices in Mexico, with scientific support from the Conservation Biology

Institute. Its main product to date is a “vision” for habitat conservation in the border region (LC 2004) that has a major focus on existing and proposed protected areas.

In both California and Baja California, many of those involved in these and other cross-border conservation efforts are frustrated that so much effort has gone into data collection, mapping, and strategizing, with very little results on the ground. They are also frustrated with the large number of overlapping binational efforts and having to attend their meetings.

There are several barriers to progress:

- The region is distant from the capitals of both countries, and getting the national governments to give its problems sustained attention has been difficult.

- Those involved from both countries have little awareness of transboundary conservation elsewhere in the world (IUCN 2006e) and, when informed of it, believe it has little relevance to their work.

- Land ownership patterns and conservation mechanisms differ significantly between California and Baja California.

- In Mexico, land ownership records are often unclear, making it difficult for agencies and NGOs to acquire land.

- As in many countries, Mexico does not have strong traditions of voluntarism or philanthropy.

However, there is good conservation leadership in both countries and many of those involved are bilingual and often bicultural. There are strong personal relationships across this troubled border, and a deep fund of good will.

Fragmentation and wildlife migration corridors

One of the problems caused by urbanization along the border between California and Baja California, and the planned border fence, is interference with wildlife migration. In much more populous California, connectivity between protected areas has become a major concern. This is because most protected areas were not designed to care for biodiversity, but rather for water-supply or flood control purposes, to preserve landscapes, or to provide opportunities for outdoor recreation. This is further complicated by administrative fragmentation. Protected areas are managed by many different national, state, and local agencies. Their boundaries commonly follow the rectilinear cadastral system used in California, rather than watersheds or other natural features. Their managers spend much of their time on inter-agency coordination. And, in some cases, cooperation is constrained by long-standing institutional rivalries (Trzyna 2001, 11).

The Missing Linkages initiative, launched in 2000, is a coordinated effort to “systematically identify, study, and protect wildlife corridors” in California. Its participants are national and California state agencies and several conservation NGOs (Penrod

2000). Missing Linkages has led to very specific studies that identify parcels of land required for habitat linkages. Some of these studies relate to the protected areas described below and have been conducted by an NGO called South Coast Wildlands (SCW 2006). Wildlife corridors are needed not only for large mammals that range over extensive territories, but also for migration of many types of plants and smaller animals that often occurs over many generations.

Los Angeles: Santa Monica Mountains National Recreation Area

Greater Los Angeles has 18 million people, making it ninth among the world's urban agglomerations. Although the urbanized core has relatively few conventional or natural parks, it is framed by extensive protected areas: along the ocean by state and local beaches and coastal parks; in the interior by mountainous national forests and a desert national park (Joshua Tree, described separately below).

Unique in this context is the Santa Monica Mountains National Recreation Area (IUCN Category V), established in 1978, which protects 623 sq km of a mountain range that extends from the heart of Los Angeles to the ocean. Rising from sea level to 950 meters, its predominant vegetation is chaparral, a dense growth of various species of evergreen, hard-leaved shrubs.

Within a framework administered by the U.S. National Park Service, the NRA is a cooperative effort. The largest landowner is California State Parks, followed by NPS and the Santa Monica Mountains Conservancy. Local agencies, NGOs, private landowners, and a university are also involved. Over the past 25 years, open space around the NRA boundary has gradually filled in with residential and commercial development. This is dramatically shown in a series of high-definition satellite images assembled by the U.S. National Aeronautics and Space Administration (NASA 2006) that are a very useful tool for educating decision-makers. Within the NRA, this fill-in has increased edge effects.

The Santa Monica Mountains Conservancy is an unusual California state agency set up in 1979 and given special acquisition powers out of concern that the national government was acting too slowly to acquire private lands for the NRA in a fast-rising real estate market. It has become highly skilled and proactive at acquiring land and making it accessible by combining funding from different sources and forming partnerships with other agencies and NGOs.

Fire along the wildland-urban interface is a major challenge in the Mediterranean-type ecosystems of the Californias. From May until November and sometimes later, there is virtually no precipitation in this region. Toward the end of the dry season, fires increase dramatically. Caused by lightning, accident, or arson, they periodically burn large areas of the mountains in and around cities, often resulting in death and destruction of homes. Such fires have increased in number and extent in the last few years, and the risk of large wildfires is expected to increase due to climate change (Luers et al. 2006, 10). Protected area agencies have no control over construction on private land next to, or even within, their boundaries; regulatory authority lies with local governments that are often reluctant to interfere with property rights.

There are human-wildlife conflicts in the Los Angeles metropolitan area, especially along the edges of protected areas. Coyote (*Canis latrans,* a wild dog) are common.

Long notorious for preying on pets, they now seem to be losing their natural fear of humans, occasionally attacking small children and even entering supermarkets. State wildlife officers kill aggressive coyotes because relocating them has been found to be ineffective (Rivenburg 2006).

Mountain lion *(Puma concolor)*, roam the mountains and foothills and can attack humans, although this happens very rarely; only six fatalities have been reported since 1890 in all of California. There is strong public support for protecting this impressive animal (adult males usually weigh 70-120 kg) and in 1990 California voters approved a measure put on the ballot by petition that bans hunting mountain lion. Conservation agencies, NGOs, and natural history museums educate the public about the species. The Santa Monica Mountains NRA has had a key role here. Since 2002, its scientists have monitored the movement and behavior of eight mountain lions with radio-collars and GPS tracking devices. Results are often reported in the local press, sometimes on newspapers' front pages.

Los Angeles: Little places with big results

Outside the mountains, two protected area agencies, the Santa Monica Mountains Conservancy and California State Parks, work with others to preserve, restore, and make accessible the few remnants of nature that still exist in densely urbanized Los Angeles. These remnants are mainly on low hills and along rivers and streams that were paved for flood-control purposes starting in the 1930s.

Small urban nature reserves such as these are found in many cities. Although they have little visibility in the international conservation community, they play a critical role. They provide children with the direct experience of nature they need for healthy intellectual and emotional development. They also help protect remote large-scale natural areas: if people haven't experienced nature, they are much less likely to care about it.

Both agencies are also involved in creating "natural parks" in poorer areas of Los Angeles. The idea for the first such park came from Rita Walters, a city council member who represented a low-income part of the city. From their homes, her constituents could look up at the Santa Monica Mountains, but few of them went there (a similar situation in Cape Town is described above). Large amounts of public money had gone into preserving those mountains; couldn't nature be brought to their neighborhoods? Walters went to the Santa Monica Mountains Conservancy, which responded by converting a 3.5-hectare disused municipal storage yard into a "natural park."

