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157

Human-wildlife conflict in Africa

Causes, consequences and management strategies

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Cover image:
The crocodile is the animal responsible for the most human deaths in Africa
Fondation IGF/N. Drunet (children bathing); D. Edderai (crocodile)

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Foreword

Conflicts between humans and wildlife have occurred since the dawn of humanity. They occur on all continents, in developed as well as developing countries, yet the problems vary according to the particular environment and people's way of life. This publication concentrates on Africa, where problems are particularly common and pronounced. Rural and peri-urban communities are affected all over the continent.

Consequences of human-wildlife conflict can be both direct, including injury and death from encounters with dangerous animals, and indirect, including loss of crops and livestock and damaged infrastructure. Crocodiles, hippopotamuses, elephants, lions and baboons are among the main aggressors. However, not only these large animals pose threats to human beings; mass aggregations of birds, rodents or insects can devastate agricultural crops in a short time.

Human-wildlife conflicts have become more frequent and severe over recent decades as a result of human population growth, extension of transport routes and expansion of agricultural and industrial activities which together have led to increased human encroachment on previously wild and uninhabited areas. Competition for the available natural habitats and resources has increased. Moreover, the effects of climate change are exacerbating these conflicts.

In times of progressive loss and degradation of natural habitats and biodiversity, wildlife populations are declining in many areas where human-wildlife conflicts occur – sometimes as a result of indiscriminate retaliation following conflicts with humans, as well as through unregulated hunting exceeding sustainable harvest levels. A decline in populations of prey species of large predators may attract carnivores towards domestic livestock, further aggravating human-wildlife conflict. It is therefore fundamental to monitor wildlife populations and maintain them at adequate levels, and to restore natural habitats and the balance between predator and prey species.

The aim of this publication is to facilitate the coexistence of humans and wildlife and assist affected communities in applying best management practices. There is no simple solution. Different circumstances, beliefs and values are to be taken into account in evaluating which approaches are best.

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Acronyms

AWF	African Wildlife Foundation
AVIGREF	Community Associations for the Management of Wildlife Services (Benin)
CBNRM	Community-Based Natural Resource Management
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
ECOPAS	Ecosystèmes protégés en Afrique sahélienne (European project)
GEF	Global Environment Facility
HACSIS	Human Animal Conflict Self Insurance Scheme (Namibia)
HWCC	Human-Wildlife Conflict Collaboration
IRDNC	Integrated Rural Development and Nature Conservation
IUCN	International Union for the Conservation of Nature
NGO	Non-governmental organization
PAC	Problem animal control
WWF	World Wide Fund for Nature
WWF SARPO	WWF Southern Africa Regional Programme Office

1. Introduction

According to the 2003 International Union for the Conservation of Nature (IUCN) World Parks Congress, human-wildlife conflict occurs when wildlife requirements encroach on those of human populations, with costs both to residents and wild animals (IUCN, 2005).

Human-wildlife conflict has been in existence for as long as humans and wild animals have shared the same landscapes and resources (see below).

Human-wildlife conflict does not occur only in Africa. Nowadays human-wildlife conflict exists in one form or another all over the world. Conflict between humans and crocodiles, for example, has been reported in 33 countries spanning the tropics and subtropics, and the problem probably exists in many more.

All continents and countries, whether developed or not, are affected by human-wildlife conflict. However there is an important distinction to be made between the level of vulnerability of agropastoralists in developing countries and that of well-off inhabitants of developed nations.

This review focuses on Africa, where human-wildlife conflict is particularly prevalent, even in countries with a higher average annual income. Crocodiles still kill people in the Lake Nasser area in Egypt and within towns in Mozambique; leopards still kill sheep within 100 km of Cape Town, South Africa, and lions kill cattle around the outskirts of Nairobi, Kenya.

In terms of the scale of their impact on humans, it is the smaller animals, occurring in vast numbers, that have the greatest impact. The red locust has been responsible for famines across vast swathes of Africa for centuries. Annual losses of cereals caused by the red-billed quelea have been estimated at US$22 million (Bruggers and Elliott, 1989). In Gabon, the number of overall complaints about grasscutters far surpasses those relating to any other animal species, including the elephant (Lahm, 1996).

However, the larger herbivores (elephants, buffalo and hippopotamus), large mammalian carnivores (lions, leopards, cheetahs, spotted hyenas and wild dogs), and crocodiles are traditionally seen as the animals representing the greatest threat to humans and responsible for the majority of human-wildlife conflicts. This may be due to the fact that local communities often regard the large wild animals as government property, as was the case under previous colonial legislation, and therefore feel prohibited from dealing with the problem themselves (WWF SARPO, 2005). The impact of the activities of large mammals on farmers and their livelihoods is enormous and even traumatic when people are killed. These incidents are often newsworthy, and generally attract the attention of political representatives who demand action from governments.

Baboons can cause significant damage to timber forest plantations and are also considered a pest, notably in Southern Africa.

For these reasons this survey deals with larger herbivores and carnivores, particularly animals that have been investigated in FAO studies, i.e. elephants, lions, baboons and crocodiles.

A BRIEF HISTORY OF HUMAN-WILDLIFE CONFLICT

Fossil records show that the first hominids fell prey to the animals with which they shared their habitats and shelters. Forensic evidence has recently demonstrated that the "Taung skull", perhaps the most famous hominid fossil, which was discovered in South Africa in 1924, belonged to a child who was killed by an eagle two million years ago (Berger and Clarke, 1995; Berger, 2006).

Crocodiles have an ancient lineage dating back to the Mesozoic era, and have remained functionally unchanged for longer than the human species has been in existence. It is likely that crocodiles have attacked and eaten humans and their predecessors in Africa over the last four million years. Egyptian historical records reveal that in 2000 BC, hippopotamuses in the Nile delta in Egypt fed on cultivated crops while crocodiles ate livestock and occasionally humans. It is no coincidence that the Egyptian god of evil was depicted as the crocodile-headed deity Sobek.

Human-elephant conflict is as old as agriculture in Africa (Treves and Naughton-Treves, 1999). San or Bushman rock art in Africa frequently portrays people fleeing from predators or other large animals. Pre-colonial and early nineteenth century historians describe areas in Africa and other parts of the world where elephants invaded human cultivations, causing food shortages and leading to the displacement of settlements (Barnes, 1996). Some authors blame colonialism for ruining traditionally harmonious relations between wildlife and local people (see for example, Adams and McShane, 1992). In actual fact, from the eighteenth

E. KAESLIN

Human-elephant conflict is as old as agriculture in Africa (a rural inhabitant tries to scare away elephants by throwing stones at them)

to the mid-twentieth centuries, the larger African mammals were regarded more as a resource to be exploited than a major threat. Ivory formed a cornerstone of the early trade with Europe and the Orient, while meat and hides were essential products both for the African people and colonialists alike. In the twentieth century, with the expansion and development of modern agriculture, exploitation diminished and interaction with large wildlife species came to be increasingly dominated by conflict.

HUMAN-WILDLIFE CONFLICT AROUND THE WORLD

North America

In the northern United States, bears raid dustbins in the national parks and even at the edge of towns, waking up residents and creating disorder in the streets. Deer collisions with automobiles in the United States injure an average of 29 000 people annually and cause more than US$1 billion in damages (USDA, 2006). In Alberta, Canada, over a period of 14 years (1982–1996) wolves killed 2 806 domestic animals, mainly cattle but also some dogs, horses, sheep, chickens, bison, goats, geese and turkeys. In Idaho, Montana and Wyoming in the United States, wolves killed 728 animals, mainly sheep and cattle, over a similar time period (1987–2001) (Musiani *et al.*, 2003).

Europe

Several wildlife species are responsible for causing substantial damage both to crops (wild boar, wild rabbit, hare, wood pigeon) and to regenerating forests (red deer, roe deer). For this reason, some of these species are labelled as "pests" and can be killed outside of the hunting season.

The monetary losses can be high (Table 1). In France in 2007, damage caused by wild boar and deer to agricultural crops amounted to €22 million to €23 million (E. Dion, personal communication). Large predators such as bears, wolves or lynx are regularly responsible for attacks on sheep or even cattle. In Slovenia, damage caused by large predators has increased since 1993. In the period 2000–2003, 1 440 claims were made for predation damage, mostly to livestock. The compensation for damage exceeded €706 000 (Adamič, Jerina and Jonozovič, 2004).

In the United Kingdom, badgers are known to spread bovine tuberculosis to dairy cattle (Wilkinson *et al.*, 2004).

TABLE 1
Cost of damage caused by bears and wolves in western Europe in 1997 (€)

	Bears		Wolves	
Country	**Total cost**	**Cost per bear**	**Total cost**	**Cost per wolf**
Austria	8 640	346	–	–
France	31 510	3 501	151 690	3 792
Greece	130 870	1 091	708 330	2 833
Italy	33 600	448	1 095 164	2 434
Portugal	–	–	407 010	1 163
Spain	70 562	882	173 970	1 160

Source: After Fourli, 1999.

Australia

The losses in productivity caused by wild rabbits eating forage are substantial: fewer livestock, lower wool clippings per sheep, lower lambing percentages, lower weight gain, lower wool quality and earlier stock deaths during periods of drought. At the end of the 1980s, the cost in production losses was estimated to be US$20 million per year for the pastoral districts of South Australia alone, and US$115 million per year for the wool industry over the whole of Australia (Williams *et al*., 1995).

Australian farmers have always regarded kangaroos as a pest, because they damage crops and compete with sheep for forage. Every year the federal government authorizes the culling of a certain number of kangaroos. Without taking into account the animals killed by farmers and poachers, a possible total of nine million kangaroos are eliminated each year (Therin, 2001).

Asia

Large feline predators (tigers, leopards, lions and snow leopards) and elephants are the principal sources of conflict in Asia. In India, in the state of Himachal Pradesh, near the Kibber Wildlife Sanctuary, wild carnivores – mainly snow leopards – killed 18 percent of the total livestock holdings in 1995 (Mishra, 1997). In the state of Gujarat, near the Gir National Park and Sanctuary, the Asian lion and leopard hunt prey such as buffalo, cattle, pigs and dogs (Vijayan and Pati, 2002). In the southern state of Karnatake, the overall annual damages caused by large tigers and leopards near the Bhadra Tiger Reserve, are reported to be approximately 12 percent of total family livestock holdings. In addition, elephant damage to crops accounted for an average loss of 14 percent of total annual production (Madhusudan, 2003). In China, the rural inhabitants of the mountain area of Simao, near the Xishuang Banna Nature Reserve, claimed that elephant damage reduced the community's annual income in 2000 by 28 to 48 percent, and that the total economic losses between 1996 and 1999 amounted to US$314 600 (Zang and Wang, 2003).

2. Human-wildlife conflict: the issues

TYPOLOGY OF HUMAN-WILDLIFE CONFLICT

Human deaths and injuries

Human deaths and injuries, although less common than crop damage, are the most severe manifestations of human-wildlife conflict.

The hippopotamus was long considered to be responsible for more deaths than any other large animal in Africa. Nowadays, however, the crocodile seems to have superseded the hippopotamus (Box 1). Crocodile attacks are common for the following reasons.

- The numbers of large crocodiles are high, and their distribution range is wide. In addition, crocodile populations can recover relatively rapidly when afforded protection.
- Crocodiles can live in close proximity to people without being detected, while lions or elephants cannot.

In addition, the number of attacks is certainly much underestimated, for the following reasons.

- In some cases there is no evidence of a person having been taken by a crocodile, especially if that person was alone at the time of the attack.
- Many deaths due to crocodile attacks go unrecorded because human births and deaths are often not registered. In addition, attacks on humans by crocodiles are often ascribed to witchcraft (Musambachime, 1987). This may be because crocodiles often seem to be wary of humans, yet will attack without warning from an invisible position. There is a widely held belief that crocodiles that attack humans are not real crocodiles, but either creatures constructed by witches, so-called "human crocodiles", or crocodiles controlled by a spirit as a result of a curse.

Large mammalian carnivores are responsible for numerous fatal attacks on humans, and large herbivores, such as elephants, are also involved in human deaths every year, albeit more rarely. Elephants and hippopotamuses will rarely deliberately attack humans; in most cases deaths occur while people are protecting their crops against raiding animals (usually at night); when people accidentally come into close contact with the animals, especially on paths near water at night; or when people encounter injured animals whose normal sense of caution is impaired.

Baboons are seldom, if ever, dangerous to humans, though they are capable of inflicting serious wounds to dogs. But they will intimidate humans – especially women – in urban areas, when scavenging for food.

BOX 1

Fatal wildlife attacks in Africa: some figures

Crocodiles

Unpublished documents from Zambia (Zambia Wildlife Authority records) and Mozambique (Magane, 2003) show that, although data collection is sparse, crocodiles are the animals causing the greatest number of deaths. In Mozambique, many deaths go unreported, simply because of the difficulty for many people of getting to a government office. A rough estimate would be around 300 people killed by crocodiles per year nationwide (FAO, 2005).

In the United Republic of Tanzania from 1999 to 2004, crocodiles killed at least 28 people and injured 57 others in the Jukumu Wildlife Management Area, an area of about 500 km² comprising 22 villages located in the northern buffer zone of the Selous Game Reserve. In one village alone 11 people were killed in a single year (Baldus, 2005).

In Namibia, 157 crocodile attacks on humans and cattle were recorded in 2005 by community rangers in registered conservancies in the Caprivi region (Murphy, 2007).

Large felines

In Mozambique, lions killed 70 people in Cabo Delgado province over a period of 18 months between 2001 and 2002. Most of these people were out at night protecting their crops from elephants (FAO, 2005).

In the United Republic of Tanzania, home to the world's largest lion population, lion attacks are widespread. Between 1990 and 2004, lions killed at least 563 people and injured more than 308. The problem has increased dramatically over the past 15 years, with the majority of cases occurring in the southern part of the country (Packer *et al.*, 2005). A few lions are known to eat humans, such as the notorious Osama which killed at least 34 people along the Rufiji River (Baldus, 2008).

In South Africa, between 1996 and 1997, at least 11 (possibly more) illegal immigrants making their way on foot from Mozambique across the Kruger National Park were reportedly killed by lions. This tragic situation may have occurred many times over the years (Frump, 2006). Information gathered from the Ugandan Game Department archives (1923–1994) reveals that leopards and lions have preyed on hundreds of humans in Uganda over the past several decades. Analyses show that lion attacks were more dangerous than leopard attacks (Treves and Naughton-Treves, 1999).

Elephants

More than 200 people were killed in Kenya over the last seven years by elephants alone (WWF, 2007a). In Ghana, ten people were killed by elephants in the last five years, in the Kakum conservation area. In the densely populated Caprivi region of Namibia, a population of 5 000 elephants – one of the largest free-ranging population of elephants – was responsible for twice as many aggressions as lions in the 1990s, and attacked over a larger area (O'Connell-Rodwell *et al.*, 2000).

FONDATION IGF/D. ROQUES-ROGERY

The crocodile is the animal responsible for the most human deaths in Africa

D. CORNELIS

Some lions are known to prey on humans regularly

Finally, road accidents caused by wildlife can result in human death and injury. This phenomenon, well known in Europe and the United States (Mouron *et al.*, 1998; Scanlon, 1998) is also a serious problem in Namibia where vehicle collisions with greater kudus are responsible for more human deaths than attacks by both crocodiles and elephants.

Destruction of crops

Crop damage is the most prevalent form of human-wildlife conflict across the African continent. The occurrence and frequency of crop-raiding is dependent upon a multitude of conditions such as the availability, variability and type of food sources in the area, the level of human activity on a farm, and the type and maturation time of crops as compared to natural food sources.

A wide variety of vertebrates conflict with farming activities in Africa. These include birds, rodents, primates, antelopes, buffalos, hippopotamuses, bush pigs and elephants. While it is widely recognized that in most cases elephants do not inflict the most damage to subsistence agriculture, they are generally identified as the greatest threat to African farmers (Parker *et al.*, 2007). Elephants can destroy a field in a single night raid. Most peasant farmers are unable to deal with the problem of elephant damage themselves and governments rarely offer any compensation (see Box 2).

In most cases the adult male elephants carry out crop-raiding, while the female herds prefer to keep away from areas inhabited by humans. It is worth noting that during dry seasons elephants can also break into storage bins and steal grain. When they do so the consequences for food security are even more serious.

Hippopotamuses can cause substantial damage to fields while feeding at night. Cultivations at risk are those close to rivers or lakes such as rice, vegetables and other crops grown on river banks during a drop in the water level, or crops grown directly in the water such as bourgou (*Echinochloa stagnina*), which is cultivated in the Niger river.

Primates cause widespread damage to plantations of exotic trees by stripping away bark (Box 3). Baboons and vervet monkeys are also highly skilled at raiding

J. ANDERSON

Elephants can destroy a field in a single night

BOX 2

Elephant crop-raiding in Africa

Within the Zimbabwean portion of the AWF Zambezi Heartland, elephants are estimated to be responsible for up to three-quarters of all crop damage caused by wildlife (Muruthi, 2005). In the area around the Kakum National Park in Ghana, approximately 80 to 90 percent of crop-raiding is attributed to elephants (Osborn and Parker, 2002). Every year the 500 households living close to the Kakum Conservation Area lose about 70 percent of their food crops to elephant raids alone (Barnes *et al.*, 2003).

In the Djona hunting zone in North Benin, 34 percent of surface crops were destroyed by elephants during the agricultural season from 2001 to 2002. A survey carried out in the area revealed that 80 percent of those interrogated had lost crops to elephant raids every year over the previous four years (Alfa Gambari Imorou *et al.*, 2004). Table 2 shows the actual agricultural losses caused by elephants to crops in selected regions.

TABLE 2

Percentage of total agricultural output reported lost as a result of elephant crop-raiding in some African countries

Country	Zone	Year of study	% lost
Gabon	Gamba	1996	0.75
		1998	0.3–6.2
Ghana	Red Volta	1996	8.6
Malawi	Kasungu	1981	6.3
	Liwonde	1997	8.8
Mozambique	Maputo	1996	10.2
Uganda	Kibale	1996	21
Zimbabwe	Binga	1994	11.7
	Sengwa		5.4

Source: after Hoare, 1999.

food crops. They will even chew on young tobacco or wheat stems to extract the juice and then spit out the fibre, in the same way that humans chew on sugar cane.

Finally, this study assesses the competition between humans and crocodile over fish. This competition can take various forms: the theft of live fish from fishing nets and associated damage to fishing gear; and crocodiles encroaching on and diminishing fish catches. Two species are particularly implicated: the Nile crocodile (*Crocodylus niloticus*) and the African slender-snouted crocodile (*Crocodylus cataphractus*), a smaller species of fish-eater with limited distribution, which is also capable of taking fish from nets and destroying fishing gear. The third African species of crocodile (*Osteolaemus tetraspis*), is small, docile, and not in any way a threat to humans.

J. ANDERSON

Storage bins damaged by elephants

BOX 3

Bark stripping and its consequences

In southern and eastern Africa three species of baboon are responsible for stripping bark from trees: the chacma baboon, the yellow baboon and the olive baboon. In the same region, at least three species of monkey are also known to be bark strippers: samango monkey (*Cercopithecus mitis labiatus*), blue monkey (*Cercopithecus mitis*) and Syke's monkey (*Cercopithecus mitis albogularis*).

These animals raid timber plantations for the inner bark of several species in the genera *Pinus, Eucalyptus, Acacia* and *Cupressus*. The areas most affected by the problem are in South Africa and Zimbabwe. Between 2002 and 2006, baboons damaged 5 percent of the total area of pine plantations in South Africa, and 8 percent of the total pine planatation area in Zimbabwe. Initially the animals targeted young pine trees, selecting species that were lower in tannin. However, over the following five years they went on to strip all the species of pine grown, as well as eucalyptus, and to some extent even wattle. Eventually they targeted all the trees in the plantations, including the mature pine trees. Damage in all cases was similar; the baboons bite into the bark, lifting and pulling it from the tree. Then they use their front teeth to scrape off and eat the soft inner layer of cambium. If the pine tree is not killed by ring barking, fungal and borer damage make the attacked parts unmarketable. More importantly, stripping of the bark forces the tree to coppice, and it no longer produces the straight grain timber for which it was selected. The baboons attacked the base of gum trees, in a similar way to porcupines. They also pulled newly planted wattle seedlings from the ground. The motivation for this behaviour is unknown and a range of hypotheses have been raised. Bark stripping may simply be a bad habit, or else the fulfilment of some dietary or medical requirement, or other non-food stimuli.

Attacks on domestic animals

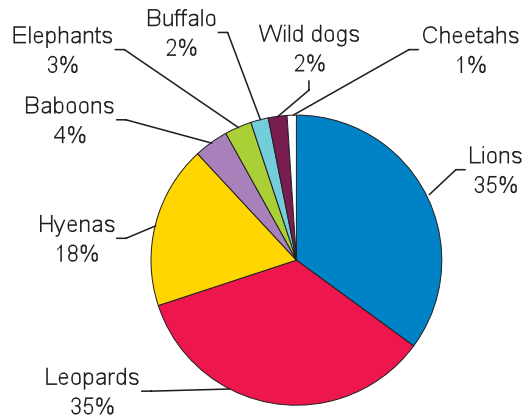
Another adverse effect of the human-wildlife conflict is the killing of domestic animals by predators. The number and type of domestic animals killed by wildlife varies according to the species, the time of year, and the availability of natural prey. In the savannah and grasslands where pastoralism remains the main source of livelihood for many people, attacks on livestock are an issue. On a national level the losses are hardly significant, but for the individual stock owner, they can be catastrophic. For a small-scale herder, losses to wildlife can mean the difference between economic independence and dire poverty.

Large carnivores are the principal culprits. Patterson *et al.* (2004), for example, analysed 312 attacks claiming 433 heads of livestock over a four-year period on two neighbouring arid-land ranches adjoining Tsavo East National Park in Kenya. Lions were responsible for 86 percent of the attacks while the rest were carried out by hyenas and cheetahs. Lions and hyenas attacked mainly cattle and at night, whereas cheetahs nearly always took smaller sheep and goats. Some other smaller carnivores are also responsible for attacks on livestock. In Bénoué National Park in Cameroon, the civet is the main predator, causing losses to livestock income of about 18 percent (Weladji and Tchamba, 2003). Nevertheless, mammalian carnivores are not the only group involved (Figure 1).

On the Gokwe communal land, situated next to the Sengwa Wildlife Research Area in Zimbabwe, 241 livestock were killed by baboons, lions and leopards between January 1993 and June 1996 over a study area of 33 km², which contributed respectively to 52, 34 and 12 percent of their kill. Their predation techniques are different; baboons attack by day and usually kill small stock such as goats and sheep, while lions and leopards attack at night, and lions kill larger prey such as cattle and donkeys (Butler, 2000).

FIGURE 1

Domestic animals killed by wild predators in the African Wildlife Foundation (AWF) Samburu Heartland, Kenya (% of reported deaths)



Source: Ogada and Ogada (2004).

