



**THE PREVENTION OF LION ATTACKS ON LIVESTOCK AND HUMANS:
REVIEW AND INSIGHTS FROM LITERATURE AND FIELD EXPERIENCE**



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INTRODUCTION

Our current generation is bearing witness to the greatest ever increase of the human population and, in the meantime, an outstanding decrease in biodiversity. The interlink is obvious: humans have benefited from their overuse of biodiversity and, to its own cost, the biodiversity has supported the human upsurge. It looks like humans and biodiversity have conflicting agendas: roughly, humans are looking for improving their livelihood while biodiversity is resisting to survive. The respective development and conservation goals appear to be opposed, and the latter is admittedly loosing the ongoing battle at this stage. Such a warlike vocabulary (conflict, battle, opposition, etc.) demonstrates the highly breakable nature of the delicate equilibrium these days, if there is any, between humans and biodiversity. Do we really live in a state of war? As a matter of fact, the coexistence between humans and wildlife (understood as wild flora and fauna) is becoming more and more problematic. It happens that wildlife may suffer from humans and humans may also suffer from wildlife. The response to suffering is the cure, since curing the pain helps refreshing or rehabilitating the soundness of the global system.

Standing on the very top of the trophic chain, the large carnivores are the most charismatic emblems of the clash between people and nature. Jaguar in America, tiger in Asia, lion in Africa and Asia, and a few more, look nowadays like odd sorts of living creatures. In a world becoming modern, the finger is pointed at these strange “beasts” with acute paradox: (i) on one hand they are magnified by the world-wide history for their beauty, their power, their magic and the fear they inspire; (ii) on the other hand they are hated and harassed for their need to rely on meat, their capacity of killing human beings and domestic animals, their supposed cruelty. Furthermore and unfairly, large carnivores tend to crystallize the common oppositions (i) between urban-dwellers and rural-dwellers, the former advocating the beauty of the species and the latter defending their lives and goods, and (ii) between countries of the North and countries of the South, the former claiming the right to enjoy tourism and to admire beautiful wildlife, the latter complaining about the cost of living in the vicinity of large predators. Indeed, conservation areas cannot contain carnivores within their boundaries and problems with carnivores on neighbouring farmlands are well documented (Van der Meulen 1977; Mills et al. 1978; Stander 1990; 1993) especially as the intensity of peripheral pastoralism increases (Van der Meulen 1977; Anderson 1981; Hines 1990; Stander 1990).

The purpose of the present collective work is to contribute at maintaining a balance in Africa between human beings and lions. In this document the conflict between humans and the African lion is understood both ways, a definition in accordance with the recommendation of the 5th World Park Congress in 2004 in Durban: *“Human-wildlife conflict occurs when the needs and behaviour of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact the needs of wildlife. These conflicts may result when wildlife damage crops, injure or kill domestic animals or kill people”* (IUCN - The World Conservation Union, 2004). However, the emphasis has been placed here on addressing the issue of lion attacks on livestock

and humans. Doing so does not mean that human aggressions toward the lion are not considered. By analysing the roots of the humans/lion conflict, the evidence comes up that human pressure on lion (direct pressure: killing of lion by people; indirect pressure: destruction of prey basis and lion habitat) takes a substantial share of responsibility in lion attacks on livestock and humans. The rapid encroachment of human activities on lion habitat - the withdraw of wilderness as a whole - increases the interface between man and lion, leading to the difficult coexistence of a large predator (lion) with a potential prey (man). To some authors (Madden, 2004), human-wildlife conflict is increasing in both frequency and severity world-wide and will likely continue to escalate. It hardly applies to the lion. More probably, the co-evolution of man and lion has always been difficult and might have been even more difficult in the past: long before turning major predators themselves, human beings were the "hunted or chased men" as described by paleontologists (Ehrenreich, 1999). Also communication tools nowadays facilitate reporting and recording incidents, introducing bias for comparing time periods.

Solutions are studied here for solving the problem of lion attacks on livestock and humans. In general, an animal becomes a problem animal when it competes at an unacceptable level for human food resources, becomes a nuisance or is a danger to human life (La Grange, 2005). That definition would no doubt be different for each type of land use and management associated. The issue is to define this degree of acceptance which might differ from one area to another. First of all, a good comprehension of the problem is already a step forward to the cure: understanding the timing and distribution of attacks on rural communities will help to prevent them (Packer et al., 2005). Usually, it is very difficult to make one's mind since, many time, the complaints of the livestock herders tend to be exaggerated, while the reactions of non-stakeholders tend to minimize the amplitude of damages. Factual and emotional sides of the problems must be analysed properly. Then, a comprehensive review is proposed to cover all the mitigation methods available to solve the problems. Finally, a decision-making process is submitted to the stakeholders in charge of managing the conflicts, based on reflexions from specialists of the African lions, but also from experience drawn from similar problem solving framework related to jaguar.

The conservation needs must be recognized for preserving the lion on a long term basis. Compared to many other mammal species, the resilience of the lion is high. The species is capable of very quick recovery as demonstrated for instance after the distemper outbreak in the lion population of the Serengeti - Masai Mara ecosystem. However its resilience to any kind of shocks - or conflicts - becomes limited when prey basis disappears, when exotic diseases are introduced and when harassment is too systematic. Keeping wild lions in natural condition requires large habitats with enough prey basis and sustainable use of all natural resources (flora and fauna).

The development constraints of the local communities sharing a space reduced by droughts and desertification with lion must be definitely acknowledged since these people are the ones who guarantee the long-term survival of the species. The very people living with lion are some of the poorest on earth. Imposing unbearable measures to them is both not fair to them and not strategic to the lion. Conserving lion at the expense of people might produce "enemies of conservation" as similarly described by some authors (Dowie, 2006) in respect to Protected Areas. And understandably the lion range countries have other political priorities than lion conservation. Therefore, to have a chance of being effective, the choice of human/lion conflict mitigation measures must be pragmatic and take into account their implementation acceptability.

I. THE CONFLICT

“ . . . The lion population continues to be fairly strong and well distributed but because of the necessity to shoot cattle-killers and man-eaters, lion must be carefully looked after or else they will become rare.” (Ugandan Game Department Archives, 1962–1963: p. 9).

The African lions, as most large carnivores, require vast areas in which to roam, however human expansion and subsequent harassment by people increasingly restricts the lion to protected areas, including National parks and hunting areas - Safari areas or “ zones de chasse” - (Mills, 2000). Interactions between humans and these large predators in Africa are increasing as with human expansion and human-lion conflicts are intensifying accordingly. Logically, it is at the periphery of the protected areas that the majority of the conflicts take place (Mills, 2000). The fact that the herders now often penetrate with their cattle in these protected areas, and that new villages settle at their borders, the risks increase of lion attacks on both livestock and people (Bourn & Blench, 1999).

Therefore, understanding the lion-human conflict does not only need some classification of the conflicts, or an assessment of the severity or costs, but a thorough contextualisation, as solutions may only be found through integrating the local realities. The roots of the conflicts need to be analysed in order to mitigate the interactions between lions and humans, but also understand circumstances where no solution exists but to drastically decide which point of view (the human's or the lion's) prevails.

1. NATURE OF THE CONFLICTS

1.1. Types of conflicts

1.1.1. Predation of the cattle

In Africa, pastoralists and their livestock have co-existed with wildlife for some 7,000 years or more and it is likely that few of the tensions evident today were present in the past (Cumming, 1982; Bourn & Blench, 1999). However, co-existence has become more difficult in recent times due to a combination of reasons and circumstances, and in the regions of Africa where lions occur, lion predation on livestock is reported as the main form of conflict between the predators and local people. The problem is particularly acute in semi-arid rangelands of the Sahel and Eastern and Southern Africa where human expansion and recent changes in land use practices have increased the competition between pastoralists, newly settled farmers owning livestock, and lions, especially around protected areas. If these protected areas stigmatise the conflict, it is a direct consequence of the spatial segregation between land-uses over much of Africa in the 20th

century, where livestock and wildlife were managed separately. On the one hand National Parks were set aside and livestock and people were, and still are, excluded from the great majority of such areas, on the other hand outside those protected areas, wildlife was extensively hunted and high pressure was exerted on predators as they impede human development. Large predators have been eliminated from most of the world because they prey on livestock. Only in the last few years has the public become aware that populations of African lions have plummeted. Few parks are large enough to ensure lions' long term survival, and because conflict with livestock is by far the most serious threat to large carnivores, it is critical that we find methods to integrate predator conservation with realistic livestock management (Franck, 2006).

In the last few decades, demographic pressure in some parts of Africa has led to rural people moving progressively into wild lands that were former lion habitat. Pastoralists are gaining access to protected rangeland and villagers are farming up to park boundaries (Bourn & Blench, 1999) containing large carnivores, thereby accelerating the potential for lion attacks on livestock and sometimes people. Indeed, the periphery of conservation areas is where most of the reported clashes with lions occur in Africa. The immediate vicinity of human settlements and farmland with protected areas is often the direct cause of their occurrence. In some cases, local communities, living traditionally within the boundaries of the newly created park, were displaced right outside its borders. In this context, it is easy to understand that these communities object to lions coming from the park to kill their livestock and sometimes people. In addition, because of their resentment against the park system, these communities will not hesitate to intrude into the adjacent park to let their domestic animals graze. In Waza National Park, Cameroon, presence of cattle inside the park is increasing and people do not hide the fact that many of the lion predation incidents on domestic animals occur inside the park boundaries (Bauer *et al.*, 2001). This of course multiplies the possibilities of lethal encounters between lions and people and their livestock. Worse, according to Bauer *et al.* (2001), the increasing predation on cattle by lions both outside and inside the park could transform the entire lion population of the area into stock killers.

Freedom of movements of livestock and wildlife across protected area boundaries is increasing the risk of encounters, and these are common in lion range states as most of the areas in Africa having the largest lion populations are not fenced. In the W National Park, for example, many herds cross or station inside the Park, accompanied by the shepherds and their dogs. It was recently estimated that more than 100 000 heads of livestock (65% of cattle, 35% of sheep and caprine) were stationed illegally in the Park, mainly in the Beninese part (Hars, 2002). In some regions, however, fences have been erected to prevent interaction of wild animals from the parks with people and livestock who live outside their boundaries, but fences are costly to maintain and are often damaged by erosion or animals like warthog. Lions can therefore move easily out of the parks to neighbouring farmlands. In other cases, surrounding communities deliberately destroy fences. In South Africa, on the border of Kruger National Park, the people of the adjacent village of Makoko were found eating roasted meat of four lions. The villagers claimed that lions coming from the park had killed eight of their cattle. According to the *South Africa's Sunday Time* of 23^d March 1997, which relates the incident, the villagers had taken 500 metres of the park fence for housing and crop protection (Cat News, 1997).

Obviously, the attacks of lion on the domestic herds can represent a significant problem for the rural populations, for whom the domestic animals often represent not only their main resource (milk and the meat constitute a food essential with their survival) but also their only wealth (means of saving and of ensuring a source of income; the social role of the cattle has major

importance in the pastoral cultures). The losses can thus push people to be hostile toward lions. In Mali, the lion-cattle conflicts are one of the reasons which led to the drastic reduction of the number of lions. Similarly, in the north of the CAR, one of the principal reasons for the decrease in lion numbers is the systematic shooting by the pastoralists who enter with their cattle the protected areas during the dry season (B. Chardonnet, pers. com.). Between 1997 and 1998, in the National park of Haut-Niger, Guinea, 7 lions killed 168 domestic cattle according to local authorities (Oulare, pers. com. *in* Bauer, 2003). In reaction, the authorities organized to push the lions back inside the Park with local hunters, hence reducing the number of attacks on the cattle.

The big issue with most of human and carnivores conflict is breeding depredation (Jonker 1998). Lion are capable of inflicting serious damage to livestock and ranchers can loose large numbers of livestock to them if they are left unchecked. The impact of lion predation on the domestic animals varies according to the size of the herds. This impact is considerable for the small stockbreeders who have only few bovines or small ruminants. The problem can be very acute locally as exemplified by a study at the periphery of the National park of Waza, Cameroon (Table 1).

Table 1: Herds of cattle and annual losses declared due to the predation of the large carnivores around the National park of Waza (Source: Bauer, 2003)

Zone	Villages and Permanent Camps	Cattle shepherds (number of heads)	Loss	%	Small domestic ruminants (number of heads)	Loss	%
1	Badaday	300	20	6,7	100	30	30
	Amaheiri	400	20	5	150	30	20
2	Andirni	680	5	0,7	450	75	16,7
	Dieguere	80	0	0	300	300	10
	Tchede	0	/	/	150	25	16,7
	Camp 1	400	5	1,3	0	/	/
3	Mahe	40	2	5	325	60	18,5
	Camp 2	400	4	1	50	0	0
	Camp 3	1 100	4	0,4	300	5	1,7
4	Zina	0	/	/	200	8	4
	Camp 4	350	1	0,3	125	0	0
	Sifna	150	0	0	200	3	1,5
	Camp 5	700	0	0	350	0	0

In the area of Waza, the domestic animals would constitute even the principal prey for a score of lions (Sounds, 1998 *in* Bauer, 2003). The attacks take place during the day primarily. At night, the herds are kept in enclosures inside the villages where the lions generally do not dare to venture. In contrast to East Africa (Butler, 2000 *in* Bauer, 2003), these attacks mainly take place during the rainy season. The attacks of lion take place also inside the park where herders illegally take their animals (Scholte, Kari & Moritz, 1996 *in* Bauer, 2003). What is more to fear, according to Bauer *et al.* (2001), it is that the lions of the area, offered the opportunity of domestic herds both inside and outside the Park, can become exclusive killers of cattle. Further, in this area there is no mechanism of financial compensation for the endured losses, but people have the right to

kill lions in defence of life and livestock. However the administrative procedures to obtain the authorisation are often too complex.

At the periphery of the National park of W in Niger, an anthropologist studied the relationship between people and lions in the village of Moli-Haoussa/Gourma (400 inhabitants), in the buffer zone of the “Réserve de Tamou” where the population coexists narrowly and daily with the lion (Galhano Alves & Harouna, 2005). Investigations were made into all the aspects of the relationship between the population and fauna (ethologic, technical, cultural, economic, etc), and into the lion in particular. He estimated that, during the period of investigation, the attacks of the lion on the cattle amounted to approximately 4 % of the cattle population each year, that is to say approximately 10 cows out of a total of 250.

Lion typically kill cattle, not by leaping in boma at night, but by approaching bomas at night, causing the cattle to stampede and break out, where they are killed by lions or other predators. It would appear that the close proximity of a struggling animal triggers a response, a killing frenzy, where lion attack any animal in reach. Daytime attacks on herds were perceived to have been initiated by the predator approaching the herd (rather than the herd stumbling upon a resting predator) in 65% of 17 lion attack. In Kenya, lions were found to attack both grazing herds and those enclosed in bomas.

To conclude, the impact of lion predation on domestic animals is highly variable depending on the scale of the livestock operation. As mentioned above, it can be particularly devastating for small traditional farmers who depend on few livestock to sustain their living. It is thus a significant problem on a local level, which can induce drastic human retaliation. Frank et al. (2006) mentioned the report of Ogutu (2005) stipulating that Masai morans (warriors) killed by spears about 90 lions since 1998 in the Nairobi National Park and the Kitengela Plains in response of attacks on livestock. The same authors report some studies carried out by Richard Bonham documenting that at least 76 lion were killed (poison or spears) since 2001 in the region on Mbirikani Group Ranch in southeast Kenya. Bernard Kissui in the greater Tarangire-Manyara, Tanzania, reported more than 125 lions killed between 2000-2005, and Dennis Ikanda mentioned 35 kills of lions in the Ngorongoro Conservation Area between 1998-2004.

1.1.2. Attacks on human

The African lion also occasionally preys on people (Quigley & Herrero, 2005; Skuja, 2002; Treves & Karanth, 2003). Lion attacks on humans have been attributed to diverse triggers, including the defence of their kills from “thieves” (human scavenging food from lion) (Treves & Naughton 1999). For instance, information gathered from Ugandan Game Department archives (1923–1994) reveals that twentieth-century agropastoralists regularly tried to scavenge from leopard (*Panthera pardus*) and lion (*Panthera leo*) kills, and that these large carnivores have preyed on hundreds of humans in Uganda over the past several decades. There are nine reports which describe human scavenging from lion or leopard kills. In three of these, reference is made to this general practice, rather than to a specific incident. Lion might attack when surprised suddenly particularly at night or with cubs or driven off a kill (La Grange 2006). In general, attacks on humans can be differentiated in two types depending on which environmental circumstances they are associated with: provoked and unprovoked attacks. Provoked attacks are defined when a person enters an animal’s personal space or purposely tries to touch, injure or kill the animal and the animal attacks, or the person(s) had human food or garbage attractants that brought the animal nearby, again, within the animal’s personal space (e.g. area around an animal

where the animal reacts to the presence of the person) (Quigley & Herrero, 2005). Unprovoked attacks by African lion are usually fatal, and mostly associated with a true predation act.

Fatal lion attacks on local people inside or outside the perimeter of African conservation areas have often been reported, however they are not always publicised. These incidents usually take place in or around areas with high lion density, i.e. mostly in East and southern Africa. For instance, between December 1996 and August 1997 in South Africa, at least 11 (possibly more) illegal immigrants making their way from Mozambique across the Kruger National Park (KNP) on foot were killed by lions (Cat News, 1997). In March 2002, the *Star* of 4th March 2002 reports that another Mozambican immigrant was killed by a lion and the predator then dragged his body through the neighbouring town of Phalaborwa (Wildnet Africa, 2002). Since 1990, some villages in Tanzania have suffered dramatic attacks by lions on people, probably due to the increase in human population (Packer et al. 2005). Lions have killed more than 563 Tanzanians since 1990 and injured at least 308. 39% of attacks occurred during the harvest seasons, 27% occurred in the field themselves. The level of conflicts around the Selous Game Reserve (SGR) is regarded as high with 15-30 people killed each year (V. Booth, comm. pers.). One single village, on the edge of the Selous Reserve, has had between 29 to 50 people killed a year during this period (E. Pasanisi in Strang, 2002). In 1999 alone, a total of 21 people were killed by lions in Southern Tanzania (J.J. Jackson, pers. comm.). However, not all the reported conflicts occur along the borders of Protected Areas. In South-eastern Tanzania human population densities are low. Precisely because of this low human density, lion populations are widespread outside Protected Areas and the level of incidence of man-eaters in the region is high (V. Booth, pers. comm.). Similarly, the Luangwa Valley in the Eastern part of Zambia provides good lion habitat but it is also an area of human settlement, such as villages and cultivated areas. This situation increases the chances of conflicting encounters between lions and local people. Three fatal lion attacks on people were reported in August 1991 in the Luangwa Valley (Yamazaki & Bwalya, 1998). Lion attacks can lead to serious human injuries or in dramatic cases to the loss of human life. In Uganda, among 275 humans attacked by lions between 1923 and 1994, 74.9% were fatal, 25.1% lead to injuries.

Although during the 1923 rainy season, as many as 21 people were killed by a pair of lions near Po, Burkina Faso (Raynaud & Georgy, 1969), lion attacks on humans are perceived as only very occasional in West Africa and Central Africa. However, it is extremely probable that some of these attacks are not recorded; particular circumstances, such as nocturnal attacks on a single person can result in a lack of recording. In Cameroon, around the National park of Waza, people do not fear lion attacks, and indeed such attacks are rare, with 3 men being attacked in the whole area during one 10 year period (Bauer, 2003). Disarmed herders regularly encounter lions but are seldom attacked, hence migratory pastoralists are not generally afraid of the lion. They know how to frighten it and chase it with their sticks and by particular cries (Galhano Alves & Harouna, 2005), as do the migratory herders further north with the cheetah (J Tubiana, pers. com.). In Niger, around the National park of W, the attacks on the man are rare, but they are often mortal. For example, in the zone of Moli Houassa, since the end of 1990, a child was killed by a lion, and a shepherd was seriously wounded (Galhano Alves & Harouna, 2005).