The Augustus F. Hawkins Natural Park opened in 2001. Situated in a rundown, high-crime neighborhood, it was designed in consultation with the people who live there. The park is not a restoration, but rather a "reflection" of the natural ecosystems of the region. (In other places, this would be seen as an opportunity to recreate the original vegetation, but in this case the original landscape was an alluvial plain thinly covered with shrubs and grasses that would be uninteresting at such a small scale.) Nevertheless, nature in some ways is taking its course; for example, indigenous plants have created habitat for birds rarely seen in urban settings. The park has a visitor center, hosts school and other youth groups, and sponsors free outings to mountain protected areas. Operations were transferred to the municipal government in 2005.

Among its strategic objectives, the Conservancy now lists: “Expand efforts to integrate nature into the urban environment.” There are plans to replicate the Hawkins Park elsewhere in the city, including on the grounds of a new secondary school (Trzyna 2005b, 107-110).

The desert: Joshua Tree National Park

East of metropolitan Los Angeles is a classic example of ribbon development leading to urban sprawl around a protected area. Joshua Tree National Park (IUCN Category II) preserves 3,196 sq km of desert mountains, three quarters of which is designated as wilderness. It was established in 1936 as a national monument and elevated to national park status in 1994. It receives about 1.2 million visitors a year.

The park’s signature species, the Joshua tree *(Yucca brevifolia)* is an unusual member of the agave family that has stiff, sharp-pointed leaves and reaches 3 meters or more in height; each tree forms thick, rigid branches in its own unique way. Several animals are specifically dependent on Joshua trees, including a moth, a lizard, and several birds. There are also five palm oases scattered through the park (of the California fan palm, *Washingtonia filifera*). Depending on winter rainfall, there can be spectacular spring wildflowers. Altitude ranges from 163 m to 1,772 m.

On the south side of the park is the already urbanized Palm Springs area where, in some places, houses are being built right up to the park boundary.

The ribbon development is happening on the north side of the park, in the Morongo Basin, where there is still a chance to create buffer zones between growing towns and the park boundary, and preserve wildlife corridors to other protected areas farther to the north.

Contrasts between the basin’s two municipalities, Twentynine Palms and Yucca Valley, which regulate the use of private land within their boundaries, demonstrate the value of sustained contact between a protected area and its neighbors. Both towns abut the park boundary. However, since the park was established in the 1930s, Twentynine Palms has served as the park’s headquarters, and many of its employees have lived there and been involved in its civic life. As a result, Twentynine Palms has a sense of ownership of the park and its council tends to make land-use decisions that protect the desert landscape. Walls of buildings in its small business district are decorated with colorful murals depicting local human and natural history. On the other hand, faster-growing Yucca Valley identifies much less with the park and the desert and is following a path of conventional suburban development.

The Morongo Basin is expected to double its population between 2006 and 2025, from about 60,000 to 120,000. Park officials are working to consolidate other lands owned by the national government in the basin to create a buffer zone around the park, as well as a wildlife corridor between the park and a military reservation. The military are interested in creating a buffer around their own land so that development along their boundary does not interfere with training operations; thus, the park and the military have common interests. A local NGO, The Mojave Desert Land Trust, was set up in 2005 to acquire private land for conservation purposes, facilitate interagency cooperation, and work with local governments. In the privately owned parts of the basin that are still

relatively undeveloped, one means of creating buffer zones and wildlife corridors would be to limit the building of houses to one per 40-acre (16 ha) parcel.

Joshua Tree National Park is an example of three other impacts of urbanization on protected areas:

- Air pollution blown into the park from greater Los Angeles and the agricultural San Joaquin Valley deposits large quantities of nitrogen on the soil, fertilizing invasive European grasses that thrive on fire. Before the grasses became established, lighting-caused fires were confined by barren ground to small areas. Now, fires have become much more intense, spreading quickly through the grass over much larger areas and killing woody plants. In recent years, several such fires have occurred in and around the park, destroying stands of Joshua trees, pines, and junipers that will take decades or even centuries to recover (Wilson 2006). Although park officials keep air pollution control authorities informed of the nitrogen phenomenon, little staff time is available to do more.

- In a desert climate that is naturally very dry, irrigation of gardens and golf courses in neighboring towns is humidifying the air in the park, changing insect life and bird migration and making it possible for new exotic plants to invade.

- A solid waste landfill was proposed in the early 1990s less than a kilometer from the park's boundary. If approved, it would be the largest landfill in the United States. Garbage from Los Angeles would be brought in by rail, 18,000 metric tons of it a day. The dump would pollute groundwater and the trains would add to air pollution. Opponents of the project, mainly local residents and conservation NGOs, have so far successfully challenged it in the courts.

Global warming is expected to have severe impacts on the California desert. Some of its plants will not survive an increase in summer heat, at least in their present ranges. Other plants need cold weather and will not survive warmer winters. Within 75 years, there may be few Joshua trees left in Joshua Tree National Park, although the species will survive elsewhere at higher elevations and more northerly latitudes. The park may participate in a pilot project to inform the public about the effects climate change will have on natural environments. By example, this project would also publicize energy alternatives: Joshua Tree National Park has more photovoltaic solar cells than all other units of the U.S. National Park System combined. The park has already conducted a one-day seminar on practical energy alternatives in cooperation with the local community college.

As in many U.S. national parks, another concern at Joshua Tree is light pollution from nearby towns, as well as "sky glow" from more distant cities. The National Park Service has a policy to "preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light . . . To prevent the loss of dark conditions and of natural light skies, the Service will seek the cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks" (USNPS 2006). Artificial light not only detracts from visitors' park experiences; it can also harm nocturnal wildlife (Harder 2006).

The Mojave and Colorado Deserts Biosphere Reserve includes Joshua Tree National Park, along with Mojave National Preserve and two other protected areas, but it is inactive, as are most biosphere reserves in the U.S.

The desert: Protected areas in a coalescing megapolis

Some 100 km north of Joshua Tree National Park is Mojave National Preserve. (No IUCN Category has yet been assigned to this protected area. A "national preserve" is managed following all National Park Service standards, except that certain extractive activities are permitted, in this case hunting and some mining and cattle grazing.) The preserve covers 6,201 sq km of desert mountains and valleys that range in altitude from 268 m to 2,417 m. Although it has few facilities, it attracts about 500,000 visitors a year.