Of the three species of crocodiles in sub-Saharan Africa, the Nile crocodile is the most common, and the main culprit in attacks on livestock. This large species (with a mass of up to 1 000 kg) lives off aquatic and terrestrial prey species. In the Jukumu Wildlife Management Area in the United Republic of Tanzania, for example, 53 cows were killed and 41 injured by crocodiles in a single year (Baldus, 2005).

Transmission of diseases to livestock and/or humans

Serious diseases are known to be transmitted by wildlife to domestic livestock and possibly also to humans (i.e. rabies). Scavengers and predators, such as spotted hyenas, jackals, lions and vultures, also play a role in disseminating pathogens by opening up, dismembering and dispersing parts of infected carcasses. For example, predators ingest anthrax spores together with carcass tissue; the spores are then widely disseminated in the predators' faeces (Hugh-Jones and de Vos, 2002).

The key role played by the African buffalo as maintenance host of foot-and-mouth disease was identified in the late 1960s. The important role played by wildebeest in the maintenance and seasonal shedding of alcelaphine herpesvirus-1 has also been established (Bengis, Kock and Fischer, 2002).

It is now generally accepted that the parasite *Theileria parva parva* is a cattle-adapted variant of *Theileria parva lawrenci* borne by buffalo. Infection with this organism, which is generally silent in buffalo, causes high mortality rates in cattle (Bengis, Kock and Fischer, 2002). Cattle farming is therefore risky where buffalo and a suitable vector are present. In the Gaza Province of Mozambique, 228 cows – of which 76 were pedigree Brahmans – died from theileriosis as a result of contracting the disease from buffalo (FAO, 2005).

D. EDDERAI

Wildlife can transmit diseases to domestic livestock when they share the same grazing areas

In lowland areas of Africa, where the winters are mild, African horse sickness is endemic in zebra populations, which are ideal maintenance hosts.

Sylvatic rabies has been diagnosed in 33 carnivorous species and 23 herbivorous species (Bengis, Kock and Fischer, 2002). Endemic rabies has been identified in certain communal burrow-dwelling wildlife species, such as yellow mongoose, bat-eared fox and jackal.

Brucellosis, caused mainly by *Brucella abortus* biotype 1, has been observed to infect predominantly hippopotamuses and waterbuck in several free-range ecosystems (Bengis, Kock and Fischer, 2002).

Adverse interaction with other species (endangered or highly valuable)

Attacks on other wildlife species are only viewed as forms of conflict in countries – such as Botswana, Namibia and South Africa and to a lesser extent Zambia and Zimbabwe – where game ranching and game conservancies have developed populations of high value ungulates, such as sable and roan antelopes, which are managed for trophy hunting or live sale. In most cases, the landowners are wealthy and can generally resolve conflict problems themselves.

Competition between wild species occurs when habitats become degraded, especially by elephants (see Box 4).

BOX 4

Impact of elephants on habitat and sympatric wildlife

In southern Africa, where savannah animal communities tend to be dominated by a few large species such as hippopotamuses, buffalo, zebras, wildebeest and especially elephants Cumming (1982), Craig (1992) and Martin (1992) have calculated that elephant densities need to be kept below about 0.5 animals per km² in order to maintain existing woodland canopy cover intact. This level is far lower than the densities currently occurring in many of the national parks and safari areas, which were estimated to range from 0.25 to 2.12 animals per km² in 1991 (Cunliffe, 1996).

The destruction of habitats by elephants can even jeopardize the survival of sympatric wildlife species. In Waza National Park in Cameroon, the destruction of *Acacia seyal* by elephants near the ponds where they gather at the end of the dry season endangers the survival of the giraffes that feed off this tree. In Chobe National Park in Botswana, there has been concern over the survival of the indigenous Chobe bushbuck as a result of elephants altering vegetation patterns along the Chobe River (Ben-Shahar, 1999). In the Caprivi region of Namibia, the damage caused by large numbers of elephants to habitats is likely to be detrimental to the development of populations of roan, sable and tsessebe after rainfall. The same phenomenon was also observed in the Sebungwe region in Zimbabwe where all three species have been in decline for a number of years. This coincided with a period in which the elephant population has continued to grow and has brought major structural changes to habitats (Martin, 2005).

Overgrazing by wildlife occurs sporadically. Leaving aside the question of enclosed areas, unfenced natural habitats may be subject to overgrazing if natural cycles are left unmanaged or if external intrusions such as human disturbances are allowed. The decline in populations of elephants and other herbivores in Tsavo National Park, Kenya, was a result of discrepancies between the park's carrying capacity, which was lowered by severe drought, and the overabundance of wildlife due to mismanagement practices (Waithaka, 1997).

Other manifestations of human-wildlife conflict

Baboons raid gardens and food in lodges and camping areas and can cause an immense nuisance in small urban settlements if left unchecked. On the Zimbabwean side of the Zambezi valley, baboons are a major menace in bush camps and small towns such as Chirundu and Victoria Falls, and in wildlife camps and lodges where they are not actively controlled. They pull thatch from thatched-roof buildings and will even intimidate wide-eyed tourists in order to steal food directly from the tables they occupy (Gaynor, 2000; Kansky, 2002).

In the Gourma region, located in sub-Saharan Mali, livestock and humans compete for water with a herd of about 500 elephants. Aside from the fatal accidents which could occur due to the close and often dangerous encounters with the elephants at the ponds, this competition can lead to loss of cattle, particularly at the end of the dry season or in times of drought.

Finally, elephants can damage infrastructures such as ponds or tracks in national parks (Alfa Gambari Imorou *et al.*, 2004) and elsewhere. In Namibia, for example, the main problem caused by elephants in the arid northwest is damage to water installations whereas, in the rest of the country, it is damage to crops (Government of Namibia, 2007).

CAUSES OF HUMAN-WILDLIFE CONFLICT

A set of global trends relating to human populations, habitat evolution and animal distribution and behaviour has contributed to the escalation of human-wildlife conflict worldwide.

Human factors

The following factors are among the main causes of human-wildlife conflict in Africa.

The requirements of human development. The main cause of human-wildlife conflict worldwide is the competition between growing human populations and wildlife for the same declining living spaces and resources. The transformation of forests, savannah and other ecosystems into agrarian areas or urban agglomerates as a consequence of the increasing demand for land, food production, energy and raw materials, has led to a dramatic decrease in wildlife habitats.

This is particularly true in Africa where the human population came close to tripling in the four decades from 1960 and where, in consequence, settled

agriculture has spread to more marginal rangelands leading to encroachment into wildlife habitats. Under these conditions, conflict between wildlife and local communities has inevitably increased (Siex and Struhsaker, 1999; Muruthi, 2005; Tjaronda, 2007). This is perfectly illustrated by the conflict between humans and elephants. It is estimated that about 80 percent of elephant range lies outside protected areas. This habitat is rapidly being eliminated and fragmented by intensified agriculture, and is resulting in one of the most serious human-wildlife conflicts.

Another consequence of the opening of new lands and villages into areas that were once private wildlife refuges is the creation of new bush paths between these settlements. This generates a greater traffic of pedestrians, increasing the risk of contact with wild animals. Other activities organized around the new settlements such as the daily collection of wild fruit, berries and fuelwood, fishing, and poaching further expose the inhabitants to encounters with wildlife.

Access to water is another essential human requirement. Permanent settlements are developed close to a source of water, but this prevents access to wildlife. Despite efforts to develop alternative water supplies, in rural Africa water is still most frequently drawn from natural or man-made surface waters, i.e. rivers, lakes and dams. People are dependent on access to these water bodies for their daily needs: collection of water for domestic use, washing clothes and utensils and bathing. Many of these water bodies are habitats for crocodiles and with growing human populations needing to make use of water "the scene is set for increasing human-crocodile conflict" (Fergusson, 2002).

Migration of peoples for reasons of security or food safety. Drought, floods, civil unrest, natural disasters or war disrupt the normal production and distribution of food, resulting in famines. This phenomenon is on the increase; the number of food emergencies in Africa each year has almost tripled since the 1980s. Across sub-Saharan Africa, one in three people are undernourished (McCarthy, 2006). These factors spur the continuing migration of rural people into areas where resources could be obtained, and which are frequently occupied by wildlife. The resultant occupation of the habitat of wild animals by humans leads to conflict.

War and civil unrest force people to seek shelter in protected areas where they exert a strong pressure on natural resources and enter into competition with wildlife. For example, it is estimated that more than 120 000 people displaced by civil war are currently living in protected areas in Mozambique (Government of Mozambique, 2006). Political upheaval can have indirect repercussions on the human-wildlife conflict situation. Funding for the Campfire organization in Zimbabwe, which acts as custodian for wildlife in communal areas, has been seriously depleted as a result of the current crisis in the country. Rural populations are forced to take matters into their own hands. They resort to the illegal hunting of problem species with incorrect calibre weapons, with the result that they often wound the animals. They use agricultural pesticides to control lions, leopards and to some extent also baboons.

The human population surrounding the Kakum Conservation Area in Ghana has increased dramatically during the past 30 years. During the 1970s farmers migrated in large numbers from other regions of the country to take advantage of the ideal cocoa-growing conditions at the edge of the forest. This has contributed directly to the increase in levels of conflict between humans and elephants.

In Africa waterside communities have grown in recent years at a rate of about 3 percent per annum (Bryant, 2005), partly as a result of migration of peoples displaced by drought conditions and by political upheavals (McGregor, 2004; Bourdillon, Cheater and Murphree, 1985). In Zimbabwe, the human population occupying fishing camps along the shore of Lake Kariba doubled during the 1991–1992 drought and subsequently increased again as people were displaced by land reforms and economic collapse. More people are exposed to the risk of attacks by crocodiles now that the numbers of residents drawing water directly from the lake, and the numbers of people informally engaged in subsistence and commercial fishing in the area, have increased.

Successive droughts and the subsequent desertification of the land have led to the substantial migration of northern populations southwards. These migrants often settle near the last pockets of natural resources within protected areas where they are particularly exposed to human-wildlife conflict. Conflict is most acute in zones in which a wide range of species coexists with high-density human populations (Ogada *et al.*, 2003). A good example is the Tsavo National Park buffer zone (about 20 000 km²) in Kenya, which supports almost 250 000 people (Patterson *et al.*, 2004).

Attitudes and perceptions. In general rural Africans have little sympathy for wildlife and see animals purely in terms of their meat value. This is illustrated by the fact that, in several Bantu idioms, the word *nyama* used for wildlife also means "meat". Rural communities consider wildlife, particularly large mammals, as threats to their safety and food security. This adverse perception is particularly strong near protected areas where the presence of wildlife populations inflicts daily costs on local communities, which can erode local support and tolerance. In turn, local people can develop a negative attitude towards reserves and wildlife, exacerbating conflict and undermining conservation efforts.

Landowners, traditional land-users and even wildlife managers still sometimes deliberately kill species they consider a threat –from elephants to birds such as *Quelea* sp. – with a view to reducing the population or even exterminating species within the locality.

The continued negative attitude of communities towards wildlife emanates from losses (including human life, property, crops and even agricultural land set aside for conservation purposes) incurred by wildlife. The association of wildlife with damage is now so integrated in the minds of local populations that they will even blame beneficial species. In Zanzibar, for example, Siex and Struhsaker (1999) found that red colobus monkeys, which villagers in agricultural areas adjacent to the Jozani Forest Reserve blamed for serious losses of coconut crops,

actually increased final tree yields. By pruning away small, immature coconuts, they accounted for a 3 percent increase in the potential harvest. Primates are also a source of income in that they attract tourism.

Elephants seem to crystallize the hatred of rural communities. Field reports from across Africa describe local antipathy to elephants beyond that expressed for any other wildlife. People living in central African forests "fear and detest" elephants (Barnes, 1996). Farmers in Zimbabwe display "ingrained hostility" to elephants, which are the "focus of all local animosity toward wildlife" (Wunder, 1997). Rural Ugandans complain bitterly about elephants, except where they have been eradicated (Hill, 1998).

In the minds of most rural communities in Africa, lions are considered a pest that should be eliminated. In a study conducted in and around Queen Elizabeth National Park, Uganda, 37 percent of 156 respondents thought that the best way to deal with stray lions entering the village was to kill them; 35 percent said a fence should be erected around the protected area, and only 28 percent felt people should be taught how to avoid lions (Driciru, 1999). In Cameroon, of 236 herders questioned from 10 different villages along the borders of Waza National Park, 50 percent had a negative perception of lions (Bauer, 2003b). In the Niger, 81.5 percent of 154 people questioned between 2000 and 2006 in 87 villages in the peripheral zone of the W transboundary Park had a negative attitude towards predators, and 14 percent confirmed that they would kill predators (Hamissou and di Silvestre, 2008).

In some instances, the eradication of large carnivores has been linked to sports hunting and in others to systematic widespread elimination by trained agents (Treves and Naughton-Treves, 1999). Well known examples are the professional hunters who frequently kill wild dogs because they regard them as excessively cruel and efficient as predators. National veterinary services and herders will poison lions and hyenas in order to protect livestock development.

The tolerance level for human-wildlife conflict varies according to the species or the location. For example, African people have a complex but generally negative perception of crocodiles (McGregor, 2004). There seems to be almost no indigenous knowledge remaining about the role of crocodiles in the natural ecosystem, in contrast to the perceptions held by older generations concerning the roles of many terrestrial wildlife species (Musambachime, 1987). Consequently, people simply see crocodiles as a threat and as a source of hardship because they attack livestock and compete for fish. However, there are a few exceptions, mostly linked to ancestral and totemic respect. These include the sacred crocodiles at Lakes Bazoulé and Sabou in Burkina Faso and other parts of French-speaking West Africa (Kpera, Mensah and Sinsin, 2007). In these localities a human death or injury is better tolerated if it is caused by a crocodile rather than an elephant or a lion. In the first case people consider that it was the human who encroached on the habitat of the crocodile while, in the second case, the animal intruded into the human environment.

Local beliefs have an impact on the occurrence of some conflicts. As previously cited, attacks on human victims by crocodiles are often ascribed to witchcraft

(Musambachime, 1987). The fatalism associated with witchcraft may, to some extent, explain the apparent lack of concern shown by communities in their daily exposure to crocodiles. Described as "carelessness" by Sichali (2000), this lack of any attempt to take even rudimentary precautions against attack, together with the repeated and frequent exposure to risk in the face of known and often recently demonstrated risk is difficult to understand. Wanjau (2002) refers to the same phenomenon in Kenya.

In rare cases, some local populations have a favourable perception of wildlife. Rural villagers who live close to the Waza National Park in Cameroon appreciate nature's intrinsic value and agree with the need to protect forests and their wildlife inhabitants for future generations. Their positive attitude towards conservation arises from their use of natural resources, such as regulated harvesting of non-timber forest products, the use of waterholes and fishing (Bauer, 2003a). In the United Republic of Tanzania, several villagers in the Rufiji district (which has experienced 92 lion attacks on humans since 1990) reported a high tolerance for lions because the lions helped to control the bush pig population (Packer *et al.*, 2006).

Specific activities. Some activities particularly expose local populations to human-wildlife conflict. Box 5 shows an obvious gender bias in this respect.

Growing interest in ecotourism and the increasing presence of humans in protected areas are exacerbating conflict between humans and wildlife. The local capacity to manage and regulate public access and large-scale use of protected areas is weak. Equally, tourists are unaware of the dangers of wild animals. Each year, tourists are killed or injured by elephants, crocodiles, lions or other wildlife species in protected areas. In 2004 an American tourist was killed by a crocodile while in a canoe at Mana Pools National Park (Zimbabwe) on the Zambezi River (United States Department of State, 2007). Two British tourists were killed and another seriously injured by a rampaging elephant in Zimbabwe's Hwange National Park on 24 March 2007 (Vasagar, 2007).

Habitat factors

The gradual loss of habitat has led to increasing conflict between humans and wildlife. As wildlife range becomes more and more fragmented and wildlife is confined into smaller pockets of suitable habitat, humans and wildlife are increasingly coming into contact and in conflict with each other. In the Kakum Conservation Area in Ghana, the forest area available to elephants has decreased by about half since the 1970s. This explains why the density of elephants (about 0.6/km^2) is now higher than in most other West African forests, thereby resulting in increased crop-raiding activities (Barnes *et al.*, 2003).

Nowadays, the last suitable habitats generally survive inside protected areas. This explains why conflicts are particularly common in reserve buffer zones where healthy wildlife populations stray from the protected area into adjacent cultivated fields or grazing areas.

BOX 5

Gender and human-wildlife conflict

Most of the people killed by large mammals are men, and many of these incidents occur at night. In Kenya, alcohol was found to be a key factor in one third of the deaths; victims were drunk and returning home from the bar. Others died protecting their crops, herding cattle, walking at night between neighbouring villages or even taking the prey of large felines. Information gathered from the Ugandan Game Department archives (1923–1994) reveals that twentieth century agropastoralists regularly tried to scavenge from leopard and lion kills (Treves and Naughton-Treves, 1999). This hazardous behaviour led to many human deaths.

An analysis of conflict with lions in the United Republic of Tanzania showed that, above ten years of age, men are at much greater risk of being attacked by a lion than women. This is because men are more likely to tend cattle or forage for bushmeat, and they are more likely to walk around alone at night. Men are also attacked when trying to retaliate against man-eating lions, often relying solely on nets and spears. Although men are more at risk overall than women, both men and women are almost equally at risk when working in fields or near their homes (Packer *et al.*, 2006). Attacks on men however were often less lethal than attacks on women and children.

On the other hand, the gender roles prevalent within traditional African society and the fact that children and adolescents perform many household tasks expose more women and children to crocodile attacks. Attacks on women and children are more frequently fatal than attacks on adult males.

A study on human-wildlife conflict carried out by AWF in the Chobe-Caprivi corridor between Botswana and Namibia has also revealed a gender disparity relating to how people are affected by wildlife conflict, which is linked in turn to the ownership of resources. Men tend to view the lion as the most problematic animal because men mostly own livestock, which are prime targets for lions. In Botswana the highest compensation rates are paid for livestock losses. On the other hand, women, who generally tend crops, rank the elephant as the most problematic animal because of its tendency to raid crops. Households headed by women are most affected by wildlife conflict, with over 85 percent reporting damage to crops and 95 percent reporting attacks on livestock. This is because in most cases these households are relatively poor and unable to invest in mitigation measures such as building strong fences and animal enclosures (Muruthi, 2005).

In this respect, border zones of protected areas may be considered population sinks; critical zones in which conflict is one of the major problems (Woodroffe and Ginsberg, 1998).

Several factors can contribute to the modification of the quantity or quality of wildlife habitats. The two most important factors are the following.

- ***Impact of human activities***. Human activities such as husbandry, agriculture, fishing, the development of infrastructure or even of tourism or wildlife protection itself, can dramatically modify wildlife habitats either directly or indirectly (Box 6).

BOX 6

Human activities and wildlife habitat

In Kenya, the fencing of farms to keep wild animals away has created physical barriers for migratory species. Conflicts can arise when migratory species such as zebras and wildebeest, which had previously migrated without any hindrance, destroy fences and crops in a bid to reclaim their traditional routes from dispersal areas to the parks. The subdivision of state and trust ranches, sold as smallholdings and cultivated with commercial horticultural crops, also creates a source of conflict. Land-use fragmentation resulting from the development of small-scale farming has intensified the human-wildlife conflict in many areas where wildlife is abundant, such as Samburu, Trans-Mara, Taita and Kwale in Kenya (Kenya Wildlife Service, 1996).

The San people of the communal Na Jaqna conservancy are critical of the small-scale farming project currently implemented in Namibia for the same reason (Damm, 2008).

The eradication of the tsetse fly (*Glossina* sp.) and the development of anti-trypanosomiasis treatments have opened up abundant new grazing territories for cattle herders in areas that were once inhabited uniquely by wildlife. The concomitant eradication of *Simulium* sp., vector of *Onchocerca volvulus*, responsible for onchocerciasis (river-blindness), has allowed farmers to settle in new areas. With the geographical extension of human activities, especially husbandry, it is increasingly common for livestock and wild ungulates to share the same grazing fields. This is an obvious risk for the transmission of pathogens. The single most important factor contributing to the outbreak of diseases associated with wildlife is probably the direct or indirect (vector) contact of infected wild hosts or populations with susceptible domestic animals at the interface of their ranges, i.e. where mixing has occurred on common rangeland, or where other resources such as water are shared (Bengis, Kock and Fischer, 2002).

Baboons have been eradicated from some areas of South Africa and Zimbabwe, particularly where they interfered with commercial agriculture, to the extent that the current distribution range of baboons is largely restricted to areas that are not used for commercial cropping and horticulture. Baboons are now concentrated instead in areas where subsistence agriculture is practised, where they can raid crops grown by subsistence farmers.

Subsistence and commercial fishing are common in most African waters. Fishing was formerly concentrated in places where the rewards in terms of fish catch were highest and where crocodiles – being naturally wary of the presence of humans – were scarce. As a result crocodiles tended to inhabit areas that were less heavily fished, where they were less likely to be disturbed. But the growing demand for fish has meant that these areas have also become subjected to fishing pressure. The chances of contact and conflict between humans and crocodiles have increased as a result.

The surge in dam construction from the 1940s to the 1980s undoubtedly benefited wild crocodile populations inhabiting the rivers prior to closure. Damming a river

vastly increases the extent of shoreline where water is relatively shallow (hence warmer), eutrophic and stable in depth. Dams create ideal habitats for the survival of juvenile crocodiles. The construction of dams also attracts human inhabitants, thus favouring potential human-wildlife conflict.

In recent years, the successful recovery of declining or near extinct species, through wildlife management and protection from poaching and overexploitation, has created new conflicts. Effective protection and habitat management within the Kakum National Park in Ghana, for example, has increased the population of the forest elephant and resulted in many elephants straying out of the reserve into local villages. Similarly, elephant conflict in Zimbabwe has largely been brought about by the overpopulation of elephants, which have totally swamped the state wildlife land provided for them, and overflowed into the adjacent communal lands. It is here that most of the elephant damage is reported; elephants compete for water and take advantage of easy food found there. As regards crocodiles, the small individuals that survived the hunting pressures of the 1950s and 60s are now large breeding animals in the size class, which feed on large mammalian prey including livestock and even humans (Fergusson, 2002).

- ***Natural factors***. Droughts, bush fires, climatic changes and other unpredictable natural hazards can contribute to a decrease in suitable wildlife habitat and therefore affect the occurrence and extent of human-wildlife conflicts (Box 7). Similarly, the seasonal modification of habitats due to rainfall can also have an impact on human-wildlife conflict (see Box 8).