Certain lions can develop an aggressive behaviour towards the man. It is generally allowed that the lion avoids the man because it is afraid of it, but this fear can attenuate once that the lion already killed a man. It is also known that walking at night is dangerous. Lion, like most carnivores, are generally less fearful of man at night than during the day and attacks against man occur more frequently at night. Human victims (Tarangire National Park, Tanzania) were mainly

taken at night (76% of kills), which is consistent with lion predatory behaviour, as ambush and escape are easier. Experts have also noted that some individual animals can, in certain circumstances, develop abnormally aggressive behaviour. After several dangerous personal encounters with lions, the senior South African researcher, Ian Whyte, considers that old, sick or injured lions, or animals that have been pushed out of a pride were the animals that usually became man-eaters. *“It is generally accepted that lions avoid man because they have a great respect for him. This fear disappears however, after a lion has killed a human for the first time. Lions that are held in captivity and relocated in the wild are among the most dangerous animals in the world, purely because they have lost their fear of humans”* (CAT News, 1997). Although men-eater are not common (Macdonald, Sillero-Zubiri 2002; Yamazaki & Bwalya 1999), the African lion will attack human opportunistically and victims are usually easy target like children (18% aged under 10 out of 538 victims in Tanzania, from Packer et al. 2005) and alone individuals. Men were most often targets of carnivore attack, particularly while engaged in hunting-related activities (Packer et al. 2005). However attacks on men were less often lethal than attacks on women and children. A renowned exception of the opportunistic nature of human predation by lion was that of the man-eaters of Tsavo, who killed 140 workers building a railway bridge in Kenya in 1898 (Patterson, 1907; Kerbis-Petermans, 1999) and Mfuwe (Hosek 2006). Poor burial practices may have also contributed to the Tsavo tragedy. Railroad workers who died of injury or disease were often poorly buried, or not buried at all. A scavenging lion coming across this easy meal might start going after live human.

Even in the 21st Century man eating by lion is a true problem in Ethiopia, Mozambique and Tanzania (Frank et al. 2006). The opinion of these authors is that retaliatory killing and pre-emptive killing of lions by rural people, particularly livestock owners is the single greatest threat to lion populations. Poison (strychnine and organophosphate cattle dips) has been widely used on East African ranches up to the latter half of the 20th Century (Denney, 1972 in Frank et al., 2006). Until recently, the Kenya Wildlife Service and the Kenya Veterinary Department has widely poisoned hyenas, which certainly affected other scavengers like lions. Because poison is indiscriminate it may remove not only the target animal but also the whole prides at once (Jenkins, 2001 in Frank et al., 2006). At this concern a great worry is the use of the soil dressing Furadan (carbofuran), widely available and cheaper than the strychnine, in some pastoral areas of Kenya (Frank, unpub. data in Frank et al., 2006). Despite of the recent ban on lion killing in Botswana, poisoning of lions is still recorded (Hemson, 2003 in Frank et al., 2006).

1.1.3. Predation on endangered species

One neglected aspects of the potential conflict between lion and human, is that of predation by lion on endangered species. Although this is part of a natural process, it is possible that rare species stuck in a predator pit would require intervention from managers on their predators to escape extinction. For instance *“...the Kenya Wildlife Service has, over several months, culled some (30) lions from the Aberdares National Park which is fenced, [where] the total number of lions is estimated to be between 145 – 180. The principal reason for the culling is their having been the main predators of the rare bongo (Boocercus euryceros) population as well as inflicting serious depredation on the bushpigs (Potamochoerus porcus) and giant forest hogs (Hylochoerus meinertzhageni) within this particular habitat...”* (Nehemiah Rotich, *in litt.* Anon., 2001).

In the Kruger National Park, lion predation is thought to be the main cause for the decline of the roan antelope *Hippotragus equinus* (Harrington et al., 1999). Similarly, lion were considered pest in Angola during the 1940-1950 because of their threat on the giant sable in the

Reserva do Luando (Hippotragus niger varians). Later, further studies showed that lions were rare in the area, and their impact on the giant sable existed but was weak (Silva, 1972). The effect of lions on endangered species is not restricted to herbivore species, as they can account for up to 80% of the mortality in painted hunting dogs (*Lycaon pictus*) in Botswana, and certainly represent the main limit to hunting dogs distribution (McNutt, 2001). Similarly, lions (and hyenas) regularly kill young cheetahs in the Serengeti, which have only 5% chance of survival to adulthood (Laurenson 1994 in Jackson 1997). Extinction risk for cheetah is considered high at high lion density (Kelly 2001). Lions are also known to prey on the rare chimpanzees (*Pan troglodytes*) in the tropical forest areas (Inagoki, H. & T. Tsukahara, 1993; Tsukahara, T., 1993).

1.2. Importance of the conflict

1.2.1. Frequency, costs and impacts

Depredation on livestock can cause indirect economic losses e.g. decrease in breeding performances (abortion, lactation, birth interval) due to stress when herds are attacked. In the late 1970s, East African pastoral tribes lost between 2% and 10% of their livestock per year, mostly to lions, spotted Hyaena and black-backed jackal. Nowadays, in Kenya (Laikipia District, commercial ranching with tolerance for wildlife), lions remain serious predator of cattle at bomas and in the field. They kill the largest number of sheep and goats at bomas in comparison with spotted Hyaena, leopard, cheetah (Ogada et al. 2003). In Laikipia District, the average ranch losses 0.8% of cattle per year to lions, costing them an estimated average of US\$ 362 to maintain an individual lion on ranch land (Franck 1988, in Frank & Woodroffe, 2002). On ranches neighbouring Tsavo National Parks (Kenya), the predation represented 2.6% of the herd estimated economic value, and cost the ranch US\$8749 per annum. Each lion cost ranchers approximately \$290 per year in depredations (Patterson et al. 2004). In Galana Ranch, over an approximately 20-year period (approx 1968-1988), lions killed about 1% of livestock per year, i.e. 250-300 head of cattle (A. Radcliffe, pers. comm.). Fifty-eight head of livestock were killed during the years 1970-75 from the Kitengela Conservation Unit, an area adjoining the southern boundary of Nairobi National Park (Rudnai, 1983). In Uganda, in the vicinity of Northern Queen Elizabeth National Park, losses caused by lion predation on livestock between 1990 and 2000 are estimated at US\$6,400 (Bauer & De Iongh, 2001). In Zimbabwe, a single example is given here for the sole District of Nyaminyami. During the past 3 years (1999, 2000 and 2001), a total of 32 incidents have been reported to the District wildlife officer with observed losses of 50 goats, 13 donkeys and 1 dog; 3 lions were destroyed by PAC operations during the period, with averages of 1 lion destroyed per year and 10 incidents per lion destroyed (Chamoko Snodia, pers. comm.). It must be emphasized that more incidents happen which are not registered.

Around Waza National park, predators cause losses as significant as the diseases (respectively 220 000 \$US/year and 225 000 \$US/year). The lion is the predator responsible for the greatest number of cases of predation on the cattle. It is estimated that approximately 700 cattle and more than 1000 small ruminants are taken each year by lions. With them only, the lions cause losses of 130 000 \$US, primarily on the cattle herds, that is to say approximately 370 \$US per stockbreeder (Bauer & De Iongh, 2001) (Table 2).

Table 2: Predation of the domestic animals by predators (average between 1996-1998 in number of heads) in periphery of the National park of Waza (Source: Bauer, 2003).

	Predator			
	Lion	Hyena	Jackal	Others
Cattle (number of heads)	699	27	1	0
Sheep	742	1 141	911	0
Goats	507	1 227	1 263	0
Poulties	0	867	40	5 297
Value (\$ US)	130 000	47 000	38 000	5 000

In Namibia, most of the lion population occurs in the North and North-East of the country where they are found mainly in Etosha National Park (ENP) and, to a lesser extent, in Kaudom Game Reserve, Nyae Nyae Conservancy and Western and Eastern Caprivi (Stander, 2000). With the intensive livestock farming that has developed around the borders of conservation areas, lion predation on livestock in these regions is a serious issue. Along the borders of ENP and in adjacent areas, 46 cattle, 13 goats, 8 donkeys and 3 horses were killed by lions between 1984 and 1988 (Stander, 1990). A study undertaken in the Kwando Region in East Caprivi evaluated the cost of stock raiding by lion in the area: between 1991 and 1993, the total economic value of stock losses amounted to US\$9,073 (O'Connell-Rodwell *et al.*, 2000). According to the same study, lions are considered as the animals inflicting the greatest financial losses to farmers, even more than crop raiding elephants.

The economic impact of these losses is often severe, but is especially hard to bear for impoverished communities with meagre income such as the Namibian Bushmen community. In the extreme North-East of Namibia, the Tsumkwe District, adjoining the Kaudom Game Reserve, is the traditional land of the Ju/Hoan San. The Bushmen community, traditionally hunter/gatherers, resorted to small cattle farming in the early 1980s, but farming activities were low (Stander, 1997). From 1993, pastoralism intensified in the area, in the form of large-scale settlements, and the number of conflicts with lions increased dramatically (Stander, 1997). Stander (1997) reports that between January 1992 and December 1993, livestock were killed on 17 occasions. Twenty head of cattle and 5 horses (12.2% of total) were killed. 40% of the total number of villages of the Tsumkwe District suffered from livestock losses with an average annual loss by lion predation of US\$18.75 for each affected village. This represents a severe drawback for subsistence farmers.

1.2.2. Continental overview (lion range states inquiry)

In this section, we will report the answers to our continental inquiry, in which a questionnaire (see below) has been sent to all the personalities in charge of natural resources and protected areas in each lion range states (Ministries or Authorities).

Table 3: Inquiry form sent to the target people in charge of dealing with wildlife-human conflict in the lion range states

Human / lion conflicts at country level		2001	2002	2003	2004	2005
Problems between people and lions (complaints)	Number of cases reported					
	Sites of reported cases (mention if close to a Protected Area)					
Attacks of people by lions	Number of persons wounded					
	Number of persons killed					
Attacks of domestic animals by lions	Number of cases					
	Number of domestic animals killed					
Mitigation methods adopted	Lion killing by administration (PAC)					
	Lion killing by local communities					
	Translocation of lions					
	Enclosing and guarding livestock					
	Compensation of victims					
	Other methods (to be described)					

2. ROOTS OF THE CONFLICT

To fully grasp the growing importance of the livestock-lion conflict issues in some parts of rural Africa today, it is appropriate to review here some of the driving factors that have led to the current conflictive co-existence.

2.1. The human element

2.1.1. Requirements of the human development

Whereas the contribution of developed countries to the world demographic growth stagnates since the years 1990, that of Sub-Saharan Africa (SSA) does not cease increasing, indicating thus clearly one of the requirements of the development in SSA. In 1950, the human population of the SSA accounted for only 7% of the world population. In 2000, it reached 11 %, and it will probably reach the 14,5% in 2030, meaning a total of approximately 1,2 billion individuals, almost as much as in the developed countries (Figure 1). Dependent on demography (but not strictly), the effort of development is an essential requirement which failure to meet would mean progressive impoverishment.

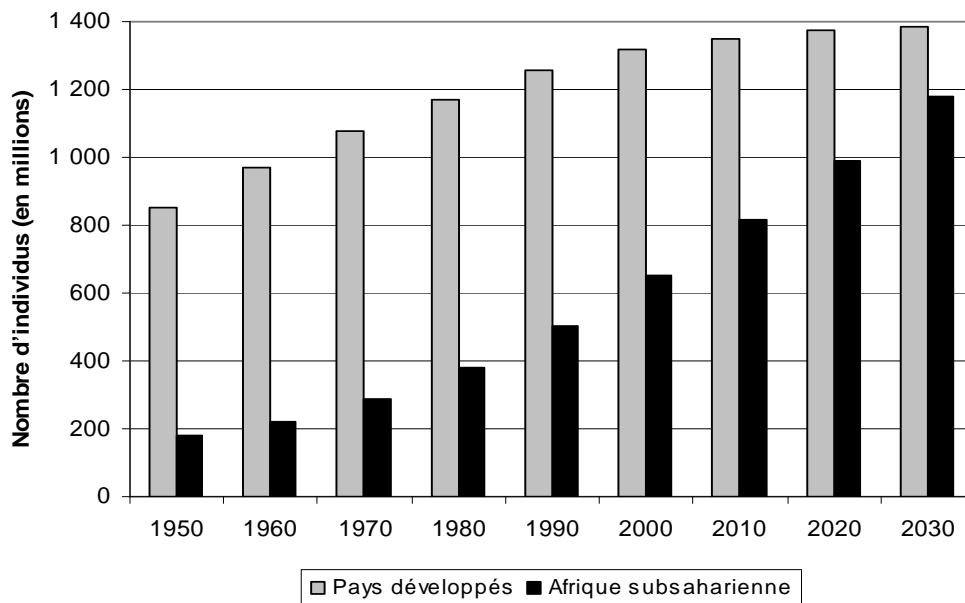


Fig. 1: Demographic growth of the human populations (number of individuals in millions) in Sub-Saharan Africa (black bars) and in the developed countries (grey bars) (Source: Tacher, 2002)

Another geographic factor is that urbanization has developed very quickly in SSA: in 50 years, from 1950 to 2000, the size of the urban population was multiplied by 12, and is estimated to increase again by a factor of 2.7 from today to 2030. As for the sub-Saharan rural population, the increase for the second half of the 20th century was “only” by a factor 2.7, and it is estimated to increase again by 1.6 from today to 2030 (Figure 2). It is understood that the rural population is confronted with a formidable challenge: improving their own food situation as well as that of the urban population.

Since 1950, most of the increasing demand for food in the world was satisfied by the intensification of agriculture, husbandry and farming systems, rather than by the increase in the geographic area of the production zones. Thus, for developing countries in general, between 1961 and 1999, the expansion of agricultural land areas accounted only for 29 % in the increase in production. But the situation is opposite in Sub-Saharan Africa: expansion of agricultural area contributed to two thirds of production increase in SSA (Millennium Ecosystem Assessment, 2005). It is understood that the increase in production in SSA cannot be insured only by an improvement of the productivity (production per unit of area and unit of time) because technical and technological progress cannot match the rate imposed by demography. So a continued expansion of agriculture and husbandry areas can be expected, varying in impact on habitats and biodiversity in general. Development in SSA thus inevitably involves, given the current state of things, an accelerated transformation of natural areas, unless development undergoes a major change in strategy.

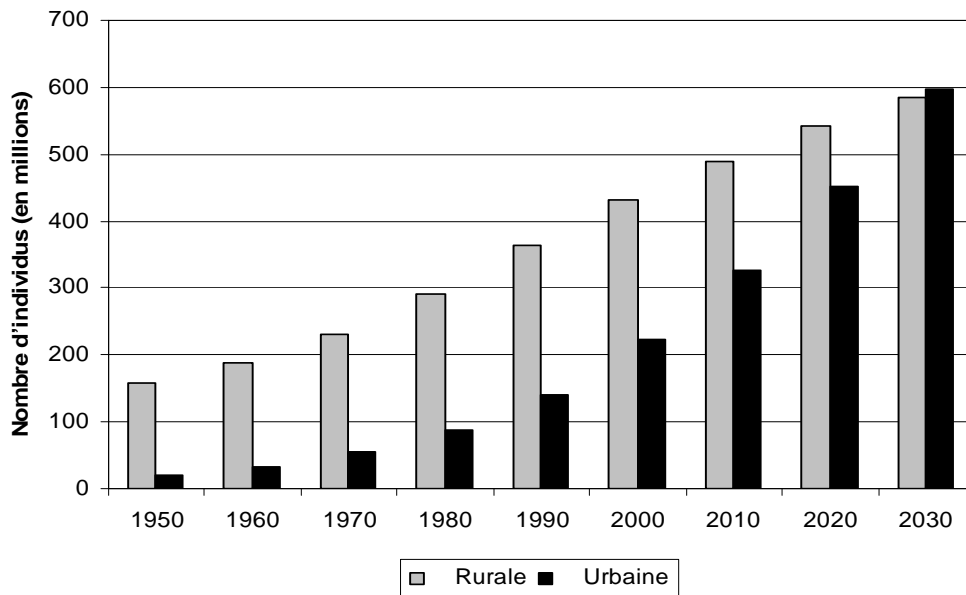


Fig. 2: Evolution of the rural (grey) and urban (black) populations in Sub-Saharan Africa (in millions of individuals) (Source: Tacher, 2002)

2.1.2. *The security risk*

2.1.2.1. Political safety

In SSA, as in other parts of the world, the alternation in space and time of stability and instability creates a mosaic of situations which impose new constraints - security - on the development: safety of the people and the goods, safety of the structures and the services in place, food safety, environmental safety, etc. Conflicts of all kinds, whether local, regional, national and international were and still remain responsible for very significant negative environmental impacts. Africa underwent more than 30 wars since the years 1970 (Myers, 1996) and more than 200 attempts of political coups (Renner, 1999). Whether the cause or consequence of the conflicts, political instability impedes good governance in the environment and other fields. Administrators in charge of wild fauna are disorganised, unmotivated, and impoverished in means of all kinds.

The impact of a conflict is multiple and depends much on its nature: the conflicts in SSA range from conflicts of strong intensity and short duration to conflicts of low intensity and long duration (Shambaugh *et al.*, 2001). The destruction of the habitats and wild fauna counts among the most widespread and most serious effects of the wars on the environment and occur for strategic, commercial or subsistence reasons. The proliferation of light weapons is often an after-effect of these conflicts: the light weapons - more than 500 million all over the world - are accessible in quantity and cheap in various areas of the African continent (Smith, 2003). The proliferation of the weapons coming from conflicts contributes in a considerable way to the intensification of the poaching in several countries, not only those implied directly in conflicts but also those in which these weapons end (Shambaugh *et al.*, 2001). Even when the conflict is finished, armed groups can continue to exert devastating effects on wild fauna for some time (Austin & Bruch, 2000). Allah-Demngar & Falmata (2003) showed that certain villages in edge

of the National park of Zakouma, in Chad, supply the large cities nearby with bushmeat, and that this trade is facilitated notably by the proliferation of firearms in the area.

Another consequence of the conflicts, the massive movement of population involve environmental consequences which are not always evaluated in all their diversity. The great concentrations of refugees and the displaced people exert strong pressures on their environment (Binder & Mwinyihali, 2001 *in* FAO, 2005). Refugee camps are very often surrounded by a halo of degradation in terms of deforestation and erosion, but also of biodiversity. The exhaustion of the resources and the environmental pollution can precipitate a country, or a region, in a vicious circle of increased impoverishment, growing political instability and intensification of environmental pollution or degradation (Shambaugh *et al.*, 2001). Environmental safety is one of the major influences on lion conservation, among the others discussed in this document.

2.1.2.2. Food safety

The satisfaction of the food need is one of the first requirements of the development: the number of people badly nourished in SSA was estimated at over 100 million, at the end of the years 1960, with nearly 200 million in 1995. But the development is subjected to other constraints imposed by the fight against poverty on a wide front including nutrition, but also health, education, improved standard of living as whole. Indeed, if a third of the sub-Saharan population suffers from malnutrition, the majority among it lives with less than one US dollar per day (UNEP, 2002). The economic and social development of the populations of SSA is still today based primarily on the exploitation of the natural resources, to which belong a wide range of wild fauna and flora species which also contribute to people's in food safety. The paradox here is that the environmental pollution and the increasing exhaustion of the natural resources of a given area often go with the aggravation of poverty.

The phenomenon of desertification, induced by "natural" and anthropic factors simultaneously, makes the food challenge even more difficult to raise. If the degradation of the cultivated land continues, the predictions state that the harvest yields would be reduced by half in 40 years (UNEP, 2002). In Niger for example, according to Burini & Ghisalberti (2001), the anthropic pressure from the villages at the periphery of the Transborder Park of W is one of the consequences of consecutive famines in the area. People were probably attracted by the uncultivated grounds at the edge and even inside the Park, and perhaps also by the possibility of taking in the Park resource to feed themselves. In the village of Allambaré inside the "Reserve Totale de Tamou", a protected area where the majority of the human activities are theoretically prohibited, the traditional practices and the institutional texts are contradictory. In addition, the village experiences a high demographic pressure because of many waves of immigration coming from the North.

The conservation of the lion clearly depends on a context influenced by the dissatisfaction of the proteinic needs for the human population. In Sub-Saharan Africa, the red meat consumption decreased these 30 last years (FAO, 2004), passing from 9,8 kg/pers/yr in 1970 to 7,3 kg/pers/yr in 2000 (Tacher, 2002) whereas it increased overall in the other developing countries for the same period (Figure 3). The regression in protein consumption may be due to the overall increase in livestock number at the detriment of natural habitats, but with little use the extra domestic protein production. More likely, the increasing pressure by humans on natural resources, mostly wild fauna, has decreased their share as protein sources.