The government of Clark County in the adjoining state of Nevada is buying land only 15 km from the Mojave National Preserve's northern boundary for a second airport to serve the gambling and entertainment resort city of Las Vegas. The second airport is needed, the county's planners say, because Las Vegas expects to double its hotel capacity by 2025 and the existing international airport will run out of capacity. Already, Las Vegas' airport ranks tenth in the world in passenger traffic, 44 million, just after Frankfurt and Amsterdam (ACI 2006).

Although the National Park Service has been working with the U.S. Federal Aviation Administration to ensure that planes from the new airport will not overfly the preserve, the noise will certainly disturb visitors, and research indicates it will cause migratory tropical birds to bypass the preserve or stop reproducing.

The airport site is also on or near proposed routes for a high-speed rail line that would connect Las Vegas with California desert towns and greater Los Angeles. Already, many people make the long drive between Los Angeles and the desert several times a week. A high-speed train will likely have an impact similar to those in Europe. In France, for example, workers with flexible schedules are able to live in villages and cities along the Mediterranean coast and commute to Paris two or three days a week.

The large region that includes Los Angeles, Las Vegas, San Diego, Tijuana and their environs is an example of a coalescing megapolis or megapolitan area. The word "megapolis" derives from "megalopolis," which has had differing connotations.[4] As Robert Lang and Dawn Dhavale (2005, 1-4) define them in U.S. terms, megapolitan areas are "integrated networks of metropolitan and micropolitan areas." Among other things, their characteristics include combining at least two metropolitan areas, but perhaps dozens of them; linking large centers through major transportation infrastructure; and constituting "an organic cultural region with a distinct history and identity."

Extending the concept over the globe, Richard Florida (2006, 64-65) identifies 20 "mega-regions" or "megas," half in the U.S. and the rest scattered around the world. These include, for instance, "Euro-Lowlands," which includes the Ruhr, Cologne, Amsterdam, Rotterdam, Brussels, Antwerp, and Lille; and "Hong-Zen," comprising Shenzhen, Guangzhou, and Hong Kong. (He calls the Los Angeles-Las Vegas-Tijuana mega "So-Cal," as do others.)

The growing literature on megapolises focuses on their economic implications; rarely is there any mention of environmental quality, let alone conservation. Yet, where they exist or are coming into being, these complexes have serious implications for once relatively remote protected areas.

Sierra Nevada parks: Sequoia-Kings Canyon and Yosemite

Two gems of the U.S. National Park System, Sequoia-Kings Canyon and Yosemite, are in the Sierra Nevada, a 650-km-long mountain range that is California's most prominent topographic feature; its southern end is some 250 km west of the Mojave Preserve.

Sequoia and Kings Canyon National Parks (IUCN Category II), administered as one unit, cover 3,500 sq km. They were created in 1890 and 1940, respectively. They protect groves of giant sequoia *(Sequoiadendron giganteum),* a tree that grows to immense proportions — it is the world's largest living thing — and can live as long as 3,200 years. The parks also preserve deep granite canyons and peaks rising to 4,400 m. They receive some 1.5 million visitors a year.

Unfortunately, Sequoia-Kings Canyon has the worst air pollution of any unit of the U.S. National Park System. This is chiefly because it is downwind of the San Francisco area, some 275 km to the northwest, as well as the farms, cities, and roads of the San Joaquin Valley, a vast agricultural area to the east. The mountains keep the pollution from escaping the valley and turn it into a swirl that concentrates near the parks, rising to 2,500 meters and higher. The main culprit is ozone, a serious hazard to human health. Many visitors complain of difficulty breathing, and park officials have had to curtail some guided tours because of poor air quality. The ozone also cuts down visibility — to less than 15 km on the worst summer days. Although the ancient trees seem unaffected, sequoia seedlings suffer from the pollution, as do pines.

Although California has the strictest air pollution controls of any of the 50 U.S. states, certain pollutants are especially sensitive to population growth, especially ozone (UCD 1998). The National Park Service has an Air Resources Division that cooperates with air pollution control agencies in monitoring pollutant levels. Legislation gives national authorities some authority over major stationary sources of air pollution within 90 miles (145 km) of any national park; however, in this case the pollution originates in distant cities and numerous small sources in the valley and the law is of no use.

According to Annie Esperanza, who runs the parks' air pollution program, the only way to cut this pollution is to build a constituency for clean air. The parks publicize health hazards on warning signs and in interpretive displays, brochures, and rangers' campfire talks. "We have very little political clout," Esperanza told a journalist. "We want people to know about it so anybody who can do something about it, will" (Polakovic 2005).

University researchers monitoring air pollution at high elevations in the Sierra Nevada see increasing amounts of particulate matter, ozone, and other pollutants originating from China, almost halfway around the world. This is expected to increase (Chea 2006).

Yosemite National Park (IUCN Category II), farther to the north in the Sierra Nevada, was the first park created by the U.S. Government (in 1864, through a land grant to the California state government). It was designated a national park in 1890 and a World

Heritage Site in 1984. Yosemite protects 3,080 sq km of lakes, meadows, sequoia groves, and granite peaks rising to 3,997 m. The park receives 3.5 million visitors a year, three quarters of whom arrive in private vehicles. Most visitors go only to 18-sq-km Yosemite Valley, which is surrounded by spectacular granite cliffs, pinnacles, and waterfalls.

Two forms of urbanization affect Yosemite National Park directly: growing gateway communities and overdevelopment within the park itself.

Like most national parks in the western U.S., Yosemite is buffered from private land by other publicly owned protected areas that keep gateway services such as lodging and restaurants at a distance. However, commercial complexes and residential development along several roads leading into the park have been growing and changing the rustic character of these corridors. In 2003, working with local business and government leaders, Park Superintendent Mike Tollefson helped start a dialogue on park-related issues called Yosemite Gateway Partners, which meets in the park quarterly. Growth of gateway communities throughout the U.S. National Park System has been receiving increasing attention by park managers as well as several NGOs, including the Conservation Fund (2006) and the Sonoran Institute (2006).

Two other initiatives are helping to deal with development around protected areas throughout the Sierra Nevada: The Sierra Business Council (SBC 2006, Innes and Sandoval 2004) is an NGO founded in 1994 that enlists business leaders in securing the “social, natural, and financial health” of the region. The Sierra Nevada Conservancy is a unit of the California state government created in 2004 to work in partnership with public and private landowners and NGOs to help protect and restore the region, most of it managed by the national government; it covers over 100,000 sq km, a quarter of California. Although it has no regulatory powers and cannot buy land, the Conservancy can purchase easements from willing sellers, fund restoration projects, and give grants to NGOs and local governments for easements, land acquisitions, and other projects. It is one of nine conservancies within The Resources Agency of California that work in regions of special conservation concern (another, the Santa Monica Mountains Conservancy, is described above).