One of the main consequences of the loss of habitats is the decrease in natural resources available for wildlife. The destruction of natural vegetation around protected areas and in some cases the total disappearance of buffer zones force herbivore species to feed in cultivated fields. This phenomenon is on the increase because the growth rate of cultivated areas is high at the periphery of protected areas. The W-Arly-Pendjari (WAP) ecological complex (Benin, Burkina Faso, the Niger) in West Africa lost 14 percent of its natural savannah vegetation within 30 km of protected area boundaries (Clerici, Hugh and Grégoire, 2005). Likewise, species with a more diversified regime such as primates will encroach on cultivated areas when the availability of natural food diminishes, as demonstrated in the case of baboons stripping bark from trees (Box 9).

The decline in numbers of natural prey is one of the major reasons why carnivores shift their diets to livestock, which are easier to capture and have limited possibilities of escape (Mishra *et al.*, 2003; Patterson *et al.*, 2004). Indeed many authors recognize that when native prey is abundant, wild predators consume it in preference to livestock. Possible causes and consequences of the impoverishment of prey populations are given in Box 10.

BOX 7

Natural hazards, habitat and human-wildlife conflict

The severe drought that struck Zimbabwe and South Africa from 1982 to 1983 caused baboons to raid exotic timber plantations. Over the last 30 to 40 years baboons had only been known to cause damage to timber plantations in a few localized sites in the mountainous regions of these two countries. The drought forced the baboons to search out alternative marginal foods, and caused the bark-stripping problem to surface in "hot spots" several kilometres apart. Thereafter over the following 10 to 12 years the problem seemed to spread relatively slowly from these hot spots into other adjacent forest areas until the next major drought hit in 1993 and 1994, and the problem escalated again.

The rise in lion attacks observed in the United Republic of Tanzania in 1999 was largely attributed to the El Niño floods of 1997 and 1998, which caused wildlife in many parts of the country to seek higher ground. As the floods receded in 1999, the wild ungulates returned to their normal ranges, leaving the lions with insufficient prey (Packer *et al.*, 2006).

In 1983, prolonged drought in Ghana caused severe bush fires. The fires reduced the quality of most wildlife habitats and forced some animals to seek refuge in adjacent habitats and farms. In Kakum, many wild animals were spotted in cocoa farms close to the park boundary; the resultant damage, especially to cocoa pods, forced the government to take immediate action by sending the military to the communities to force wildlife back to the park.

BOX 8

The seasons, habitat and human-wildlife conflict

Seasonal changes in rainfall are directly linked to the intensity of predation. Patterson *et al.* (2004) have demonstrated that in Tsavo National Parks in Kenya, lions are more likely to attack livestock during seasonal rains. The same tendency was found in Cameroon around Waza National Park (Bauer, 2003b) and in the Niger in the peripheral zone of the W transboundary Park (Hamissou and di Silvestre, 2008). During dry seasons, ungulates are easily found and killed close to the limited number of water sources; when rain fills seasonal pools, ungulates disperse, driving lions to prey on easier targets.

Near Sengwa Wildlife Research Area in Zimbabwe, in contrast, wild predators were found to be more likely to attack domestic animals in the dry season (Butler, 2000).

Lion attacks on humans in the United Republic of Tanzania also appeared to be highly seasonal, with most cases occurring in the harvest season of March, April and May. During this period, most people were attacked while sleeping in makeshift huts to protect their crops from nocturnal crop-raiding pests such as bush pigs (Packer *et al.*, 2006).

In Kakum, Ghana (Barnes *et al*., 2003), the Democratic Republic of the Congo (Mubalama, 2000) and the Caprivi region of Namibia (Hanks, 2006), wildlife – particularly elephants – were observed to raid crops most frequently during the major rainy season between May and June, when the crops began to mature.

Nile crocodiles are poïkilothermic reptiles, and are most active when temperatures are highest; this often coincides with the time of year when water levels are lowest and population densities of the crocodiles and their aquatic prey sources are thus highest. Fisherfolk who prefer to fish at periods of low water because the catches are greater are thus more exposed to contact with crocodiles during the warm season. This is confirmed by the more numerous crocodile attacks observed in the warmest months.

BOX 9

The link between monospecific tree plantations and bark-stripping baboons

In Zimbabwe, the elimination of natural vegetation to plant large tracts of monoculture vegetation such as pine, eucalyptus and wattle (*Acacia* sp.) was instrumental in fuelling the baboon problem. Aside from wild granadillas (*Passiflora* sp.) and a few indigenous plants and insects, natural food is scarce in these afforested areas, and therefore the baboons are more likely to eat the cambium layer beneath the tree bark. Extensive single species plantations also make it difficult for the baboons to move in search of alternative foods, even though the food value in the cambium is minimal, in fact insufficient to sustain a baboon in the long term. The link between these monocultures and bark stripping by baboons is now confirmed by the fact that troops whose territory lies adjacent to indigenous forest or commercial farming land did not cause the same kind of damage, whereas those adjacent to other afforested areas did. The same phenomenon was observed in South Africa where the isolated plantations were largely unaffected and conversely those adjacent to one another suffered the most damage.

BOX 10

Possible causes and consequences of the decrease in natural prey hunted by wild carnivores

Poaching, hunting and fishing

The dramatic rise in lion attacks in the United Republic of Tanzania since 1990 is most likely due to the human population increase in the country (from 23.1 million in 1988 to 34.6 million in 2002) and an associated increase in illegal bushmeat hunting that has eradicated much of the lions' prey from outside the protected areas. This in turn

Continues

Box 10 continued

has forced the lions to enter villages and feed on livestock (Barnett, 2000; Nowell and Jackson, 1996).

Similarly, in the Kakum Forest Reserve in Ghana, wildlife was frequently killed as a result of intensive logging and hunting before the area was officially gazetted as a national park in 1989. This adversely affected the number of prey, thereby forcing predators to look for food outside the reserve.

The human-crocodile conflict is sometimes attributed to the overfishing of the crocodile's primary food source, which led crocodiles to hunt other prey, including humans (FAO, 2005). However this argument oversimplifies a more complex relationship between predator and prey; fish constitute only 33 percent of the diet of adult crocodiles.

Agriculture and husbandry

The decline or local extinction of wild herbivore populations is partly linked to growing densities of livestock populations, the competition for forage and consequent overgrazing (Butler, 2000).

Diseases can cause a huge decline in the numbers of prey. In the 1890s, an outbreak of rinderpest killed millions of zebras, gazelles and other African wildlife. As a result lions had to look elsewhere for food, and attacks on humans increased across Kenya.

Natural characteristics of wildlife

The intrinsic characteristics of wildlife, such as food preferences, migration patterns, wariness or predation behaviour, can influence human-wildlife conflict.

Some particularly palatable food items can attract wildlife over rather long distances. This is the case for some crops. For instance, according to Barnes *et al.* (2003), of the crops planted outside the Kakum National Park in Ghana, maize and cassava particularly attract elephants. Maize is also the crop most frequently raided in the area around the Djona hunting zone in North Benin. It is raided twice as often as cotton, and far more often than groundnut and millet (Alfa Gambari Imorou *et al.*, 2004).

In Benin, elephants raiding maize and groundnuts were found to be attracted by mature wild fruits such as shea nuts (*Vitellaria paradoxa*) and *Parkia biglobosa* pods growing in the crop fields (Kidjo, 1992; Mama, 2000). Likewise elephants are attracted by wild fruits growing alongside cultivated fruits such as mangoes (*Mangifera* sp.) or guavas (*Psidium* sp.) in central Burkina Faso (E. Compaoré, personal communication).

The species as well as the availability of wild prey can have an impact on potential human-wildlife conflict. A study in the United Republic of Tanzania (Packer *et al.*, 2005) showed that the number of humans attacked by lions in each district was closely linked to two factors: the abundance of medium-sized prey (zebras, hartebeest, dikdik or impala) and the abundance of bush pigs. Lion attacks

were most common in areas where normal prey was scarcer and bush pigs were abundant (Packer *et al.*, 2006).

Species that migrate seasonally on a regular basis, such as elephants, are known to use the same traditional routes. Establishing cultivations along these routes exposes them to being raided. This has been observed for instance in Mali and Togo where the most serious damage occurred in villages located along the elephants' habitual paths (Maïga, 1999; Okoumassou *et al.*, 2004).

The wariness of wild species can explain why some fields are more prone to raiding than others. For example, baboons and monkeys tend to raid smaller fields surrounded by large trees and rocky hillocks, which provide cover for them. These vantage points provide them with easy escape routes and make it difficult for guards to follow them. On the other hand, when, for various reasons, wild species lose their fear of humans, this can also cause conflict. Elephant numbers have increased within many parks and reserves. Some individuals have grown accustomed to harmless contact with tourists, have lost their fear of people and will visit communities and destroy life and property. Crocodiles are naturally wary of humans, especially in places where they are frequently hunted, but they can learn that people pose no threat. Food is a strong stimulus and a reward for learning; it is certainly possible for animals to acquire the habit of eating humans.

A particular aspect of lion behaviour known as "surplus killing" certainly exacerbates human hostility towards lions and enhances conflict. Like any other large felid species, once a lion breaks into a fenced enclosure it is often tempted to kill more –sometimes many more – domestic animals than it can eat (Nowell and Jackson, 1996). In addition, some lions become specialized and are chronic livestock killers (Frank, 2006).

Behaviourally, the Nile crocodile is an opportunist ambush predator which has evolved many physical attributes to optimize its success in this role. Adult crocodiles will feed on any animal they can capture or find animals that are freshly dead ranging in size from fingerling fish to a hippopotamus. Humans are less powerful and slower in water than any similar-sized wild mammal and are therefore easy prey.

The physiological (e.g. rutting) or health (e.g. injuries, diseases and parasitism) status of a wildlife species may affect its normal behaviour and subsequently create conflict with humans (Box 11).

CONSEQUENCES FOR HUMANS

The consequences of the human-wildlife conflict are more serious in the tropics and in developing countries where livestock holdings and agriculture are an important part of rural people's livelihoods and incomes. In these regions, local people with a low standard of living are particularly at risk, as are agropastoralists who depend exclusively on production and income from their land.

Safety issues

Injuries to people mostly occur as a result of chance encounters with elephants, buffalo, hippopotamuses and lions, usually along paths between dwellings and

BOX 11

The impact of pathology and physiology on human-wildlife conflict

Behavioural modifications can be generated by different phases of reproduction. In the male elephant, during the rutting or "musth" period, plasma testosterone levels increase, characterized by the enlargement of, and copious secretions from, the temporal gland, persistent dribbling urine, and also increased aggression towards other elephants and objects (Poole and Moss, 1981). Male aggressiveness during the rutting period has also been observed in lions. In the same way, females become aggressive in the presence of youngsters – particularly elephants and lions – and may even attack humans.

Numerous authors have invoked the infirmity theory (injured, sick or old lions) to explain instances of human-eating and marauding by lions (Kruuk, 1980). Patterson and Neiburger (2000) examined evidence for this hypothesis in the skulls and mandibles of the Tsavo and Mfuwe human-eaters: all the cats had sustained serious and chronic injuries to the teeth and jaws. However, although the infirmity theory used to explain human-killing is widespread, this explanation may be too simple. In Uganda only 14 percent of 275 lion attacks documented in the archives were attributed to wounded animals, suggesting that a majority of healthy animals were involved in attacks on humans.

Wounded buffalos are known to be particularly dangerous. This is not the case for crocodiles; there is no evidence to suggest that attacks by crocodiles on humans are carried out only by old, sick or otherwise challenged individuals.

Wild animals may become irritated as a result of disease or parasites. In Mozambique, lions affected by TB after a contamination from buffalos, were noted to be more prone to prey on livestock than healthy individuals. Observers report that buffaloes parasitized with *Oestrus* sp. larvae will attack humans for no apparent reason. Encephalitis and parasitic diseases affecting the brain will significantly alter the behaviour of the sick animal; the exacerbation of aggressiveness and loss of fear of humans due to rabies is a well-known example.

a water source. Contact with crocodiles when bathing or collecting water more frequently result in death than in permanent injuries, nevertheless many of these permanent injuries cause significant disability. The amputation of limbs is quite frequent, as are attacks that result in major scarring, often on the trunk.

The dramatic consequences of these attacks go well beyond the unfortunate victim, for they have a repercussion on the whole community. At national level, the loss of a human life due to human-wildlife conflict has little consequence, but at the family and village level, it can be catastrophic. The death of a family member caused by a wild animal is a traumatic experience. For a poor peasant family in a developing country, the death or injury of the bread-winner can mean the difference between a secure life for all and one of destitution where simple day-to-

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Wildlife can be a safety concern for people in rural areas

day survival becomes a priority. If a mother is killed, the child has to take her place in carrying out family chores and has lost the opportunity to receive an education. In time, this will have consequences for her children and their future.

The danger of wildlife attacks restricts some activities considered "at risk" such as walking at night, guarding crops, bathing, etc. Security measures are then taken at the community level. In certain areas of Kenya, for example, such as Taita Taveta District that borders Tsavo National Park, curfews have been imposed on villagers to protect them from the uncontrollable movement of wildlife through villages and farms (Kimega, 2003).

Food security

In most of rural Africa, food security is precarious, relying intimately on the results of a single cropping season or on the sale of livestock.

Although on a national scale, the loss of two hectares of maize to elephants in a single night means nothing, to the family concerned, it can mean the loss of their food supply for the year, and the difference between self sufficiency and destitution. This consequence is particularly acute where governments do not have the capacity to pay compensation for losses. The capacity of smallholder subsistence farmers to cope with these losses can vary even within the same region. The owners of large farms situated on the edge of Kibale National Park in Uganda can employ guards or create a crop buffer zone to separate vulnerable yields from the forest edge, by cultivating less palatable plant species or using the land for pasture. These options are not available to subsistence farmers, who have less choice in their land use and cannot afford to pay for guards (Naughton-Treves, 1997).

The elephant is one of the wild species that can jeopardize the livelihoods of entire families by causing substantial damage to crops (see Box 12). The impact of elephant raids can be dramatic, but other species cause more insidious losses. In areas where subsistence agriculture is practised, baboon raids on grain crops

BOX 12

Elephants as a threat to food security

In some semi-arid rural farming areas of Zimbabwe and Kenya, elephant damage to food crops accounts for 75 to 90 percent of all damage caused by large mammals (Hoare and Mackie, 1993). In the area around the Kakum National Park in Ghana, about two-thirds of all farms that are susceptible to crop-raiding are devastated each year. It is estimated that about 300 households lose up to 60 percent of their food crops annually to elephants alone. The main crops damaged are maize, cassava, cocoyam, plantain and yam (Barnes *et al.*, 2003). At the periphery of the Djona hunting zone in North Benin, in 2002, elephants destroyed 50 ha (of an estimated total of 152 ha), representing an overall loss of 61 tonnes of crops for the villages. A survey showed that 80 percent of people questioned has registered damages each year over the last four years (Alfa Gambari Imorou *et al*., 2004).

It has been estimated that the annual cost of elephant raids to crops ranges from US$60 (Uganda) to US$510 (Cameroon) per affected farmer (Naughton, Rose and Treves, 1999). In the Caprivi region of Namibia between 1991 and 1995, elephant crop damage amounted to a total economic loss of US$39 200 (O'Connell-Rodwell *et al.*, 2000). At Kakum in Ghana, crop loss caused by elephants is estimated at US$450 per farmer.

In Mali, the average area of crops destroyed by elephants is estimated at 1 000 hectares per year, i.e. a financial loss of about US$195 230. In some areas, these damages forced the families affected to abandon their traditionally cultivated fields (Maïga, 1999; Marchand, 1999). In Togo, around Fazao Malfakassa National Park, the area raided between 1994 and 1999 was estimated at 204 ha, and represented a loss of 252 tonnes of yam, maize, rice, sorghum and cassava, with a gross value of US$77 730 (Alfa Gambari Imorou *et al.*, 2004). In the area around the Bénoué National Park in Cameroon, communities lost an estimated 31 percent of their annual crop income and 18 percent of their annual livestock income per household (Weladji and Tchamba, 2003).

Elephants can also damage food stores during the dryer months following the main harvest. The loss of this stored food is considered far more disruptive to farmers than the raiding of crops while they are still growing in the fields, because so much damage can be done to a concentrated food source in a short space of time. Damage to field crops can be repaired by planting replacements if the damage occurs early in the season, but food stores cannot be replaced until the following growing season.

such as maize, sorghum and millet, as well as fruits and some vegetable crops can reduce the yield by a significant percentage. Around the Bénoué National Park in Cameroon, the species inflicting most of the crop losses are elephants, baboons, green parrots and warthogs (Weladji and Tchamba, 2003).

Likewise, the loss of a family's small herd of cattle to lions can effectively destroy that family's wealth and way of life. For rural populations, domestic animals are not only their main resource through production of manure, milk, meat, and live sales, but are also their only source of wealth (means of saving, source of income, social role). Predators such as lions often kill numerous domestic animals such as cattle in one raid, and can devastate a household's food security. In the Kanamub area of the Namibian Sesfontein Conservancy, farmers lose as many as three to four animals a month to lions, leopards, hyenas and cheetahs (Tjaronda, 2007).

The evidence relating to the direct competition for fish between crocodiles and humans is limited (Games, 1990). Crocodiles consume about 0.5 percent of annual fish production or from 6 to 10 percent of the amount caught by artisanal fisheries. Most (about 67 percent) of these fish are scaleless non-commercial fish species avoided by subsistence and artisan fishers.

On the other hand, crocodiles threaten food security by causing damage to fishing nets, particularly the thin monofilament gill nets with small to medium mesh size frequently used by artisanal fishermen. McGregor (2004) reports that at Lake Kariba in Zimbabwe, over 80 percent of a sample of fishermen's nets was damaged by crocodiles. The holes torn in the nets are often extensive – up to several metres in diameter. This reduces the fish offtake for the fishermen, and repairing or replacing the damaged sections requires significant amounts of time, effort and resources.

Economic and social costs

Agriculture. As illustrated in Box 12, crop damage not only affects farmers' ability to feed their families, it also reduces cash income and has repercussions for health, nutrition, education and ultimately development. When crop damage occurs finances are diverted from these areas to cover the cost of staple foods.

Forestry. Baboons stripping bark from exotic timber plantations may also have economic consequences such as:

- a decrease in the mean annual increment;
- a loss of overall productivity in the affected area which ranges from 25 to 32 percent (Van der Lingen, 2001; S. Valintine, personal communication);
- losses due to subsequent infestation by other pests (*Sirex* wood wasp in South Africa, and fungus such as *Lasiodiplodia* sp. responsible for "blued" timber which is more difficult to market because of its abnormal colour);
- increased cost of harvesting and log-making;
- an increase in replanting and protection/management costs;
- an increase in handling time and effort, and in the wastage off the saw;
- expenses linked to the cost of controlling the problem.

Although the loss of wood volume and value has been minor in economic terms, in Zimbabwe baboons have also damaged and raided non-timber forest products such as granadillas (passion fruit) or mushrooms which are interplanted with the pine trees and provide a significant additional income.

BOX 13

Livestock depredation – some figures

In Zimbabwe many areas of traditional agropastoralism bordering protected areas are exposed to livestock depredation. In the Gokwe communal land, neighbouring the Sengwa Wildlife Research area, the average annual loss per household, between January 1993 and June 1996, amounted to 12 percent of the total family's income. Although baboons killed more animals, lions caused the greatest economic loss because of the high value of cattle (Butler, 2000).

In the Caprivi region of Namibia, lion depredation between 1991 and 1994, totalled US$70 570 (O'Connell-Rodwell *et al.*, 2000). In Cameroon, around Waza National Park, as many losses are due to predators as to disease (respectively US$220 000 per year and US$225 000 per year). Lions alone are responsible for losses of US$130 000, primarily to cattle herds, that is approximately US$370 per stockbreeder (Bauer *et al.*, 2001).

In the Niger, the economic losses for all those interviewed between 2000 and 2006 in the peripheral zone of the W transboundary Park are estimated at approximately US$149 530. This loss equals an annual average of US$138 per year per person (Hamissou and di Silvestre, 2008).

Depredation by carnivores does not only affect vulnerable rural communities, but also commercial cattle ranches. In Kenya, two commercial ranches adjoining Tsavo East National Park lost an average of 2.4 percent of the total herd per annum over a four-year study period, to lions, spotted hyenas and cheetahs. This represented 2.6 percent of the herd's economic value and amounted to losses of US$8 749 (Patterson *et al.*, 2004).

There is little documentation of the number, type and value of domestic animals killed by crocodiles, but these indicators are significant. Small stock, such as goats and sheep, are much more frequently killed than cattle but the economic loss associated with the loss of a cow is considerable. At Kibwezi, Kenya, 478 goats, 48 sheep and 50 cows were killed by crocodiles over five years representing an economic value of US$16 958 (Wanjau, 2000). Ducks and dogs are also frequent victims although their value is difficult to quantify. In addition, the cost of replacing fishing gear damaged by crocodiles is significant for a subsistence fisher.

Husbandry. Mammalian carnivores and crocodiles are responsible for the loss of a high proportion of livestock throughout Africa (see Box 13). However the number of livestock killed over a period of time is an inconsistent indicator in appraising the real impact on the livelihood of the rural population, and it would be more informative if it were related to the total family livestock holdings or total village units. The quantification of economic losses should also be related to annual household incomes or the economic value of family holdings (such as cattle or agricultural fields) (Sekhar, 1998).

The possibility of disease transmission from wildlife to livestock jeopardizes international trade. Cattle and/or meat can only be exported if they come from areas that are certified free of foot-and-mouth disease. This can only be done if the areas are free of buffalo.

Infrastructure. The economic cost of the damage caused by elephants to infrastructure in the Pama National Reserve in Burkina Faso would amount to about US$587/pond/year and US$23/track kilometre/year (Alfa Gambari Imorou *et al.*, 2004).

Sports hunting. The Department of Wildlife and National Parks in Botswana placed a new ban on lion hunting for the 2008 season, because of its concern over the number of lions killed in defence of livestock in certain areas of the country. As a precautionary measure, the Department has taken the decision not to issue any lion hunting quotas until further notice. The Department wishes to assure the public that appropriate measures are being put in place to reverse the current trends (Damm, 2007). This hunting ban represents an important economic loss for the state and the hunting operators. In 2007, the trophy fee for a lion in Botswana was US$5 000 and the costs of a lion safari ranged from US$60 000 to US$92 000, depending on the duration of the safari.

Health and employment. Nuisance encounters with small animals, exposure to zoonotic diseases, physical injury or even death caused by attacks by large animals have high financial costs for individuals and society in the form of medical treatments. Nocturnal surveillance of fields results in a higher exposure to malaria (WWF SARPO, 2005).

Human-wildlife conflict can have repercussions on employment. In Zimbabwe, for example, approximately 9 400 permanent staff and regular contractors are employed in forest plantations and sawmills (Timber Producers Federation, 2006) and a further 3 770 employees are engaged in urban primary processing of forest products. Any threat to their employment arising from baboon damage can adversely affect the financial viability of the companies concerned and is keenly felt in the economy of the recruiting area. In South Africa, the number of people directly employed in the plantation sector would range from 67 469 to 164 800, although not all of these people work in geographical areas currently subject to baboon damage.