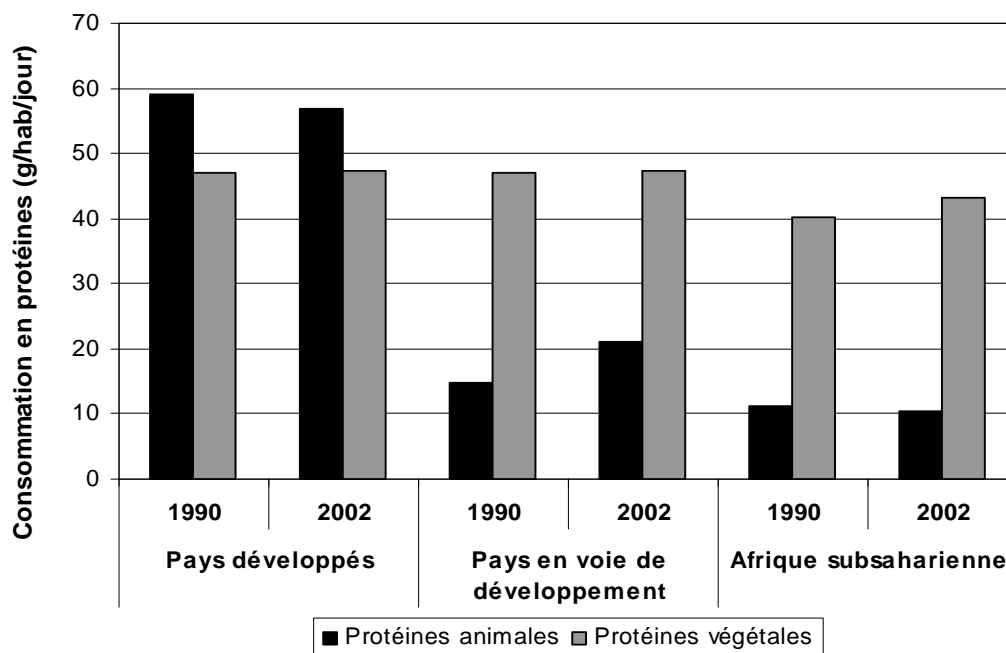


Fig. 3: Protein consumption (g/inhab/day) in Sub-Saharan Africa: comparative evolution between 1990 and 2002, with developed countries (left), developing countries (centre) and SSA (right) (Source: FAO, 2004)

One can classify the sources of animal proteins in two main unequal categories: (i) domestic animal proteins: meat, the milk, eggs and fish produced by the livestock; and (ii) wild animal proteins: products provided by the vast diversity of wild animals, including mammals, birds, reptiles, amphibians, fish and insects (note wild fish is excluded from Table 4), all grouped under the term "bushmeat". The total production of bushmeat in SSA is considerable since it would exceed one million tons per annum, that is to say more than 2 kg per person per year for a human population near to 600 million individuals. But bushmeat consumption varies considerably with environmental or socio-cultural context (Chardonnet, Fritz, Zorzi & Féron, 1995). For instance, wild meat is more consumed in the forest ecosystems than in savannas, but in the latter one eats also more domestic meat (Table 4). The relative proportion of bushmeat in the diet, compared with domesticated meat and with fish, ranges from 6% (Southern Africa) to 55% (Central Africa) (Chardonnet *et al.*, 2002). In general, hunters-gatherers have higher levels of bushmeat consumption compared to groups of agro-hunters. In addition, wild fauna contributes for a significant share to the food of the underprivileged social classes in rural environment, whereas in certain cities game meat is more expensive than domesticated meat.

Fallow or dry periods between two farming seasons, and years of food shortages and famines encourage poor populations to resort to the wild resources and fauna. These populations are found sometimes in the need for overexploiting the faunal resource with the risk of endangering its capacity to regenerate. The extremely random character of the African intertropical climate, especially in the Sahel zone, contributes largely to the food insecurity. The many rural populations which live from subsistence farming experience these climatic catastrophic episodes, which have a role in determining the food choices, notably in respect to the wild prey of the lion, but also amplify any livestock loss to the predator.

Table 4: "Bushmeat" and "domestic meat": relative importance in Sub-Saharan Africa in 1994 (Source: Chardonnet *et al.*, 1995b)

Ecological area	Population human (Million inhabitants)	Production of bushmeat		Production of all meats	
		Total (ton)	Average (kg/pers/yr)	Total (ton)	Average (kg/pers/yr)
Savannah	344	405 421	1.2	4 857 133	15.2
Savannah/Forest	163	533 763	3.3	1 571 732	9.7
Forest	54	287 225	5.3	418 527	7.8
Islands	16	3 846	0.2	378 029	22.7
Total	577	1 230 255	2.1	7 225 422	12.5

Table 5: Respective contributions of the meats "wild and domestic" in 3 countries of West Africa and Central Africa (Source: Chardonnet *et al.*, 1999)

Country	Domestic meat consumption (kg/hab/an)	Wild meat consumption	
		Kg/hab/an	% of the total meat
Burkina Faso	9,2	3,7	28,7
Côte.d'Ivoire	11,8	7,4	38,5
RCA	16,9	11,6	40,7

Table 6: Some levels of bushmeat consumption in 5 countries of Central Africa (Source: Chardonnet *et al.*, 2002)

COUNTRY	SITE CONCERNS	GAME CONSUMPTION (kg/pers./an *)	SOURCE
Central African Republic	RCA	11,6	Chardonnet <i>and Al</i> , 1995
	Bangui	14,6	Dieval, 2000
	Urban zones	11,05	Bui Quang Minh, 1977
	Rural zones	14,4	Bui Quang Minh, 1977
	Cities (except Bangui)	11,58	Docky, 1987
	Kaga Bandoro	15,2	Redjehoya, 1988
	Moussapoula (Babenjele)	18,25	Noss, 1995
	Kanaré, forest of Ngotto	85,25	Dethier & Guirghi, 2000
Cameroon	South (Mvae, Bakola, Yassa)	[7,3 - 73]	Kopper <i>et al.</i> , 1990
	Reserve of Campo	69,35	Dounias <i>et al.</i> , 1995
Congo Brazzaville	UFA of Pokola	[58,4 - 105,5]	Auzel, 1996
	Park of Odzala	[29,2 - 73]	Delvingt, 1997
Congo RDC	Ituri, hunters-gatherers	58,4	Bailey & Peacock, 1988
	Ituri, farmers	43,8	Aunger, 1992
Gabon	Gabon	17,2	Chardonnet & Bonnet, 1996
	Ogoué-Ivindo	[36,5 - 62]	Lahm, 1996

2.2. The habitat factors

The reduction of habitat might be considered as an indirect, although most powerful, effect threatening the lion taxon. Direct effects also originate from the presence of man as super-predator within lion habitat. If wildlife prey habitats are converted to agriculture or grazing for domestic livestock, human/lion conflicts are bound to increase. Unless conflicts are alleviated (compensation to local people for losses incurred, removal of problem animals, etc), locals will shoot, trap or poison them, leading to fewer lions in that area. A common consequence of the human occupation of lion habitat is the development of negative perceptions of lion presence in the mind of local communities. A demonstrative example is the case study in Queen Elizabeth National Park, Uganda, where questioned local communities openly expressed their negative attitude towards lions (Dricuru, 2000), to the point that "...in Queen Elizabeth NP...we are more concerned about the poisoning of wild carnivores and scavengers (lions, hyenas, vultures, etc)...this is extremely destructive - ecologically and economically" (Siefert, 2000).

As humans appear to be the main cause of the modification of lion habitat through a number of factors, we have tried to review those in order to provide a framework to analyse the local contexts of the reported conflicts.

2.2.1. Natural factors

With an area of approximately 30 million km², Africa is the second-largest continent on the planet, and SSA represents approximately the three quarters of this continent. These vast rangelands are being gradually transformed under the complex influence of various factors which can be simply classified (i) in factors of nonhuman origin or "natural" & (ii) into factors of human origin.

There are natural factors have a significant impact on the habitat of the lion, mainly desertification. Africa is the continent most seriously affected by this phenomenon, with more than 33% of its area threatened, particularly in the Sahel zone. Desertification contributes to the exclusion of the lion from the northern latitudes of its SSA range. Not much time has passed since the lion was present in Adrar of Ifhoras at Mali, in Air Ténéré in Niger, in Ennedi in Chad and in other Saharan areas (Lhote, 1951). Desertification acts on the lion in several ways: (i) the reduction of the prey, (ii) the reduction of water availability, and (iii) increase of its vulnerability (Eloff, 1980), even if the lion remains well adapted to the semi-arid climate (of Waal *et al.* , 2001).

In Sudanese savannah zone, desertification can also have a negative influence on the lion. Among the prey of the lion, the Reduncinae *antelopes*, more especially the Buffon's kob (*Kobus kob*) and waterbuck (*Kobus ellipsiprimnus*), probably underwent a retraction towards the south of their distribution range, notably because of habitat change (desertification), but also because of the movement of the human populations of the Sahel towards the South in search of arable lands and pastures (indirect effect) (Chardonnet B & Ph Chardonnet, 2004).

2.2.2. Agricultural influence

The human expansion is probably the most influential factor on the conservation lion in Sub-Saharan Africa. The range maps of the various subpopulations of lion in Centre and West Africa tend to show a negative correlation between, on the one hand, the density and the number of lions, and on the other hand, the presence of the man and his various activities (Chardonnet *et al.*, 2002). The agricultural influence on the habitats of the lion finds its explanation in the paramount importance that agriculture has for Africa, rural and urban: it provides approximately 40% of the GDP of SSA and employs more than 60% of the labour of the area. In 2005, FAO estimated at c. 5.5 million hectares the area of forest which was transformed into arable lands or was exploited during the decade 1990-2000, which represents an annual rate of loss twice higher than that of South America (FAO, 2005). In 1990, *World Resources Institute* estimated that 80% of the natural habitats had disappeared in Burkina Faso, 79% in Côte d'Ivoire and 45.3% in Central African Republic (WRI, 1990).

At the planet scale, the total cultivated lands were multiplied by 1.1 during 30 last years (1970-2000). But this pressure exerted on the natural habitats varied considerably in different parts of the world. The total area of the cultivated areas increased by 21.5 % in the developing countries, whereas it remained overall the same one in the developed countries, even decreased in certain European countries. In SSA, the total area of the cultivated grounds increased by 25%, much more than the world average (Figure 4). Cultivated lands increased by 0.65% per annum in SSA while it decreased in the developed countries (between 1970 and 2000). Still, in 2000, each inhabitant of the SSA only has on average 0.27 hectares of arable lands, whereas an inhabitant of the developed countries has 0.49 hectares (Tacher, 2002).

Further, in West Africa and Central Africa, the area of distribution of the lion is singularly convergent with that of the cotton zone. However, cotton is one of the cultures which showed the largest recent expansion in SSA, particularly in West Africa (Figure 5). In several areas of the world, and especially in several countries of Africa, cotton represents a paramount source of incomes for the States and a major tool for development for the rural world. The environmental assessment of cotton is difficult to establish because of the intimate interactions between development and conservation. Whatever they may be, the conclusions of such an assessment cannot be translated into terms of alternative because cotton is today a reality impossible to circumvent, which is necessary to take into account and even from which conservation should make an ally. The CAR President stated in 2005 that «cotton *made [however] live one the third of the population [of RCA]*» (Le Monde, 16/09/2005).

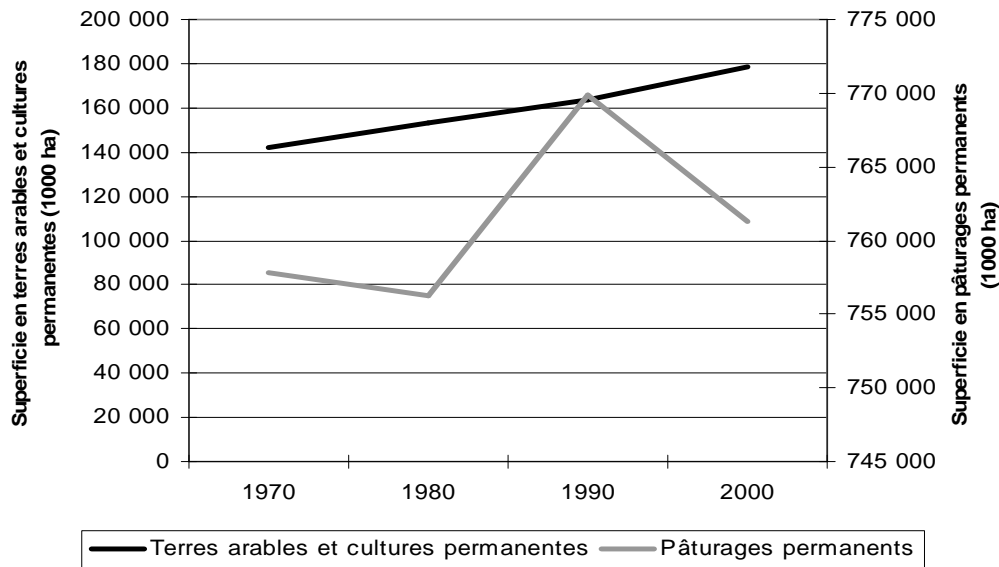


Fig. 4: Evolution of land use in Sub-Saharan Africa, opposing arable lands (in black) to pastures (in grey) (Source: Tacher, 2002)

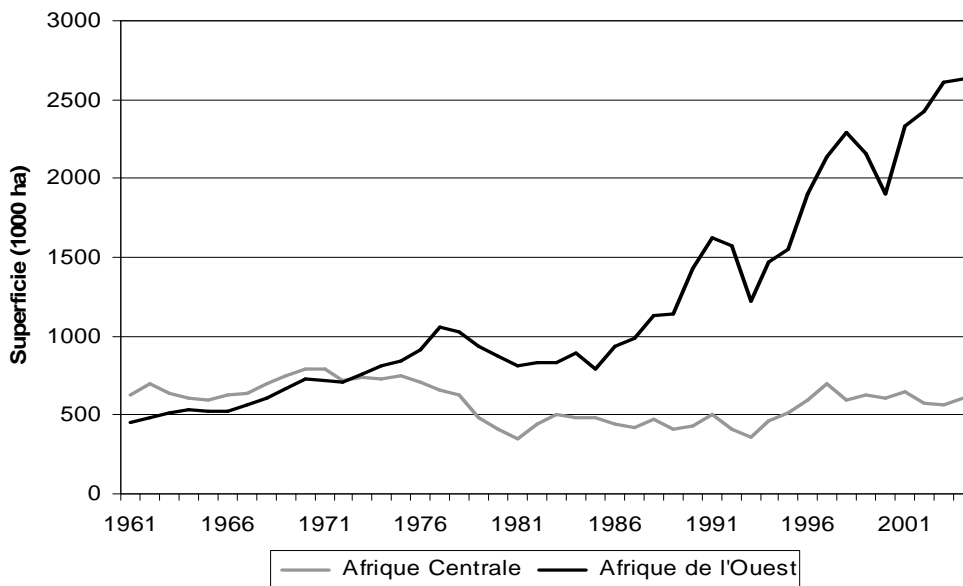


Fig. 5: Cotton in Central Africa (grey) and West Africa (black): increase in area of the cotton culture (Source: FAO, 2004)

In certain countries like Mali, Benin or Burkina Faso, the production of cotton shows a considerable progression compared to other cultures (Figure 6). In Burkina Faso and Benin, some villages that border the Transborder Park of the W develop around the cotton production, providing the incomes upon which the wellbeing on the villagers and the construction of the

village infrastructures depend. Introduced at the end of the 1960s, cotton farming became the remunerative activity, and it is even the only culture for which the peasants are given financial appropriations from the agricultural banks (Burini & Ghisalberti, 2001). Unfortunately, this agricultural practice has also harmful consequences for the biodiversity, and notably (i) the "race with space" for the expansion of the cotton-growing areas: it largely depends on natural habitat, notably on access to savannah systems, which could mean protected areas in West Africa; (ii) considerable increase in the use of the plant pesticides and fertilizers; (iii) the competition with the pastoralists who have less and less pasture per head of cattle (Figure 8), and are thus pushed to penetrate inside the Parks.

The disappearance of the natural habitats at the periphery of the Protected Areas affects their capacity potentially to preserve the biodiversity. Clerici *et al.* (2005) currently study the transformation of natural savannah in the peripheral areas of the vast Complex W-Arly-Pendjari (WAP) to which belonged the abovementioned Transborder Park of W system. Within a zone 30 km wide around the perimeter of the protected areas, more than 14,5% of savannah was lost between 1984 and 2002, revealing a fast process of transformation of the landscape (3,514.4 km²). According to Clerici *et al.* (2005), the complex lost 2% of its capacity to preserve its specific richness between 1984 and 2002, and should lose 15% more of this capacity if the natural habitats from the periphery of the complex completely disappear.

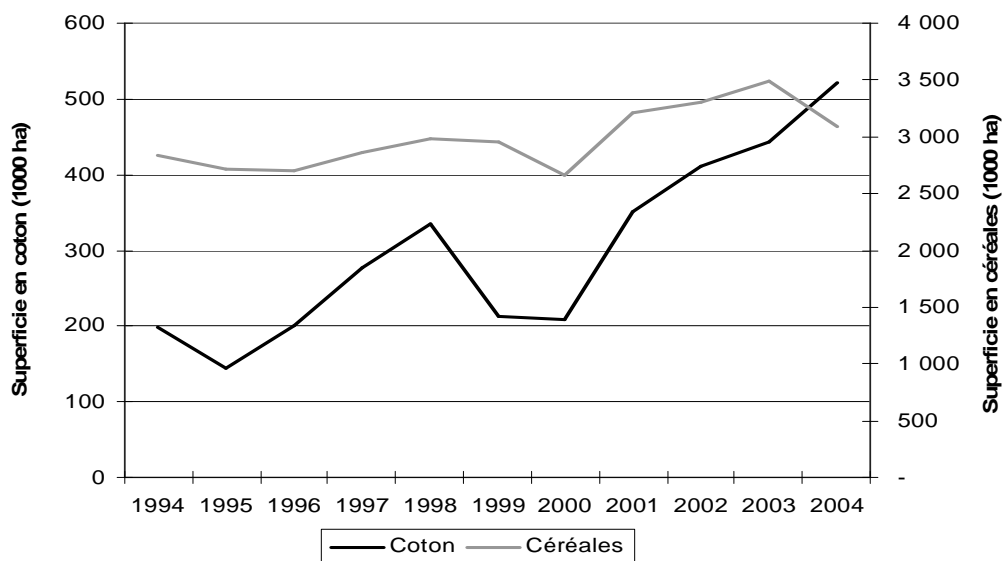


Fig. 6: Cotton (black) and cereals (grey) in Burkina Faso: comparative evolution of cultivated areas (Source: Direction of the Agricultural Statistics, 2005)

The peripheral areas of the Benin part of Complex WAP are significant for the long-term conservation of the lion. It is where the rate of disappearance of the indigenous vegetation has increased the most, that is to say 17.3% of their area of 1984, which corresponds to a loss of 1 764 km². Losses in the other countries from the Complex are also high: Burkina Faso (13.1%), Niger (11.2%) and Togo (5.2%). This progressive transformation of natural savannah habitats at the periphery of the Complex is primarily consequence of the strong expansion of the agricultural activities: 15.8% of the landscape in 1984 and 26,9% in 2002. It is with Benin that the

agricultural expansion is most significant: 15.1% of the peripheral areas were converted into arable lands between 1984 and 2002, against 9.1% in Burkina Faso, and 7.5% in Niger.

The rate of loss of natural habitat inside complex WAP is much lower than at the periphery: broadly, 82.5 km² of natural savannah were lost between 1984 and 2002, i.e. 0.3% of the whole of the complex. The "hot spots" for habitat conservation are located in the enclaves of the "Reserves Partielles de Pama (*Tintagou*) and d'Arly (*Madjoari*)", and to a lesser extent in the "Reserve Totale de Tamou" and in the Southern part of the Hunting Area of the Pendjari. The National parks of Arly (Burkina Faso) and Pendjari (Benin) do not seem to have undergone a significant loss of habitats, but in the Benin part of the Park W, there is a strong pressure along the southern edge.

In addition to cotton, berbéré (a variety of sorghum) is also a culture which exerts an increasingly significant pressure around certain Protected Areas, like the National park of Zakouma, in Chad, which shelters a significant population of lions in the dry season. In an area traditionally dedicated to livestock breeding more than to agriculture (Tubiana, pers. comm.), agricultural areas, in particular of berbéré, showed a significant expansion. Practically non-existent formerly, it currently accounts for 97% of the cultures at the periphery of the park, themselves accounting for 5% of the land use within a 30 km wide boundary at the periphery (Edderai & Arranz, pers. com. 2005). In fact, in this area, berbéré became the principal culture since the suspension of cotton in 1979. To meet the food and financial needs for the local populations, the culture of berbéré was largely spread, and encroaches today gradually on the natural habitats, tending even to gradually encircle the National park of Zakouma. Certain woody formations are increasingly cleared each year to make space for the cultures of berbéré. In the Kacha-kacha village, at the edge of the Park, 97% of the villagers primarily practice the culture of berbéré, a culture which covers the largest areas and which produces the highest yields, according to the investigation of Allah-Demngar & Falmata (2003). The same investigation shows that to have large fields of berbéré and to produce good harvests establishes the villager in a respected and coveted social position, and it is also for him a sign of bravery and masculinity. Berbéré is regarded simultaneously as a capital and an invaluable heritage.