Within Yosemite Valley, overdevelopment, as well as traffic, pollution, and noise from cars and buses, have been criticized for decades. In 1997, the issue was forced by a flood that took with it virtually all the roads, lodging, employee housing, and campsites on the valley floor. Successive Park Service plans to rebuild these facilities in ways that intended to have less impact on the valley’s natural assets have been met with controversy and are still in the courts. One group that opposes the current plan, Friends of Yosemite Valley (2006), asserts, among other things, that it would significantly increase paved areas and replace modest cabins with high-priced accommodations. John Reynolds (2005), a former senior official of the Park Service, describes the background and politics of this issue in an article in *The Urban Imperative.*

Organized recreational users have been deeply involved in matters relating to the future of Yosemite National Park, as well as pressures of urbanization on many other protected areas in the U.S. (McMillan 2006).

The new University of California campus at Merced has established the interdisciplinary Sierra Nevada Institute, which has educational and research partnerships with nearby Sequoia-Kings Canyon and Yosemite national parks. The institute set up its first field station in Yosemite in 2004 (UCM 2006).

Web sites

Binational

Biodiversity Research Center of the Californias: http://www.sdnhm.org/research
Border 2012 Tijuana Watershed Task Force: http://trw.sdsu.edu (English/Spanish)
Institute for Regional Studies of the Californias: http://irsc.sdsu.edu. Lists links to other border Web sites.
International Boundary and Water Commission / Comisión Internacional de Límites y Aguas. Mexican Section: http://www.sre.gob.mx/cila (Spanish). U.S. Section: http://www.ibwc.state.gov
U.S.-Mexico Border Initiative (producing an online map of a 100-km band on both sides of the border that includes protected areas): http://international.usgs.gov

Mexico

Baja California state government: http://www.bajacalifornia.gob.mx (Spanish/English)
Pronatura: http://www.pronatura.org.mx (Spanish/English)
Secretaría de Medio Ambiente y Recursos Naturales (Secretariat of Environment and Natural Resources, Government of Mexico): http://www.semarnat.gob.mx (Spanish/English)
Terra Peninsular: http://www.terrapeninsular.org (Spanish/English)

USA

California Biodiversity Council: http://www.ceres.ca.gov/biodiv
Desert Protective Council: http://www.dpcinc.org
National Park Service: http://www.nps.gov (includes links to all parks)
The Nature Conservancy: http://www.nature.org
The Resources Agency of California: http://www.resources.ca.gov (includes links to California State Parks and the state conservancies)
Sierra Club California: http://www.sierraclub.org/ca
South Coast Wildlands: http://www.scwildlands.org
Tijuana River National Estuarine Research Reserve: http://www.tijuanaestuary.com

d. A MISCELLANY

Australia: Urban invasive species

Many Australian protected areas in and near cities are severely impacted by invasive species, especially feral cats and dogs and garden plants that go wild. Local authorities are helping to control these invasives. Here are two examples:

- Dandenong Ranges National Park (IUCN Category II), in the northeastern suburbs of Melbourne, has trouble with feral cats that prey on wildlife, including ground-dwelling

birds. The local government, the Shire of Yarra Ranges, has enacted strict regulations controlling pet cats, including a night curfew.

- Blue Mountains National Park (IUCN Category II), 100 km west of Sydney, has a serious problem with exotic plants spreading from private gardens. The park is one of seven protected areas within the Blue Mountains World Heritage Site. It lies within the city of Blue Mountains, which calls itself "The City within a World Heritage National Park." The city has a public information program aimed at encouraging property owners to remove exotic invasives and replace them with plants indigenous to the immediate area, especially those that are wildlife-friendly.

Web sites: Shire of Yarra Ranges: http://www.yarraranges.vic.gov.au (go to "Infractions"); City of Blue Mountains: http://www.weedsbluemountains.org.au.

Brazil: The São Paolo Greenbelt

The Forest Institute of the São Paulo state government is using a biosphere reserve as a mechanism for managing a greenbelt.

São Paulo has a population of 20.2 million and is the world's fifth largest urban agglomeration. It is surrounded by the São Paolo City Green Belt Biosphere Reserve, composed of several state parks and other protected areas. The Forest Institute is responsible for coordination. The greenbelt is the subject of a subglobal assessment under the global Millennium Ecosystem Assessment (Victor 2006; MA 2006, UNESCO 2006b).

In 1993, the greenbelt was made an integral part of the Mata Atlântica Biosphere Reserve, which covers important parts of the Atlantic rain forest that stretches over 3,000 km along Brazil's coast. Within the southern part of the biosphere reserve are 25 protected areas that comprise the Southeast Atlantic Forest Reserves World Heritage Site.

Biosphere reserves are areas recognized within the framework of UNESCO's Man and the Biosphere Programme. They consist of a core protected area, or a cluster of such areas, a buffer zone, and an outer transition area. They bring together stakeholders ranging from conservation agencies and scientists to economic interests and local authorities. In addition, one of their main purposes is to foster international exchange of information and experience.

Under UNESCO guidelines, each biosphere reserve is intended to fulfill three complementary functions: (1) conservation of landscapes, ecosystems, species, and genetic variation; (2) local economic development that is culturally, socially, and ecologically sustainable; and (3) research, monitoring, education, and information exchange related to local, national, and global issues of conservation and development.

Although several biosphere reserves already exist alongside or close to cities, their role has generally been limited to coordinating conservation activities. The idea of a distinct category of urban biosphere reserve is being considered in several countries and by UNESCO. The proponents of this new category offer a different perspective, among other things, on how managers of protected areas can cope with (and take advantage

of) urbanization and its impacts. Their ideas and energy could also help to invigorate the biosphere reserve concept, a good concept that has yet to reach its potential (Trzyna 2005a, 18-19).

Web sites: São Paulo City Green Belt Biosphere Reserve: http://www.iflorestal.sp.gov.br/rbcv (Portuguese). Mata Atlântica Biosphere Reserve: http://www.rbma.org.br (Portuguese). UNESCO Man and the Biosphere Urban Group: http://www.unesco.org/mab/ecosyst.urban.shtml.

Cape Verde: Second-home enclaves on the island of Sal

Cape Verde, an independent republic composed of a group of islands in the mid-Atlantic Ocean some 450 km west of Senegal, is a good example of how tourism, second-home, and retirement development is affecting vulnerable environments formerly considered remote.