Other economic costs of human-wildlife conflict include the time spent and cost of guarding crops from elephants and bush pigs at night, and from baboons and granivorous birds by day. The task of guarding crops at night generally falls to men; by day this is frequently the responsibility of children. Time that might have been spent on production is instead spent on farm patrols to ward off rampaging wildlife. Human-wildlife conflict thus has a wide-ranging negative social impact, which includes missed school and work, additional labour costs, loss of sleep, fear, and also restriction of travel or loss of pets (Hoare, 1992). The costs of altering human behaviour patterns is also significant and is suspected to have contributed

to the apparent difficulty of persuading communities to reduce their exposure to crocodile risk.

In view of the socio-economic impact of human-wildlife conflict on communities living adjacent to parks, it is no wonder that most of the zones close to protected areas in Africa remain poor. Communities bear a disproportionately high cost in maintaining wildlife.

Politics and media

Human-wildlife conflict frequently has a political dimension. Incidents occurring in rural areas, particularly when the outcome is fatal and no official response is made or action taken, often lead to parliamentary questions and debate. In Mozambique and Burkina Faso, human-wildlife conflict is one of the most frequently raised issues when the president goes to the field to meet the rural population. As a result human-wildlife conflict has become an issue that receives national government attention.

Crocodile attacks on humans elicit an emotional response in the immediate family of the victim but also in the public at large, albeit from different perspectives and with different intensity. This is possibly the psychological root of the fascination that such incidents seem to hold for print, visual and electronic media, particularly when the victim is of European or American origin. For example, the fatal attack by a crocodile on an 18-year old British student in Kenya led to pages of headline coverage in the European press, while a summary of eight recent deaths of Kenyan citizens received only one paragraph on an inside page of a local newspaper.

CONSEQUENCES FOR WILDLIFE CONSERVATION

Short-term: conservation of individuals

The killing of wild animals in retaliation for incidents of human-wildlife conflict is a common reaction, even though the identification of the real culprit is seldom possible. This is particularly true for predators, but also for other species (Box 14).

Mid-term: conservation of species

Several species of large carnivores such as lions or hyenas have been eliminated from a large part of their former home ranges in response to human-wildlife conflict. In Mali, lion-cattle conflicts are one of the main reasons for the drastic reduction in the number of lions. Similarly, in national parks of northern Central African Republic, the decrease in lion numbers is largely due to systematic shooting by pastoralists who enter the parks with their herds during the dry season (Chardonnet, 2002). Today, illegal persecution of predators, including poisoning, shooting and trapping, is still one of the greatest threats to these species (Muruthi, 2005).

The situation for the crocodile is different. When a crocodile kills or injures a human, the human response is to kill or remove not just the individual crocodile

BOX 14

Killing wildlife in retaliation

In Northern Kenya, the number of predators killed by farmers has been reported to be equal to the number of livestock killed by lions, hyenas and leopards (Ogada *et al.*, 2003). Kenyan pastoralists poisoned all the lions in Amboseli Reserve in 1990 and speared 27 out of 40 lions in Nairobi National Park in 2003. Pastoralists in Chad and in several districts of the United Republic of Tanzania also poison lions (Packer *et al.*, 2006). In Namibia, an average of about 60 lions were killed each year outside Etosha National Park over a 20-year period, almost always by communal or commercial farmers (Government of Namibia, 2007).

Crocodiles attack from the water and retreat underwater with the victim immediately after the attack. For this reason it is unlikely that a particular individual is ever identified as being responsible for attacks. In general more crocodiles are killed in retaliation than the number of people attacked (Wanjau, 2002; M. Foloma, personal communication). Smaller crocodiles are sometimes trapped by nets if they are unable to tear away the netting which holds them beneath the water surface, and will eventually drown. Alternatively, fishermen who find live crocodiles trapped in their nets will typically dispatch the animal with a blow to the head.

Elephants are often killed in retaliation for human deaths. Kenyan Wildlife authorities shoot between 50 to 120 problem elephants each year (WWF, 2007a).

In the surroundings of Virunga National Park (Democratic Republic of the Congo), habitat destruction and human population growth mean that the mountain gorilla and other forest animals, such as elephants and buffalo, are increasingly coming into contact and conflict with people. For mountain gorillas, interactions with local people are a source of stress, can result in the transmission of human diseases, and can lead to direct physical attacks, disabilities such as loss of limbs from snares, and even death: 18 mountain gorillas were killed between 1996 and 2003 in Virunga and Bwindi (MacFie, 2003; Woodford, Butynski, and Karesh, 2002).

responsible, but the whole local population. The Nile crocodile is not endangered on a continental scale by the existence of conflict, given that significant populations are conserved in protected areas where by definition, conflict cannot occur. On the other hand, in countries such as Mozambique and Madagascar where none of the major crocodile habitats are conserved within protected areas, conflict with the human population places the crocodile populations at risk, in addition to the potential risks of habitat degradation and disturbance.

Additionally, in some countries such as Uganda, deliberate campaigns have been launched aimed at eradicating crocodiles in the belief that this would benefit the fishing industry (Graham, 1973).

Human-wildlife conflict also has several indirect consequences. The transmission of diseases from domestic animals to wildlife, competition over grazing land,

BOX 15

Adverse effects of human-wildlife conflict on wildlife conservation

The rinderpest pandemic of 1889–1905 in sub-Saharan Africa, reputed to have been introduced into Eritrea from India by the Italian army in 1887–1888, or by a German military expedition that brought infected cattle from Aden and Bombay to the East African coast, caused the death of countless wild artiodactyls. Buffalo, tragelaphs, wild suids and wildebeest were most severely affected and in some areas only relic populations survived. Bovine tuberculosis, probably introduced in Africa with imported dairy and beef cattle during the colonial era, has become endemic in several buffalo populations in South Africa and Uganda, as well as in a Kafue lechwe population in Zambia.

Buffalos and lechwes have become true sylvatic maintenance hosts of this mycobacterial disease, and sporadic spill-over of the infection has been documented in greater kudus, common duikers, chacmas and olive baboons, lions, cheetah, leopards, warthogs, bush pigs, spotted hyenas and common genets. The long-term effects of this chronic progressive disease on African wildlife host populations at sustained high prevalence rates is unknown, but preliminary evidence suggests that it may negatively affect population dynamics or structure in buffalos and lions.

Canine distemper virus is said to have been introduced into the African continent by domestic dogs. In the past decade, this disease has apparently crossed the species barrier in the Serengeti ecosystem, causing significant mortalities in lions. It is estimated that 30 percent of lions in the Serengeti died in this outbreak. The major population decline of the wild dog in this ecosystem may also be attributed in part to canine distemper (Bengis, Kock and Fischer, 2002).

The competition between growing human populations and declining wildlife populations for the same living space and resources has been demonstrated as being the underlying cause of the decline in the continent's elephant populations (Parker and Graham, 1989).

Veterinary fences erected to control the spread of livestock diseases in order to protect the European Union beef market have been responsible for the decline of wildlife populations either by blocking the movements of some species such as buffalos, roans, wildebeests, zebras and tsessebes, or by direct (collision, entanglements in the fence) or indirect (poaching) mortalities. This was particularly observed in Namibia (Martin, 2005) and in Botswana, especially in the Okavango delta (Mbaiwa and Mbaiwa, 2006).

Pollutants including silt can limit the distribution of crocodiles. Rivers that previously provided a habitat for crocodile populations, but which are now heavily affected by informal alluvial gold panning which releases toxic pollutants and massive amounts of silt, have resulted in the almost complete loss of habitat for crocodiles.

habitat fragmentation or pollution; all pose threats to the survival of wildlife populations or even the species as a whole (Box 15).

Long-term: conservation of wildlife outside protected areas

Human-induced wildlife mortality not only affects the population viability of some of the most endangered species, but also has a broader environmental impact on ecosystem equilibrium and biodiversity preservation.

Conflict between people and wildlife today undoubtedly ranks among the main threats to conservation in Africa – alongside habitat destruction and commercially motivated hunting of wildlife to satisfy the demand for bushmeat – and represents a real challenge to local, national and regional governments, wildlife managers, conservation and development agencies, and local communities (Kangwana, 1993; Conover, 2002; Treves and Karanth, 2003).

Conservation of wildlife outside protected areas cannot be achieved merely by protecting animals and avoiding the issues of people's needs and rights and their conflict with wildlife. Human-wildlife conflict, rural poverty and hunger, the prohibitive costs of wildlife law-enforcement arising from land use practices; all severely limit wildlife conservation outside Africa's national parks. The following example perfectly illustrates a situation that is common today. In Cameroon, in the area around Bénoué National Park, wildlife is causing major damage to crops and livestock, especially staple food crops. As a result people are attempting to

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Veterinary fences have been responsible for the decline in populations of some species of wildlife

secure their livelihoods through illegal encroachment of farms and poaching, to the extent that bushmeat now constitutes about 24 percent of their animal protein intake (Weladji and Tchamba, 2003).

Developing conservation approaches in response to these challenges, which are both culturally acceptable and financially and ecologically sustainable, could help solve the problem of maintaining viable large-mammal populations in Africa.

3. Human-wildlife conflict management

Human-wildlife conflict can be managed through a variety of approaches. Prevention strategies endeavour to avoid the conflict occurring in the first place and take action towards addressing its root causes. Protection strategies are implemented when the conflict is certain to happen or has already occurred. Mitigation strategies attempt to reduce the level of impact and lessen the problem. The main difference between the options is the moment at which the measure is implemented.

By definition management techniques are only cost-effective if the cost of implementing the technique is less than the value of the damage, taking into account the fact that a short period of active management may have a continued effect, by instating longer-term protection of crops or herds.

The various management possibilities are presented according to the characteristics of conflict (whether they relate to humans, production, animals and the environment), rather than according to their ability to prevent or mitigate damage.

HUMAN MANAGEMENT

Community awareness

Awareness raising can be carried out in the community at different levels, for instance in schools or in adult education arenas such as farmer field schools. Educating children, coupled with awareness raising among adults through the traditional authority of chiefs and headmen, would certainly be highly cost-effective means of managing conflict.

Education and training activities could be directed towards disseminating innovative techniques, building local capacity for conflict prevention and resolution, and increasing public understanding of human-wildlife conflict. Educating rural villagers in practical skills would help them deal with dangerous wild animal species and acquire and develop new tools for defending their crops and livestock. Over time, it would result in a change of behaviour among local populations and would contribute to reduced risks, improvements in local livelihoods and a reduction in their vulnerability. In an optimistic scenario, education and training would promote commitment towards conservation, raise awareness of the essential role of wildlife in ecosystem functioning and its ethical and economic value, as well as its recreational and aesthetic importance. Box 16 provides a few examples of issues which can be developed for awareness campaigns in order to reduce human-wildlife conflict.

BOX 16

Awareness raising: key points

Behavioural changes that reduce human vulnerability

A few basic rules can be provided to decrease the risk of lion attacks such as:

- wearing bush-coloured clothes when carrying out activities in the field;
- checking the direction of the wind when approaching a risky area;
- wearing a backpack or heavy clothing to bulk out the silhouette and appear larger;
- avoiding activities at night;
- taking small children off the ground when travelling with them (Quigley and Herrero, 2005).

As regards crocodile attacks, adopting some simple behavioural habits, such as always entering the water in groups of several people together and keeping basic weapons (sticks, stones, axes and spears) close at hand, may not alter the likelihood of a crocodile attack occurring but reduces the chance of an attack being fatal. Not all attacks are immediately fatal, and it has been shown that resistance by the victim or bystanders can cut short an attack, even though this may still leave the victim injured.

Providing environmental and ecological training to villagers, fishermen and officials on the role of the crocodile and how the eradication of crocodiles as an apex predator would be likely to reduce rather than increase the volume and value of fish catch, would also be a useful means of alleviating the human-crocodile conflict. Finally, allowing community members to observe a captured animal would provide a new perspective on the risks they take on a daily basis. Rural Africans are largely unaware of the size and strength of adult crocodiles, possibly becaue these are normally seen with only their heads above the water and are not approachable in daylight.

Waste management

Every stage of waste handling should be addressed, from collection and transportation to disposal. Waste deposit systems that restrict wildlife access to garbage and good standards of waste management are important to avoid attracting wild animals to human settlements and to prevent wild populations from proliferating and becoming artificially sustained by the availability of human foods.

The following example shows that education and training can generate good results in mitigating human-wildlife conflict. In 2003, in the framework of a FAO pilot project, over 50 farmers drawn from ten communities around the Kakum National Park in Ghana, were trained as farmer trainers in deterrent techniques to prevent crop-raiding. These trainers were expected to help the majority of farmers in their respective communities to adopt the relevant techniques. After that it

was anticipated that the techniques introduced would spread through farmer-to-farmer training and by word of mouth. The success of the pilot project resulted in a reduction in crop losses around Kakum National Park of over 70 percent.

Practical manuals specifically targeting local communities such as the *Human wildlife conflict manual* edited by the Southern Africa Regional Programme Office of the World Wide Fund for Nature (WWF SARPO, 2005), a farmer's manual on protecting crops from damage by elephants prepared during the Kakum project (FAO, 2008a) or *Community-based problem animal control – livelihood security for people living in elephant range – training manual* realized by Elephant Pepper Development Trust (2006) are useful tools for raising awareness of human-wildlife conflict at local level.

Compensation

Direct compensation. The payment of compensation in the event of loss is usually confined to a specific category of loss, such as human death or livestock killed by predators or elephants. These schemes are often funded by a conservation organization, although government schemes also exist. All are designed to increase damage tolerance levels among the affected communities and prevent them taking direct action themselves, such as hunting down and killing the elephants, lions or other species involved (Muruthi, 2005).

In sub-Saharan Africa, some compensation schemes for losses caused by wildlife exist. However, as shown in the examples of Box 17, few are effective. Most African countries do not pay compensation for damage caused by wildlife, arguing that compensation schemes can do little to reduce the human-wildlife conflict and need to be modernized in order to become less bureaucratic, more reactive and transparent (Kenya Wildlife Service, 1996).

The IUCN African Elephant Specialist Group and Human-Elephant Conflict Task Force also advise against using compensation for elephant damage and argue that it can only at best address the symptoms and not the cause of the problem.

The failure of most compensation schemes is attributed to bureaucratic inadequacies, corruption, cheating, fraudulent claims, time and costs involved, moral hazards and the practical barriers that less literate farmers must overcome to submit a compensation claim. They are also difficult to manage, requiring among other things reliable and mobile personnel, able to verify and objectively quantify damage over wide areas (Muruthi, 2005). This often leads to delays in decision-making, low rates, irregular and inadequate payments or the rejection of compensation claims. All these factors discourage farmers from submitting complaints. A study of elephant damages carried out in the region of Boromo in Burkina Faso in 2001–2002, for example, revealed that 98 percent (100 out of 133) of the damages caused by elephants were not reported to the administration because the farmers knew there would not be any form of compensation (Marchand, 2002).

Furthermore, compensation programmes increase the return to agriculture and can therefore be viewed as a subsidy towards crop and livestock production. Such subsidies can trigger agricultural expansion and habitat conversion, an inflow of

BOX 17

Some examples of compensation schemes in sub-Saharan Africa

A compensation scheme was piloted by one district in Zimbabwe but abandoned when the number of claims quadrupled in the second year of operation (Taylor, 1993). In 2005, the Government of Mozambique paid compensation for elephant damages in the area adjacent to Maputo Special Reserve in the form of food products (e.g. maize and dried fish). However, crop raids continued in such a way that the government had difficulty obtaining enough food for compensation. It then decided to implement a definitive solution by erecting a fence preventing elephants from entering the villages. In Kenya, a compensation scheme was implemented with promising results, but it was suspended in 1989 because the system had become unworkable. This compensation scheme however neither replaced nor repaired any of the installations that were destroyed by wild animals (Thouless, 1993).

In Kenya, a compensation scheme for livestock killed by lions has also been introduced as well as a compensation scheme for loss of human life or injury, which pays about US$400 to the family concerned (Wanjau, 2002). This is not even sufficient to cover funeral expenses or hospital bills (Obunde, Omiti and Sirengo, 2005). Nor does the scheme take into consideration the impact of such incidents on dependent children who are often taken out of school because of lack of funds to pay their fees. During the recent ban on lion hunting in Botswana, the government made public its intention to pay compensation for any livestock killed by lions. There is no information available to indicate how successful the scheme was.

In Namibia, the Ministry of Environment and Tourism allocates a subvention of approximately US$710 for the funeral fees of people killed by elephants, crocodiles and hippopotamuses in cases where the affected person could not reasonably have been expected to defend him or herself or to avoid the incident, and where the family has to meet funeral costs (Government of Namibia, 2007). In Burkina Faso, the damage caused by wildlife is considered a natural hazard by law and as such is likely to be indemnified after analysis by a specific committee (Government of Burkina Faso, 1993). This procedure appears to be rarely operational due to the time lag between the complaint and the scarce indemnifications.

Non-monetary compensation schemes are preferred in some countries. In Ghana, where wildlife laws forbid the payment of compensation for crop damage by wildlife, the Wildlife Division and the Ministry of Food and Agriculture help victims of crop damages around Kakum to adopt mitigation and crop improvement techniques to enhance their livelihoods. In Burkina Faso, in 1991, the victims of elephant crop-raiding were preferentially contracted as workers to maintain infrastructure in the Deux Balé Reserve; this operation involved 127 farmers who received about US$40 each, i.e. the equivalent of 3 50 kg bags of millet. This compensation scheme was much appreciated and helped to sensitize the villagers to conservation issues (Marchand *et al*., 1993).

agricultural producers from outside the affected areas, and ultimately, intensification of agricultural production. This system is not sustainable as it depends heavily on the budget of the local governing bodies and/or non-governmental organization (NGO) support. Finally, it does not encourage villagers to protect their holdings and to coexist with wild animals, because there are no penalties for actions that exacerbate human-wildlife conflict. All of these consequences can be shown to have potentially adverse effects on the wildlife population that compensation intends to favour. In some circumstances, the net impact on wildlife stock could even be negative (Bulte and Rondeau, 2005).

Insurance schemes. The insurance scheme is an innovative compensation approach where farmers pay a premium for cover against a defined risk, such as livestock depredation. The premium can be set at the true market rate or be subject to subsidy provided by conservation organizations (Muruthi, 2005). The method also requires an accurate assessment of the cause of crop damage, livestock depredation, human injury or death, but because it operates on a more local scale, reports can be more easily verified. Although the insurance scheme can impose certain practices which need to be undertaken by participating farmers to avoid human-wildlife conflict, overall the method seems promising. An example is the Human Animal Conflict Self Insurance Scheme (HACSIS) in Namibia (Box 18).

Indirect compensation. Alternative compensation systems rely on giving out licenses to exploit natural resources, through tourism, hunting or collecting fuelwood, timber, mushrooms, fodder, etc. This type of compensation scheme, also known as the "settlement of rights" to use natural resources, appears to be a more practical solution than monetary payment. Indeed, the benefits derived from the legitimate use of natural resources influence the attitudes and perceptions of rural residents (Sekhar, 1998).

In Zimbabwe for example, crocodile eggs are collected from the wild by communities and sold to private crocodile farms. When communities receive a financial incentive, this increases their tolerance of crocodiles in the wild (WWF SARPO, 2005).

Benefit-sharing can also be considered within this broader approach which provides tangible benefits to land owners in recognition of the role they play in hosting wildlife on their land and covering associated costs. In this way wildlife becomes a valuable resource rather than a liability. In Mozambique, for instance, the law stipulates that local communities living in areas where natural resources are exploited, should receive 20 percent of the income resulting from this exploitation, particularly through tourism in protected areas and hunting in *coutadas* (hunting blocks) (Government of Mozambique, 2005). This measure ensures that about US$32 000 each year is distributed to the communities concerned.

Several modes of wildlife valorization can be used to provide income to compensate populations suffering human-wildlife conflict. The viewing tourism industry, for example, by creating additional job opportunities, compensates the

BOX 18

Human Animal Conflict Self Insurance Scheme, Namibia

The Human Animal Conflict Self Insurance Scheme (HACSIS) was developed in Namibia by the NGO Integrated Rural Development and Nature Conservation (IRDNC) with nine conservancies in Caprivi and Kunene regions, and is funded by the Global Environment Facility (GEF) Small Grants Programme.

HACSIS seeks to balance individual losses of conservancy members with benefits received by the conservancy, by offering payment for livestock mortalities to those members who have taken the required precautions to protect their livestock from wildlife (e.g. use of crocodile-proof fences at drinking points for cattle, careful herding during the day and kraaling cattle at night). Under this scheme, no payments are made for livestock killed in a protected area or conservancy exclusive wildlife zone, or if they are killed at night outside of a secure kraal or other enclosure duly inspected by conservancy staff and traditional leaders. Claims will not be accepted if members were warned that predators were in the area and they took no action to bring livestock to safety.

In the Kunene region, farmers are paid about US$114 for cattle, US$36 for goats, US$21 for sheep and US$43 for donkeys and horses. Sesfontein Conservancy paid out US$3 290 in compensation in 2005, and US$5 720 in 2006. No compensations were paid in 2007, because the conservancy management felt that livestock owners were not taking sufficient precautions to protect their animals. The Torra conservancy did the same. Meanwhile, in six conservancies in the Caprivi Region the scheme operated successfully. It covered human life, livestock deaths and crop damage. The conservancies pay between US$17 and US$114 for loss of cattle, horses, sheep, donkeys, goats and pigs, and for damage to maize, sorghum and millet (from US$17 for a quarter to US$69 for a whole field damaged by elephants). They also take into account injuries; a woman who lost her arm as a result of a crocodile attack, claimed US$430 for her injuries through HACSIS. This amount may seem small in modern insurance terms for the loss of a limb, but it was a significant amount of money for the family and helped cover hospital visiting expenses (Murphy, 2007).

IRDNC pays half of the costs while the conservancies pay the other half. Over the past four-and-a-half years, the conservancies have paid out over US$14 300 for 112 livestock and four human deaths and US$1 012 for the crop insurance scheme, which started in March 2007. There were 43 claims for crop damage (Tjaronda, 2007). Payments per year would be capped at about US$1 430 (N$10 000). There is some indication that the scheme could become a drain on conservancy finances if total annual payments are not capped, or if conservancies are not able to increase their incomes. Some conservancies are considering establishing livestock herds which can be specifically used to replace animals lost to predators in lieu of making payments (WWF, 2007b).

cost of maintaining wildlife and helps alter local people's negative perceptions of conservation (Box 19). Where areas have little appeal for photographic tourism, safari hunting on communal land has been successful in generating a sustainable revenue stream for rural communities to be divided among participating villages within and adjacent to the hunting zones (Box 20). Community-Based Natural Resource Management (CBNRM) programmes involving local communities in several modes of wildlife valorization are a new and promising alternative to mitigating human-wildlife conflict (Box 21).