2.2.3. Pastoral influence

The pastoral influence on the habitats of the lion results from several factors and initially from the strong and continuous increase in the domestic livestock in Sub-Saharan Africa (Figure 7). This tendency in SSA is similar in the whole of the developing countries, whereas the tendency is opposite in the developed countries. The SSA has today the greatest number of small ruminants (sheep, goats and dromedaries) among all the developing countries (in particular, twice more goats). It also has, after the Latin America, the greatest number of cattle heads. SSA currently counts nearly 450 Millions small ruminants and approximately 200 Millions cattle.

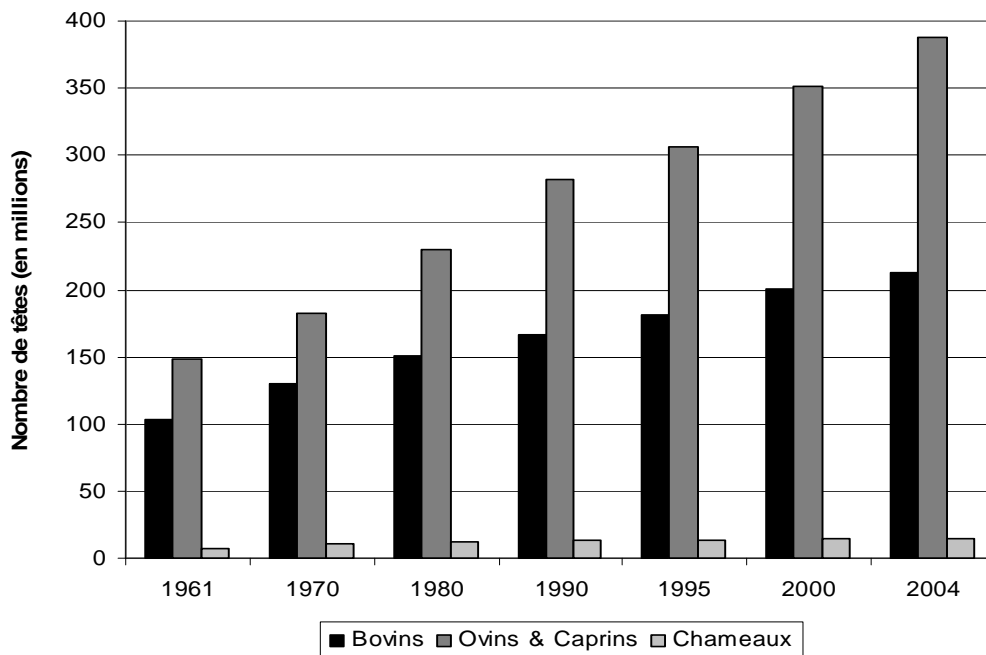


Fig. 7: Evolution of population of domestic livestock in Sub-Saharan Africa, cattle (black), Sheep & goats (dark grey) and dromedaries (light grey) (Source: FAO, 2004)

The influence of cattle husbandry on the habitats of the lion also results in the expansion of the grazing pasture areas (zones grazed by domestic stocks). The total area of the grazing area increased by 0.46% per annum in SSA between 1970 and 2000 (Tacher, 2002). It should be noted that in same time, it remained stable in the majority of the areas of the world. There is an apparent discrepancy between the strong growth of the cattle population and the more moderate growth of grazing lands. One can suppose that most of the expansion of the breeding livestock is sustained by the arable lands (agricultural by-products and fallow of less than 5 years) rather than by a significant increase in pasture areas (Tacher, 2002). However, the grazing areas recorded as such (i.e. "official") generally do not take count the vast Protected Areas which are used seasonally by the stockholders. This discrepancy emphasizes (i) that the requirement for livestock grazing lands is still growing, and (ii) that Protected Areas are often considered by the stockholders "free" or "unutilised" pastures.

One also has to bear in mind, that during the 25 last years, because of the strong human demographic growth, the per capita area of grazing land decreased, especially in SSA where it passed from 2 650 ha/inhab. in 1970 to 1 166 ha/inhab. In 2000, thus revealing the deep economic and environmental modifications which the husbandry sector undergoes today (Figure 8). Concerning the conservation of the lion, this indicator shows how important it is for the cattle herder to obtain new pastures for his cattle. The cohabitation of the stockbreeder with the lion is thus far from being reduced to the question of the predation cattle; rather, it comprises a wide spectrum of stakeholders and stakeholder problems including the sanctuarized Protected Areas excluding any human activity.

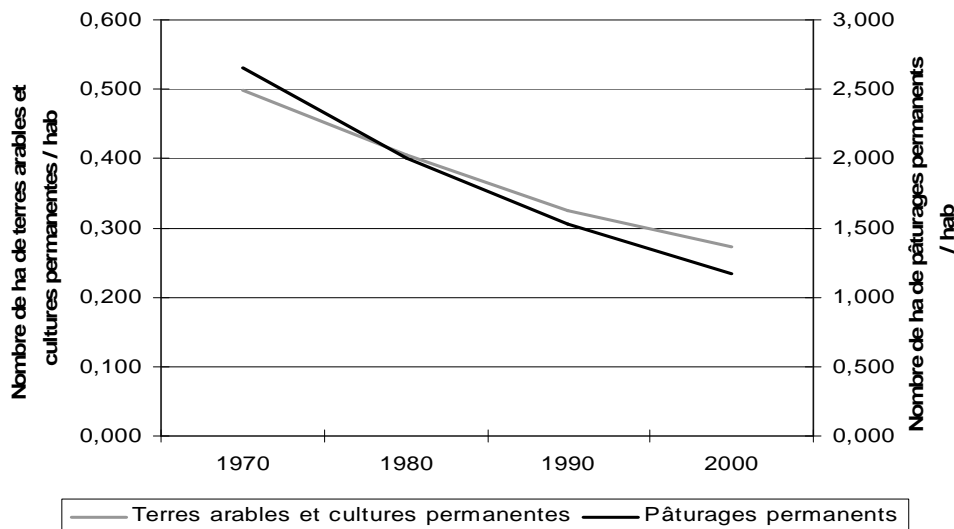


Fig. 8: Per capita areas of cultivated grounds (grey) and permanent pastures (black): evolution in hectares per capita (Source: Tacher, 2002)

2.3. The lion factors

2.3.1. Behaviour

An adult female lion needs a minimum of 5kg of meat per day to maintain basic metabolic requirements (Schaller, 1972). Lions also need more room than any other predator. Their behaviour, predatory and reproductive strategies etc. show extensive regional variation. They are highly adaptable. Fundamental ecological and behavioural characteristics of carnivores such as density, grouping, pattern, range size and prey selection are influenced respectively and individually by habitat and prey density, dispersion and richness (Stander, 1997).

Results and field observations indicate that lions are still found in the human areas because of favourable habitat, a water source, and an adequate prey base in the form of domestics. In peak condition lion most often do not present a problem preferring to distance themselves from developed areas. However, specific behaviour or habitat preference may increase the risk of conflict. For instance, lion preference for dense habitat may increase the likelihood of accidental encounters between humans and lions, increasing the opportunity for lions to ambush humans and livestock (Chellam, 1994). It could also influence the willingness of predators approaching bomas. However, there was no significant correlation between distance cover and rates of depredation on sheep and goats and cattle by lion.

A particular aspect of lion behaviour, which can further exacerbate human hostility toward lions and cause conflicts, is what is called “surplus killing”. Similarly to some other large felids, a lion breaking into a fenced enclosure will sometimes kill many more domestic animals than it can eat (Nowell & Jackson, 1996). Nowell & Jackson (1996) refer to Guggisberg (1961) who reports that six lions killed 51 ostriches kept in an enclosure but only a small part of these animals were actually eaten.

Some lions are chronic livestock killers (Franck 2006). Stock raiding is usually carried out by individual animals of either both sexes or small groups of young inexperienced males,

possibly those thrown out from territorial prides that have moved out of their normal home range limits inside established wildlife areas. It can also be mature individuals forced out of the prides within and no longer capable of killing wild animals on their own due to some previous damage to paws or teeth or to old age in general (La Grange 2005).

2.3.2. Injured lions

Stock-raiding lions are rarely dangerous to human unless wounded. Numerous authors have invoked the infirmity theory to explain instances of man-eating and marauding by lion (Kruuk 1980). Patterson and Neiburger (2000) examined evidence for this hypothesis in the skulls and mandibles of the Tsavo and Mfuwe man-eaters. All three of the cats had sustained serious and chronic injuries to their teeth and jaws. If lions have resorted to hanging around dwellings and taking small stock (e.g. chickens); they should be considered dangerous, as this often signifies their inability to catch the fleetest animals. Such animals may often become marauders or man-eaters (La Grange 2005). Deprived of the ability to hunt and kill natural prey, such individuals may be predisposed to attack humans and stock. *In many parts of Africa, rural people customarily explain the disappearance of goats and other livestock by saying ‘‘Ah, there is an old toothless lion about. We must turn out and kill him, or he will soon begin eating us’’* (Fitzsimons 1919).

However, if the infirmity theory is widespread use to explain man-eating, it is not so simple. In Uganda only 14.0% of the lion attacks (n= 275) described in the archives were attributed to wounded animals, the data still suggest that healthy animals were involved in attacks on humans. Numerous other factors may lead carnivores to man-eating. A lion that has lost its fear for humans may not appear dangerous but will, for example, usually chase a child who runs from it in much the same way as its normal prey behaves (La Grange 2005). This could be the case of lions breeding in captivity and released in the wild.

2.4. The prey factors

2.4.1. Availability in prey

Change in lion prey availability can be a direct consequence of human development as exposed in the preceding paragraphs. Low prey densities result in low lion densities. Most research on available prey biomass is from East and Southern Africa, but this subject remains still very little studied in West and Central Africa. The availability in prey in its various aspects (diversity, abundance, distribution, accessibility, size of the prey, etc.) is known for its direct effect on the density of lions (Schaller, 1972; Dunhamndt, 1998; Dublin & Ogutu, 1998; Stander, 1997; many other authors). In Central and West Africa, the availability in prey is very heterogeneous. It is often described as ‘‘catastrophic’’ and indeed the conservation status of wild fauna appears problematic in many situations. In Northern CAR, for instance, the recent decline of lion populations may be partly due to the decrease of kob (Buffon’s kob, bohor reedbuck, defassa waterbuck) populations submitted to severe poaching pressure (J. Tello, pers. comm.), even though another cause is the systematic shooting of lions by nomadic cattle herders entering Protected Areas during the dry season (B. Chardonnet, pers. Comm.). There are however some encouraging situations in West and Central Africa where wild prey numbers are stable situation or even increasing, often thanks to international cooperation programs (e.g. ECOPAS, ECOFAC,

AGIR, CURES). Two categories of areas harbour such favourable situations for the conservation of the lion, some large National parks and Hunting Zones or Safari Areas.

When wild prey availability is reduced, for instance because of drought or disappearance of wild habitat due to expanding human settlements and activities, lions, more so than in the case of other large predators, feel disposed to prey on domestic herds. This is particularly tempting when, as explained previously, they can easily access the farmlands just outside the conservation areas. Rudnai (1983) reports that a decreased availability of game in Nairobi National Park, Kenya, in 1974-75, due to a year of drought, which caused a massive die-off of wild ungulates, resulted in an increase in the hunting range of the resident lion prides and thus more regular excursions of lions into the surrounding areas. During the 1980s, fatal attacks by lions in Southern Tanzania were attributed to heavy poaching of wild ungulates, so that lions, deprived of natural prey, turned to livestock and entered villages (Nowell & Jackson, 1996). When lions cannot hide in vegetation to hunt wildlife due to a drought, they often migrate into the villages in search of domestic food. Around Tarangire National Park, Tanzania, attacks were most common in the dry season (80%). Most attacks occurred during the dry season because of more difficulty obtaining wild game due to lack of vegetative cover which was exacerbated by the drought. Even the recent man-eating behaviour was associated with environmental factors even if the reasons of attacks varied slightly depending on each geographical area. In general, there has been a human immigration (past few years) putting the settlement closer to the forest which itself recently became avoid by wildlife due to drought. In the 1890s, an outbreak of rinderpest disease killed millions of zebras, gazelles and other African wildlife. Lions had to look elsewhere for food, and attacks on humans increased across Kenya.

In conclusion, prey depletion in human-dominated areas could thus trigger the opportunity and necessity of exploiting people or livestock (or both) as prey.

2.4.2. Competition for prey between the man and the lion

As previously pointed out above (Food safety section), the use of the potential lion preys by humans is initially aimed at satisfying proteinic needs, a function very significant for certain human groups mostly relying on bushmeat. In such circumstances, humans and lions compete directly for consumption of wild preys. Even if this may seem an additional obstacle to lion conservation, the high level of wild meat consumption compared to domestic (Table 3, 4 & 5), one should not perceive it in a simplistic way because the substitution of the wild meat by the domestic meat inevitably implies an increased transformation of natural habitats into agricultural zones, to create new pastures necessary to the domestic ruminants and to put in culture new spaces to produce the manioc and corn essential to the breeding of pig and poultries.

These perverse effects must be taken into account before launching out in a policy of change of diets, without neglecting either the cultural and social factors which are impossible to circumvent. Indeed, in Chad, in the village of Kacha-Kacha located in periphery of the National park of Zakouma, 35% of the consumed meat are bushmeat. The meat of hunting is intended for 42% for subsistence of the hunter's family, 41% for sale, and 17% for gifts, legacy, etc. In addition to the food contribution that hunting represents, this activity confers on the hunter a significant social consideration (Allah-Demngar & Falmata, 2003).

Obviously, commercial poaching can become a significant threat, as the use of automatic weapons develop, and in contrast the traditional bow-hunting, which is not very effective, is less and less practised, although it constitutes a significant sociocultural inheritance (Galhano Alves & Harouna, 2005).

The other side of the competition for wild prey between lion and man is that lion may prey on species, or individuals, that are thought after by professional hunters. In some Hunting Zones, guides complain about the significant off take carried out by large predators on the trophy antelopes significant for hunting, especially when the predatory species hunted as it is the case for the leopard in West Africa (Mr. Bardet, pers. Com.) or when it is subjected to a very restricted quota, as it is the case of the lion (F Kaboré, pers. Com.).

2.4.3. *Pathology of the prey*

The fragmentation of the natural habitats, caused notably by the human influence on space in general, is accompanied by an increasing interface between the lion and the human activities. The resulting promiscuity spurs the conflicts between man and lion as mentioned earlier, but it also exacerbates the disease interactions between domestic and wild animals. It follows from there a direct effect on the lion itself but also an indirect effect on the animal species which constitute the prey of the lion.

2.4.3.1. Diseases transmitted to the lion by its prey (direct impact)

Among the conclusive examples, the buffalo tuberculosis is well-known to be transmitted to predators and vultures (Michel, 2002). The case of the Kruger ecosystem is well documented (Keet, D.F. *et al.*, 1996; Keet D.F. *et al.*, 1998; Keet *et al.*, 2000), but other ecosystems such as the Queen Elizabeth National Park are less so (Mr. Woodford, pers. Com.). The situation in Central and West Africa is not studied at all to our knowledge although the contagious risk is quite real.

Another risk must be mentioned for Central and West Africa lions: Feline Leukemia virus (FeLV). It was recently shown that this disease is quite present in the domestic cats around the Regional Park of W, in West Africa, with an average seroprevalence of 8.2% (0-13.3) (Herme-Rey, 2004). The mode of contamination of wild felids could be predation of domestic cats; it could perhaps also be indirect by the environment. It is not known yet if the lion and the wild cats of the W are affected by FeLV, but the medical risk is indeed there.

Anthrax can also be transmitted to the lion by a prey, as seen in southern Africa, but it is occasional, notably because of a better resistance of carnivores compared with herbivores (Jager *et al.*, 1990; Berry, 1993). The disease exists in West and Central Africa, but it has not yet been investigated with respect to the lion.

2.4.3.2. The diseases which affect the prey and reduce the food resource of the lion (indirect impact)

They are the diseases that are not transmitted to the lion itself, but which involves a strong mortality of the prey, and thus a reduction in their availability. When an epizootic occurs in a lion prey species, there are generally two principal phases. In a first phase, the disease kills a great number of individuals of the prey species. The surplus of sick and dead animals brings an exceptional abundance of food easily accessible for carnivores. A positive effect can result from it for carnivore population dynamics. In a second phase, after the initial phase of prey morbidity and mortality, the remaining number of animals is lower than the original situation. This drastic reduction in the food resources can impact the lion population negatively, even more seriously

given the initial increase in food abundance caused by the mortality surplus. This further unbalances predator/prey ratios

We will not list here all the diseases that affect the domestic and wild prey of the lion. As an example, one can quote one of most spectacular, rinderpest, which affects several lion prey species (eg, giraffe, buffalo, antelopes, phacochère) without being contagious to the lion. There is one notable exception in this category, a disease which affects both the lion and the prey: tuberculosis is undoubtedly one of the "complete" diseases in terms of impact on the lion because it affects the prey of the lion and the lion itself, and can be spread from lion to lion.

3. ATTITUDES AND PERCEPTIONS

For those rural African communities that have to share their lives with lions, the perception of the "*King of Beasts*" is often very different from those who do not live side by side with wildlife. The interface between people and large predators in rural Africa most often consists of predation on livestock, but also of human injuries and death. This problem is particularly acute in the semi-arid rangelands of Africa where pastoralists compete with large wild herbivores and in contact with lions. Lions are dangerous predators whose existence is mostly at odds with human activities.

Many rural Africans have little or no sympathy for the predators. The communities therefore often view them in a negative perspective. In the mind of most rural communities in Africa, lions are considered as pests and should be eliminated. For instance, a study conducted in and around Queen Elizabeth National Park, Uganda, showed the following results when asked about the best way to deal with stray lions that come into the village. 37% of the respondents (156 questionnaires returned and analysed) advocated they should be killed, 35% said a fence should be erected around the protected area, and only 28% felt people should be taught how to avoid lions (Dricuru, 2000). In Cameroon, for example, out of 236 questioned people from 10 different villages along the borders of Waza National Park, 50 % of the herders have a negative perception of the lion (Bauer, 2003). However, the damage due to the lion is sometimes lower than perception than the stockbreeders have some. One can perhaps explain it owing to the fact that the lion is an impressive species whose movements are influenced with difficulty by the local populations, and who is potentially able to devastate a domestic herd. And according to Siefert (2000): "... *in the PN Queen Elizabeth... we are more concerned with the poisoning of the wild carnivores and vultures (lions, hyenas, vultures, etc.)... it is extremely destructive, from the ecological as well as economic point of view*". Even in the countries where the populations of lions are small, the psychological impact of the lion remains very strong. According to Abdoulaye Kane (pers. com.), representing IUCN in Senegal, "*a strong pressure is exerted by the local populations on the authorities to organize eradication campaigns against lions in response to the losses caused with the herds of cattle*".

Additionally, responses from the conservation authorities to address the issues are absent or not always appropriate and compensation schemes to alleviate stock losses are often not functioning. A study carried out in 1974-75 in the areas bordering the Southern part of Nairobi National Park in Kenya showed that the Masai pastoralists who traditionally tolerated wildlife were less and less willing to suffer losses by predation without compensation. As Rudnai (1983) explains, "*while these losses may be low in statistical terms, resentment engendered by even a few kills may be out of proportion with real damage suffered, since the individuals feel they do not benefit from game in general and predators in particular, yet have to bear the brunt of the*

damage inflicted by wild animals. Even though compensation payment for livestock killed by lions is on the books, in practice it is virtually unavailable because of a cumbersome administration". This leads to further persecution of lions by people.

Experience with large carnivore recovery in Europe and North America had shown that the social conflict dimensions can be even more important and even harder to deal with than the material conflict (Keller et al., 1996; Bjerke & Kaltenborn, 1998; Linnel et al., 2005). Even in the absence of any material and economic conflict, any overlap with humans and large carnivores distributions will directly reduce the perceived quality of life for those people (Linnel et al. 2005). Thus, the origins of the conflict are deeper than economy and resemble more to land use conflict between Nature and Society. When a lion is jumping a fence, it is symbolically a violation of the barrier men set up to keep wildlife separate. If consequences could be physically serious, they are also emotional for people. Cattle predation and man-eating are strikes against the very core of the people, as their cattle symbolize life for them and their family. This creates the current reality of insecurity and almost-like attitudes towards what lies beyond the village boundaries in the form of 'mbojo' or evil lion spirits (Skula, 2002).