Much of this is on the island of Sal, which is only 30 km long by 12 km wide. Sal's population is 14,000; its largest town, Vila dos Espargos, has 8,000 people. One resort complex, Murdeira Beach, being built by an Irish Company, has 1,400 residences in its first stage alone. The company was attracted to Sal by "prices that are a fraction of those for comparable sites in Europe and the Caribbean" (Brass 2006, 20). Sal has several terrestrial protected areas and one marine natural reserve, Baia da Murdeira. One area, the Salt Marsh of Pedra Lume, is on the Tentative List of World Heritage Sites (UNESCO 2006c). It is unclear what impacts the new development will have on these areas, or on the migratory birds that use the island as a stopover site. Also, the islands have meager and erratic rainfall and periodic droughts. Although a desalting plant is planned, many of the hotels and second homes have swimming pools and are notorious consumers of water. Similar developments are being built or planned elsewhere on Sal and on four other islands in the archipelago (CVP 2006).

Research on sustainable tourism has found that such "enclave tourism" and similar developments often have hidden economic and social costs, especially in poorer countries (UNEP 2001). Cape Verde's 421,000 people have a per capita income equivalent to only U.S. $6,000. Overgrazing and introduced species have already caused severe loss of natural habitats and stressed a number of endemic plant and animal species (Stuart 1990, 65-66).

China: Hong Kong's Country and Marine Parks

Hong Kong is a fine example of how pressures of urban intensification on protected areas can be resisted.

In the preface to his book *Above the World: Stunning Satellite Images from above Earth*, Sir Ranulph Fiennes (2005) describes widespread evidence of environmental damage around the globe, but makes special note of Hong Kong, "which glows at the space cameras in the orange hue that denotes fertile vegetation." Indeed, in Hong Kong, where 7 million people live in an area of little more than 1,000 sq km, some 40% of the land is in protected areas, as well as much of the marine environment. This is one of the best illustrations in the world of how natural areas can thrive within or right next to dense cities.

The urbanized parts of Hong Kong, a special administrative region of China, are among the most crowded areas in the world. The city is a thriving business and financial center whose population is projected to grow to 8.7 million by 2050. There is constant demand to open up more land for urban development.

How has this pressure been successfully resisted? First of all, Hong Kong has strong land-use planning and regulation. This is essential, but certainly not enough by itself; many other places have regulations that look good in print but are not enforced. According to Fook Yee Wong, head of Hong Kong's Country and Marine Parks, the key has been fostering a sense of community ownership by organizing citizen volunteers to carry out projects ranging from nature education to park clean-up; by involving NGOs, including those represented on government advisory bodies; by providing information to the public via publications, signage, and the Internet; and, not least, by encouraging his own staff to love nature (Wong 2005, 58-61). A citizens' support group, Friends of the Country Parks, while recognizing that Hong Kong in many respects "already does very well" believes "a comprehensive conservation policy would assist the preservation and management of biodiversity" (Dudgeon and Corlett 2004, 262).

Web sites: Hong Kong Country and Marine Parks: http://www.afcd.gov.hk (Cantonese/English). Friends of the Country Parks: http://www.focp.org.hk (Cantonese/English).

Kiribati: Impacts of dense population on a small scale

In island countries that are small in both land area and population, migration into towns from outlying areas can concentrate sewage, garbage, and toxic waste. Where there are inadequate means of disposing of it, this can have serious impacts on biodiversity. Tarawa Atoll in the island Republic of Kiribati in the Pacific Ocean is an extreme example (Connell and Lea 2002, 41, 180-185). Surrounded by a coral reef that was damaged during a major battle in World War II and subsequently by pollution and construction, Tarawa includes some of the most densely populated islands in the world. These include Betio islet, which has a land area of 1.7 sq km and a population density of over 7,000 per sq km, more than that of Hong Kong (Taoaba 2006). Although about half of Tarawa Atoll has been declared a conservation area, it is not clear whether regulations have been issued or enforced (FAO 2002). It is also unclear what measures are being taken to manage waste and prevent further damage to the reef from urban pollution. The country has limited resources (per capita income is equivalent to U.S. $1,900 a year).

4. CHALLENGES AND OPPORTUNITIES

a. Challenges

Many protected areas face serious problems from urbanization. These problems are likely to increase as the world becomes more and more urban. They will be exacerbated by other global change factors, such as overall population growth, migration, climate change, and continued spread of invasive alien species.

Local authorities often fail to take protected areas into account in planning and regulating the use of privately owned land. In many countries, such land-use decisions

are commonly influenced by bribery. In many cases, local authorities also fail to control other factors that affect protected areas, such as pollution, crime, and overdrawing of groundwater.

To overcome these problems, protected area managers need broad support from citizens, but city dwellers tend to have less and less contact with nature: the urban poor often have no access to natural areas, while more affluent people often choose to spend their leisure time in activities that separate them from nature, such as with electronic entertainment or in off-road vehicles. If people haven't experienced nature, they won't care about it. People who don't value the natural environment may vote for political candidates who have no interest in protected areas.

b. Opportunities

As rural protected areas become urban ones, opportunities arise to use them to educate the urban public about the benefits of nature. Being close to people makes it easier to earn public support.

Urban local governments can be important allies for protected areas. This is more likely to happen as a new generation of environmentally conscious city managers and planners emerges.

Several articles in *The Urban Imperative* (Trzyna 2005a) describe innovative ways of engaging urban people. These include programs in Argentina, Australia, Brazil, China, France, India, South Africa, the United Kingdom, and the United States.

5. LESSONS LEARNED

Realize that the answers are more political than technical

When asked what they would do about urbanization and protected areas, no doubt most conservationists would start talking about land-use planning, zoning, regulation of privately owned land, buffer zones, and an overarching ecosystem approach to resource management.

Although these tools are certainly useful, the reality is (a) protected area managers rarely have authority to implement them alone; and (b) such tools usually don't work well in places where protected areas are under pressure from urbanization, unless they are accompanied by political action.

Since protected area managers are usually restrained from intervening in politics, they need to make alliances with those who can.

Forge alliances

Alliances are essential for many reasons. They come in many forms, ranging from temporary coalitions around immediate issues, to formal long-term partnerships, to umbrella organizations that deal with a wide scope of subjects. Many examples are given in the case studies above and in *The Urban Imperative* (Trzyna 2005).

Some potential allies are obvious, such as other conservation organizations, both governmental and nongovernmental. Other allies may be less obvious: local agencies of many kinds, organized groups of recreational users, public health authorities, local businesses. Some allies are specific to situations, for example, in Kenya, the commercial fishing industry concerned about the decline of the Mombasa fishery; in the California desert, the military wanting to discourage urbanization near its reservations.

Talks aimed at forming alliances should begin as early as possible. Top-down bureaucracies tend to decide what they want to do and then look for partners. It works better the other way around. Intermediaries, such as NGOs and consultants expert in negotiation and convening, can be useful in this regard.