Although they are much appreciated by the communities concerned, the settlement of rights and the benefit-sharing approaches are expensive and require funds to be made available year after year in order to guarantee the sustainability of the system. Often, income is insufficient to finance the conservation activities required, let alone to share these revenues with neighbouring communities. Furthermore, the issues of ownership, participation and disbursement of income need to be universally agreed before any such venture is attempted. Other impediments are administrative arrangements; such as the formal acknowledgement of existence, setting up of a bank account and actual claiming of funds from the relevant authorities. Finally, it is worth stressing that, while the community as a whole receives the benefits,

BOX 19

Indirect compensation for human-wildlife conflict: viewing tourism

The managers of Kibale National Park in Uganda aim to foster positive attitudes towards the park and encourage local populations to support conservation by sharing revenues from tourism with them (Naughton-Treves, 1997). In Kakum in Ghana, the fringe communities benefit from revenues realized from conservation of the park. The community representatives serve on the board that oversee the day-to-day management of the park and therefore share the responsibility of protecting wildlife. In the Nyae Nyae Conservancy in Namibia, the sustainable use of leopards, through ecotourism, was evaluated as an option to balance the cost of living with these predators borne by the San community. A programme was developed whereby the San community linked up with ecotourism ventures to offer specialized leopard tours. Using their traditional tracking skills, the San led tourists on a four-day expedition following the tracks of leopards, reconstructing the movements and behaviour of these secretive animals and setting up hides at the sites of fresh leopard kills. These expeditions were tremendously successful, generating as much as US$110 per adult per year, an amount which far exceeded the losses incurred by leopard raids on livestock (WWF SARPO, 2005). The development of crocodile ecotourism marketed as a "green" and eco-friendly adventure tourism sector, and relying partly on the fascination associated with the fact that crocodiles eat humans, has been considered in Zimbabwe as a means of compensating for the presence of crocodiles in Lake Kariba (McGregor, 2004).

BOX 20

Indirect compensation for human-wildlife conflict: safari hunting

This method is being carried out in a number of countries of southern Africa including Botswana, Namibia, Zimbabwe and Zambia where, in 2003, the Zambian Wildlife Authority distributed about US$403 000 to 49 communities living beside or in game management areas (Damm, 2004). In eastern Africa, in the United Republic of Tanzania and Uganda for instance, some local communities receive a given percentage of sport hunting income. In some countries in western Africa such as Benin, Burkina Faso and the Niger, the European project Ecosystèmes protégés en Afrique sahélienne (ECOPAS) has set up community associations to benefit from wildlife hunting (Boulet *et al.*, 2004). Income from hunting is also redistributed in central Africa: in Cameroon, local communities living near hunting areas received US$172 000 in 2002 (K. Denis, personal communication); in the Central African Republic, in 2001, the ten acting Village Hunting Zones received an income of about US$135 000 from hunting activities (Boulet, Mbitikon and Ouamoudjou, 2003; Mbitikon, 2004). The communities also receive other benefits such as employment opportunities related to the sports hunt. Participating communities are often expected to conduct regular "watch and ward" patrols to ensure that target species are not being illegally hunted or poached, and undertake specific measures to enhance habitat so that target populations can be increased, especially with regard to the proportion of trophy-sized males.

Selling special hunting rights to sport hunters for particularly problematic animals (see "Regulation of problem animals through trophy hunting" in Chapter 3 for the limits of this system) is a slightly different method of generating greater goodwill among communities. In that case, the trophy fee and a share of the daily service fee are generally paid to the community.

The sale of the meat, skin, ivory etc. of the animals shot can bring an additional income to the communities.

In Namibia, where this method is commonly used and has been labelled "shoot and sell", the government registered crocodiles as a protected species in 1975, but, as part of the conservancy's right to benefit from their wildlife, two crocodiles per year have recently been acquired as part of the trophy-hunting quota from the Ministry of Environment and Tourism. For example, the Kasika Conservancy Committee has chosen, through a tendering process, a professional hunter who will bring his clients to their conservancy to hunt crocodile, as well as elephants, hippopotamuses and buffalos. In addition to paying a hunting fee to the conservancy, the hunter provides employment for a few local people and supplies meat from the trophy-hunted animals to the villages (Murphy, 2007).

compensation seldom reaches the individuals who have suffered losses and who generally continue bearing the direct costs of human-wildlife conflict (WWF SARPO, 2005; Muruthi, 2005; Government of Namibia, 2007).

BOX 21

Indirect compensation for human-wildlife conflict: Community-Based Natural Resource Management

In Namibia, CBNRM was established in 1998 through the conservancy programme in the Caprivi region where the ecotourism industry and hunting concessions are potentially valuable tools for developing a local economy based on wildlife related revenues. The aim was to establish a system of returning benefits to rural communities in order to motivate them to protect wildlife outside protected areas and to discourage poaching (O'Connell-Rodwell *et al.*, 2000). In 2007 the conservancy programme counted 50 conservancies. It encompassed 14 percent of the national territory and involved 60 communities, representing more than 200 000 people, i.e. 10 percent of the whole Namibian population and about 20 percent of the rural population. In 2004 alone, the conservancies earned more than US$2 335 000 by valorizing wildlife through sport hunting, subsistence hunting, viewing tourism and the sale of game meat and live animals. As an example, in 2003, the Nyae-Nyae conservancy bordering the Khaudom National Park was already economically sustainable; its income from tourism and hunting covered its running costs and allowed it to pay dividends to community members of about US$67 per person at the end of the year (Skyer, 2004).

In Benin, the ECOPAS project set up Community Associations for the Management of Wildlife Reserves (AVIGREF) in villages neighbouring national parks. The AVIGREF of the villages bordering the Djona hunting area are associated with the management of the Alfakoara elephant tourist zone and receive an income from the site exploitations as well as from the adjacent hunting zones. A part of this income is used to compensate the victims of elephant crop-raiding (Alfa Gambari Imorou *et al.*, 2004).

In conclusion, a number of key questions should be asked of the compensation schemes (Muruthi, 2005). Do they help wildlife species in conflict with humans? Are they based on concrete information to be applied effectively? Do they pay the appropriate amount of compensation? Do they target the right culprits? And are they fair, timely, transparent and sustainable?

Voluntary relocation

Where alternative land and incentives are available, the voluntary relocation of local communities to areas offering better access to natural resources and improved socio-economic opportunities can offer an adequate solution to managing human-wildlife conflict (Madhusudan, 2003). In fact, resettlement schemes aimed at preventing the overlap of wildlife and people can be successful in the long run if some essential assumptions are met: the villagers must gain substantial benefits, such as better access to resources; they should be relocated to an area where the

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Safari hunting is a means of providing indirect compensation for human-wildlife conflict

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Community-Based Natural Resource Management programmes involving local communities in several modes of wildlife valorization are a new and promising alternative for mitigating human-wildlife conflict

risk of losing property is lower; and they should not face any political, social and cultural opposition (Treves and Karanth, 2003).

When socially acceptable, this option is expensive. For example, donors paid approximately US$16 million to relocate the 6 000 people living inside the Limpopo National Park in Mozambique.

PRODUCTION MANAGEMENT

Different methods used to protect human production against the adverse effects of wildlife are presented below. However, given the inadequate resources of most subsistence farmers in Africa, effective protection of crops or livestock is often unaffordable, time consuming and risky.

Intensifying human vigilance

Vigilance is an important component of crop or livestock protection and human-wildlife conflict management. The fear of humans normally dissuades animals from committing damage. In Kibale National Park in Uganda, elephants waited at the forest edge until farmers left the fields before they would enter (Naughton-Treves, 1998), suggesting an aversion to the presence of humans. Elephants in the area around the Kakum Conservation Area in Ghana appear to avoid farms where people are present (Barnes *et al.*, 2003).

Guarding herds and taking steps to actively defend them are essential features of animal husbandry. Where herdsmen are present, the rate of depredation is generally lower than in free-ranging herds (Kaczensky, 1996; Ogada *et al.*, 2003; Breitenmoser *et al.*, 2005). In East Africa, where human herders are effective and fearless in warding off predators, herders are reported to challenge and scare away dangerous carnivores such as lions, hyenas and cheetahs with nothing more than simple weapons such as spears, knifes or firearms (Patterson *et al.*, 2004).

On the other hand, some species such as baboons show less fear, and simple vigilance therefore gives less effective results. Determined troops of baboons can intimidate guardians, particularly women, who are often chased away. Baboons will adapt rapidly to measures taken against them and are remarkably quick to find weaknesses in the guarding of crops.

Watchtowers providing good vantage points, built around cultivated fields, can increase the farmers' chances of being alerted to the presence of potentially harmful wildlife before damage has occurred. Farmers need to cooperate among themselves to manage the watchtowers and set up duty rosters, as is widely practised in Zimbabwe, Mozambique and Zambia (WWF SARPO, 2005). Farmers can cooperate by means of a rotating system of guard duty whereby only a few of them patrol during the night. If an elephant is sighted, other farmers are woken to chase them away (Thouless, 1994). Simple alarm systems, using a network of cowbells or tins filled with stones connected along a length of twine, can also be effective and avoid the farmer having to stay alert all night long (Muruthi 2005).

Specifically constituted teams can act as guards. The FAO project in Kakum in Ghana set up a cadre of community scouts to provide vigilance and promote community-based problem animal control in an area of high human-elephant conflict. A total of 11 communities were grouped into a community scout cadre with an average membership of 5 scouts per community. Each group had a leader and a secretary who was responsible for the custody and updating of the patrol record book. This record book was available for inspection by other community members and stakeholders.

Guard animals

Guard animals provide an alternative to a herder monitoring a flock, which is labour-intensive, time-consuming and costly. To be successful, a guard animal must bond with the animals they are to guard. This bonding, combined with the guard animal's natural aggression toward predators, can make a guard animal an effective protector.

Dogs can be effective in protecting homesteads and livestock from attack by predators (see Box 22). The dogs are trained to alert people to the presence of predators, rather than chasing predators. These dogs are raised from puppyhood with sheep or cattle and live with the herd full-time. Several new training aids are now available to the dog handler including "shock collars" to provide stimuli to the animal in obedience training and are used in conjunction with whistles and global positioning system (GPS) collars in the event of animals becoming lost (La Grange, 2005).

Donkeys have also been used as guard animals in many parts of the world. In some areas of Kenya one or two donkeys per herd of cattle have been used to guard against lions. Donkeys appear to have a higher defence instinct than cattle and are naturally more alert and aware of predators. They make formidable opponents, they are not afraid and will find predators and chase them away, even by biting and kicking. Mares with foals are particularly protective. Foals should be raised with livestock. However, stallions tend to break fences and become aggressive during breeding (Schumann, 2004).

Both dogs and donkeys have recently been used in Namibia and Botswana to accompany livestock. This has been reasonably successful in reducing incidences of human-wildlife conflict, especially where cheetahs and spotted hyenas are concerned (WWF SARPO, 2005).

BOX 22

Effect of guard animals on predator attacks

In Northern Kenya, the presence of shepherds, dogs and humans has been linked with lower rates of livestock attacks by large predators. However, the presence of dogs was only linked with reduced rates of lion raids on cattle, but not on sheep and goats (Ogada *et al.*, 2003). Under a specific guard dog programme in Namibia, Anatolian sheep dogs were used to protect livestock (WWF SARPO, 2005). A study carried out between January 1994 and November 2001 of domestic dogs accompanying herds in 117 Namibian farms, showed that guard dogs were successful in terms of reducing livestock losses, with 73 percent of responding farmers reporting a significant decline in losses since they acquired a dog (Marker, Dickman and MacDonald, 2005).

Fencing

If they are properly designed, constructed and maintained, fences can be almost completely effective in preventing conflict between people and wild animals. Fences are used to protect crops and to protect people and livestock (Box 23). They are also used to insulate protected areas; communities seem increasingly to opt for separation rather than integration of culture and nature in the landscape, as a result of increasing human-wildlife conflict and scarce human involvement in or direct benefit from conservation. Fenced wildlife sanctuaries enable people to benefit, yet be separated, from wildlife, so that they can practise other land uses such as pastoralism and agriculture.

BOX 23

Examples of fences used against carnivore attacks

To prevent crocodile attacks, the Namibian Kasika conservancy used traditional thorn bushes placed in the river at cattle drinking points to offer protection from crocodiles. These were replaced with stronger materials such as wire fencing, with funds from GEF. Ten such crocodile-proof fences were constructed at village harbours for a cost of about US$286 each (Murphy, 2007). The construction and maintenance of palisades or barriers need continued effort, and there is little evidence elsewhere of communities making that effort now to erect the kinds of protective barriers found in pre-colonial times (Musambachime, 1987), particularly at frequented spots such as watering points.

To protect their livestock, herders traditionally resort to several fencing devices. In the Laikipia District in northern Kenya, pastoralists use different traditional techniques, which are popular among Maasai and Samburu local communities. The enclosures can be made of: stone or wooden posts (solid); Acacia brush (acacia); branches woven around cedar poles (wicker) or 10 cm wire mesh (wire). A study was made of the effectiveness of different enclosures types in defending livestock from predator attacks; the depredation rate for domestic animals was lower when they were penned in corals over night, and the type of pen was a significant factor in accounting for a lower total loss of sheep and goats, whether they were kept in wire, acacia, wicker or solid enclosures (listed in order of effectiveness) (Ogada *et al*., 2003).

Farners can erect fencing that deters or keeps out large carnivores and allows livestock to graze freely. This technique is used extensively in Namibia and some parts of Botswana, to assist farmers in controlling raids on their livestock by lions, spotted hyenas, wild dogs and cheetahs. Farmers in northern Namibia sometimes erect smaller fenced camps (two to ten hectares) near their settlements, where they keep some animals, such as cows with small calves. This has been a successful option, which has reduced raids on calves during the vulnerable stage of their growth (WWF SARPO, 2005). However, these predator-proof barriers require more maintenance than normal livestock-proof ones.

Fences also help prevent the transmission of certain endemic contagious diseases such as foot-and-mouth disease, African swine fever and theileriosis. The establishment of control areas, game-proof fences, sanitary cordons and movement control to separate wildlife from domestic livestock has frequently given the best results. This method has generally been used in countries with an advanced land-use policy where nomadic pastoralism is not practised. It is less likely to succeed against endemic arthropod-borne infections such as trypanosomiasis, epizootic hemorrhagic disease, African horse sickness, and Rift Valley fever, where vaccination and vector control may be required to reduce transmission (Bengis, Kock and Fischer, 2002).

Although the introduction of fencing is a good way to manage human-wildlife conflict, it also brings a number of environmental and economic disadvantages and is never 100 percent efficient (Box 24).

Several types of fences are used throughout Africa for various purposes.

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If properly designed, constructed and maintained, fences can be almost completely effective in preventing conflict between people and wild animals

BOX 24

Some drawbacks of fencing

In Kenya, the fencing of farms has created physical barriers to migratory species such as zebras, topis and wildebeest, or species making seasonal displacements such as elephants. Fencing reserves may affect the dynamics of wildlife populations and hinder their natural migratory and dispersal behaviour, especially in the case of highly territorial species such as lions. It is also essential to take into consideration the different, unexpected effects that fencing may have on a wide range of non-target species (Hoare, 1992).

Physical barriers are not always an economical management practice. They frequently require additional labour from farmers and their family members and never ensure complete protection. The reason for this failure can be explained by the behaviour of different animal species. Burrowing animals for instance, will breach barriers and allow access to other species, as Hoare (1992) mentions; lions for example can use holes that have been dug by warthogs.

In Zimbabwe, in the areas neighbouring the Sengwa Wildlife Research Area, livestock are still attacked even though the reserve is fenced and livestock are penned in fortified enclosures at night. This is because baboons, lions and leopards can pass through the reserve fence and jump into the enclosures. Improving fences with the addition of a roof (chain link ceilings for instance) would substantially reduce economic losses (Butler, 2000).

Traditional barriers. Plant hedges of various spiny cacti (e.g. *Caesalpinia decapetala* and species of *Euphorbia*, *Opuntia* and *Agave*) have the advantage of being a low-cost solution, effective against both carnivores and ungulates. On the other hand, they are slow to establish, do not deter baboons and elephants, and are often made of exotic species which can spread uncontrollably. Although less permanent, fences made of dead thorny branches are erected as kraals for cattle but also against elephants. In the Malian Gourma they make up 32 percent of protective measures used, as against 28 percent for moats (Maïga, 1999). Trenches, either covered or uncovered, have been widely used in Africa to keep elephants from cultivated areas with considerable success. Stone walls have been used to exclude buffalo from invading cultivated areas in the AWF Virunga Heartland (Muruthi, 2005). Large, sharp rocks act as a effective elephant barrier in some parts of Namibia (Hanks, 2006).

In some areas, farmers simply run bark or sisal ropes from tree to tree or set up 3-metre long poles placed 30 metres apart and hang pieces of white cloth attached to twine at 5 metre intervals. This is done in conjunction with grease and hot pepper oil, which, when applied to the twine acts as a waterproofing media and causes irritation to any animal (such as elephants) making contact with the fence (see section on deterrents, p. 55) (WWF SARPO, 2005).

Artificial fences. Fences constructed using strong material such as galvanized steel wire protect crops successfully against many mammals. The major factor limiting the wider use of wildlife fences is their cost, which varies depending on many factors such as topography, type of fence and the species it is designed to contain. The high maintenance cost of fencing is another limiting factor, which explains why fences are effective when managed by commercial farmers for high-value crops such as sugar cane or citrus. This option is beyond the means of emerging farmers or subsistence growers. Moreover, for some species, such as baboons, standard wire fencing is ineffective.

Electric fencing. Electric fencing is a more sophisticated and efficient solution. It is more durable, due to the reduced physical pressure from animals; it deters a wider range of species; and it is more aesthetically appealing. However, the cost of installation and maintenance is higher than for simple fences (Hoare, 1992). The construction of a 3.3 m high electric fence around Aberdare National Park in Kenya cost an average of US$20 000 per kilometre (Muruthi, 2005); in Namibia, the cost per kilometre of electric fence was US$10 000 compared to US$600 for a non-electric wildlife fence.

In Kenya, in Endarasha and Ol Moran villages in the Nyeri and Laikipia Districts, electric fencing is successfully used to separate wildlife from human settlements and agricultural areas (Kenya Wildlife Service, 1996). The electric fencing of the cultivated areas of Kimana and Namelok in the AWF Kilimanjaro Heartland has significantly reduced the levels of elephant crop damage; however, fence maintenance and the proximity of fences to areas with a high concentration of elephants appeared to be significant determinants in the long-term performance of electric fences in mitigating elephant crop-raiding (Kioko *et al*., 2008). In Namibia, in the East Caprivi region, electric fencing is an effective strategy in reducing the human-elephant conflict on a large-scale. Electric fencing has proved to be the only long-term deterrent to elephants. Despite the high cost of maintenance and installation, electric fencing is demonstrably cost-effective to the community because it reduces elephant attacks, and thus allows crop increases and increased income for farmers. It is anticipated that it will take four years for a return on investment to be realized (O'Connell-Rodwell *et al.*, 2000).

Electric fencing can be adapted to rural conditions. For example, it is possible to construct a fence with just a single live strand at 1.5 metres above the ground in order to stop elephants, while allowing other species to pass through. This cuts costs considerably; in Mozambique, for instance, the cost per kilometre of a single strand of electric fence is US$900 to $1 000 compared to $9 000 for a classic elephant-proof fence. Another means of cutting costs is to hang this single strand fence from bush poles instead of metal stanchions. Nevertheless, the theft of the solar panels, batteries and energizers used to power television sets, noted for instance in Botswana and Mozambique, means that electric fences can only be considered where the security to guard them is adequate.

CROP OR HERD MANAGEMENT

Human-wildlife conflict can be reduced, and in some cases totally prevented, by implementing changes to the resource or production that causes the conflict. This can be achieved by altering the resource itself, or the way it is managed or making changes to the surrounding landscape so that the problem-causing animal is more vulnerable, easier to spot by people and dogs, and generally less at ease in the area (Muruthi, 2005).

These possibilities can be applied to the different productions affected by human-wildlife conflict.

Agriculture

Little research exists on wildlife preferences for particular crops, but some crops are less palatable to wildlife. There are some crops that elephants appear not to eat. For this reason alternative crops such as ginger and chilli have been encouraged around Kakum National Park in Ghana. Several farmers who were considered to be in high-conflict areas have shifted from cultivating food crops to growing other crops such as cocoa and ginger to sell at the local market in Foso. It is possible to harvest 30 or so baskets of ginger from an acre of land. Each basket is worth a minimum of 60 000 cedis (¢); an acre of land can produce a total of ¢1 800 000 (US$205). These prices can double towards the end of the season. Growing chilli peppers around the land has been encouraged in Namibia, in the Salambala Conservancy in Caprivi, where the first two sales of chillies in 2006 brought a total of US$925 to about 50 farmers (Hanks, 2006), and in Zimbabwe where a programme to grow this crop for export was set up to raise income for farmers while also repelling elephants.

Other agricultural practices such as changing the time a crop is planted or harvested can also result in a decrease in crop-raiding. This can be done by using special varieties such as open pollinated maize varieties which can be harvested earlier than other food crops and consequently are less vulnerable to crop damage, which tends to occur late in the growing season. (WWF SARPO, 2005). By intensifying agriculture, increasing inputs and boosting yields, farmers are able to maximize their returns from smaller plots of land which are also much easier to defend against crop-raiding elephants. Intensification can be facilitated through the introduction of practical, environmentally sensitive practices such as mulching, and the use of organic fertilizers and liquid dung.

Small islands of crops scattered across a landscape inhabited by wildlife are more vulnerable to destruction than those that are clustered together. A landscape approach to reducing human-wildlife conflict might therefore involve growing crops in large communal fields with straight edges, fences or thorny or spiny hedges, and also removing nearby cover and habitat for wildlife (Muruthi, 2005). In that respect, a cleared margin of about 50 metres around crops does help as a preventive measure, since both baboons and bush pigs are wary of crossing these open areas (La Grange, 1984).

Forestry

The wealthy owners of commercial afforested areas are not greatly interested in management options to alleviate damage caused by baboons in the long term. However, several silvicultural methods could be employed to mitigate damage caused by baboons in timber plantations, such as:

- eliminating damaged trees by thinning;
- reducing pruning and weeding;
- limiting branches big enough to support baboons;
- planting other species;
- clearing and replanting;
- planting larger compartments;
- integrating natural vegetation.

All these methods can help alleviate the damage but can also have important disadvantages in terms of yield and productivity.

Husbandry

Livestock raids can be minimized through good husbandry practices, such as herding during the day, keeping livestock in a predator-proof enclosure at night or avoiding predators' home territory. Additionally, a livestock keeper can remove thick cover from near animal holding areas. Equally herders should systematically avoid taking livestock to water points which are known to be inhabited by large crocodiles. Good husbandry also requires vigilance and a willingness on the part of the owner to confront predators when the need arises. This is a daunting task when the farmer is not properly equipped for it, especially since confrontations usually occur at night.