The "social carrying capacity", i.e. the tolerance of humans towards the predator, is a key issue in mitigating carnivore human conflict. The acceptance of losses is strongly varying between cultures. In general, local inhabitants and pastoralists view large carnivores with antagonism and as nuisance, and tend to see little financial or aesthetic value in them. However, positive cultural perceptions with regard to the lion exist among certain people of West Africa and Central Africa, as in the Masai tribe in East Africa. In spite of the pressure exerted by the lion on their pastoral economy, certain herder people preserve a balanced attitude with regard to the lion. They do not systematically seek to poison it, trap it or shoot it with a rifle. In Niger, at Gourmantché, in spite of the attacks on the cattle, and sometimes on the man, «in general, the opinions of the inhabitants are favourable to the conservation of the lion, because of importance symbolic system of the species in their representations [Fouali], and of its emblematic importance in the environment" (Galhano Alves & Harouna, 2005). In addition, beyond the cultural interest that certain African people allot to the lion, there is also the financial interest far from being negligible: the lion is perceived like a source "*of potential incomes in tourist terms for the area, more especially as certain villagers work seasonally like guides or employees in the Park* " (Galhano Alves & Harouna, 2005).

When assessing a conflict situation, social and holistic investigation should be totally integrated into the investigation process at the same level than biological explanations. This could help building mitigation processes on a diversity of values, and use at its maximum the positive perception if it exists. This approach was chosen by the Kilimanjaro Lion Conservation Project to understand the recent loss of tolerance from people to lions inhabiting Masailand, an area covering much of southern Kenya and northern Tanzania. The project is combining different topics including the understanding in changing Masai attitudes toward predators and conservation, the typology of herding practices in both Masailand and Laikipia and the assessment of community attitudes towards the Predator Compensation Fund (Frank 2006). Changing farmer's views of wildlife is a challenging process. However, since forcing people to live into protecting carnivores only leads to illegal hunting (Eltringham (1984), Martin (1984), and Martin & de Meulenaer (1988), a positive attitude towards wildlife appears to be a vital step in the conflict mitigation process. This can be achieved by targeted environmental education and by upgrading the wildlife as a natural resource (consumptive and non-consumptive use). If farmers derive direct and substantial benefits from wildlife they will be more willing to tolerate the costs of living with wildlife. Different types of management measures for conflict mitigation

are currently being devised and experimented in Africa. However, the apparent mutual exclusivity of lion cohabitation with people remains one of the main threats to lion conservation outside Protected Areas (Jackson, 1997).

II. MITIGATIONS

It is apparent that locally lion predation is a significant problem in Africa, especially for rural communities with meagre resources. The loss of this important resource to marauding lions represents a very real hardship and understandably creates hostility towards lions and increased apathy and antagonism towards wildlife conservation *per se*. Ultimately, the survival of wildlife and lion in particular depends on their acceptance by the people who must share their habitat. However, when the cost of cohabitation is high and compensation is low, there is little or no incentive for conservation. As Stander (1997) explains, “*the future of large carnivores outside conservation areas in Africa depends on the views and aspirations of the local people. Only when the local inhabitants...have a particular interest in conserving large carnivores will their future be ensured*”. This is a common problem associated with many Parks and Reserves in Africa. Local communities bear the costs of the protected area through the loss of stock due to lion predation and the opportunity costs as a result of loss of grazing and arable land. Few if any of the benefits from photographic or sport hunting tourism ever filter down to these communities. As a consequence, wildlife is illegally hunted and the park is used illegally as pasture for cattle or human settlement. With no tangible benefits to these communities, wildlife-human conflicts are intensifying and are threatening the survival of large predators outside National Parks (Lichtenfeld, 2001). “*If viable predator populations are to persist between protected areas, two conditions must be met: (i) Pastoralists and ranchers need affordable and culturally acceptable methods of protecting their domestic animals from large carnivores; and (ii) they must realize significant financial gain from predators to offset the costs of living with them*” (Frank, 2006 but see also Breitenmoser et al., 2005).

Human-wildlife conflicts are highly variable and there is no single management option or solution that can successfully deal with the problems. In all cases a combination of options is needed. To be sustainable, such options should match the financial and technical capabilities of local communities and the individuals responsible for its implementation. Options available will partly be determined by the institutional arrangements or policies found at national, regional and local level (WWF, 2005). Therefore, successful interventions should take prevailing local circumstances into account because local management, culture, governmental policy, trade and law enforcement can all have overriding effects on large carnivore extinctions (Linnell et al., 2001; Ogotu et al. 2005).

As the prevention and resolution of human/lion conflicts is as complex a problem as it can get, it certainly requires a holistic approach. Every situation is different and it will be dangerous to extrapolate from one area to another. Among methods that have been tested on other carnivores world-wide, some will merit to be explored to be applied to lion but in all cases with initial experimentations and with the help of biologist (Frank & Woodroffe, 2002). Consequently, solving the problem is not the purpose of the present study and therefore here we present both

some options and methods easily applicable by managers to rapidly overcome local tensions and long term strategies for a harmonious co-existence with large carnivores.

1. HUMAN MANAGEMENT

1.1. Environmental education

The first logical step is to inform the people of the fact that they are in a wildlife area, and of the potential consequences. Indeed, living, working or traveling in areas with large carnivores takes awareness and preparedness. Prevention consists both in being alert and in using strategies that decrease the potential of being viewed as prey (Quigley & Herrero, 2005; Parris, 2006). Being alert requires a good knowledge of its environment as well as learning the habits of the predator (Paris, 2006). Although this seems trivial, the amount of movement and human activity redistribution causes naïve people to settle in the vicinity of a wildlife area, and incur greater costs than the local communities that have the experience. It is for instance surprising that it is common that people living along park boundaries have never visited the adjacent protected area, or even rarely or never saw wild species.

Perhaps the single most important action that can be undertaken to reduce the potential for attack is to reduce or eliminate food as an attractant (open butchery, pets, domestic stock, and habituated wildlife) near areas of human use. Preventive action is essential; once an animal has obtained food, the development of habituated behavior and attraction to human attack is an important factor in attacks (Quigley & Herrero, 2005). In addition, the level of human activity can act as a repellent for lions. Attack of lion on cattle herds was influenced by the total number of people present at the boma with attacks more likely where human activities was low (Woodroffe et al., 2006).

Decrease human vulnerability as a potential prey is another obvious topic to be developed. When doing some field work, follow basic rules like wearing bush colors clothes, check for the direction of the wind when approaching a risky area. A backpack or heavy clothing may also increase one's silhouette to appear larger. Displacements at night should be avoided and travel with small children should be made with them off the ground (Quigley & Herrero, 2005). Reducing the attractiveness is key aspect, but increasing the repulsing nature of the area around which people live is also crucial, for instance reducing the cover near the house especially when small children are using the place. The presence of lights may reduce movements around the camp.

Environmental education could thus include ecosystem functioning (ex: sink), carnivore behavioural ecology, attacks risks factors, but also mention ways of distributing human activities to reduce human vulnerability. Extremely important is also educational centres, performing education to children for the future generations, as developed by the Painted Dog Conservation Project (PDC), at the periphery of Hwange National Park (Zimbabwe). Diffusion of knowledge is central in the educational process, as exemplified by the creation of predator conservation video for pastoralists in Laikipia. This educational video in Masai language on predator conservation and livestock husbandry, using local settings and local Masai-speaking people as

narrators will be shown in schools and community meetings using the Laikipia Wildlife Forum's mobile video theatre.

Training is also a very important part of the educational process. The Demonstration Boma Project in Laikipia and Samburu (funded by the African Wildlife Conservation) can be used as an example to capacitate local communities. In the communal areas of Laikipia, the major human-wildlife conflict is hyena depredation on goats and sheep, taken from flimsy bomas at night. Series of experiments on methods of improving bomas at low cost were run. Based on those results, the African Wildlife Foundation funded a project to build four demonstration bomas on every group ranch in the District. Predator Conservation Officer, the local Community Liaison Officer, and KWS Community Wildlife Officer, holds a community meeting on each group ranch to explain the reasons for conserving carnivores, and that people can eliminate their losses to hyenas very cheaply. Each community selects four local residents to receive a demonstration boma, two of which have a solid gate (the critical improvement) and are surrounded by low-cost wire mesh, the other two which have only the gate. A local carpenter from each community helped with construction, so that they can duplicate the design for other people. In 2005, the project expanded into Samburu District, where some people had already been copying the demonstration design they saw in Laikipia. In total, 115 demonstration projects were developed in the two districts, and the results have been gratifying: the communities unanimously found that problems have decreased dramatically and many people have copied the design for themselves.

1.2. Compensations

1.2.1. Direct compensation: subsidies

1.2.1.1. Compensation Assessment

Success of compensation scheme in mitigation human and wildlife conflict is controversial and can lead to reversal effect. Caution must be taken to avoid "deviation" in the system and to prevent from abuses leading to the failure in mitigating lion and human conflict. Thus, when establishing an insurance fund to compensate pastoralist for livestock killed by predator and human injuries, it is necessary to have an independent and effective wildlife damage control to verify that a livestock death was due to depredation rather than other cause, as well as an objective mechanism for determining the value of livestock (Linnell, Swenson & Andersen, 2001; Frank & Woodroffe 2002; Ogotu et al. 2005).

Another issue when dealing with compensation or wildlife benefits distribution is the adequate money distribution. It is often raised that benefits are too low to off sets cost or that they are inadequately distributed. This is the case in Zimbabwe, where benefit distribution is theoretically "equitable" whereas the extent of damages varies among districts and towards seasons. In some cases, depredation is occurring in areas where hunting operations do not exist because of animals migratory pattern (N. Drouet pers.com. IUCN Workshop minutes).

1.2.1.2. Insurance and livestock compensation scheme

Financial compensation for losses resulting from lion predation can be the final step and a way to encourage local people to tolerate lions' presence. Compensation can be an effective tool when it is not abused (Nowell & Jackson, 1996; Breitenmoser et al. 2005). However, while it may be

feasible to assess the level of livestock losses, the exercise relates to values which can only be accounted for with great difficulty in the case of loss of human life. Generally speaking, lethal and non-lethal control options for lion conflict resolution are costly. The system of compensation requires that the central wildlife authorities have the appropriate financial resources and the capacity to implement the scheme. This can be a major impediment for conflict resolution in African countries where budgets for conservation are low.

However, compensation is essentially a negative payment. It does little to remove the over-riding conflict of interest between local peoples' development aspirations and the conservation of lions. Ultimately, measures consisting of creating or increasing the value of lions to local people through ecotourism and hunting operations while ensuring that the benefits from such operations accrue to local communities might be a suitable option to alleviate conflicts and to improve people's perception of the predators, thus creating the local incentive to conserve lion populations outside Protected Areas.

Projects in Brazil and Russia are testing insurance programs, premiums are based on loss rates, such that people with few losses pay lower premiums to encourage good husbandry practices.

1.2.1.3. State subvention /Local employment

Communities are often very eager to get the financial benefits from wildlife, but are reluctant to invest their own money in the activities and infrastructure that will reduce the problem. Communities can build goodwill with the authorities and reduce their own problems by investing in activities that will help reduce human-wildlife conflict. e.g. Communities in Guruve, Gokwe in Zimbabwe have invested in problem animal management by employing community Problem Animal Reporters and Game Guards (WWF 2005).

Similarly, Leela Hazzah MSc work in Kenya within the Lion Conservation program (under Dr. L. Frank) has shown that the strongest incentive for conservation among the Masai comes from financial benefits, particularly employment. Lion killing is done by young warriors (*morans*), who are uneducated, unemployable and bored. The suggestion is that a number of young men be employed as lion guardians, to help with monitoring, education on predator-friendly livestock management, improved herding practices, etc.

1.2.1.4. NGO subvention

For instance, the Laikipia Predator Project used the Laikipia Wildlife Forum's Conservation Liaison Officers in an outreach role to encourage predator-friendly livestock husbandry in their communities and pay 25% of the CLO salaries and transportation costs. They have been essential in planning and building the demonstration projects as well as education on methods to better protect livestock.

In Kilimanjaro, the KLCP (Kilimanjaro Lion Conservation Project) works closely with the privately funded Predator Compensation Fund, the first experiment in compensation for livestock kills since the Kenya government abandoned its own corruption-riddled system years ago. The PCF is a carrot-and-stick approach, entailing rigorous verification of claims by a team of Predator Game Scouts. Compensation is generous, but is reduced for losses due to poor husbandry and withheld if predators are killed in the zone within a two-month period. The lion monitoring is essential to assessing the success of the PCF (Frank 2006).

1.2.2. Indirect compensation: Wildlife valorisation

The income generated specifically by lions is poorly documented and publicised. Regardless of the distinction between consumptive and non-consumptive use, lions bring foreign currency through tourist wildlife viewing and consumptive tourist hunting as well as live sales. There are also non-monetary benefits due to (i) the key role lions play in the ecosystem and (ii) to the spiritual value of the lion in local cultures.

Conservation strategies have recently been introduced in some African regions to alleviate lion-people conflicts by encouraging local participation in conservation. The establishment of a fund fed by money generated from live sales, trophy hunting of problem lions, and photographic safaris, along with the establishment of a local management committee, may provide the basis of an effective compensation scheme. Further, by regarding large carnivores as a natural renewable resource, as well as identifying the value of their ecological roles, it should be possible to provide local communities with an incentive to tolerate large carnivores on their land and develop policy to the mutual benefit of humans and large carnivores.

The most successful way to do this is by giving farmers a high degree of control over the wildlife as well as allowing them to derive the potentially significant benefits that can be earned from wildlife management. Community based natural resources management schemes (CBNRM) assumes that local communities will be willing to conserve, manage and live with wildlife only when the benefits they derive from the wildlife outweigh the costs. Lions may thus be both an ecological and economic resource that can be managed in a sustainable manner.

Following these principles, two biologists, experts on African carnivores, Laurence Frank and Rosie Woodroffe, are behind an innovative conservation project in the Laikipia Plateau (Kenya) to reconcile local communities with predators and lions in particular. At the basis of the scheme is the development of cooperative ventures between commercial ranchers and local communities where the latter receive some of the benefits derived from commercial tourism operations. Ranchers and local communities are slowly realizing that there is more money to be made in keeping wildlife alive (Martin, 2001).

Similar schemes are being implemented successfully in Tanzania where sport hunting makes a positive contribution to the local economy. Under the new laws (Wildlife Policy of Tanzania, 1998 and the forthcoming Wildlife Management Area Regulations, 2001), benefits from trophy hunting and ecotourism go directly to local communities. Under this legislation, the communities can draw up contracts with hunting companies and lodges. In pilot projects this has proven a major incentive for villagers to conserve and protect game on their village land (V. Booth, pers. comm.). The Selous Game Ranch generated US\$1.28 million in 1992 and lion generated 12%-13% of this income (Creel & Creel, 1997).

Similarly, in Namibia, a system for allowing conditional rights over wildlife and returning benefits to rural communities has been established. Through this policy, organised tourism enterprises directed at viewing or hunting lions with benefits going to pastoralists should be implemented: *“Revenue gained through lion-tourism is expected to exceed lion-related livestock losses, which will turn the large carnivores into a benefit for the communities in the Kunene region”* (Stander & Hanssen, 2001). These schemes, currently in place for the Kunene and Kaudom sub-populations (P. Stander, pers. comm.), are being designed as part of a long-term strategy to alleviate economic losses from lion predation and reduce indiscriminate persecution of lions by farmers outside Protected Areas.

1.2.2.1. Viewing tourism

Viewing tourism would increase people tolerance for the low frequency of stock losses (Stander, 1993; Loveridge, 2002; Woodroffe et al. 2006). Large predators are central to all wildlife based enterprises and may increase the ecotourism potential of an area. This is particularly true for the lion, an emblematic species associated with the image of the African savannah scenery (Skuja 2002). If viewing tourism is largely occurring since the beginning of the century within protected areas, new eco-tourism ventures are developing in the communal areas and are promising. It is one option proposed by Hansen & Stander (2000) for the Kgalagadi district. In this area, such non-consumptive lion-tourism could easily exceed the losses caused by stock-raiding lions, and would turn the presence of large carnivores into a benefit for the local communities. In both South Africa and Namibia, two large potential stock-rangers are already being operated rather as game reserve. Furthermore, greater tolerance for predators is found among commercial ranches of Laikipia District that are engaged in or are planning ecotourism activity.

Although this is rarely compatible with intensive livestock husbandry, wildlife tourism is a management practice that encourages coexistence of lions and people. However, it can only be achieved with success in the areas where there is enough wildlife to support this activity. Therefore ecotourism activities must be encouraged as well as the development of new approaches to make predators more visible and accessible to tourists (Frank & Woodroffe 2002).

1.2.2.2. Capture tourism (or darting safari)

Darting safari also known as green-hunt or eco-hunt is a recent concept offering clients the privilege of hunting while participating in wildlife conservation research and experience adventure activities. In this specialised form of game utilization, a professional hunter and a veterinarian accompany an individual client on a safari where a dart rifle or bow and arrow are used to project a dart containing an immobilization drug into an animal. Once immobilized, a photograph of the client is taken with his trophy animal while the professional hunter measures the animal for inclusion in a trophy record book. Conservation and research work are performed like collaring the animal, taking biological samples...When finished the veterinarian administers an antidote to the immobilization drug. The hunt is considered complete when the immobilized animal recovers and is fully able to continue with its normal activities.

1.2.2.3. Trophy hunting

Game viewing is often presented as "non-consumptive" use whereas other forms of use such as tourist hunting or live sales are presented as "consumptive" use. This distinction is certainly Manichaean and even possibly invalid as has been pointed out by the Southern Africa Sustainable Use Specialist Group of IUCN/SSC (SA/SUSG, undated): *"many uses which are non-consumptive at the level of the individual are consumptive at the level of the ecosystem. By the same token, certain uses which are consumptive of individuals are non-consumptive at the ecosystem level. Our primary concern is that use be sustainable at the level of the ecosystem"*. However, despite its obvious ambiguity, the distinction between "non-consumptive" and "consumptive" is nonetheless used here because it is easily understandable and widely accepted.

A more consumptive use is suggested to be the one option to involve local people directly in conservation of their wildlife. A low intensity utilisation of lions, such as trophy hunting,

would suffice in providing benefits to the local communities and would thus increase their tolerance for the low frequency of stock losses (Stander 1993). Therefore, in areas supporting trophy harvesting, hunting of the large carnivores may be both compatible with their conservation and the benefit of local communities (Creel & Creel 1997). Sport hunting could be combined with problem animal. By turning lion raiders into a source of income, attitudes would change dramatically. Control hunting can be performed in areas where it is desirable to reduce lion densities such as buffer zone and wildlife management areas or to remove known problem animals in accordance with the national legislation. In Namibia's Kunene and Caprivi regions problem animals have recently been offered to trophy hunters. A substantial sum of the trophy fee is then paid to the community. In one area of the Kunene, lions killed approximately 8 cattle, 12 donkey and 16 goats over a three-year period, amounting to an estimated loss of N\$10,150. During this period two male lions were shot by trophy hunters and the community earned N\$25,000 from the fees paid by the hunter. The same system is used in Zimbabwe and Zambia (WWF 2005). However, one needs very clear definition of what is an animal problem for hunting

If consumptive use is an option, all sub-regions in Africa do not face the same reality in terms of potential and feasibility. Indeed, in Sub-Saharan Africa out of 32 countries which are permanent lion Range States, a total of 13 countries (40%) operate lion tourist hunting activities. In 2001, the Executive Director of UNEP, Dr. Klaus Töpfer, declared: "*The sustainable utilisation of wild animals through trophy hunting offers economic incentives to the local rural population, reduces poaching and offers incentives to conserve critical habitat*". Tourist hunting has quite different characteristics from other forms of off-take in that the harvest is usually confined to a relatively minute segment of the population so that the impact on the population is very small (Bell & McShane-Caluzi, 1984) (Table 7). In most cases, it is preferable to control lion numbers by trophy hunting, which provides a source of revenue which can then be allocated to wildlife conservation, rather than by poisoning, culling or Problem Animal Control, which costs money and is a waste of the resource, giving no revenue to rural people.

The closure of all hunting, or only lion hunting, in a few countries, suppresses much needed income from nature-oriented activities in huge tracts of natural habitats which are unsuitable areas for photographic safaris (often several million hectares of wilderness) and consequently gives place to alternative activities which are detrimental to the whole biodiversity, e.g. agriculture or excessive grazing by domestic stock. Lion hunting quotas should be allocated yearly, based on the knowledge of wildlife managers in the field, since lion populations can vary considerably from one year to the next, with a large increase if food is abundant or with a significant decrease in case of disease or excessive off take. Quotas can then be adjusted accordingly (Table 7).