Multipurpose projects are a good way of building long-term partnerships. In Los Angeles, for example, water and conservation agencies and outdoor recreation groups found they had a common interest in restoring the natural area behind a flood-control dam. In areas around San Francisco and Rio de Janeiro, interconnecting trail systems with common signage have helped to build good relationships among agencies.

Encourage social entrepreneurs

People with entrepreneurial skills are essential to making partnerships work and seeing that creative ideas are carried out. These agents of change are not always extroverted "leaders." They often prefer to have a low profile and work behind the scenes as connectors, quiet supporters, and constructive critics. Entrepreneurs need to be identified, encouraged, and supported.

Help and engage your neighbors

Urban neighbors are much more likely to help protected areas if protected areas help their urban neighbors. In Kenya, Lake Nakuru National Park is giving direct support to local schools and is assisting the municipality of Nakuru with water and sewage facilities. In South Africa, Table Mountain National Park provides employment and life-skills training to people from neighboring shantytowns. In California, the Santa Monica Mountains Conservancy works with city officials to provide poorer areas of Los Angeles with access to nature.

Protected area agencies should think in terms of urban engagement, rather than urban "outreach," which can seem patronizing. Sherry Arnstein's (1969) widely used Ladder of Citizen Participation is useful in discussing local community involvement:

- Rung 8: Citizen control
- Rung 7: Delegated power
- Rung 6: Partnership
- Rung 5: Placation
- Rung 4: Consultation
- Rung 3: Informing
- Rung 2: Therapy
- Rung 1: Manipulation

Ideally, citizen involvement should push upward toward at least Rung 6. In some locations, going to Rung 7 or even Rung 8 might be desirable and possible, but in most countries there would be statutory and other barriers. These issues are discussed in detail in a case study from Australia in *The Urban Imperative* (Parker and Punturiero 2005, 68-72), which concludes that, currently, management of most protected areas is incompatible with community involvement much beyond Level 3.

Some conservation professionals wonder where to draw the line in serving disadvantaged populations. “We can’t become social service agencies,” one park manager complained at The Urban Imperative workshop at the 2003 World Parks Congress. Joe Edmiston, Executive Director of the Santa Monica Mountains Conservancy, responded: “Environmentalists often write off urban ecosystems, but you can’t write off people” (Trzyna 2005b, 110).

Engage political and community leaders

Organized visits are very effective ways to show political and community leaders the resources, opportunities offered, and problems faced by protected areas in urban and urbanizing settings. Such leaders include not only national, state or provincial, and local government officials, but also heads of local businesses, universities, civic associations, and opinion leaders, especially members of the press.

In working with decision-makers, choice of words is key. In one city council, a policy document that used the words “biodiversity” and “nature” was not well received, but once the term “ecological services” was substituted, the council approved the otherwise identical policy.

The term “protected area” can give the wrong impression. For many residents of urban and urbanizing regions, it implies such places are off-limits. “Conservation area” might be a better choice of words.

Decision-makers respond to numbers. The more benefits can be quantified, the better: numbers of visitors, numbers of students served, money generated from tourism that stays in the local and national economies, quantities of water generated, and so forth.

Educate conservation colleagues

The doctrines and priorities of agencies responsible for protected areas, and many of their NGO allies, typically relate to protected areas in the hinterlands. The leaders of these organizations need to be educated about the special problems faced by protected areas in urban and urbanizing situations, such as urban-based crime and urban air and water pollution. They also need to be educated about the special opportunities offered by urban protected areas. In addition to providing ecosystem services to cities, and recreation for urban residents, these opportunities include strengthening support among urban voters for large-scale conservation everywhere.

Educate and engage the public

Over the long term, the most important things that can be done to cope with urbanization are educating the public about its impacts on protected areas, and

engaging them in finding and carrying out solutions. Here are a few examples of approaches that have worked in various urban and urbanizing places:

- Work closely with NGOs sophisticated in communication.

- Keep the messages simple, for example, “This is where your household water comes from,” or “Foreigners visiting this park bring money to our local economy.”

- Appeal to loss of local history, culture, and identity as well as loss of nature.

- Don’t be afraid of appealing to emotion. People are motivated more by what they believe and feel than by what they know.

- Help people understand the environment as a whole and how the specific natural place they are visiting is an important part of it. Help them understand the world is as dependent on nature as it ever was.

- Where appropriate, help establish and support a “friends of the park” group — but before doing so, consider that such groups are not always an efficient use of staff time, and explore alternatives, such as working through existing NGOs.

Give special attention to immigrants

Many of the world’s cities have become magnets for immigrants from other countries. Three of the cities discussed above are good examples: Cape Town, Los Angeles, and Nairobi. Newcomers, even those from other parts of the same country, are often unfamiliar with the natural environments of their new homes, environments that can differ radically from their places of origin. For instance, many people moving to Los Angeles from more humid climates see California’s deserts as wastelands. Probably the most successful effort to reach out to immigrants is the United Kingdom’s Mosaic Partnership (Memon 2005, Mosaic 2006).

Demonstrate good environmental behavior

Heavily-visited protected areas in urban and urbanizing environments present an excellent opportunity to promote by example such sustainable practices as recycling, green building, and solar energy. One such opportunity is in Joshua Tree National Park in California, which has more photovoltaic solar cells than all other units of the U.S. National Park System combined.

Bypass the local establishment if you must

Bruce Babbitt, U.S. Secretary of the Interior during the Clinton Administration (1993-2001), writes that “local officials, with few exceptions, seem unwilling or unable to stand up to the onrushing forces” of urban sprawl. In U.S. terms, he concludes that the ingredients of success are grassroots demand, amplified by writers “giving voice to a strong regional identity,” effective state governors and good state legislation; and a “carrot” in the form of funds from the national government. The examples he gives are

Everglades National Park and the New Jersey Pinelands National Reserve (Babbitt 2005, 5, 175-179).

The action recently taken by Kenya's President to set up a regional development board for Nairobi within the national government is another example of recognizing a need to bypass local authorities.

Take advantage of international organizations and processes

International organizations, governmental and nongovernmental, can help with problems arising from urbanization around protected areas by providing expert advice, funding, and opportunities to exchange and synthesize experience.

In addition, formal processes under treaties and other intergovernmental agreements can sometimes provide remedies. For example, those involved in protecting Lake Nakuru National Park in Kenya are seeking help from the Secretariat of the Convention on Migratory Species of Wild Animals. Some of those concerned about the poaching of abalone off Cape Town would like to see it listed under the Convention on International Traffic in Endangered Species. The sewage problems along the U.S.-Mexico border are a major concern of the International Boundary and Water Commission, a binational agency.