Farmers can actively manage their herds to protect them against depredation by controlling breeding times. By directing the movement of the bull, the farmer can plan and synchronize calving. This helps protect cows and their calves against carnivores during the days and months in which they are most vulnerable to depredation, and means that animal protection can be seasonally managed (WWF SARPO, 2005).

With regard to diseases that threaten wildlife populations, such as bovine tuberculosis, rinderpest and canine distemper, containment and control is best effected by addressing the disease in the domestic compartment through test-and-slaughter methods and mass vaccination. Rinderpest control, for example, has been based on vaccination (Bengis, Kock and Fischer, 2002).

NON-LETHAL CONTROL

With diminishing wildlife populations and criticism in the media of the killing of species such as elephants, baboons and lions, non-lethal methods for managing problem animals are preferred provided they can solve or mitigate human-wildlife conflict problems and not simply shift them elsewhere; and provided they represent a permanent solution.

The non-lethal methods described below can be effective if rural people living around reserve areas are involved in their implementation and are also involved in the conservation and sustainable utilization of wildlife resources.

Deterrents

Deterrent methods are designed to repel animals from the targeted resource. They can be grouped into several categories according to the sense they target: hearing, sight, smell, taste and touch (see below).

Acoustic deterrents. Acoustic deterrents are those that shock wildlife away by emitting an unexpected loud noise or specific sounds known to scare wildlife.

Traditional acoustic methods are widely used by farmers throughout Africa, mainly against elephants: such as beating drums, tins and trees; using whips in addition to shouting, yelling and whistling; and setting off explosive devices such as "bamboo blasters" using calcium carbide or fertilizers, pipe bombs (in Zimbabwe), and homemade gunpowder (in Zambia).

Disturbance shooting (firing gunshot over the heads of crop-raiding elephants) has been a long-standing deterrent, but it needs the intervention of problem animal control units or administration representatives. People have used shotgun blasts to scare off lions in commercial ranches in Laikipia, Kenya. Cracker shells are 12 bore cartridges which launch a small charge that explodes near the predator, presumably providing greater shock value than gunshot coming from a boma (Frank and Woodroffe, 2002).

To scare baboons, the use of shots, cannon noise or predator sounds can be used. Sound aversion barriers generating a frequency that causes pain have also been considered but this technique is impractical for large areas, and has several other disadvantages: it is difficult to trigger; the signal generation is expensive; and it can potentially cause auditory damage to non-target species. Disturbance shooting at roost sites is a method easy to implement once all roost sites are known. However, baboons may return to their roost sites once the disturbance ends. The destruction of roosts is a more permanent solution, but as in the case of disturbance shooting, it may cause major changes to range use and transfer the problem to a new area.

Alarm systems established at the boundary of farms and set off by a tripwire (e.g. electric sirens in Namibia) or set up directly on fences (e.g. cowbells in Zimbabwe) alert farmers to the presence of elephants, but also have some deterrent effect.

Some more sophisticated techniques using tape recordings are currently being tested in Kenya, where play-back of Massaï cattle noise to elephants in Amboseli National Park scared off elephants which are periodically hunted or injured by the local Massaï tribesman. Researchers in Namibia have recorded elephant warning calls and played these back to elephants in order to scare them away.

Visual deterrents. Visual deterrents are a traditional method. Brightly coloured cloths and plastic may be hung from a simple fence at the edge of fields. Scarecrows

could have a potentially deterrent effect, but they are not as successful against lions as they are against leopards (Woodroffe *et al.*, 2007). The flames and smoke of fires lit on the boundaries of fields or burning sticks carried by farmers can deter wildlife. Burning tyres produce a lasting and noxious smoke which affects both visual and olfactory senses, and increases the deterrent effect.

Olfactory deterrents. Some chemical compounds deter elephants effectively either by generating an unpleasant or painful smell or by simulating a targeted compound such as a hormone that triggers fear.

In the first group, capsaicin resin extracted from chilli peppers (*Capsicum* sp.), which causes an extremely unpleasant irritation and burning, is the most effective and widespread. Repellents based on this resin have been used to alter behaviour in a variety of species, including bears, ungulates, dogs, and humans (Bullard, 1985).

Capsicum deterrent is employed under different forms.

- chilli-impregnated twine (grease and extract of hot chillies mixed together and applied to string);
- chilli-dung bricks (made of dried chilli mixed with elephant or cattle dung and compressed into bricks which are then sun-dried and burnt slowly at the edge of fields producing a strong smelling cloud of chilli smoke);
- pepper spray (capsaicin mixed with soybean oil and inserted into an aerosol can with a modified spray nozzle);
- chilli "bombs" which are shot at elephants and burst upon impact, delivering the capsicum to the skin (this delivery system is under development in Zimbabwe).

Chilli-impregnated twine and burning balls of elephant dung containing chillies registered some success in Zimbabwe (Osborn and Parker, 2002, Parker and Osborn, 2006). In 2003, farms close to the eastern wing of Kakum National Park in Ghana, where elephant activities had been highest, harvested up to seven bags of maize per hectare after chilli-based deterrents were put in place to scare off wildlife – as compared with only 0.5 bags or less per hectare in 2001. The chilli-dung brick designed by the Kakum project is easy for farmers to make; the method is described in a farmer's manual (FAO, 2008a).

The effectiveness of olfactory deterrents on primates is limited. Trial results suggest that chilli-based olfactory deterrents may have a short-term effect on baboons, but the delivery system has not yet been fully developed.

Tobacco is also efficient as a deterrent either in conjunction with chilli or alone. Trials funded by WWF in Mozambique and in Kenya's Trans-Mara District have shown that a concoction of used vehicle oil, ground chilli and tobacco, smeared on ropes surrounding fields, barred elephants from raiding crops. Similar results have been observed in Zimbabwe. (Kiiru, Kioko, and Granli, 2006). In the United Republic of Tanzania, it was shown that when the supply of chillies, used as an olfactory deterrent for elephants, was insufficient, tobacco dust obtained from a local cigarette factory proved as effective (Hoare, 2007).

Field trials carried out in a number of areas in the Namibian Caprivi Region, have shown that granules of REVIRA®, a compound made of citronella and used

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Capsaicin resin extracted from chilli peppers, which causes an extremely unpleasant irritation and burning, is the most effective and widespread repellent for elephants

as a game repellent in Scandinavia, had a certain deterrent effect on elephants. Tests show that elephants failed to cross a line of REVIRA granules placed around a field. This chemical barrier could work for up to a month or more (Hanks, 2006).

Compounds from musth secretions seem to have some potential as an olfactory deterrent. In recent trials, elephants would not consume food items encircled by rings of dilute concentrations of one natural ketone in particular. This method may have great potential, but at present it is not applied in practice.

Some empirical methods based on olfaction have also been tested. Some experimentation was carried out for example in the eastern highlands of Zimbabwe in dealing with baboons, using a method developed by a traditional healer. This involved taking soil where baboons had urinated and then making up a solution (water mix) and spraying it along the edge of the field. On sniffing the ground the baboons retreated. This method has yet to be scientifically proven (WWF SARPO, 2005).

Taste deterrents. The existence of crops that are unpalatable to wildlife has already been mentioned. These crops, which include sisal, chilli, tea, ginger or oilseed, may not necessarily deter elephants. The experimental use of conditioned taste aversion on carnivores at Loisaba Ranch in Samburu Heartland (Kenya) failed to reduce livestock depredation (Muruthi, 2005). More research into chemical repellents effective against African carnivores is needed. Lithium chloride, for example, though effective against coyotes in the United States, has not proved to be effective in Africa (Forthman Quick, Gustavson and Rusiniak, 1985). Conditioned

taste aversion using lithium chloride or cyclophosphamide would be effective on baboons, given that they are physiologically close to humans. Repeated exposure or large initial doses would be needed to cause and maintain aversion. Compounds that are extremely bitter, such as Bitrex, or irritating such as chilli (see above), could also have a possible short-term deterrent effect on baboons.

Contact deterrents. Many traditional methods fall into in this category, which targets the sense of touch. Farmers throw rocks, burning sticks and, occasionally, spears at crop-raiding elephants. East-African herders challenge and scare away dangerous carnivores (see section on intensifing human vigilance). This usually involves getting close to the animals, and therefore the danger level is high. Experiments have been carried out in Kenya on the use of bees in problem-causing animal control. Beehives are placed on the edge of the fields and the bees are conditioned to react to approaching animals. This can be used not only for the big herbivores such as elephants which are scared of bees, but even for smaller problem animals (WWF SARPO, 2005).

Challenges to the use of deterrents. There are no known and proven deterrent methods for some species such as crocodiles. This is not because deterrence is impossible but simply because it has been simpler to remove the crocodile rather than to investigate possible methods. Crocodilians have acute senses and perceive sounds, smells and tastes in the water at low volumes or concentrations. They also sense and respond to pressure, electrical impulses and salinity using integumentary sense organs in the skin. In South Africa, electric fields have been used with some success to deter shark attacks (Dudley *et al.*, 2006) and the same principles could potentially be applied to crocodiles, although these species are behaviourally quite different.

While deterrent techniques are widely used, they are not effective in the long term. Animals soon learn that they pose no real threat and then ignore them. Both modern and traditional methods face this problem and become less effective over time (Muruthi, 2005). It is recommended that a combination of techniques be employed to minimize the risk of wildlife becoming used to any single method.

Finally, deterrent techniques present several disadvantages that could limit their successful application. They can generate adverse effects by displacing the problem to other areas. Some methods require close contact with the animal and expose the operator to danger. In many cases, government or NGO support is required to maintain the deterrent. Over most of the more remote areas where human-elephant conflict occurs, this support is difficult to provide. In northern Mozambique, for instance, in a region where chilli-pepper has been used, villagers rapidly lost confidence in its efficacy once NGO support ceased (FAO, 2005). External factors can lessen the efficiency of deterrents as shown by the following example: in Zimbabwe, wildlife is the natural resource that becomes targeted in an economic decline and as more and more people are unable to cultivate crops, they turn to wildlife, including the problem species, for bushmeat. Even projects to deter animals from crops using repellents then become jeopardized, because

people are more intent on obtaining meat from an elephant rather than scaring it off their crops.

Translocation

Translocation consists of moving a certain number of animals from a problematic zone to a new site. In spite of the risk of exporting the problem to another site, it may be a practical and politically correct approach in some cases, especially where suitable habitats with territorial vacancies are available.

In some situations, translocation can be a pre-emptive action before human-wildlife conflict occurs. For instance, the presence of a lion in a cattle ranching area or large crocodiles in water bodies close to human habitation can often be detected before the animals have caused a problem. These potential problem-causing animals can then be removed and translocated before they kill livestock or people. In addition, the sale of live animals to private reserves or crocodile farms can provide additional income.

This technique has been used more or less successfully with elephants, crocodiles and other carnivores (Box 25). Trapping and translocating baboons is feasible and can potentially provide an immediate solution to the bark-stripping problem within the troops range. However because baboons are abundant and widespread, there are few interested recipients. On the other hand, removing the problem troop potentially leaves an empty range that may be occupied by another bark-stripping troop.

Translocation is a controversial means of resolving human-wildlife conflict, as it can bring a number of problems, as shown by the examples in Box 25 (see also Conover, 2002).

- The animal causing the problem must be identified with certainty prior to capture; this is at best difficult and often impossible to achieve.
- Translocated animals commonly return to the site where they were originally captured.
- The problem is likely to persist, especially in the case of baboons. New animals are likely to immigrate to empty territories once translocation has taken place.
- The translocated animals can cause similar problems at their release site.
- Translocation is a risky procedure. Often a proportion of translocated animals dies, either because of the stress of capture or soon after release (see Omondi *et al*., 2002).
- Translocated individuals can endanger a resident animal population by introducing disease or destabilizing that population through increased competition for territory (as in the case of carnivores) or food (in the case of elephants).
- In order for the strategy to work, species such as large carnivores and elephants need to be translocated to a large area, up to hundreds or thousands of square kilometres, lacking potential for conflict with humans (Stander, 1990).
- The cost-effectiveness of translocation is in question; it is extremely expensive and involves specialist equipment and skills.

BOX 25

Wildlife translocation

Elephants

Elephant translocation methods used to be unsuccessful, but improved significantly at the beginning of the 1990s when it was shown that only family groups or solitary males should be moved (Coetsee, 1996). Since then, more than 1 000 elephants have been successfully translocated to 58 reserves in South Africa (up to 2004); and 141 individuals were translocated in Kenya between 1996 and 2002, with a mortality rate of 9 percent (Omondi *et al.*, 2002). However in some cases elephant translocations are still unsuccessful. Out of the first three family groups translocated in September 2001 from the northern parts of Kruger to the Limpopo National Park in Mozambique, each group was composed of seven animals and four bulls of different ages. Three of the four bulls returned to Kruger within four weeks to three months of being released in Mozambique. All three family groups remained in Mozambique for at least nine months, when one family group returned to Kruger. The other two groups remained for almost another year in Limpopo, and then both returned to Kruger in early 2003 (Hofmeyr, 2004).

Mammalian carnivores

The translocation of carnivores, although technically feasible, is generally unsuccessful. Only the translocation of leopards in South Africa has met with some success. Of over 38 translocations of male lions carried out between 1997 and 2001 in the Kgalagadi Transfrontier Park (South Africa and Botswana), 14 males were translocated more than once during the four-year period study. The territorial males were translocated to areas about 50 km away from their territory, but always returned to their original range (FAO, 2008b). In Namibia 16 leopards and 22 lions were relocated, marked with radio collars and then followed, in a study to test the success of relocations. All the leopards, and many of the lions, returned to the area where they were captured (WWF SARPO, 2005).

Furthermore, the translocation of carnivores can cause numerous problems, notably because most species are territorial. The following example illustrates the effects of territoriality: during a ban on lion hunting in Botswana, a cattle-killing male was captured and translocated seven times (I. Khama, personal communication) presumably because on each occasion it was being evicted from the area it had been moved to. Translocation into areas already occupied by individuals of the same species can lead to aggression and infanticide and a much higher death rate (Treves and Karanth, 2003).

Crocodiles

The capture of live wild adult crocodilians is possible using a variety of methods (boma traps, cage traps, rope traps, whip traps, nooses, harpoons, baited snares, etc.)

and is routinely carried out for research and commercial purposes, albeit with some difficulty and danger. Translocation of adult and juvenile Nile crocodiles from one wild population to another has been tested for academic and management purposes (Fergusson, 2000). This species has demonstrated that it is highly motivated and able to return to its original habitat. Given that wild crocodiles are relatively widespread, it is unlikely that any conservation benefit can be achieved from translocation; on the contrary, potentially significant damage could be done by introducing animals to a locally adapted gene pool in the wild. Translocation from the wild to captivity is a more potentially useful solution. Although captive crocodiles do little for the conservation of the species in the wild, this has the advantage of permanently removing crocodiles that are believed to be problem animals. In captivity adult female crocodiles, together with a smaller number of males are a biological asset and they continue to produce eggs which are one of the key inputs for the crocodile production industry. As such, crocodile producers are prepared to cover the costs of capture and removal of problem crocodiles

Contraception

The fertility of wild animals can, at least in theory, be controlled by using a variety of mechanical, surgical, endocrine-disruptive or immuno-contraceptive methods. One problem limiting many of these methods is the difficulty of administering drugs to, or capturing, free-ranging animals. Moreover, several health-related issues need to be resolved before fertility control becomes acceptable. The contraceptive used must not have harmful effects on the target animals, non-target wildlife, or on humans who might consume the meat.

The first attempts to use immuno-contraceptive methods in elephants were made in Kruger National Park in 1996 (Butler, 1998) using a contraceptive vaccine elaborated with antigens from pork zona pellucida. To date this vaccine has been largely unsuccessful. The procedure was difficult (requiring several repeat injections, as well as mandatory monitoring of the vaccinated females) and seemed to generate aggressive behaviour both in treated females and in rutting males, which were chased off by the females (Delsink *et al*., 2003).

A second solution explored was that of chemical castration by selectively destroying the pituitary gland cells that produce gonadotrophin. This system would stop spermatogenesis in males and ovulation in females, and inhibit sexual behaviour. Chemical castration, which is still in the experimental phase, would require a single injection. Its side effects are unknown.

A third theoretical solution considered is that of surgical vasectomy in dominant males (Bokhout, Nabuurs and De Jong, 2005).

Controlling the fertility of wild crocodiles is technically possible but impractical in the wild. Essentially this is futile in a species that has evolved to survive the loss of more than 97 percent of its offspring before reaching reproductive age/size.

Contraception or surgical or chemical sterilization would theoretically be feasible for baboons, since it was successful in Brazil with capuchin monkeys engaged in bark stripping of commercial timber species (Rocha, 2000). However, there would be a lag period before damage to timber would be reduced, and the socio-ecological effects are unknown. The procedure would affect the whole population and not just individuals or troops.

Contraception as a wildlife management tool is still largely in the experimental stage and, to date, cannot be considered as an available option in managing human-wildlife conflict.

LETHAL CONTROL

Lethal control means killing the animals concerned. This strategy is still widely used in Africa, but rather with the purpose of maintaining social peace than resolving the human-wildlife conflict problem definitively.

In general, shooting a problem-causing animal is believed to be the best way of warning the others away. With lethal control it is obviously desirable to focus on those individuals actually causing the problem, or at least to target the group of animals whose home range includes the site where the problem is occurring. In reality, it is often difficult for wildlife managers to obtain permission to shoot an animal quickly, thus making killing the culprit virtually impossible. Any individual is then killed to satisfy the demand for action and revenge by the aggrieved community, especially in the case of loss of human life or the killing of livestock.

The killing of some animals often has only a short-term effect. This was noted in Ghana, where crop damage ceased for three to five years after raiding elephants were eliminated, but then recommenced. After 55 baboons, mainly immature animals, were shot dead in Malawi in 1977, and guards were employed to deter the baboons from entering the forest, the baboon damage returned by 1978.

The reduction of the wildlife population can have adverse effects on the species killed, on sympatric species or even on the environment. It often results in an increase in birth rate, a decrease in other causes of mortality and an increase in the immigration of naïve animals into the area. The possible consequences of eradicating certain species from a locality include upsetting ecosystem function and dramatic changes in the populations of other species. A phenomenon called "mesopredator release" can arise, for example, when small to medium-sized carnivores proliferate following the removal of large carnivores (Crooks, 2002). Similarly, profound changes to the local flora and landscape can occur as a result of the eliminatation of elephants.

Finally, this method is increasingly criticized by the public. For this reason, there has been no lethal control of baboon populations in South Africa since the voluntary moratorium in May 2006 which followed a public and media outcry against implementation of the "trap-and-shoot" protocol. Elephant culling has been abandoned in favour of non-lethal techniques. On the other hand, in Zimbabwe, discussions are under way between the Parks Management and Wildlife Authority, the Centre de coopération internationale en recherche

agronomique pour le développement (CIRAD) and private enterprise to introduce mini elephant cropping campaigns to the areas surrounding state-owned wildlife areas to reduce the conflict there and provide cheap meat for rural inhabitants.

In general, problem-causing animals are shot, but poisoning has been used with baboons (see Box 26). The diffusion of diseases or parasitic infestations could be used to eliminate problem-causing animals as in Australia, where an attempt was made to eliminate rabbits with myxomatosis. Although biological control using diseases and predators has been considered as an option for reducing elephant overpopulation in South Africa (Mabunda, 2005), it has never been carried out because of the danger of unintentional crossover to non-target species or even humans.

The killing of problem-causing animals can be carried out by three main groups of actors: public services, local populations and trophy hunters.

Lethal control of problem animals by public services

Generally, the department in charge of wildlife management is most involved in the killing of problem-causing animals. With some species such as crocodiles, wildlife departments can delegate implementation to private operators. Other government departments, namely animal husbandry, generally only use lethal control for predators.

On a few occasions, the national army has been required to kill problem-causing animals. For example, in Ghana in the early 1970s, it was a common practice for rampaging elephants to be killed by a team of military personnel, in order to reduce crop damage within the Kakum conservation area. The meat of these elephants was often shared among community members as a way of compensating them for their crop losses.

Wildlife departments. Killing is carried out directly by wildlife officers, specialist problem animal control (PAC) units or honorary conservation officers, experienced individuals who can assume responsibility for problem animal control when needed.

PAC units have all the required clearances and the necessary material available to solve human-wildlife conflict. They are supposed to be able to respond rapidly to reports of human-wildlife conflict occurrence. Unfortunately, their effective deployment is often jeopardized by a lack of material and capacity.

PAC units are particularly used for large carnivores such as lions. In Namibia, around Etosha National Park, more than 30 lions are killed every year by PAC units (Stander, 2000). In Botswana, in the period from 1999 to 2000, an average of 25 lions per year was eliminated by Problem Animal Control in the Okavango Delta, and an average of 7 lions per year in the Pan region (V. Booth, personal communication).

Culling has been used in South Africa to avoid damage to the biodiversity of national parks and problems associated with elephants wandering outside of the park to surrounding communities in search of food. Between 1967 and 1994 a

BOX 26

Regulation of bark-stripping baboons by poisoning

The sporadic control of bark-stripping baboons by poisoning was introduced in Zimbabwe from 1982 to 1983 using ™Telodrin (an organochlorine insecticide) and later ™Papiol (brodifacoum, a highly toxic anticoagulant).

A disciplined protocol was developed through trials and adhered to subsequently, concentrating on careful pre-baiting to habituate the baboon troops before applying the toxicant. In order to minimize the effect on non-target species, the toxicant was delivered in closed boxes which can only be opened by baboons. Approximately 5 000 baboon carcasses were recovered over the derogation period, and the problem was considerably reduced.

An important ethological study was made alongside the poisoning, to gain better understanding of troop behaviour. The study showed that some troops damaged trees, while others did not. It was also discovered that, due to the social organization of the troops, the success of the control operation is dependent not on capturing first the dominant troop males, nor the favoured females in oestrus, but rather concentrating on the less important individuals. Finally, the study concluded that in order to solve the problem, the whole bark-stripping troop and the groups of bachelors had to be removed. The conclusions of this study were used to control baboon populations further by trapping.

This system was carried out from 1997 to December 2004 when the derogation permit to use the toxicant granted by the Forest Stewardship Council (FSC) expired. Thereafter, its use was prohibited, and was replaced by other lethal mechanical devices, mainly trapping using baited cages. Since early 2007, one of the companies has employed a full time baboon control officer with responsibility for baiting and controlling baboons in selected areas of the plantations (S. Van der Lingen, personal communication).