Table 7: Quotas of lion according to the literature (% of the population of lion per annum)

Category	Maximum off take (%)		Source
	Prélèv. durable maximum	Prélèv. of trophy hunting max.	
Lioness	6	3	WWF, 1997
Male lion	6	5	WWF, 1997
Mature male lion	10		Greene <i>et al.</i> (1998) in Loveridge, 2002
	2-3		Creel & Creel (1997) in Loveridge, 2002
Total of lions in the population	8		Jachmann, 2001
	10		Cumming <i>in</i> Bell & McShane-Caluzi (eds.), 1984

■ *Western Africa*

Out of 15 countries in the Western Africa region, 3 countries (one fifth) allow lion tourist hunting. In this region, the lion is not the main species sought after by tourist hunters who preferably look after buffalo, roan, hartebeest and medium-size game. However, (i) to hunt other species in lion habitat, (ii) the little although real chance to see a lion during a hunting party, (iii) and the even smaller chance to collect a lion trophy, remain a powerful attraction for the tourism hunting market in these countries. When booking a hunting trip, the tourist hunter is not only buying a hunt he is also dreaming of the whole atmosphere and of remote opportunities of approaching flagship and charismatic animals such as lion. Indeed, in the region, only one out of 16 tourist hunters is lucky enough to collect a lion, which is a rough assessment, since not all big game hunters are pursuing lion. The total hunting area necessary to collect a single lion is about 26,000 km², the actual surface area hunted for lion being 14,000 km² per lion collected.

The average total number of adult male lions taken by tourist hunters in the Western Africa region is about 18.5 per year. The first destination for lion tourist hunting in Western Africa is Burkina Faso with a stable number of 12 animals collected per year on a regular basis since now 20 years, which is a good indication of an appropriate quota allocation system.

■ *Central Africa*

Out of the 9 countries in the Central Africa region, 3 countries (one third) allow lion tourist hunting. In this region, the lion is playing a similar role for tourist hunting as in the Western African region. The lion is not the main species sought after by tourist hunters who preferably look after elephant, giant eland, bongo, buffalo, roan, hartebeest, korrigum and medium-sized game. The average total number of adult male lions taken by tourist hunters in the Central Africa region is about 17.4 per year, a number comparable to that of Western Africa, so that the total number of lions taken by tourist hunters in the whole Western and Central Africa regions reaches about 36 animals per year. In the region, only one out of 18 tourist hunters is lucky enough to collect a lion, which is a rough assessment, since not all big game hunters are searching for lions.

The total hunting area necessary to collect a single lion is about 59,000 km², the actual surface area hunted for lion being 34,000 km² per lion collected.

The first destination for lion tourist hunting in Central Africa is Cameroon with a steady number of 9 animals collected per year on a regular basis over the last 20 years, which is a good indication of an appropriate quota allocation system. Indeed, in these regions, hunting success is a good indicator of lion densities (Figure 9).

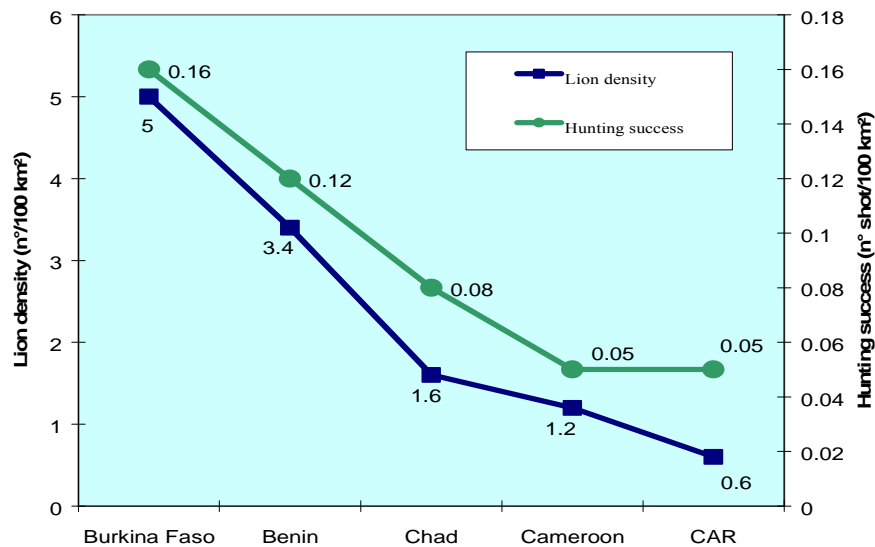


Figure 9: Lion density and hunting success in Western and Central Africa

■ *Eastern Africa*

Out of 8 countries in the Eastern Africa region, 2 countries only (one quarter) allow lion tourist hunting (Table 10). In Tanzania, consumptive use is not allowed in National Parks and in some Reserves (Mkomasi, Saadani). The major form of consumptive use is through trophy hunting by tourists, but lions are also destroyed through problem animal control, which is carried out by wildlife officials. Lions are also often poisoned by herdsmen, and also get caught in snares laid by poachers for other animals. Tourist hunters operate in allocated Hunting Blocks. The number of Hunting Blocks varies slightly from year to year. Currently around 110 Hunting Blocks are being utilised. The overall quota of lions is around 500 per year (516 in 1996). The trophy hunting off take is around 50 % of the quota: on the average 250 lions are taken every year in Tanzania (236 in 1996). This off take appears to be sustainable, as hunting success has remained fairly even since safari hunting was fully re-established in the late 1980's. The tourist hunting quotas are set for each species allowed to be hunted during the year for each Hunting Block. However, as hunting permits are issued on a block basis, hunting success varies between blocks depending on the occurrence and distribution of lions, which in turn depends on a multitude of environmental factors and can thus fluctuate from year to year. Unless problems as to the availability of lions and hunting success are reported, the same quota will be issued for the following season. This method implies that when there are problems reported from certain Hunting Blocks, such as sickness amongst the lions or non-availability of trophy males, the quota

is adjusted downwards depending on local population dynamics. In some cases additional animals have been added to the quota in particular blocks.

In Tanzania, sport hunting generally makes a positive contribution to the local economy. Under the new laws (Wildlife Policy of Tanzania, WPT, 1998 and the new Wildlife Management Area (WMA) Regulations, 2001), benefits from trophy hunting and ecotourism will go directly to the local communities. Under these new laws, local communities can draw up contracts with hunting companies and lodges etc. In pilot projects this has proven a major incentive for villagers to conserve and protect game on their village land. Giving wildlife an economic value from the perspective of the primary stakeholders namely the villagers encourages sustainable management of the resource. At the same time socio-economic development is furthered, as more cash is available in the village, villagers are empowered and management capabilities strengthened. The Selous Game Reserve generated US\$1.28 million in 1992. Lions generated 12% - 13% of this income (Creel and Creel, 1997).

In Somalia, tourist hunting was reported to occur during Siad Barre's regime up until 1991 with hunters coming from the Arab States. The continuing civil unrest in Somalia has reportedly stopped such hunting.

■ *Southern Africa*

Out of 8 countries in the Southern Africa region, 5 countries (two thirds) allow lion tourist hunting (Table 27). In the Southern African region, tourist hunting is often the main source of profit generated by wildlife (Luxmoore, 1985).

In Namibia, the national total quota ranges between 0.4 and 0.9% of overall the lion population. Local quotas do not exceed 5% of the adult and sub-adult numbers. Trophy hunting quotas exist for Kaudom (Nyae Nyae Conservancy) and Caprivi sub-populations: Kaudom has a mean annual quota of between 0.7, which represents about 2.2% of the population (1997-2001), and Caprivi has a mean annual hunting quota of 1.4, which is about 2.8% of the population (1996-2001). In Namibia, lion quotas are often set based on the frequency of problems experienced with lions. According to P. Stander (pers. comm.), trophy hunting in this country does not have a measurable impact on lion conservation. An attempt is being made to involve local communities and redirect financial benefits from trophy hunting fees to curb losses due to lion predation on their livestock.

In Botswana, trophy hunting of lions with no baiting is traditionally allowed at a national level. Generally trophy hunting takes place in the areas less suitable for photographic safaris. The Department of Wildlife and National Parks (DWNP) sells as public auction some pelts of the lions shot on problem animal control. Sustainable trophy hunting and problem animal control take place in the Okavango Delta. Lion survey data is used to set quotas in the Okavango Delta Wildlife Management Areas. The quota, set at less than 1% off take for trophy hunting in the Okavango Delta, is determined by the DWNP. Problem animal control along the boundaries of the Protected Areas (National Parks, Game Reserves and Wildlife Management Areas combined) forms the largest part of the off take. Hunting of lion in the Dry North is considered not sustainable and the quota is to be reviewed after a proper survey has been conducted to ensure sustainability. There is no trophy quota in the Pans region, but problem animal control was not thought to be sustainable. A lion PAC and lion hunting ban was imposed in November 2000. A quota of 39 lion for sport hunting quotas was given for the year 2000 at the national level. In Botswana, commercial photographic and multiple use Wildlife Management Areas are on 15-

year leases. An annual fee is paid to the Government and a resource utilisation fee to the local Government. Community Wildlife Management Areas with a Community Trust Fund are leased to operators or communities engaging in joint ventures with operators. A resource fee is paid to local Government. A trophy hunting licence fee is paid to Government. Financial benefits are not enough to accrue to the conservation body. Photographic camps and hunting camps are, however, the largest job providers. The Northern Region's economy is driven by tourism.

In South Africa, very limited hunting of lion takes place in Kruger surrounding reserves, quotas are based on advisory committee meetings with limited availability of data. In Mpumalanga Parks, off take is reactive. The only off take of lions in Hluhluwe-Umfolozi is for research purposes when animals are sick or in poor health. The removals in the North West Parks are sporadic and no fixed annual quota exists for lion but rather animals are made available for hunting to achieve various management objectives. In such cases individual animals are identified for removal and then tendered to hunting operators who then offer a “classic hunt” within the reserve (less than one lion per year on average). In South Africa, North West Parks and Hluhluwe-Umfolozi (Kwazulu-Natal) achieve their various management objectives through lion utilization. Very limited benefits are derived from lion utilization in Mpumalanga Parks. Phinda gains exposure through their relocation programmes and revenue is derived (although lions are donated to state-owned reserves). In Kwandwe and Shamwari, lions are flagship species and essential for photographic tourism operations. Without them, benefits through revenue generation would be severely reduced as tourists want to see the ‘Big 5’.

In Zimbabwe, consumptive use mainly consists of trophy hunting mostly by foreign tourists, but also for problem animal control. Skins and skulls are taken as trophies. During the year 2000, foreign hunters paid a total of US\$1,859,932 to the safari operators who conducted the hunts, for a total of 91 lions trophy-hunted. Lions account for only about 2% of sport hunting revenue earned by Rural District Councils in those Communal Lands where CAMPFIRE programmes operate (Bond, 1994). No precise data are currently available on the total annual off take of lions, apart from the animals collected by tourist hunters. Therefore, no opinion can be offered on the sustainability of the annual off take of lions, but quotas give an upper limit. At present, there is no evidence that consumptive and/or non-consumptive uses are having any measurable impact on the number of lions in Zimbabwe (V. Booth, pers. comm.). Lion sport hunting quotas for Parks and Wild Life Estate, Forest Lands and Communal Lands for the year 2002 was 139 at the national level (N. Masulani, Department of National Parks and Wild Life Management, pers. comm.). While the quotas for year 2000 were reportedly similar to that planned for 2002, however the quotas for 2001 were reported to have been 224 (N. Monk, pers. comm.). It is doubtful that the variation in these numbers actually closely reflects a variation in the number of lions. In the Parks and Wildlife Estate, the Department of National Parks and Wildlife Management sets sport hunting quotas after consultation with stakeholders. Information that is considered during quota setting includes: survey results (if any), the perceived trend in lion numbers, trophy quality and animal condition data (if any) during the previous year, and stakeholders' opinions on lion numbers and the trend in lion numbers. In the Communal Areas, the appropriate authority proposes sport hunting quotas, in a similar manner to that used by the Department of National Parks and Wildlife Management, which are then sent to that Department for approval. On privately owned land, sport-hunting quotas are proposed by the landowner and then sent to the Department of National Parks and Wildlife Management for approval.

In Zambia, interest in lion from safari hunters is substantial and growing. Over the 1995-2000 period, lion have been hunted successfully in the prime, secondary and even some of the under-stocked Game Management Areas (GMAs). It is interesting to note that fewer licences for

lion were issued than were available on quota. Hunting pressure on lion and their prey (plains game species) in the GMAs is largely seasonal. Poor access by road and even on foot (particularly in the floodplain areas), dense vegetation, and the dispersed nature of wildlife populations during the wet season months between December and May, largely preclude successful hunting of lion and their prey during this period. In contrast, throughout the dry season months, hunting pressure on lion and other species is sustained at high levels, not only from safari hunting, but also through hunting by Special Licence (often not accountable against quotas), local hunting, poaching and snaring activity. With many GMAs sharing boundaries with the principal National Parks, particularly along the major rivers, this hunting activity continues right along the boundaries of the National Parks. The total number of lions hunted in 2000 amounted to 78. In Zambia, based on more than 20 years' experience, it is estimated that trophy male off take quotas can be set up to 8 % of the adult lion population, in order to obtain the best male trophy quality (Jachmann, 2001). The quotas allocated for safari and resident hunting are broadly based on prior hunting success rates, but in some cases purely on levels of demand. Systematic assessments of hunting returns can and have been used fairly successfully by the authorities to determine sustainable hunting quotas, but this procedure is likely to have lapsed in recent years during the process of institutional changes in the wildlife authorities (R. Jeffery, pers. comm.; J. Pope, pers. comm.).

In Malawi, no sport or trophy hunting of lions is permitted and none has been considered for many years, since lions are scarce in this country.

Game viewing and tourist hunting are often presented as being exclusive one from the other. This is not always the case. There are many examples where both activities are carried out side-by-side, together with trekking, wildlife-watching and live capture. One of the best examples is the outstanding Pilanesberg Reserve, South Africa, where all these activities are carried out simultaneously with great success in a small area. Even though less spectacular, many other cases exist, particularly in Southern African countries such as Botswana: "*...a combination of photographic and hunting safaris ensure the economic viability of the Wildlife Management Areas in Botswana in a way that neither can achieve on their own*" (Van der Merwe, 2001).

2. LIVESTOCK MANAGEMENT

Depredation on livestock is to some extent, preventable (Ogada et al., 2003). Preventative measures include those that attempt to protect livestock through management and to prevent predators forming the habits of killing livestock (Frank & Woodroffe 2002). Indeed, effectiveness livestock husbandry can reduce livestock depredation by wild carnivores and mitigating the impact of predators on human livelihood in Africa's community rangelands (Ogada et al., 2003; Breitenmoser et al. 2005; Woodroffe et al. 2006). For traditional societies, the investment for the protection of livestock was high both in terms of labour and resources (Kruuk 2002). Refining the methods of livestock management developed by generations of traditional pastoralists is one of the most promising solutions to reduce human and lion conflict.

For instance, on commercial ranches and community rangelands in East Africa, traditional Masai livestock husbandry practices were effective in reducing depredation by wild predators. Various aspects of livestock husbandry, including boma design, herding practices, use of deterrents, can be effective in reducing the probability of predator attack (Kruuk, 1980, Ogada et

al. 2003; Woodroffe et al. 2006; Frank et al. 2006). A preliminary analysis of herding practices in Masailand and Laikipia indicated that a large majority of livestock killed by predators on Mbirikani have been left in the bush at night. As this rarely occurs in Laikipia and Samburu, a detailed study of herding practices was started to learn what people are doing right in northern Kenya, and help those in the south improve their herding and avoid depredation losses (Frank 2006).

In southern Africa, abandonment of herding traditions, livestock are often left by themselves (Ogada et al, 2003). In the following sections, we review practices and contexts that may help reducing livestock losses.

2.1. Intensifying human vigilance

Changes in modern society also affect traditional stock management practices, for instance, in rural Namibia, young boys used to protect herds at night. However, with the independence of Namibia in 1991 and increased access to schools, herds are now left unattended at night and they wander into predator areas (O'Connell-Rodwell *et al.*, 2000). Guarding livestock has been the natural response to depredation losses since the beginning of domestication. Where herdsmen are present, predation rate is generally lower than in free-ranging herds (Kaczensky, 1996; Linnell, 1996; Ogada et al., 2003; Breitenmoser et al. 2005). The use of additional deterrents (arm, dog) can be used to improve the human guard efficiency during the day but also at night in bomas. As a matter of fact, firearms are rarely used to shoot predators but to scare predators away, usually by shooting in the air, if they approached the bomas too closely (Frank, 2000; Ogada et al, 2003) . Even if a lion does kill stock, a shotgun can deter lion from depredation habits by showing the predator that killing stock will not result in a meal (Skuja, 2002). Government of Tanzania is employing armed guard to protect the villages around Tarangire National Park from lion man-eating. However, efficiency is not total. *“If the presence of firearms at bomas appeared to deter lions from predation on sheep and goats but not cattle although the sample of bomas with guards with arms was small”* (Ogada et al, 2003).

In general, livestock that were closely herded by day and kept at night in bomas with watch dogs and high level of human activities were less likely to be killed by predators (Ogada et al, 2003). Motivating people in their job could be efficient. Thus, rewarding herders for good performances and organize them under a headman in charge of several herds had shown dramatically reduced in depredation in the experience of Laikipia, Kenya (Frank & Woodroffe, 2002). Children should not be employed for herding.

The use of watchtowers can alert farmers to the presence of approaching wildlife. Constructed at half-kilometre intervals these can be used to spot approaching wildlife and raise the alarm to their presence. There needs to be co-operation between farmers to manage the watchtowers and set up duty rosters, used widely in Zimbabwe, Mozambique and Zambia (WWF 2005). However, a recent study of lion attacks on humans suggested that men were often taken from watchtowers while guarding fields against crop raiding animals (Packer et al. 2005).

2.2. Livestock guarding animals (LGAs)

LGAs are able to detect an approaching predator and to interrupt the attack sequence (Smith et al. 2000 a). LGA constantly lives with the livestock (Coppinger et al. 1983). They are either potential prey (herbivores) acting in self-defence or potential competitors (carnivores) to the attacking predators (Breitenmoser et al., 2005).

The use of donkeys to protect livestock, especially calving herds, reduced losses considerably as long as guidelines for successful implementations were properly followed (see Marker, 2000; Breitenmoser et al., 2005). Livestock guarding dogs are selected for their ability to respond (barking) to any strange event and hence to disturb the predator (Breitenmoser et al, 2005). Dogs are known to actively protect livestock against predators, whereas donkeys act more as a deterrent (WWF 2005). Having domestic dogs accompanying a herd reduces the risk of attack by 63 % (Woodroffe et al, 2006). The role of those dogs is to alert people to predator presence. They are not trained to chase predators. These dogs are raised from puppy-hood with sheep or cattle and live with the herd full time. It is not likely they would chase lions but they may be more effective at detecting and raising an alarm (Frank & Woodroffe 2002). At bomas lions were less likely to take any livestock from bomas with both dogs and large numbers of people present (Ogada et al, 2003). However, presence of dogs was associated with reduced rates of lion depredation on cattle but not on sheep and goats (Ogada et al, 2003).

Interestingly, the use of both dogs and donkeys to accompany livestock has recently been used in both Namibia and Botswana. This has enjoyed a reasonable degree of success in reducing incidences of human-wildlife conflict where cheetah and spotted hyena are concerned (WWF 2005).

Domesticated dogs have been used since time memorial to hunt down, attack or bay wild animals. Properly trained and disciplined dogs are extremely beneficial diverting the attention of potential dangerous animals during pursuit from the hunter to the dog enabling lethal control or capture. The training of a pack of dogs is an expensive, time consuming exercise requiring careful consideration before embarking upon it. Technology has made available several training aids to the dog handler including 'shock collars' to provide stimuli to the animal for training in obedience used in conjunction with whistles and GPS collars in the advent of animals becoming lost (La Grange 2006).

A wide range of dog breeds can be used for protecting livestock, but under a specific "guard dog" programme in Namibia, Anatolian sheep dogs were used (WWF, 2005). The Rhodesian ridgeback is a breed of dog from Southern Africa originated in Rhodesia (1922). Also known as the "African Lion Hound" or "African Lion Dog" (Simba Inja in Shona) because of their unique ability to harass a lion and keep it at bay while awaiting their master to make the kill. (<http://caninecoalition.com/dog-breeds/Rhodesian-Ridgeback>).

2.3. Using enclosures

Erecting electric fences between conservation areas and densely populated human zones or farmlands can be an effective way to keep the lions away from humans (Yamazaki & Bwalya, 1999). On their side, cattle raisers have a responsibility to implement sound stock management practices to protect their animals from lion predation. Simple measures such as erecting lion-proof shelters for livestock at night can make a big difference (Mills, 2000). "*Perhaps the best way to avoid conflict with lions is through lion-proof bomas. When I state "lion-proof", I mean bomas which are sufficiently high and strong to prevent cattle from breaking out of them and lions from jumping in*" (Skuja, 2002).

Boma can be open and only consisted in an area where livestock are bedded down with no physical barrier between them and the surrounding environment. Most often, they are enclosure where containing herds at night. Boma can be done with locally available material such as

thornbrush bomas (constructed of whole trees or large branches cut and laid on their sides, wooden poles, stones, wires...) (Skuja 2002; Woodroffe et al. 2006).