Use advanced policy, management, and technical tools

There are well-tested policy, management, and technical tools that can help protected area managers cope with the challenges of urbanization. These include, for example, methods of collaboration, formal evaluation, geographic information systems, and satellite imagery that shows urbanization over time, often dramatically. Such tools could be used more widely.

Use policy and social science research

Although protected area agencies are accustomed to working with natural scientists, they are usually less accustomed to working with experts in such fields as economics, public policy, management, sociology, and health. *The Urban Imperative* has good examples of such research from Australia (Conner 2005, Senior and Townsend 2005) and South Africa (Roberts et al. 2005).

It is especially useful for protected areas to have ongoing relationships with universities in these fields and encourage faculty members and students to use their sites for education and research. A good example is the University of California's new Sierra Nevada Institute (UCM 2006), which has formed partnerships with two national parks.

Help organize and participate in training and exchanges

No formal training opportunities have been identified in methods of responding to the specific challenges and opportunities posed by urbanization to protected areas. The IUCN Cities Task Force (IUCN 2006a) is exploring how this can be done most effectively.

Informal exchanges of urban protected area staff have taken place over the past several years, either independently or under the task force's auspices, for example among Australia, Brazil, Kenya, and South Africa, but they have related more to management of urban protected areas, rather than the challenges of urbanization.

Draw on creative people and their ideas

As mentioned above (under Bypass the local establishment if you must), former U.S. Secretary of the Interior Bruce Babbitt concluded that writers "giving voice to a strong regional identity" are one of the key ingredients of success in standing up to urban sprawl.

Artists also play a key role, especially landscape and wildlife painters and photographers. Good examples could be given from each of the case studies in this paper.

Also important are ideas about what is possible in specific situations. In discussing citizen participation in their classic book on urban planning, *Communitas,* Percival and Paul Goodman (1960, 13) write that without such ideas, and concrete examples, citizen participation can be counterproductive or at best a waste of time for all concerned. If people are asked what kind of place they want to live in, "the answers reveal a banality of ideas that is hair-raising, with neither rational thought nor real sentiment, the conception of routine and inertia rather than local patriotism or personal desire, of prejudice and advertising rather than practical experience and dream."

Adapt buffer zone and wildlife corridor concepts to local circumstances

A commonly used definition of buffer zones is that they are areas peripheral to a protected area "where restrictions are placed upon resource use or special development measures are undertaken to enhance the conservation values of the area" (Sayer 1991, 2). However, a recent review of the literature (Martino 2001) found no agreement among scientists or conservationists on the role of buffer zones. There are two opposing positions. One is that buffer zones are extensions of protected areas; the other sees them as a means of integrating protected areas and people.

In any case, it is difficult to generalize about using either version of the buffer zone concept in urban or urbanizing settings. In some places, it is simply too late to think about a buffer zone: houses, shops, and even factories have been built right up protected area boundaries. Where opportunities still exist to create a buffer zone, it requires regulating the use of privately owned land, buying or trading such land or the development rights to it, or restricting development on land already controlled by a public agency.

In addition, protected areas can be buffer zones for other types of protected areas, for example, those managed for sustainable use of natural ecosystems (IUCN Category VI) can serve as buffer zones for areas managed for ecosystem protection and recreation (Category II) or wilderness protection (Category IIb).

Examples of all these approaches are given in the case studies in this paper.

Those who succeed in creating buffer zones in urbanizing areas are politically skilled, adept at seizing opportunities, and know how to raise money from public and/or private sources. They realize that, although national and state or provincial governments can provide a legal framework, land-use decisions are essentially local and require negotiation parcel by parcel.

The same principles apply to preserving wildlife corridors between protected areas; however, such corridors must be defined based on specific scientific knowledge of wildlife migration patterns.

In urban and urbanizing locations, farms and ranches are often good buffer zones, especially if farmers and ranchers are willing to adopt sustainable practices.

Promote alternatives to urban sprawl

Recognizing that many people want a suburban or semi-rural lifestyle, protected area agencies can work with others to promote alternatives to sprawl. In *The Experience of Place,* Tony Hiss (1990, 179) writes of regions that are mosaics of urban, working landscape, and wild. This is a "cake that you can eat and have too. People can build on a landscape without eating away at it." Even highly urbanized areas can be made more permeable and hospitable to wild species, as examples from Cape Town and Los Angeles demonstrate.

Take aggressive action to control invasive species

Urbanization often brings with it invasive plant and animal species that can cause enormous and sometimes irreversible damage to biodiversity within just a few years. The examples from South Africa and Australia show how protected area agencies and local authorities can act aggressively to control them. The Web site of the Global Invasive Species Programme (GISP 2006) has much useful information and links to national and local Web sites.

Host conservation nerve centers in urban protected areas

What could be called "conservation nerve centers" have been established in several urban protected areas. Such centers promote synergy among agencies and NGOs by housing their offices and providing meeting space. One, in Cape Town's Kirstenbosch National Botanical Garden, is described above. In California, there are similar complexes in the Golden Gate National Recreation Area in San Francisco.

Work for transparency

Almost everywhere in the world, political influence undermines efforts to control unwise development around protected areas. Sometimes this influence is bought with outright bribery or even threat of violence. More often, it is obtained by trading favors or giving money to election campaigns. As former U.S. Vice President Al Gore (2006) puts it, elected officials simply "stay on the good side of those who have the money to give."

In many countries, this is a very sensitive, even a dangerous issue. However, opportunities may arise to report corruption or make alliances with those who can do so. There is a growing international anti-corruption movement (TI 2006).

Accept that it's probably not "already being done"

An all-too-typical response to hearing about an innovative program is "it's already being done" or "we're already doing that." Helping our neighbors? "We're doing that." But look at the serious commitments taken on by Lake Nakuru National Park in Kenya and the Santa Monica Mountains Conservancy in California. Controlling invasive species? "It's already being done." But look at the aggressive programs in Australia and South Africa.

Chances are that much more could be done than is being done.

6. CONCLUSIONS

Bridging the gaps

The conservation community should pay more attention to the challenges and opportunities posed by urbanization, but four gaps make it difficult to do so:

- Protected area agencies tend to be dominated by large parks in the hinterlands. The special needs of protected areas in urban and urbanizing settings are often not well appreciated within these agencies, nor are the benefits such areas provide to large numbers of citizens, and the opportunities they offer to build public support for protected areas everywhere.

- Separate sets of people and institutions work on urban and conservation issues. It is difficult to bring them together because they have different points of view and are unaccustomed to working with each other. This gap exists between sets of agencies and NGOs; and in research, publications, professional education, and professional associations, as well as in practice.