In South Africa, the trap-and-shoot method has been employed with some success for several years. After considering previous attempts at poisoning, shooting and trapping in a detailed written protocol, this method was selected (R.A. Fergusson, personal communication) and was considered to be the most effective and humane way of reducing or eliminating entire troops of bark-stripping baboons.

total of 14 562 elephants were killed during culls in South Africa. A moratorium on culling was set up in 1994. In 2005, the Kruger National Park was thought to have a population of 12 467 elephants. Had the culling not taken place there would now be 80 000 elephants (SAPA, 2005).

The off-take of either individual crocodiles or larger numbers of adult crocodiles in a prescribed area can be carried out by officials from relevant government departments, but is more frequently contracted out to the private sector. Ideally

surveys of the population in the wild are first carried out to determine the number of crocodiles present and the age/size structure of the population. When delegated to private operators, the field implementation of the killing should be observed and controlled by wildlife officials. Without this, when the product is the skins, the incentive is to shoot many animals, but only recover or process those that will provide the best return.

Husbandry service. In Kenya, on Galana Ranch, between 1968 and 1988, roughly one lion was shot for every 10 cows killed, i.e. approximately 25 lions per year out of a stable population of 150. In West and Central Africa, not long ago, strychnine poisoning campaigns were organized annually by the administration in charge of livestock development. Between 1970 and 1972 in what was then known as Upper Volta (Burkina Faso), 55 lions were poisoned with strychnine (Chardonnet *et al.*, 2005). Poisoning is frequently used throughout Africa to kill lions that have been stock raiding. Until recently, the Kenya Wildlife Service and the Kenya Veterinary Department made widespread use of poisons to eliminate hyenas, which certainly affected other scavengers such as lions.

Lethal control of problem animals by local populations

Farmers and herders are regularly involved in the elimination of problem-causing animals. Sometimes local hunters may be involved. For instance, traditional hunters with dogs and/or traditional guns have been used to help reduce baboon populations in southern Africa.

Animal species killed or injured by local farmers or herders can be divided into two main groups; species that are killed or injured in protection of crops (this group includes African elephants, buffalo, hippopotamuses, bush pigs, yellow baboons, vervet monkeys, warthogs and rats); and species that are killed or injured in protection of domestic animals and human life. This latter group includes lions, leopards, crocodiles, and spotted hyenas. Some species fall into both categories, in that they cause crop damage and loss of human life.

These killings may be carried out legally. In most African countries wildlife laws address the issue of the protection of people from wildlife in at least one law article related to the defence of human life and property from wildlife attack. Generally, the principle of self defence is considered legitimate and legal, whatever category the animal belongs to, whether a protected or non-protected species.

However, in some countries it is illegal to kill protected species, even in self-defence. This is the case in Namibia for elephants, rhinoceroses and hippopotamuses, for example. On the other hand, every farmer is legally bound to control populations of baboons, hyraxes, black-backed jackals and caracals on his or her farm. If a farmer fails to control these pest animals he or she is liable to a fine of about US$30 per animal. In addition, the Namibian government may, under certain conditions, delegate authority to specific conservancies to destroy problem-causing animals and use the products derived from the animals (Government of Namibia, 2007).

In any case, the law stipulates that when a culprit animal is killed it must be reported to the wildlife authority. Countries differ however concerning the time of report and who benefits from the killing of the animal. This is intended to avoid local populations revenging themselves by eliminating wildlife by poisoning (e.g. with soil insecticides that are cheaper than strychnine) or poaching.

In actual fact, illegal practices are common and widespread particularly when the human population affected knows perfectly well that, for various reasons, those officially entitled to kill the problem-causing animal will be unable to do so promptly, if at all.

This legal authorization, which is more relevant for predators than for elephants, may be seen from two perspectives. Firstly, given that local communities are the most exposed to damage caused by lions, it would seem appropriate to recognize that the killing of a culprit animal by the offending stakeholder is not an offence. Local communities are often the quickest stakeholders to react to lion attacks and frequently have the highest chance of targetting the culprit. Secondly, allowing the stakeholder to solve the problem autonomously raises concern over potential abuses such as biased evaluation of damage, or overreaction by killing non-culprit lions.

Finally, it must be stressed that wild animals are dangerous and many farmers in Botswana, Mozambique, Namibia and Zambia, who decided to take matters into their own hands, have been mauled and even killed by lions, leopards and crocodiles (WWF SARPO, 2005).

Regulation of problem animals through trophy hunting

Offering problem-causing animals to trophy hunters is a low-cost technique that has the potential to raise public tolerance towards wildlife, if sport hunting involves (or is managed by) local people (Muruthi, 2005). The money provided by the sale of licences or trophy fees can fund conservation activities and the protection of human settlements (Treves and Karanth, 2003) or bring direct income to communities.

In Namibia's Kunene and Caprivi regions, for example, a substantial part of the trophy fee is paid to the community and distributed through the Conservancy Committee to those who have suffered losses. In one area of the Kunene region, lions killed approximately 8 cows, 12 donkeys and 16 goats over a three-year period, causing losses estimated at about US$1 700; during the same period two male lions were shot by trophy hunters and the community received about US$4 200 from the fees paid. The same system is used in Zimbabwe and Zambia (WWF SARPO, 2005).

With valuable species such as crocodiles, the option of using trophy hunters to kill specific problem-causing animals could be relevant if permits to cull large numbers are issued by the administration to private-sector operators in order to make the hunting or capture economically viable. The existence of a market for the skins of wild crocodiles provides an incentive for harvesting wild crocodile populations in the short term. However, Nile crocodiles are listed in Appendix I

of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), with a derogation for eight ranching countries (Botswana, Ethiopia, Madagascar, Malawi, Mozambique, the United Republic of Tanzania, Zambia and Zimbabwe) which have effectively unlimited quotas for specimens produced through ranching and an additional quota for the control of problem-causing wildlife and for trophy hunting.

In practice, the culling of problem animals has several limits. It is often difficult to identify specific animals causing problems to be shot by sport hunters. Most incidents require a rapid response, and it make take some time for the sport hunter to reach the location. Trophy hunters will generally seek the largest animals, while the culprit in human-wildlife conflict incidents may not fit this description.

Furthermore, in order to be viewed as a legitimate management practice, hunting needs to be based on scientific monitoring to ensure sustainable harvests, and needs to be controlled by policies and regulations which address the timing, location and methods of hunting, as well as the distribution of benefits, including meat, to all stakeholders.

The regulated culling of animals through hunting is not always effective in reducing crop and livestock losses since the method does not ensure that the culprit is removed. It may even increase the risk of further losses, when dangerous carnivores are wounded instead of killed (Treves and Karanth, 2003).

Finally, many regrettable illegal off-takes of elephants, lions, hippopotamuses, crocodiles and buffalos have been carried out by emergent safari outfitters operating under the guise of PAC services with an apparently unlimited quota system bought from the respective authorities. To avoid creating incentives to hunt animals other than those that are causing problems, the Ministry of Environment and Tourism of Namibia is establishing a guideline price for the trophy hunting of problem-causing animals which makes provision for variation in the quality of trophies (Government of Namibia, 2007).

ENVIRONMENTAL MANAGEMENT

Increasing alternative crops, prey or water points

The use of diversionary tactics, i.e. providing an alternative source of food or water, in an attempt to lessen competition of wildlife with people for crops or water is a less commonly used management approach.

Diversionary fields have reportedly been used successfully to reduce crop damage in the United States (Conover, 2002) and in Europe (Granval, Arnauduc and Havet, 1999). This strategy does not seem pertinent to Africa, where a part of the population is undernourished. However the improvement of habitats in protected areas and their buffer zones could retain wildlife longer and thus decrease the intensity of crop-raiding. Similarly, providing food sources for baboons as a means of reducing damage to timber plantations could attract other troops, increase the number of baboons and by extension the damage they cause in the short or long term. In addition, the cost of this solution could be high depending on the food provided.

The most promising solutions appear therefore to be protecting the prey that wild carnivores depend on for food, and providing alternative water sources for both herbivores and carnivores, in order to reduce sources of conflict with people.

Protecting the prey of wild carnivores. Preventing poaching and the commercial harvest of natural prey would maintain adequate populations and restore the natural balance between predator and prey, thus preventing carnivores from relying on a diverse diet that includes domestic livestock (Polisar *et al.*, 2003). In the United Republic of Tanzania, the bush pig is the most likely maintenance diet for lions in highly disturbed agricultural areas. Farmers sleep in their fields to guard their crops from pigs, and this seems the most likely scenario in which lions learn to eat people. Strategies to control pig populations close to village farmlands could help prevent lions from being attracted to populated areas in the first place (Packer *et al.*, 2006).

As far as crocodiles are concerned, any environmental management that improves the availability of fish would have a beneficial effect on reducing human-wildlife conflict. Fishers would have less incentive to move into new areas that are less heavily exploited and thus inhabited by higher concentrations of crocodiles.

Alternative water sources for wildlife species. In Kilimanjaro Heartland, AWF rehabilitated the water supply at Imbaringoi in 2004 to serve the livestock and people living in the Kitirua Concession Area and prevent livestock from wandering into the Amboseli National Park in search of water. This has had the immediate effect of reducing encounters between livestock and wildlife in the park, and has consequently reduced the level of conflict in the area. In the same year, a water point was also rehabilitated in the Samburu Heartland to supply water to community areas, create separate drinking points for wildlife and livestock and help boost the tourism potential of the community areas (Muruthi, 2005).

The creation of new water points was also proposed by local populations of the Gourma region in Mali who wished to conserve local elephants while improving cohabitation with them (Alfa Gambari Imorou *et al.*, 2004). The provision of water points is also under consideration in Mozambique to encourage those living in Gorongosa National Park to move to the periphery, while making natural water available for wildlife in the park.

The development of alternative water supplies from boreholes and wells would also reduce the number of activities exposing people to hazardous encounters with crocodiles (e.g. while bathing, washing and collecting water) while reducing the risk of disease through the provision of drinking groundwater.

Finally, water management can be a good means of reducing wildlife populations when increasing numbers generate human-wildlife conflict. The closure of water points in protected areas on a temporary or permanent basis has been suggested as a possible means of decreasing the number of elephants by obliging the elephants to make longer journeys to feed and drink while increasing mortality in younger

BOX 27

The adverse effect of land-use planning on human-wildlife conflict

In Botswana, veterinary zoning regulations placed a ban on keeping cattle to the north of the Southern Buffalo Fence erected to separate buffalo and other wildlife from cattle herds to the south. This seriously affected the livelihoods of local populations; in an area where agriculture had been made difficult due to the threat of crop-raiding elephants, cattle-farming had become a major source of income (AWF, 2005).

In Namibia, the Green Scheme was established in 2002 under the Ministry of Agriculture, Water and Rural Development with the aim of enhancing socio-economic development for the country's rural communities, notably by supporting the development of a sustainable and competitive agricultural sector and facilitating the empowerment of small-scale irrigation farmers (Botschaft von Namibia, 2008). The resulting land-use plans were based on the analysis of the quality of the soils. Where the analysis results meet established standards, the area is devoted to agriculture, leading to potential conflict between wildlife and newly settled farmers.

individuals (Mabunda, 2005). Baboon populations could also be controlled by restricting their access to water.

Land-use planning

Land-use planning is a basic human-wildlife conflict management strategy which offers possibly the best chance of overall and long-term success. Unlike strategies of protection and mitigation, it tackles the root of the problem. It is therefore a preventive approach designed to alleviate human-wildlife conflict by creating landscapes in which people and wildlife can co-exist and have as little negative impact on each other as possible (Muruthi, 2005).

Land-use planning is typically a long-term process that requires government support, legislation and policy changes. It can be extremely expensive to implement, for this reason land-use plans are rarely implemented on a large scale in Africa. On the other hand, land-use plans designed to reduce wildlife losses can be usefully developed and implemented at local level (Muruthi, 2005).

National land-use planning should be designed through a coordinated approach involving all government departments, especially those dedicated to wildlife and national parks, and relevant development projects. Uncoordinated planning could only increase the human-wildlife conflict instead of mitigating it (Box 27).

The following are two possible options for using land-use planning to prevent and/or mitigate human-wildlife conflict.

Planning and manipulating the distribution of human activities. Where crop-raiding occurs, the underlying problem is that farmers are growing food crops close

to areas inhabited by wildlife. The most practical land-use planning techniques for managing human-wildlife conflicts with farming communities are therefore:

- relocating agricultural activity out of wildlife range;
- moving crop fields from the forest edge closer to dwellings;
- reducing human settlement encroachment into wildlife range, by repositioning the boundaries of protected areas or creating buffer zones (WWF SARPO, 2005).

Likewise, in order to avoid livestock raids and reduce carnivore-human conflict, carnivore attacks and the long-term costs of carnivore conflict and management, new human settlements should avoid those areas where lions are likely to be present (Quigley and Herrero, 2005).

Obviously, areas that are important for cattle or agriculture rather than wildlife should be devoted to animal husbandry or crops, while areas of particular wildlife importance such as strongholds, corridors, and economically viable wildlife-use areas, should be dedicated to wildlife conservation.

The clear designation of areas suitable for human activities and areas exclusively devoted to wildlife certainly helps mitigate human-wildlife conflicts while contributing towards resolving them in the long term. An example of such a policy is described in Box 28.

The creation of wildlife corridors linking wildlife areas, where human activities are forbidden and wildlife are free to move between human settlements, has been considered for elephants whose seasonal movements are a major cause of human-wildlife conflict (Alfa Gambari Imorou *et al*., 2004; Mabunda, 2005; WWF SARPO, 2005), as well as for carnivores (Quigley and Herrero, 2005). This strategy can help alleviate human-wildlife conflict, but also carries major consequences for people living in and near these corridors where human-wildlife conflict is likely to escalate.

BOX 28

Establishing zones for wildlife and human activities

In Namibia, within the framework of the new policy on human-wildlife conflict management, the Ministry of Environment and Tourism will declare areas with chronic problems as human-wildlife conflict zones. Specific regulations will be developed for these zones, ensuring appropriate assessments are carried out and management plans are in place before new developments – such as new water points or agricultural schemes – are introduced. In addition, the Ministry of Environment and Tourism will advise and assist the Ministry of Land and Resettlement to ensure that land-use planning and the planning of resettlement schemes at local, regional and national levels take human-wildlife conflict into account. For example, land-use planning should consider agricultural schemes and the distribution of cultivations so as to leave corridors for the movement of wildlife (Government of Namibia, 2007).

Similarly, by zoning lakes and dams into areas designated for fishing and others closed to fishing to ensure successful spawning and recruitment of juvenile fish, as well as effectively policing and controlling gill net fisheries as a whole, it should be possible to reduce the frequency of conflict with crocodiles considerably. This however, requires skill and resources beyond the means of most African fisheries or wildlife authorities.

The development of improved transport options could also reduce the risk of fatal encounters with wildlife, such as those that currently take place when humans circulate on foot or on bicycles at night in areas frequented by dangerous animals such as lions, hippopotamuses or elephants, or when they cross rivers by wading or with dugout canoes. Similarly, in places inhabited by dangerous animals, toilets must be situated close to houses and should not be used at night.

Zoning around protected areas. Zoning has been widely used in biodiversity conservation and the creation of national parks, natural reserves and other protected areas (Box 29). It refers to any form of geographically differentiated land management where different forms of potentially conflicting land use are given priority in different areas. If a zoning approach is chosen, it is vital to scale management zones to the size of the biological process they are designed to manage. For instance, carnivores must be allotted bigger land areas than other terrestrial species groups (Linnell *et al.*, 2005).

BOX 29

Two examples of zoning around protected areas

In order to reduce conflict between humans and elephants in Ghana, a proposal to zone farming land has been put forward, whereby farmers with land within 1 km of a park boundary are discouraged from growing food crops over time, and are encouraged instead to cultivate crops that are unpalatable to elephants (Barnes *et al.*, 2003). This would make the land immediately adjacent to the park boundary less attractive to elephants. In the second zone, more than 2 km from the park boundary, farmers would be able to cultivate subsistence food crops.

The creation of hunting blocks or wildlife or game management areas at the boundaries of protected areas, on either state-owned or private land, is a form of zoning widely used in Africa. One advantage is that the interface of human-wildlife conflict is displaced from the park boundaries to the boundaries of the blocks which act as a buffer zone (Loveridge, 2002). Another advantage is that wildlife management in these zones whether for consumptive and, to a lesser extent, non-consumptive purposes, reduces human-wildlife conflict by controlling wildlife populations and generating income.

Zoning sets up areas with different:

- degrees of protection;
- thresholds for the initiation of control activities;
- hunting regimes;
- implementation of compensation;
- economic incentives to mitigate conflicts.

Zoning offers many advantages in terms of mitigating human-wildlife conflict. It focuses resources for costly conflict reduction and intensive conservation measures on limited areas. It simplifies management procedures which can be initiated without time-consuming investigation when responses depend on specific locations of conflict. Zoning allows for a degree of predictability, so that people can make long-term plans and economic investments knowing to what extent wildlife will be part of their future, and it may even allow people to become accustomed to the presence of wild animals, and thereby reduce levels of fear.

However, a number of sociological, political and ethical disadvantages to zoning must be considered (Linnell *et al.*, 2005). For instance, a disadvantage of zoning is that it may decrease people's tolerance of wildlife, especially for those living outside the area where wildlife damages are compensated. This situation could be alleviated by integrating these people/areas into CBNRM programmes (see Box 21) as a form of land-use planning (WWF SARPO, 2005).

Legal and institutional development is necessary in order to achieve an integrated landscape, and should be faced and tackled upfront, given that any agreement on land-use changes will take several years (WWF SARPO, 2005).

The design of a specific policy dealing with human-wildlife conflict management could be a useful tool in this respect. This has been demonstrated in Namibia, where the recently adopted policy considers the following priorities as part of its strategic approach to managing human-wildlife conflict: giving preference in allocating concessions to those living close to protected areas such as conservancies to help offset livestock and crop losses as a result of human-wildlife conflict, and promoting the adoption of compatible land uses such as wildlife and tourism on land adjoining protected areas in order to reduce human-wildlife conflict (Government of Namibia, 2007).

4. Decisional framework

Clear policies dealing with human-wildlife conflict help to establish options that can be implemented either by the administrations (national or local), the wildlife authorities, the farmers and communities and/or the private sector.

In order to be effective, policies need to include:

- a clear definition of the roles of the various stakeholders listed above;
- a distinct definition of a "problem-causing animal";
- guidelines on human-wildlife conflict, on methods of measuring the extent and nature of conflict, and on management methods available and authorized (WWF SARPO, 2005).

Policies should be designed through a bottom-up approach involving all stakeholders and particularly local communities. They should be supported by the appropriate government departments, i.e. those concerned with wildlife but also with agriculture, water, infrastructures, etc. This is the best approach in designing transparent and workable policies to manage human-wildlife conflict. These policies can then lead the way to sound legislation and contribute to the success of human-wildlife conflict management.

To date, a few African countries have designed national policies on human-wildlife conflict. The national policy on human-wildlife conflict management adopted by the Government of Namibia in December 2007, is a good example which could be fruitfully used as a starting point by other countries.

From a practical point of view, in order to carry out informed and cost-effective management decisions, a three-phase approach should be implemented:

- collection of information on human-wildlife conflict;
- analysis of information and decision-making;
- choice and implementation of management options.

PHASE 1: INVESTIGATION

To report incidents and react quickly, an efficient information system is an obvious requirement. A centralized database to identify hot spots, recurrent animal problems, etc. is also a key tool. The long-term success of an information system will depend on the proper selection and training of those collecting the basic information. In addition, the methodology and format for the collection of information must be agreed on by all parties involved (WWF SARPO, 2005).

The systematic and objective gathering of information enables the responsible authorities to place the problems and threats caused by human-wildlife conflict in context, alongside other problems faced by local communities. It also ensures that resources are correctly directed, i.e. towards solving real issues rather than perceived problems.

BOX 30

Importance of a human-wildlife conflict database

A human-wildlife conflict database would both provide a detailed overview of the impact of conflict on local populations, and help identify which geographical zones are more vulnerable to human-wildlife conflict and which species are commonly involved in conflict. As a result, it would ensure adequate use of resources, help identify high-risk areas and the most relevant species, and encourage effective responses to emergencies (Nyhus and Tilson, 2004).

This database could even be used to prevent, or at least anticipate, human-wildlife conflict. Results of past research (Sitati *et al.*, 2003) suggest that spatial correlates of conflict can be identified, and areas of vulnerability mapped, to enable the development and deployment of appropriate conflict management measures. Innovative methods employing participatory Geographic Information Systems to design maps have been developed using local landmarks and features; these are being used to produce predictor variables for conflict and to develop options with communities for wildlife conflict mitigation by documenting distribution and types of conflict, species involved, the severity and causal factors of conflict (Muruthi, 2005). This information will be useful to local farmers, who often feel powerless to combat the problem, as well as the authorities who wish to help but have inadequate information to carry out prompt targeted action.

In the absence of reliable information, the scale and nature of human-wildlife conflict becomes a matter of personal opinion. Conflict between people and wildlife is an emotional issue and, as a result, reports and opinions can be biased, creating a false impression of the size of the problem (WWF SARPO, 2005).

The collection of reliable data is complicated by the fact that the real extent of the conflict is often obscured by the agendas of many interested parties. Several factors may affect the accuracy of the information collected. For example, agropastoralists are not always able to determine the exact cause of death of an animal (diseases, poor nutrition, poisonous bites) and may blame predators instead; the local government may underestimate the problem whilst failing to take account of isolated and unreported attacks (Polisar *et al.*, 2003); and farmers may intentionally exaggerate information for various reasons (e.g. in several countries, human-wildlife conflict are often used as a pretext to slaughter an elephant for meat). This issue of broad concern is quite common but can be easily overcome by verifying suspicious declarations against the local knowledge of field assistants or through field quadrant sampling surveys (Sekhar, 1998).

There is no simple universal reporting system in place to capture and collate information relating to human-wildlife conflict. Problems sometimes occur in remote places and are never reported at all. Incidents may be reported to a number of different institutions – traditional tribal leadership, police and/or army or security

organizations, hospitals, mission stations, local government, wildlife authority etc, or any combination of these. Details of incidents taken at the time will vary between organizations and from one incident to another.

A universal reporting format introduced and circulated to all entities likely to receive such reports has proved useful in some cases in obtaining information retrospectively. Local enumerators are employed to canvas all of the above sources and record information gathered according to the universal format. This reporting form also provides information that can be used to analyse the data for biological, spatial, temporal, cultural and other patterns and determinants. In the case of conflict with crocodiles, for instance, this is done from an existing database currently holding over 500 records of attacks worldwide; an increasingly valuable research and management tool.

As a general rule, good-quality and high-value information should be gathered to develop and maintain an updated database containing the broadest array of records documenting the type and location of the incidents (Box 30).

When an incident of human-wildlife conflict is confirmed, the details of the conflict should be investigated before any management measures can be considered (Box 31). This is not easy; on the one hand, it is often difficult for the relevant authorities to get to the field, on the other, the victims sometimes tend to exaggerate deliberately or not, the importance of the conflict.