Bomas can differ in characteristics, such as the number of gates/entrances, height and thickness of boma walls, as well as transparency or orientation of branches (inside or outside), but also terrain and habitat. Some bomas – particularly those constructed from *Acacia* Brush – consisted into several “rooms” separated by internal brush walls. These internal walls separate herds within the enclosure and strengthen the boma, making it less likely that panicked livestock will escape (Ogada et al, 2003). Where livestock are kept unguarded in kraals it is better if they can break out in the event of an attack to prevent the lion continuing to kill indiscriminately (La Grange 2005).

A non significant trend suggested that rates of lion depredation on sheep and goats could be influenced by the boma type although there was no similar effect for lion depredation on cattle (Ogada et al. 2003). No effect of wall height and thickness, boma complexity, was found on depredation rate but the probability of attack was influenced by features of boma construction (the transparency of the boma wall, number of gates) as well as by deterrents present at the boma (men and domestic dogs) (Woodroffe, et al. 2006). Each gate in the boma wall increases the likelihood of attack by 40%. By night, the risk of attack was lowest for herds held in enclosures boma with dense walls, pierced by few gates, where both men and domestic dogs were present (Woodroffe et al. 2006).

Providing that they minimise structural weaknesses such as those stated above, lion-proof bomas can thus be constructed from a variety of materials, large thorn trees, stone, posts or rough lumber, provided they prevent cattle from stampeding (Frank & Woodroffe, 2002). A herdman, often responsible for guarding several herds, should bring all of them single boma each night. Refining herding method to reduce the loss of strays and the cessation of allowing stock to roam freely at night should be helped by the presence of lion-proof bomas, provided they are practical and affordable for pastoralist communities and commercial ranches. One perverse side-effect of efficient husbandry is on depredation away from the boma, as lions are likely to take more than one sheep or goat when the number of herders per sheep or goat was higher (Ogada et al., 2003).

If one does not follow the traditional boma options, fences that would deter or keep out large carnivores and allow livestock to graze freely can be erected. Where lions are not tolerated, fencing is often the option take by management to protect livestock in small night-time pens, provide predator-proof grazing areas, and exclude carnivore from entire regions. Different forms of protective fences have been developed using natural material (thorn bushes, logs, wood, earth, rocks, ditches, bush clearing) and modern material (bricks, wire, synthetics, electric) (Kruuk, 1980; Linnell et al. 1996; Charudutt, 1997; Ogada, et al. 2003; Breitenmoser, et al. 2005; WWF, 2005). Fencing is a technique used extensively in Namibia and some parts of Botswana, to assist farmers in controlling predation on their livestock by lions, spotted hyena, wild dog and cheetah. Some farmers in northern Namibia have erected smaller fenced camps (2-10 hectares) near their settlements, where they keep some animals, like cows with small calves. This has been a very successful option that has reduced predation on calves during the vulnerable stage of their growth (WWF 2005).

Creating buffer zones by clearing of a section of woodland along the boundary of a pasture can facilitate the spotting of wildlife approaching. This “buffer zone” may also act as a deterrent to approaching wildlife. A clearing area of five meters can easily be done using only slashers and axes and at a low cost (WWF 2005).

Wire-netting fences are used with success for small carnivores. This is the case in Australia to exclude dingo (5300 km of fences). But considering the jumping and climbing ability of felids netting fences without additional impediments have limited effect against them. Experience from the Laikipia case study have shown that wire fences are less effective than brush fences at excluding lions (Ogada, et al. 2003; Frank, et al. 2005). Modern approaches such as electrical fences and radio-activated guards can be used as protective measures to deny carnivore access to the livestock. Few studies address the efficiency of electric fences against felids (Linnell et al. 1996). Moreover if those methods appear useful in North America and Europe, they are costly and may be not appropriate for use in less developed areas with little infrastructure (Breitenmoser et al. 2005). Fencing is thus often costly and requires permanent maintenance. Further, fencing off larger areas is problematic since it fragments the habitat (Breitenmoser et al., 2005). Indigenous knowledge techniques (IKT) are more suitable.

2.4. Birth synchronisation / Specific management for calves

Protection of animals can be seasonally managed by controlling the reproduction (WWF, 2005). This is especially indicated in regions with seasonal transhumance so that no calving and lambing occurs on the exposed summer pastures, or during movement, when cows and calves are the most vulnerable for predation (Breitenmoser et al., 2005; WWF, 2005).

Birth synchronisation can be done by managing the movement of the bull (WWF, 2005), and techniques are easily available from livestock breeding specialists.

2.5. Mixed herds

The presence of cattle did not appear to influence depredation rates on sheep and goats and the presence of sheep and goats did not influence depredation on cattle (Ogada et al., 2003). Only, the use of donkeys seemed to have an effect (see section above).

3. LION MANAGEMENT

3.1. Non lethal

3.1.1. Deterrent methods

Many deterrents devices can be used to dissuade lion attacks. There are two conceptual groups: frightening devices and aversive devices (Breitenmoser et al., 2005). There is for example the use of lights or fires which can be kept burning at night in areas where raiding animals are regular visitors. If firewood is difficult to obtain, any material which smoulders can be used (WWF, 2005). Human activity (number of people present and number of houses next to bomas) may also act as deterrents. Rates of lion attacks on livestock seem to be strongly negatively correlated to the number of people present at boma (Ogada et al., 2003). Then scarecrow could be a potential detrimental effect. But even if it is successfully used against leopard (*Panthera pardus*), Woodroffe et al. (2006) report that it is apparently not for the lion. Unexpectedly, the presence of scarecrow would increase the risks of attack on bomas.

The most common methods are dogs and human guards with guns (Ogada, Woodroffe et al., 2003). For example on commercial ranches in Laikipia, Kenya, people use a shotgun blast to

scare off lions. Craker shells are 12 bore cartridges which launch a small charge that explodes near the predator, presumably providing greater shock value than a gunshot coming from boma (Frank and Woodroffe, 2002). Other forms of devices, aversive, may be explored in an effort to teach raiding lions that killing livestock is associated with displeased consequences. Such tactics might for example involve the use of livestock carcasses laced with lithium chloride, making predators which eat them nauseous (Frank and Woodroffe, 2002). One may also expose calves with electrical collars. Those electronic deterrents have been tested in America and Europe, but they require too much manpower and technology to be used on a wide scale (Frank and Woodroffe, 2002). No single deterrent techniques will be permanently effective but using several of them in combination may help to reduce depredation and prevent young predator from learning bad habits (Frank and Woodroffe, 2002).

3.1.2. Translocation of lions

Translocation of large carnivores is a complicated management practice with a success rate relatively low (Mills 1991, Parker, 1995; Gault, 1997; Breitenmoser et al., 2005; Lagrange, 2005), but which may be successful in specific cases (Stander, 1990). Before undertaking translocation, careful prior consideration must be given as to where the animal is to be released as serious repercussions can result if it is released in an area already inhabited by other prides or where livestock is ranched (Lagrange, 2005). Because of their territorial social systems, it is biologically defensible to translocate carnivores only in rare circumstances, when unoccupied habitat is available and predators are welcome (Frank and Woodroffe, 2002). If not then intra and interspecific competition with the sympatric carnivores, with resident lion prides in particular, may lead to a negative impact on prey populations dynamics, and ultimately to decrease of lion population. Direct fights between lion prides may also occur, with probable fatal outcomes.

Whenever a translocation operation is carried out, adequate follow up observations to assess the success and detailed long-term monitoring of the exercise are essential (Stander, 1990; Mills, 1991). In the Etosha study case, only a long-term monitoring has permitted to differentiate between “occasional stock raiding lions” and “habitual problem animals. Occasional raiders were predominantly animals from established prides. Short distances (<100 km) translocations of these animals were often sufficient to prevent these lions to kill other stock, and make them going back to their pride territories. For habitual problem animals that could not be successfully translocated, the solution adopted was the eradication (Funston pers. com.). Where attempts to relocate lion have been unsuccessful, lion can become extremely cunning, seldom showing homing behaviour and returning to kills (Lagrange, 2005; Breitenmoser et al., 2005). It is considered that for recurrent offenders, elimination is the often the adequate solution (Frank and Woodroffe, 2002).

In Namibia for instance, 22 lions have been marked with radio collars, relocated, and then followed in a study to test the success of relocations. The time it took them to return was directly dependent on how far they were moved. The majority of these lions returned to the area where they were captured. Consequently, relocation is not considered to be an effective strategy that can be used for addressing human-wildlife conflict except in the most unusual circumstances. This option is nonetheless relevant when species are endangered and thus worthy of expensive methods to save them. In the Namibian experiment, when large carnivores were not habitual livestock killers, they did not continue to kill livestock even after they had returned to their former area (WWF, 2005).

Lion depredation on domestic stock in areas bordering the Kgalagadi Transfrontier Park (KTP), Kgalagadi District, South Africa/Botswana, has been studied between 1997 and 2001

(Funston pers. com.). The success of translocation (*i.e.* whether the lions went back to their original area, when and how frequently they re-raided on livestock), has been investigated over 38 individuals' translocation of male lion. Fourteen of these males were translocated at least 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 the latter. The average time taken for them to return "home" could not be ascertained. Nonetheless in two cases, males transgressed the same boundary within 10 days. This suggests that these males moved back to their territory within only few days after translocation. Both territorial males transgressed on at least two subsequent occasions but seemed to settle down, or stop transgressing after three or four translocations. One non-territorial adult male has been recorded to move 85 km back into his usual range within five days after translocation. On the 14 transgressing males, only 3 never transgresses the boundary again.

These examples illustrate that translocation is rarely a suitable strategy. With the exception of some highly endangered species or special situations, this is more a public relation exercise than an effective management tool (Linnell et al. 1997; Woodroffe et al. 2005).

Table 8 : The age and status characteristics of translocated males, and the results of translocation.

Table 33. The age and status characteristics of translocated males, and the results of translocation.

Identity	1 st transgression			After translocation: days to return original area/ days to subsequent transgression					
	Date	Age	Status	2 nd	3 rd	4 th	5 th	6 th	7 th
km2	98/07/27	3-4 yr	sam	?/*					
km30	97/07/15	8-10 yr	tm	?/262	?/10	?/44*			
km31	98/07/10	10-12 yr	tm	?/320	?/10*				
km32	98/03/26	2-3 yr	sam	?/*					
km47							?/34*		
km51	00/05/28	3-4 yr	sam	?/86	?/108	?/54*			
km52									
km56	00/11/26	3-4 yr	sam	?/26	?/98*				
km-a									
km53	98/09/13	3-4 yr	sam	?/360 ¹					
km57	98/10/03	4-5 yr	ntm	20/216	30/141	27/63	15/46	10/62 ³	
km58				20/216 ²					
km103	00/05/06	3-4 yr	sam	#/256	#/14 ³				
km104	00/06/02	3-4 yr	sam	#/*					

* to date has not transgressed again

did not return to his original area

¹ shot at a cattlepost

² died during translocation

³ removed to another game reserve

3.1.3. *Alive lion sales*

A market for “live lions” exists. While the relocation of “habitual problem animals” should be discouraged, “occasional stock raiders”, or ideally lions residing in communal or wildlife management area, could represent at great benefit for the local communities. This is a promising approach, but no concrete experience has been reported.

3.1.4. *Contraception*

In response to overpopulation or to prevent it, particularly in small reserves of South Africa, there have been a number of attempts to sterilize males by vasectomy. However, these operations have given mixed results with some problems that arose because of the complex, and seemingly brutal, nature of social hierarchy within lion society which may be deeply affected by such surgeries.

Besides the financial cost of this method, and the logistical difficulties, it is hardly possible to carry out such surgical interventions over vast areas. In addition the population structure of lions is highly dynamic and anything that attempts to freeze this in time is likely to throw up other problems. This technique is probably most useful for managing small captive populations but is too intensive, costly and intrusive to have any useful field application to wild populations.

3.2. **Lethal**

The attacks of lion on cattle usually lead to the elimination of the accused lions, either by the means of government problem animal control, or by poisoning and poaching practised by the local populations. It happens that certain lions kill more cattle than they consume ("*surplus killing*"); this behaviour is likely to exacerbate of advantage the human hostility.

3.2.1. *Some legal aspects of people defence against wildlife damages*

In most lion range countries, the Wildlife Laws address the issue of the protection of people from wildlife damages which tacitly include lion attacks. Wildlife Laws have been examined for a sample of 10 different countries (by English alphabetic order: Cameroon, CAR, Cote d'Ivoire, Mali, Mozambique, Niger, Tanzania, Senegal, Zambia, Zimbabwe) from 4 different regions (West, Central, East and Southern Africa). The legal context in the 10 countries is remarkably homogeneous:

- In all 10 countries, there is at least one Law article related to the defence of human life & property from wildlife attacks;
- In all 10 countries, the principle of self defence is considered as legitimate and legal whatever category the culprit animal belongs to, either protected or non-protected;
- In all 10 countries, when a culprit animal is killed, the case must be reported to the wildlife authority with slight differences between countries in terms of delay to report, e.g.: at once in Niger, 3 days in Cameroon, 14 days in Zambia;
- Some differences also exist between countries in terms of who benefit from the animals killed (meat, trophy...), e.g.: in Cameroon and in Senegal the victims will benefit, while in Niger and in Zambia the State is the beneficiary.

The reality today in many lion range countries is that a cattle herder is definitely allowed by Law to kill a lion in defence of his own life, the life of another person or of his livestock. The legal context may be seen from two perspectives:

- (i) As local communities are the most exposed to lion damages, it looks appropriate to state that killing of a culprit animal by the offended stakeholder is not an offence. It looks also relevant given that local communities are often the quickest stakeholders to react to lion attacks, and many times with the highest chance to target the culprit;
- (ii) Leaving the offended stakeholder solving the problem by itself (from assessing the fault to punishing the culprit) without any control raises concerns of potential abuses such as biased evaluation of damages, overreaction by killing non-culprit lions, etc.

The question remains of the control by a non involved party with sufficient ability to react quickly, accurately and efficiently to a highly unpredictable demand. A single response to this question cannot be given, looking at the diversity of situations, even sometimes huge differences which exist from one site to another as you state. Some of the largest differences in this respect lie between pastoral societies and non cattle herder communities.

Out of the sample of Wildlife Laws which has been examined, a selection of key sentences is presented below in relation to the defence of people and property against wildlife damages. Crucial aspects are shaded to single them out.

• **REPUBLIC OF TANZANIA**

Act to repeal and replace the Fauna Conservation Ordinance, to make provision for the protection, conservation, development, regulation and control of Fauna and Fauna products and for matters incidental thereto and connected therewith – 30th July, 1974

Part IV - Hunting, capturing and photographing of animals

(d) Miscellaneous provisions relating to hunting

Killing animal in defense of life or property allowed

50 – (1) Nothing in this Act shall make it an offense to kill any animal in defense of human life or property or for the owner or occupier of such property or any person dependent on or employed by such owner or occupier to drive or kill by any means whatsoever any animal found causing damage to such property...

The Wildlife policy of Tanzania – March, 1998

3.0 The Wildlife policy

3.3.12. Solving human-wildlife conflicts.....

Strategies for solving human-wildlife conflicts:

(ii) ... devolving progressively the responsibility for problem animal control to rural communities operating CBC programmes and continuing to give assistance where rural communities have not developed this capability.

Alternatives strategies: In the long term, alternative strategies to reduce the conflict between people and wildlife will be explored. Possibilities include:

- Incorporating numbers of animals that are not shot on problem animal control into hunting quotas that can derive greater economic benefits to rural communities.

• **REPUBLIC OF ZAMBIA**

The Zambia Wildlife Act, 1998

Part IX – Killing, wounding or molesting wild animals

Self-defense

78. (1) Notwithstanding anything to the contrary in this Act, a person may kill any wild animal in defense of himself or in defense of any other person if it is necessary.

Defense of property

79. ... may kill any game animal, non-game animal, protected or non-protected animal which is identified as causing or has caused material damage to that land, building, crops or livestock, as the case may be and a report shall be made to the nearest proper officer, village scout or honorary wildlife police officer.

Game or protected animals killed through accident or error

80. (1) If any person kills any game animal or protected animal through accident or error, the person shall, within a period of fourteen days, make a report of the facts to the nearest proper officer, village scout or honorary wildlife police officer and shall hand over to the proper officer, honorary wildlife police officer or village scout the carcass, or any trophy or meat of the animal as the officer or village scout may direct.

• **REPUBLIC OF ZIMBABWE**

Parks and Wild Life Act, Revised edition 1996

Part XII – Hunting, removal, viewing and sale of animals and animal products

61. Killing or injury of animals in self-defense

(1) Notwithstanding this Act, it shall be lawful for any person to kill or injure any animal on any land in defense of himself or any other person if immediately and absolutely necessary.

(2) The burden of proving that any animal has been killed or injured in accordance with subsection (1) shall lie on the person who killed or injured such animal.

• REPUBLIQUE DU CAMEROUN

Décret N° 95/466/PM du 20 juillet 1995 fixant les modalités d'application du régime de la faune

Titre II - De la protection de la faune et de la biodiversité

Chapitre I - De la conservation de la faune

Section III - De la protection des personnes et des biens

Article 13 -

(1) Conformément à l'article 83 de la Loi, nul ne peut être sanctionné pour fait d'acte de chasse d'un animal protégé, commis dans la nécessité immédiate de sa défense, de celle de son cheptel domestique et/ou de celle de ses cultures.

La preuve de la légitime défense doit être fournie dans un délai de soixante-douze (72) heures au responsable de l'Administration chargée de la faune le plus proche.

Titre III - De la gestion de la faune

Chapitre IV - Des produits de la faune

Section I - De la récolte et de l'exploitation des produits fauniques à des fins artisanales

Article 62 -

(1) La viande provenant des animaux abattus par suite de battues administratives ou pour nécessité de défense revient aux populations locales victimes et, en partie, aux chasseurs bénévoles.

• REPUBLIQUE CENTRAFRICAINE

Code de protection de la faune sauvage

Ordonnance N° 84.045 – Portant protection de la faune sauvage et réglementant l'exercice de la chasse en République Centrafricaine

Titre II - De la Chasse

Chapitre V - Défense des biens et des personnes

Art. 95 : Les propriétaires ou usagers ont le droit de repousser de leurs terres les animaux qui feraient courir à leurs bétail et culture un danger immédiat.

Art. 97 : En toute hypothèse, les propriétaires ou usagers mentionnés à l'article 95 ci-dessus, ou bien l'autorité ayant ordonné une battue administrative adresseront au Ministre chargé de la faune, un rapport faisant apparaître les motifs de la battue, les noms des personnes, agents ou auxiliaires y ayant participé, le nombre exact, espèce par espèce, et les caractéristiques des animaux tués appartenant aux espèces intégralement ou partiellement protégées, la mention des autres animaux s'il y a lieu.

Titre IV - De la répression

Chapitre I - Des Peines

Art. 116 : Le fait d'abattre ou de blesser un animal de quelque espèce et quelque lieu ne peut constituer une infraction aux dispositions de la présente Ordonnance, dès lors que l'auteur de l'acte a agi pour la défense immédiate de sa propre personne ou d'autrui.

• REPUBLIQUE DE COTE D'IVOIRE

Législation de la chasse et de la protection de la nature – Avril 1968

Loi N° 65-255 du 4 août 1965

Titre III – Chasse et capture

Chapitre VIII – Protection des personnes et des biens – Légitime défense

Art. 22 – Aucune infraction ne peut être relevée sauf provocation préalable des animaux contre quiconque a fait acte de chasse indûment, mais dans la nécessité immédiate de sa défense ou de celle d'autrui ou de la protection de son bétail domestique ou de sa propre récolte. En cas d'abattage d'un animal intégralement protégé, la preuve de la légitime défense doit être fournie dans les plus brefs délais, aux agents de l'Administration.

• REPUBLIQUE DU MALI

Loi N° 95-031 fixant les conditions de gestion de la faune sauvage et de son habitat

Titre III - Gestion du domaine faunique

Chapitre IV - Protection des personnes et des biens

Article 108 : Aucune infraction ne peut être retenue contre quiconque a fait acte de chasse dans la nécessité absolue de sa défense, de celle d'autrui ou de ses biens.

• REPUBLIQUE DU MOZAMBIQUE

Loi N° 10/99 du 7 juillet 1999 : Loi des Forêts et de la Faune Sauvage" (Lei de Florestas e Fauna Bravia)

Chapitre IV – Régimes d'exploitation durable des ressources fauniques

Article 25 :

1. En dehors des modalités prévues dans la présente Loi, la chasse n'est permise que pour la défense des personnes et des biens, contre les attaques actuelles ou imminentes par des animaux sauvages quand l'effarouchement ou la capture n'est pas possible.