- In addition, separate groups of people and organizations tend to work on green (nature protection) and brown (pollution control) issues. In urban and urbanizing locations, these issues often coincide.

- There is often a lack of trust between protected area managers and those with whom they engage. The latter include local authorities and interests (businesses, farmers, traditional communities, etc.), conservation NGOs, and recreational users such as mountaineers and campers.

The conservation community should consider how these gaps can be bridged in different situations. At the international level, the Task Force on Cities and Protected Areas of IUCN's World Commission on Protected Areas (IUCN 2006a) has made a start. The 4th IUCN World Conservation Congress, to be held in Barcelona, Spain, in 2008, offers an opportunity to engage others in these discussions.

Making urban protected areas a global conservation priority

Global criteria for priority conservation targets, such as those listed in IUCN World Parks Congress Recommendation 5.04, “Building Comprehensive and Effective Protected Area Systems” (IUCN 2003), emphasize “large intact ecosystems” and “globally threatened species.” Protected areas in urban and urbanizing settings may not meet these biological criteria, but have a critical role in building and sustaining public support for conservation. This is especially true of protected areas in or near cities that are political, economic, or media centers. Protected areas in urban and urbanizing environments should be factored into global conservation priorities.

Sharing experience

There are no cookie-cutter solutions to the problems and opportunities posed by urbanization. Answers depend on national and local situations. However, there are many innovative ideas worth sharing. This can be done through international exchanges, telling stories of success (and failure) in depth, and holding seminar-workshops to exchange experience. This has started to happen under IUCN auspices.

Moving from awareness to action

The importance of building awareness and understanding among leaders and the general public is recognized in the conservation movement, but how can understanding lead to action? This is the biggest challenge, and it is essentially a political one.

7. RESOURCES FOR FURTHER INFORMATION

Resources on case studies, trends, and impacts of urbanization

For the case studies, Web sites for general information are listed at the end of each section (e.g., Kenya). Web sites related to individual citations in the case studies are included, when available, in the references listed below under References and Bibliography.

There is extensive literature in print and on the Web on such forms of urbanization as urban sprawl and urban infill, and on such impacts of urbanization as habitat fragmentation, edge effects, human-wildlife conflicts, and fire along the wildland-urban interface. Cited in the case studies or under Lessons Learned are print publications and Web sites related to lesser-known impacts of urbanization such as light pollution; tools such as buffer zones and wildlife corridors; and themes such as climate change, population trends, and corruption.

Broadly focused resources

There is no central source of information on the impacts of urbanization on protected areas.

The Web site of the Task Force on Cities and Protected Areas of the IUCN World Commission on Protected Areas has articles, news, and links to other resources on connections between cities and conservation: http://www.InterEnvironment.org/pa.

There are numerous books about cities in a global context. Good recent surveys include Reader 2004 and Amin and Thrift 2002, although they pay little attention to the natural environment. Hardoy et al. 2001 focuses on cities in developing countries. Lewis Mumford (1938, 1961) had a sensitive appreciation of the interdependence of urban, rural, and wild; his frequently cited works on cities are classics.

Among Web sites on urban affairs, Urbanicity is especially useful: http://www.urbanicity.org.

Google Earth, http://earth.google.com, provides detailed satellite imagery for most of the places mentioned in this paper, although using it requires patience for first-time users. Especially striking are the images of the wildland-urban interfaces along the boundaries of Nairobi (Kenya) and Table Mountain (South Africa) national parks, the Tijuana River National Estuarine Research Reserve (California), and Hong Kong's Country and Marine Parks (China), as well as the ribbon development along the north side of Joshua Tree National Park (California).

8. NOTES

1. President, California Institute of Public Affairs / InterEnvironment; Task Force Leader, Cities and Protected Areas, IUCN World Commission on Protected Areas; former IUCN councilllor and commission chair; Senior Associate, School of Politics and Economics, Claremont Graduate University; Fellow of the World Academy of Art and Science. Address: P.O. Box 189040, Sacramento, California 95818, USA. Ted_Trzyna@InterEnvironment.org.

2. Population and economic data for countries are from Population Reference Bureau 2006, in which per capita income is figured using the purchasing power parity method. Unless otherwise noted, population figures for subnational units are from Brinkhoff 2006 or government sources.

3. Terms used to describe the size or character of urban areas are rarely precise. Following are some generally accepted definitions. They relate to space and people, rather than governmental jurisdictions (i.e., in some countries cities, towns, villages, or even hamlets are local government entities).

- Human settlement: Embraces all forms of settlements, from hamlets to megacities
- Hamlet: A settlement smaller than a village
- Village: According to Reader (2004, 26), only farmers live in villages, while a key defining feature of a town or city is that farmers *don't* live in them
- Town: A compactly settled area, usually larger than a village but smaller than a city
- City: A large or important populated place larger than a town
- Micropolis: A growing smaller city removed from metropolises
- Metropolis: An important city and the densely populated surrounding areas that are socially and economically integrated with it (the word is from the Greek, meaning mother city)
- Urban agglomeration: Includes a central city and neighboring cities linked to it, e.g., by continuous built-up areas or commuters. All such areas with populations of one million or more are listed by size in Brinkhoff 2006.

- Megacity: An urban agglomeration of 10 million or more
- Megapolis or mega-region: An integrated network of metropolitan and micropolitan areas; these are discussed under “The Californias”
- Megalopolis: See Note 4

4. Elizabeth Baigent (2004) explains that the term “megalopolis,” meaning a large city, was in use in the general press by the 1820s. However, it was employed in the 20th century by Patrick Geddes and Lewis Mumford to “denote an overlarge city doomed to destruction.” Later, Jean Gottmann (1961) used it to describe a large and highly connected urban region in the northeastern U.S.

5. Size of protected areas is based on current information from the agencies responsible or, if not available from them, the World Database on Protected Areas (UNEP 2006).

6. IUCN has defined six protected area management categories, based on primary management objective. These are explained in the Web site of the World Database on Protected Areas (UNEP 2006), which lists such areas by country and type. However, the Database is incomplete and is in the process of being updated. Categories for the protected areas described in this paper follow those given in the Database unless more current information has been available from reliable national sources. In addition: (a) some areas mentioned in this paper, such as urban nature reserves, are too small to be listed in the database; (b) large parts of some protected areas have management objectives different from those of the unit as a whole; for example, most of Joshua Tree National Park, an IUCN Category II protected area, is wilderness (IUCN Category 1b). Revision of definitions of IUCN protected area categories is under consideration.

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