BOX 31

Investigations to be made in cases of human-wildlife conflict

In the case of a livestock raid, the first step before choosing any of the possible management methods is to identify the killer. Is it a lion or some other animal? Here, a five-step investigation procedure developed for caracal, brown hyenas, cheetahs, leopards, black-backed jackals and domestic dogs (Bowland, Mills and Lawson, 1994) could be adapted:

- determine if the prey animal was killed by a predator or died from other causes;
- define the size of the prey, i.e. small, medium or large (only the lion will prey on very large species);
- examine the various parts of the carcass carefully and systematically;
- look for specific behavioural traits of predators such as claw marks on the carcass, bites on the throat, etc.;
- search clues in the area surrounding the carcass (tracks, droppings, hair, etc.) or observe the behaviour of the herd (e.g. obvious signs of nervousness among the remaining animals on the morning after attack).

In addition, an understanding of the ecological, social and cultural context of conflict situations is useful. Some aspects that may be relevant in identifying appropriate solutions, such as human population density, the proportion of urban and rural populations and religious beliefs, are often overlooked.

Continues

Box 31 continued

It is useful to explore local perceptions of the severity of damage; how and whether people use particular strategies to minimize the level of crop damage occurring; who actually makes formal complaints about crop-raiding by elephants; and whether crop damage *per se* is the important issue or whether it is obscuring another issue. This information would help identify which methods are best suited to the community and which groups should be targeted in any intervention programme.

Another key point to be investigated is how local populations assess the effectiveness of different human-wildlife conflict management measures. This knowledge can be helpful in educating farmers and promoting the adoption of the most effective techniques. An assessment conducted under the FAO Kakum project in Ghana, for example, showed that farmers ranked elephant deterrent techniques as follows (from best to worst):

- disturbance shooting and burning fibres (ranked equally);
- shouting;
- beating drums;
- burning tyres;
- detonating bamboo bombs.

Further investigation is useful in guiding management decisions. The status of the wild population, for instance, is instrumental in choosing between lethal or non-lethal techniques. For some species such as crocodiles, the status of the population is not difficult to obtain through a programme of aerial surveys coupled with nocturnal spotlight surveys from a boat, as well as the use of data from ranching operations where these exist. The methodologies and analyses of these data are well established. However, determing the status of species such as baboons, which are more widespread and less linked to a specific habitat, could be more complicated.

In investigating the behaviour of baboons, the most pertinent strategy is to improve understanding of why there was a conflict, how it started and how it could be managed in the future to sustain the viability of exotic timber plantations without removing baboon populations in large numbers. This strategy of inquiry helped reverse the problem on three border timber estates in Zimbabwe.

PHASE 2: PROBLEM ANALYSIS AND DECISION-MAKING

In addition to providing a list of management methods, a human-wildlife conflict policy should also provide the authorities, managers and local populations with a decisional framework. This framework would help people identify and implement appropriate management strategies which may differ depending on prevailing conditions (ecological, socio-economic, etc.).

It is also necessary for the policy to establish a threshold level of damage which may be designated at zero or some higher level. Mitigation is then only considered when this level is exceeded.

A decision-tree process has been proposed to help decision-makers to make up their mind and determine which actions to pursue in mitigating human-wildlife conflict (FAO, 2005). This is made up of simple flow charts which cover likely eventualities and can help towards taking the correct decision as well as giving staff confidence in carrying out their task. A decision tree has been designed for each problem-causing animal species. As an example, the model for elephants is shown in Figure 2.

Decisions in response to a human-wildlife conflict situation are most often made at the central level, but can be delegated to the lowest appropriate institutional level to ensure that they are made quickly, efficiently and based on the best available information. This procedure has been adopted in Mozambique where decisions are made at the district level, or in Namibia where decision-making has been transferred to the Chief Control Wardens of the Directorate of Parks and Wildlife Managements at regional level. This allows for better reporting and monitoring as well as for a very quick response, so that the identified problem animal can be speedily dealt with.

At the same time, safeguards need to be set up to ensure that the elimination of wildlife is necessary. In Namibia for instance, the national policy on human-wildlife conflict has established guidelines relating to the delegation of authority (to determine when to eliminate a problem-causing animal), the elimination of a problem animal by an authorized conservancy, and the framework for deciding when a problem animal should be destroyed (Government of Namibia, 2007).

Ideally, a decision should be taken in collaboration with all stakeholders involved: primarily the local populations, possibly through a community-based organization; local government representatives; any private-sector tourism operators involved within the areas where conflict occurs (wildlife viewing and hunting); and scientists. The same stakeholders should also agree on mechanisms for reporting and implementing action (see Box 32).

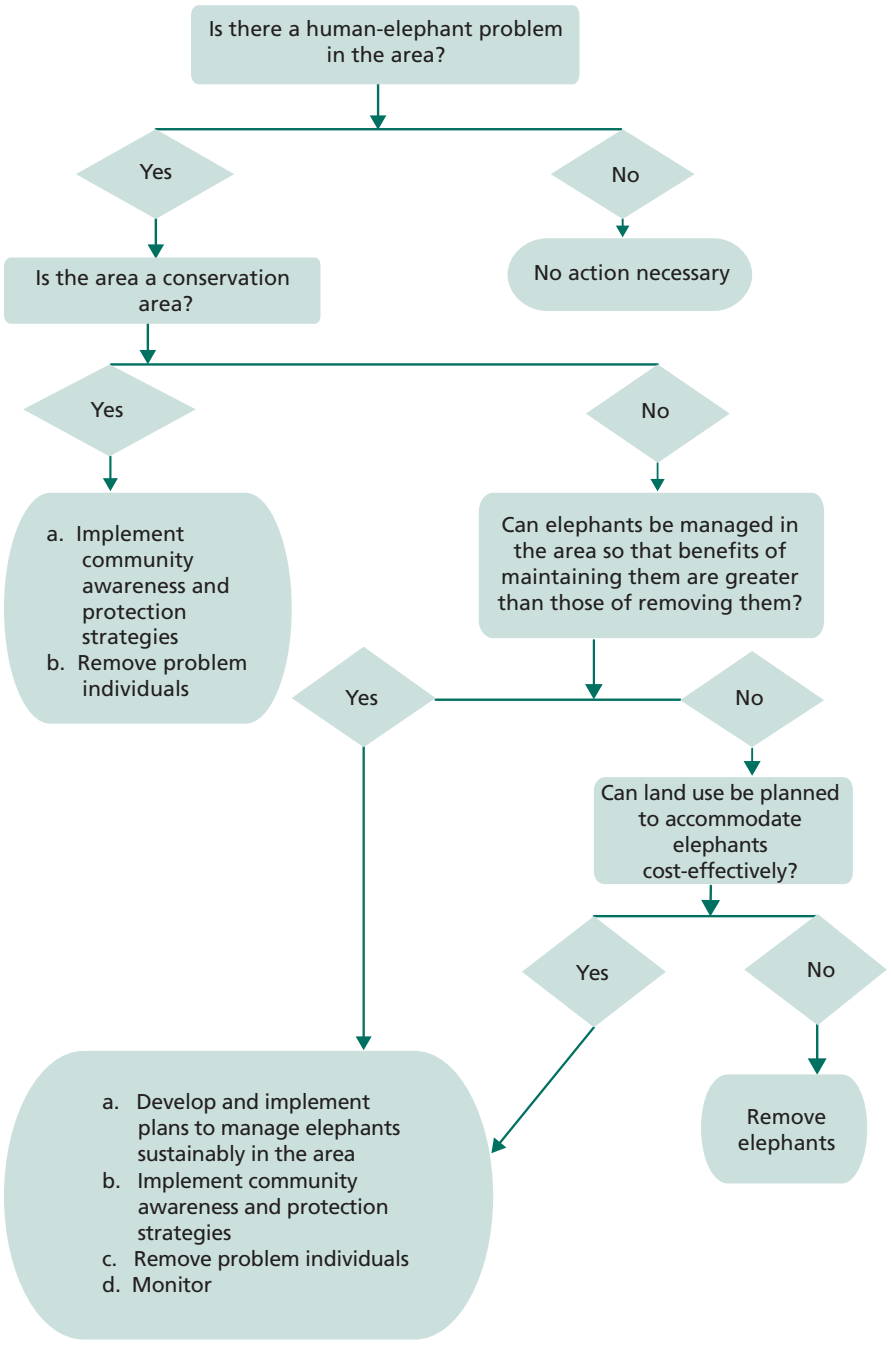
Finally, decision-making may deal both with cause and effect. For example, to lessen the damage caused by baboons in forested areas, it may be decided to address the problem by managing both the damage and the agent causing the damage (identified baboon troops or individuals). At each level thereafter, the choice of possible management activities may be constrained by their economic or practical feasibility, as well as by constraints imposed by lack of knowledge, legislation, certification programmes and/or public opinion.

PHASE 3: CHOICE AND IMPLEMENTATION OF MANAGEMENT OPTIONS

The choice and implementation of management options lies with the state, which is generally regarded as the owner of wildlife. As mentioned above these responsibilities may be delegated to local entities.

Ideally measures for human-wildlife conflict management and implementation should be chosen based on the following criteria.

FIGURE 2
Decision process to determine appropriate management action in areas with human-elephant conflict



BOX 32

An example of integrated decision-making

The decision to remove individual crocodile(s) or to authorize a mass operation is linked to decisions on how this operation should be carried out:

- how many animals will be killed (a quota)?
- are there any age/size limitations?
- who will carry out the operation (government, private sector or other)?
- when (immediate, at next optimal seasonal opportunity, delayed)?
- how – lethal (i.e. slaughter and recover skins) or non-lethal (capture/captivity)?

Management action may need to be provided for in legislation and regulations to control such operations. The disposal of any products (skins or live animals) may need to be approved, subject to the constraints of national or international obligations (e.g. CITES). The decision to select and implement other relevant management activities such as education or awareness raising, the development of alternative water supplies and transport or communications interventions must be made at this time. This will require negotiation and agreement at the national and regional levels and involve partnerships with the developed world.

Rapidity and effectiveness

Management response should be swift and should generate effective and permanent results, without simply displacing the problem elsewhere. Any efforts at management that are not implemented in an absolutely rigorous and committed manner could result in failure, and possibly in an exacerbation of the problem. In the case of baboons for example, this could happen by inadvertently teaching the baboons how to avoid the controls, or by disrupting the social structure of the target troops which could result in greater reproduction and/or damage.

Socio-cultural appropriateness

Management options should be compatible with current legislation and local culture, and politically acceptable.

In many situations, strategies or methods for addressing the human-wildlife conflict issue are constrained by local, national or international regulations, laws or treaties. The effectiveness of certain management practices is directly dependent on the establishment and application of policies and guidelines over a wide range of human activities. In various countries, existing wildlife policies are outdated, contradictory and require clarification, in particular those regarding land development planning and its impact on wildlife habitats. As mentioned before, policies on land tenure, controlled utilization of wildlife through hunting and the trade of wildlife products, game farming, tourism development and compensation schemes should be strengthened and made to conform to the current national context and population requirements (Hoare, 1992).

Local culture and religious and traditional beliefs should be taken into account, given that these can interfere with the implementation of some management techniques. For instance, the Muslim prohibition against the consumption of pork and related species, or the fact that some species – such as crocodiles in Burkina Faso – are regarded as taboo (see Box 9), affect the use of lethal methods in some parts of Africa.

The whole mitigation process must be properly documented in a manner that will satisfy international scrutiny and public opinion, which is often sensitive to animal welfare issues. The South African moratorium on the lethal control of baboon populations since May 2006 illustrates the weight of public and media concern.

Cost-effectiveness and stakeholder involvement

Human-wildlife conflict management measures should be cost-effective, should be implemented at the appropriate level (family, village, national and regional) and should involve the relevant stakeholders. A transboundary natural resource management approach may sometimes be necessary. In the case of damage caused by baboons, for example, mitigation strategies should address both the range of the baboons and the occurrence of the problem. It is ineffective for a single forest plantation to implement mitigation strategies if neighbouring stakeholders are pursuing different strategies or none at all.

It is of fundamental importance that those who are most affected by the problem be included in the solution. This is best achieved by transferring ownership of the management strategies to local communities affected (Box 33).

BOX 33

Community-based control of problem elephants

The Mid-Zambezi Elephant Project in Zimbabwe developed a system for community-based control in response to the understanding that current problem-elephant control techniques did not effectively assist communities living alongside elephants (Osborn and Parker, 2002). The system provides farmers with the necessary skills, resources and confidence to defend their crops. It was successfully implemented around Kakum Conservation Area in Ghana as a result of a three-year FAO Technical Cooperation Programme (TCP) project implemented by Conservation International.

Community-based control of problem elephants helps alleviate crop damage when used in combination with other methods, but it does not necessarily offer a complete solution. Based on the findings of the Kakum project FAO recommends the adoption a multi-stage approach to implement management measures, beginning with low-input, low-cost methods for which farmers can take full responsibility. If these methods do not succeed after a period of time, then higher-input methods should be implemented.

Simple and reliable monitoring procedures

The results of each wildlife problem management initiative should be monitored to determine its effectiveness and consolidate or modify the mitigation process if necessary (Box 34). Monitoring should also take into account any possible side effects on wildlife, such as the restriction of animal requirements, effects on non-target species and the environment as a whole, and cost-effectiveness. This is particularly important for timber plantations where the harvestable product takes more than one season or year to reach a suitable size for harvesting, and the product is therefore repeatedly exposed to damage.

AN ADAPTIVE PROCESS

To summarize, human-wildlife conflict management is an adaptive process which includes the following phases:

- determining human-wildlife conflict status (information gathering);
- setting objectives (policy/options to reduce conflict);
- implementing human-wildlife conflict management (policy/options);
- establishing whether objectives have been achieved (information gathering: has reduction of human-wildlife conflict been achieved? what is the impact?);
- modifying the objective if necessary (policy/options).

BOX 34

The event book: an example of simple human-wildlife conflict monitoring

The "event book" approach developed in Namibia by WWF, Namibia Nature Foundation and the Ministry of Environment and Tourism is a simple human-wildlife conflict monitoring system that can be used by communities. The community decides what it wishes to monitor. Technicians develop the monitoring structure accordingly, and the entire process, including analysis, is carried out locally. The approach concentrates on measuring effort and is based on the use of icons and visual displays which allow non-literate people to participate. For each incident of human-wildlife conflict, one cell is marked. This simple approach soon displays valuable information that is directly usable by communities (WWF SARPO, 2005). The approach has already gained wide acceptance in Namibia and Mozambique and is now being introduced in Botswana and Zambia.

5. Conclusion

Human-wildlife conflict is a significant problem in Africa. The conflict has important consequences for local populations in terms of food security, safety and well-being, for the micro and macro economy, and also for wildlife conservation.

Considering the current human population growth rate, the increasing demand for natural resources and the growing pressure for access to land, it is clear that the human-wildlife conflict will not be eradicated in the near future. On the contrary, it will continue to grow as African economies continue to be driven by the production of resources for supply to more industrialized nations (Friedman, 2007). This is particularly true in African countries where subsistence agriculture will continue to play a dominant role in supporting the continent's burgeoning populations. But it is also true for countries that have developed a modern agricultural sector, such as Zimbabwe and South Africa, and where recent government policies have favoured a switch from modern commercial agricultural practices to a return to subsistence agriculture.

A series of measures are available to prevent or mitigate human-wildlife conflict. Well-designed human-wildlife conflict management plans which integrate different techniques and are adapted to the nature of the problem can be successful. Potential solutions can be selected based on their effectiveness, cost and human and social acceptability.

The most sensible approach in addressing human-wildlife conflict is to implement a combination of short-term mitigation tools alongside long-term preventive strategies. In this way immediate problems are addressed while the rapid development of innovative approaches is fostered to address future issues and eradicate the problem in the long term. When low environmental impact strategies and traditional low-cost deterrents are not successful, some invasive approaches, such as regulated harvesting, wildlife translocation or human relocation may need to be implemented. Of the various strategies available, settlement of rights, benefit sharing, CBNRM, insurance programmes and land-use planning seem to be the most sustainable.

Conflict alleviation is a two-sided equation. Both wildlife and people are in conflict. The goal is thus to enable coexistence and sharing of resources at some level. This is best achieved by addressing both sides of the equation and finding a balance between conservation priorities and the needs of people who live alongside wildlife. Increasing tolerance levels of local communities for wildlife and adapting the human landscape are essential goals, but will always be the most difficult.

It is of paramount importance that an international forum be set up to promote information sharing on human-wildlife conflict issues (Box 35) and that a Web-based portal be developed to provide conflict databases, remediation technologies, good management practices, and innovative solutions and their outcomes. The portal

BOX 35

Human-wildlife conflict collaboration

The international forum Human-Wildlife Conflict Collaboration (HWCC) was established following a recommendation of the IUCN World Parks Congress in 2003. HWCC acts as a global network to share information and expertise in addressing human-wildlife conflict. Initiated by IUCN's Strategic Direction on Governance, Communities, Equity, and Livelihood Rights in Relation to Protected Areas (TILCEPA), it was formally launched in November 2006. The Wildlife Society is committed to hosting the HWCC office and serving as fiscal agent. HWCC is a global partnership supporting greater collaboration on human-wildlife conflict across disciplines, sites and policy areas. Its mission is to prevent and mitigate human-wildlife conflict through a global network and partnership that facilitates collaborative learning, innovation, scientific analysis and the development and improvement of best practices and policies. It seeks to promote the adoption of best practices for human-wildlife conflict management through conservation, development and planning professionals and institutions.

should also provide educational material, information on high-risk areas and links to other relevant and useful Web sites such as those of the IUCN and WWF. It would provide valuable support to different partners dealing with the problem, granting access to information, recommendations and effective management principles.

The overview presented in this publication suggests the key question to be addressed: is cohabitation between humans and wildlife still possible in a twenty-first century ruled by economic profit and globalization? This raises the following underlying questions.

- Should poor rural communities in the developing world be expected to bear the burden of conflict with wildlife when other options are available? For example, should rural populations have to put up with living alongside crocodiles?
- Given that most African countries do not have the resources to manage their protected areas effectively, is it reasonable to expect them also to manage wildlife living in inhabited areas?
- Can wildlife become a useful profitable resource for poor rural communities, rather than a liability?
- With the growing animal rights lobby opposed to wildlife utilization and its success in preventing the use of this resource in a few countries, is it now time to lobby responsible donors to direct greater resources towards planning and managing wildlife as an asset to rural communities?

Reducing conflict between wildlife and people is certainly a key means of responding to these questions; it is likely to improve both food security, by reducing the impact of wildlife on crops and livestock, and biodiversity conservation, by modifying the negative attitudes of many communities towards wildlife.

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ANNEX

Scientific names of animals mentioned in this book

African slender-snouted crocodile	*Crocodylus cataphractus*
Asian lion	*Panthera leo persica*
Baboon	*Papio* spp.
Badger	*Meles meles*
Bat-eared fox	*Otocyon megalotis*
Bear	Family Ursidae
Black-backed jackal	*Canis mesomelas*
Blue monkey	*Cercopithecus mitis*
Brown hyena	*Parahyaena brunnea*
Buffalo	*Syncerus caffer*
Bush pig	*Potamochoerus* spp.
Capuchin monkey	*Simia capucina*
Caracal	*Caracal caracal*
Chacma baboon	*Papio hamadryas ursinus*
Cheetah	*Acinonyx jubatus*
Chobe bushbuck	*Tragelaphus scriptus ornatus*
Civet	*Civettictis civetta*
Common genet	*Genetta genetta*
Crocodile	Family Crocodylidae
Deer	Family Cervidae
Dikdik	*Madoqua* spp.
Duiker	*Sylvicapra grimmia*
Eagle	Family Accipitridae
Elephant	*Loxodonta africana*
Gazelle	*Gazella* spp.
Giraffe	*Giraffa camelopardalis*
Goat	*Capra* spp.
Gorilla	*Gorilla beringei beringei*
Grasscutter	*Thryonomys swinderianus*
Greater kudu	*Tragelaphus strepsiceros*
Green parrot	*Poicephalus senegalus*
Hare	*Lepus* spp.
Hartebeest	*Alcelaphus buselaphus*
Hippopotamus	*Hippopotamus amphibius*
Hyena	Family Hyaenidae

Hyrax	Family Procaviidae
Impala	*Aepyceros melampus*
Jackal	*Canis* spp.
Kangaroo	*Macropus* spp.
Lechwe	*Kobus leche*
Leopard	*Panthera pardus*
Lion	*Panthera leo*
Lynx	*Lynx* spp.
Monkey	*Cercopithecus aethiops*
Nile crocodile	*Crocodylus niloticus*
Olive baboon	*Papio hamadryas anubis*
Porcupine	*Hystrix* spp.
Rabbit	*Oryctolagus cuniculus*
Red-billed quelea	*Quelea quelea*
Red colobus monkey	*Procolobus kirkii*
Red deer	*Cervus elaphus*
Rhinoceros	Family Rhinocerotidae
Roan antelope	*Hippotragus equinus*
Roe deer	*Capreolus capreolus*
Sable	*Hippotragus niger*
Samango monkey	*Cercopithecus mitis labiatus*
Snow leopard	*Uncia uncial*
Spotted hyena	*Crocuta crocuta*
Syke's monkey	*Cercopithecus mitis albogularis*
Tiger	*Panthera tigris*
Topi	*Damaliscus korrigum jimela*
Tragelaph	Subfamily Tragelaphini
Tsessebe	*Damaliscus lunatus*
Vulture	Family Accipitridae
Warthog	*Phacochoerus africanus*
Waterbuck	*Kobus ellipsiprymnus*
Wild boar	*Sus scrofa*
Wild dog	*Lycaon pictus*
Wildebeest	*Connochaetes taurinus*
Wolf	*Canis lupus*
Wood pigeon	*Columba palumbus*
Yellow baboon	*Papio hamadryas cynocephalus*
Yellow mongoose	*Cynictis penicillata*
Zebra	*Equus* spp.

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Human-wildlife conflict in Africa

Causes, consequences and management strategies

Conflicts between humans and wildlife have occurred since the dawn of humanity. In Africa, these conflicts have become more frequent and severe over recent decades as a result of human population growth, extension of transport routes and expansion of agricultural and industrial activities which together have led to increased human encroachment on previously wild and uninhabited areas. This publication was compiled to facilitate the coexistence of humans and wildlife and assist affected communities in applying best management practices. With a focus on large herbivores and carnivores such as elephants, lions, baboons and crocodiles, the book presents the issues, describes different methods of conflict management and outlines a three-step framework for decision-making. Three dozen text boxes support the concepts through concrete examples. The publication was developed through a writing workshop organized by FAO and the International Foundation for the Conservation of Wildlife (Fondation IGF) in January 2008. It will be of interest to villagers, farmers, wildlife practitioners, development workers and researchers, to local, regional and national authorities, and ultimately to anybody keen to learn more about the issue.

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