2. La chasse évoquée au paragraphe précédent est réalisée rapidement, après la connaissance des faits, par les brigades spécialisées de l'Etat ou par le secteur privé et par les communautés locales dûment autorisées.

Décret N° 12/2002 du 6 juin 2002 approuvant le règlement de la Loi n° 10/99, loi des Forêts et de la Faune Sauvage (Decreto n12/2002 Aprovando o Regulamento da Lei n° 10/99, de 7 de julho, Lei de Florestas e fauna Bravia°)

Chapitre IV – Exploitation durable de la faune sauvage – Section VI : Chasse en défense des personnes et des biens

Article 68 : **Conditions nécessaires :**

1. Les conditions nécessaires à l'exercice de la chasse en défense des personnes et des biens sont les suivantes :

- a) existence d'une attaque actuelle ou imminente d'animaux sauvages contre des personnes ou des biens ;
- b) impossibilité d'effarouchement.

2. Pour l'application du présent règlement, on considère qu'il existe une attaque actuelle, quand un ou plusieurs animaux sauvages sont en train de poursuivre ou attaquer des personnes ou des biens ; et on considère qu'il existe une attaque imminente, quand un ou plusieurs animaux sauvages sont en train de se diriger vers ou entrer dans une propriété ou une habitation, avec de forts indices que ces animaux pourront attaquer les personnes ou les biens qui s'y trouvent.

3. Pour l'application du paragraphe 1, on considère que l'effarouchement est impossible, quand il s'agit d'animaux considérés dangereux, ou d'autres qui, n'étant pas dangereux, ne prennent pas la fuite lors de l'utilisation des moyens, considérés normalement, comme des moyens d'effarouchement pour cette espèce.

4. On doit entendre par biens, la vie humaine, les cultures agricoles, les animaux domestiques, les habitations, les véhicules et les autres objets de valeur économique ou sociale pertinents.

5. La chasse concernée par cet article n'est pas sujette aux périodes de fermeture et aux limitations associées aux restrictions de l'exercice de l'activité de chasse.

Article 69 : Entité compétente :

1. Sont compétents pour l'exercice de la chasse en défense des personnes ou des biens, les brigades spécialisées constituées par les gardes et autres fonctionnaires du secteur, les agents communautaires, les agents de contrôle assermentés, les guides de chasse et les chasseurs communautaires ;

2. Pour l'application du paragraphe précédent, les agents de contrôle assermentés, les guides de chasse et les chasseurs communautaires, pourront requérir auprès des services Provinciaux des Forêts et de la faune sauvage que leur soit autorisé l'exercice de la chasse en défense des personnes ou des biens.

3. L'exercice de la chasse en défense des personnes ou des biens n'est pas rémunéré, tous les intervenants locaux devant mobiliser les moyens nécessaires pour sa mise en œuvre quand ils sont sollicités par les services ou les entités compétentes évoqués au n° 1 de cet article.

Article 70 : Chasse en défense de vies humaines :

Quand il s'agit de la défense de vies humaines, la chasse évoquée aux articles précédents peut être effectuée par tout individu, avec ou sans permis, pourvu que soient satisfaits les pré requis prévus à l'article 68 de ce Règlement et que le fait soit communiqué a posteriori aux Services ou à l'Autorité administrative les plus proches, dans un délai maximum de 48 heures, sauf si l'action a lieu dans des zones éloignées cas où le délai pourra être prolongé de façon justifié.

Article 71 : Abus de la chasse en défense des personnes ou des biens :

Quiconque qui, n'est pas autorisé, ou qui invoque la chasse en défense des personnes ou des biens sans que soient réunis les pré requis légaux à cet égard, et utilise ce prétexte pour capturer, abattre ou blesser une espèce de faune sauvage, sera verbalisé pour chasse sans permis ou en contravention des conditions légalement établies.

Article 72 : Destination des produits :

Les dépouilles résultant des animaux sauvages abattus aux termes des articles précédents, quand ils sont considérés sanitaires propres à la consommation, seront distribués gratuitement aux communautés locales concernées, après prélèvement d'une partie pour le personnel impliqué dans la chasse.

Article 73 : **Réglementation** :

Il appartient aux Ministres de l'Agriculture et du développement Rural et du Tourisme d'établir, par arrêté ministériel conjoint, les autres normes d'application et de l'exercice de la chasse en défense des personnes ou des biens, ainsi que les conditions pour les abattages pour cause de gestion et de déséquilibre écologique.

• **REPUBLIQUE DU NIGER**

Document fixant réglementation de la chasse et de la protection de la faune – 29 avril 1998

Chapitre III – Protection des personnes et de leurs biens

Art. 29 : Aucune infraction ne pourra être retenue contre quiconque aura fait un acte de chasse dans la nécessité immédiate de sa défense ou de celle d'autrui.

Dans tous les cas, la preuve de la défense doit être immédiatement faite aux responsables de l'Administration chargée de la faune la plus proche qui récupère les dépouilles et trophées au profit de l'état.

• **REPUBLIQUE DU SENEGAL**

Loi N° 86-04 du 24 janvier 1986 portant Code de la chasse et de la protection de la faune (partie législative)

Titre premier - Principes généraux

Article L. 5 : Aucune infraction ne peut être relevée contre quiconque a fait acte de chasse indûment lorsqu'il se trouve dans la nécessité immédiate de sa défense, de celle d'autrui ou de celle de son propre cheptel domestique ou de ses cultures ou récoltes.

La preuve par tous les moyens du cas de légitime défense doit être fournie dans les plus brefs délais aux agents habilités de l'administration ou aux lieutenants de chasse.

Décret N° 86-844 du 14 juillet 1986 portant Code de la chasse et de la protection de la faune (partie réglementaire)

Titre II - De la protection de la faune

Chapitre 6 - Protection des personnes et des biens

Article D. 49 : Battues administratives...La viande des animaux abattus est laissée sur leur demande aux habitants des localités ayant subi les dommages.

Ordonnance N° 007/PRG/SGG/90 du 15 février 1990 portant Code de la protection de la faune sauvage et réglementation de la chasse

Titre quatrième - Réglementation de la chasse

Chapitre VI - Infractions et pénalités

Article 151 : Aucune infraction ne peut être relevée contre quiconque fait acte de chasse indûment lorsqu'il se sera trouvé dans la nécessité immédiate de sa défense, de celle d'autrui ou de celle de son propre cheptel domestique ou des ses cultures ou récoltes.

Clear policies on dealing with human-wildlife conflict help setting the options that can be implemented by farmers and communities. In order to be effective, policies need to include not only a clear definition of the roles of the community and the authorities responsible for wildlife, but also some guidelines on human-wildlife conflict and the means to measure the extent and nature of such conflict (WWF, 2005).

3.2.2. Off take by the administration

The actions of reprisals are generally placed under the responsibility of the authorities in charge of wild fauna. Official Problem Animal Control (PAC, *battues administratives*) is the responsibility of the wildlife authorities. Lions are shot, trapped or poisoned, to prevent further damaging incursions of the predators on their lands. For example when a lion returns to a kill, it can easily be controlled using lethal toxicants or by shooting after having trapped it with either gin-traps or cage traps (Lagrange, 2005).

In the Pan region in Botswana, an average of seven lions are killed per year through PAC, which amounted to 14% per annum of the sub-population in 1999-2000. An average of 25 lions per year are killed in the Okavango Delta through PAC, which is less than 2% of the sub-population (V. Booth, pers. comm.). In Botswana, in August 2000, the Department of Wildlife and National Parks (DWNP) prohibited lion control and set a zero quota for trophy hunting for one year. According to Sarel van der Merwe (pers. comm.), chairman of the African Lion Working Group of the IUCN/SSC, reports from the Makgadikgadi Pan National Park already indicate that, as a result of clashes between lions and livestock owners, lions are now being illegally poisoned, snared and shot without these incidents being reported to the DWNP.

According to P. Funston (pers. comm.), in the areas bordering the Kgalagadi Transfrontier Park, angry South African and Botswana farmers eliminated 93 lions over a period of 4 years up to 2001, in response to losses due to lion predation. Although the Kalahari lion population would easily sustain the off-take (Funston, 2001), it does demonstrate the nature and size of the problem.

In Namibia, around Etosha N.P. alone, more than 30 lions are killed every year through PAC activities (Stander, 2000). This is confirmed by the Namibian Government biologist, Hu Berry (1996), who reports that during the period 1965-94, more than 1,000 lions were destroyed on farmlands bordering Etosha (Etosha Ecological Institute records). He further indicates that the number of animals killed may have been higher because before 1995, farmers were not legally bound to report the killing of lions to the administration. In the Caprivi, an average of 7.2 lions have been shot each year, for the last 5 years (P. Stander, pers. comm.).

In Galana Ranch in Kenya, between 1968 and 1988, persistent stock raiding lions were shot, and roughly 1 lion was shot for every 10 cattle killed. Approximately 25 lions per year were shot out of a stable population of 150. In the period 1988-1990 the Government prohibited the use of firearms, and numbers of livestock killed rose to roughly 250 to 800 per year; with approximately 70% of the stock raiding lions being young males. Around 1990, the ranch was handed over to ADC, a parastatal company, who now uses poison to control stock raiding lions (A. Radcliffe, pers. comm.).

A frequently used method of killing lions that have been raiding livestock is through the use of poisons either agricultural or natural. Farmers, particularly pastoralists in some areas have used this to great effect, even eradicating lions in some areas, as well as indiscriminately affecting other carnivores including birds. Given the availability of chemical pesticides in rural Africa today this is a serious threat to many populations.

Poison (strychnine and organophosphate cattle dips) has been widely used on East African ranches up to the latter half of the 20th Century (Denney, 1972 in Frank et al., 2006). Until recently, the Kenya Wildlife Service and the Kenya Veterinary Department has widely poisoned hyenas, which certainly affected other scavengers like lions. Likewise, in Botswana, despite of the recent ban on lion killing, poisoning of lions is still recorded (Hemson, 2003 in Frank et al., 2006).

Because poison is indiscriminate it may remove not only the target animal but also the whole prides at once (Jenkins, 2001 in Frank et al., 2006). At this concern a great worry is the use of the soil dressing Furadan (carbofuran), widely available and cheaper than the strychnine, as in some pastoral areas of Kenya (Frank, unpub. data in Frank et al., 2006).

3.2.3. Off take by the local populations/farmers/breeders

As we already illustrated with some concrete examples, in several of the countries of Sub-Saharan Africa, the laws contain an article guaranteeing the defence of the people and their goods in the event of aggression by wild animals. The self-defence is thus authorized: it is completely legal to destroy a lion which attacks people or the domestic animals. One can suppose that, very often, the defence of the people and the cattle is carried out by the herders themselves, and that they rarely make these practices publicly known. Thus one can understand that the first direct response to lion-human conflict is the destruction of the offending lions by farmers and other affected local people.

In Western Africa there is probably relatively little local lion hunting occurring, although pastoralists may shoot or poison lions in order to protect their stock. But not much data is available about the overall effects of local hunting in the region. Data is sparse in this area, which may account for the small number of lions hunted each year. The situation of Central Africa may be slightly different from that of West Africa, in that more lions occur as well as more lion depredation. Very little quantitative data is available. However it is safe to assume that a number of lions are killed each year in defence of stock, especially in situations where transient cattle-herders enter into Protected Areas. In Kenya, there are widespread traditional cultural uses, largely of lions spared. In the Masai communities, when a particularly large-manned lion is killed, the mane is taken and used at ceremonies or hung upon the warrior's village flag pole. When a lion is killed, the tail is cut off and becomes the property of the warrior who put the first spear in. After the initial celebrations this tail is discarded. Paws are also cut off and used in the

celebrations and then also discarded. Paws and teeth appear not to be kept. In the case of poisoning nothing is taken (A. Radcliffe, pers. comm.). The lion does not appear as a common major species for local hunting in this region. However, more in-depth studies are needed to explore this interesting subject.

The local communities take lions for various reasons which can be very different from/to each other, it can act to seek benefit of nature financial, social, cultural, or other, or to resolve difficulties as to eliminate lions which cause damage.

First, the off take may be "preventive" or by way of "reprisals". The initial reaction of the man in response to the conflict which opposes it to the lion is to eliminate the individual responsible for the caused damage. The responsible lion (and often any other lion met in these circumstances) are shot with rifle or trapped or poisoned to prevent all new aggression of the predator. The use of poisons is a method frequently employed to kill the lions which attacked the herds. The poisons can be manufactured starting from plants, of agricultural pesticides (cf §3.2.) or of veterinary pesticides like the acaricides (produced used for the fight against the ticks). This practice touches also the other carnivores, including birds. Local hunting for the lion undoubtedly is not practised much any more in West Africa. But few data are available concerning local hunting in the area: the fact that these data are rare is perhaps in relation to limited lion numbers. The situation in Central Africa is different from that of West Africa, in the sense that there are more lions and more case of attacks on the cattle. Very few statistical data are available. Nevertheless a certain number of lions are cut down each year with an aim of defending the domestic herds, in particular when the guards of herds enter Protected Area to graze their animals. For the tradesmen of cattle "who do nothing but pass" to convey their oxen through political borders (sometimes even from Sudan to Nigeria), the shooting of lions can become a rule of life. The use of poison to limit the impact of the lions on the cattle seems widespread in SSA. However information too limited to measure its extent (Schoemaker, 1999 *in* Bauer, 2003). Like all illegal practices it is a difficult task to get information on it (Scholte et al. 1999a *in* Bauer, 2003). Frank et al. (2006) mentioned the report of Ogutu (2005) stipulating that Masai morans (warriors) killed by spears about 90 lions since 1998 in the Nairobi National Park and the Kitengela Plains presumably in response of attacks on livestock. The same authors report some studies carried out by Richard Bonham documenting that at least 76 lion were killed (poison or spears) since 2001 in the region on Mbirikani Group Ranch in southeast Kenya. Bernard Kissui in the greater Tarangire-Manyara, Tanzania, reported more than 125 lions killed between 2000-2005, and Dennis Ikanda mentioned 35 kills of lions in the Ngorongoro Conservation Area between 1998-2004.

Then the off take of lion by local populations may also be "accidental". Hunting for the meat is a usual practice for great number of rural people in SSA, even if it is described as poaching by certain national legislations. This type of hunting is sometimes nondiscriminating, i.e. it can kill animals not targeted by the hunter. Trapping is the main indiscriminate hunting method which can result in lions being caught in snares, jaw traps and other devices. It is not rare, not to say "usual", that trackers and hunting guides of hunting in Benin and Burkina Faso encounter lions with snares around the neck or around a leg. The villagers of Kacha-kacha, close to the PN of Zakouma in Chad, use for the metal traps known as *Am cadjaman*. In addition to the buffalo, damalisc and small antelopes, they capture hyenas and lions, either quite simply to contemplate them, or to use them for traditional medicine (Allah-Demngar & Falmata, 2003). For example, the heart and the whiskers of the lion are traditionally mixed with food to cure accidentally introduced poisons (Allah-Demngar & Falmata, 2003). In Côte d'Ivoire, Djedje

(1990) recognizes various forms of poaching which can affect the lion to differing degrees: "A side of the poaching which one can describe as subsistence or artisanal, intended for the family and which relates especially to the small mammals (cane rats, porcupines, duikers, monkeys, etc.) or the birds and whose consequences are not irremediable for the future of the wild fauna. There is also a semi-industrial poaching which is the fact of organized individuals, working for the account of true companies and which are devoted to intensive massacres with a commercial aim".

3.2.4. *Off take by the trophy hunters*

Trophy hunting could also be considered as a lethal method to mitigate conflicts with problem lions. Not only it would exterminate recurrent stock-raiders, but also it could constitute a significant financial income for the casualties of lion attacks. Nonetheless, the control of problem lions through trophy hunting has not been yet developed, and is still debated.

4. ENVIRONMENTAL MANAGEMENT

4.1. Increase alternate preys

As developed in previous sections, increasing wild prey availability on a property may reduce the number of livestock lost to predators, as wild prey is often preferentially targeted. There are many ways to achieve this objective, but mostly a good conservation of habitats and control of poaching should insure the maintenance of good densities. In areas where wild preys have been decimated, drastic protection measures will allow them to build up in numbers, in complement re-introduction could be envisaged in areas where the costs of these can be covered by the benefit from the operation.

4.2. Landscape arrangement: land use planning

"We urge the development of an effective and participatory planning system for land use that restricts migration of people into the area and encourages compatible land uses, alternative livelihood options to reduce the level of dependence on livestock as the only source of income and incorporates soft edges (Ogutu et al., 2005).

Land use planning aims at creating space for people and wildlife to live together (WWF, 2005). This is a long-term mitigation method for reducing human-wildlife conflict. Greater success in the resolution of this conflict is anticipated in modifying the manner and frequency with which the activities of humans and domestic animals intersect with those of carnivores (Treves, 2003). The challenge is to integrate as many potentially conflicting elements as possible. Different schemes can be followed to achieve that goal.

Where there is a potential for planning, the landscape has to be analyzed in order to identify the habitat(s), prey densities, and travel corridors along which carnivores are more likely to be present (Quigley and Herrero, 2005). For example, one can consider some biological components relevant when the objective is to decrease the attractiveness of an area or to create secure key areas of habitat, such as routes or corridors that will permit wildlife to move freely like in the experience of Gokwe North, Zimbabwe (WWF, 2005). First, the distribution of wildlife populations can be manipulated by changing the location of water points and providing

salt licks at strategic sites (WWF, 2005). Any water supply (river bank, pan, dams, etc.) is attractive for game, especially during dry season. Consequently an area with water can be attractive for predators. In a same way, appetent crop fields constitute attractive areas for preys. Preys in return attract predators. Concerning the settlement of villages, one should think about the attractiveness of some human activities providing meat subsidies for carnivores as slaughterhouse, butchery. Then to reduce carnivore-human conflict, carnivores attacks and long-term costs of carnivore conflicts and management, the new settlements of humans should avoid those areas where lions are likely to be present (Quigley and Herrero, 2005). Limitation of encroachment of human settlements in wildlife areas can be done by relocate agricultural activities out of wildlife areas, repositioning the boundaries of protected areas, creating buffer zones (WWF, 2005).

The periphery of conservation areas, by often being an interface between wildlife and people is particularly exposed to conflicts. The type of lands to which the park is adjacent determines the degree of conflicts. Therefore neighbouring protected areas land use should be carefully planned.

Park can border directly farmlands or communally owned lands where livestock husbandry is the major economic activity. In those areas, lions are rarely tolerated unless eco-tourism or sport hunting is an important additional activity (Loveridge, 2002). One option is to reduce the frequency of contact between people and carnivores. In that case, the distribution of human settlements such that pastoralists, the development of agriculture and infrastructure in areas away from the reserve boundary should be encouraged (Ogutu, Bhola et al., 2005).

In other situations, parks could be bordered by wildlife management areas (WMAs) which are either state or private land designated for utilization of wildlife activities. The advantage is that the interface of lion-human conflict is displaced from the park boundaries to the WMAs boundaries which are acting as a buffer zone (Loveridge, 2002). Long term land use plans involving wildlife areas now tend to place barriers, called Game Management Areas (GMA), around them. The GMA are divided into manageable blocks, encouraging wildlife utilisation to prevent a direct 'hard' contact between farming operations and the wildlife reserve. In the GMA the idea is that wildlife densities will be lower with fewer animals competing for the livestock adjacent to them (La Grange, 2005).

Zoning has been widely used in biodiversity conservation in the creation of National Parks, Natural Reserves and other Protected Areas. It refers to any form of geographically differentiated land management where different forms of potentially conflicting land use are given priority in different areas (Linnell et al., 2005). The basic concept is to reduce the spatial overlap between large carnivores and unmitigated sources of conflicts by differentiating the use of management tools directed at both the carnivores and their conflict in a complementary manner (Linnell, Nilsen et al., 2005). If a zoning approach is chosen, it is vital to scale management zones to the size of the biological process that they are designed to manage (Thiollay, 1989; Schwartz, 1999 in Linnell et al., 2005). "When we are thinking about carnivores zones, we must think in terms of bigger land areas than we are used to thinking about for any other terrestrial species group (Linnell et al., 2005).

Zoning may be a mean of mitigating conflicts with lions (Loveridge, 2002; Linnell et al., 2005). The management of lions outside national parks may be done by donation of land use areas, from the areas where lions are completely protected, through areas where lions are tolerated under certain circumstances, to areas where lions are not tolerated at all and are eradicated (Loveridge, 2002). Resident lion prides usually only become a problem when

livestock are introduced into these traditional wildlife areas or immediately adjacent to them (Lagrange, 2005). In Asia for instance, the line where Tarangire National Park and the forest reserves end is exactly demarcated and quite clear at the base of the Sangaiwe and Mbulu hills. However, this doesn't stop interactions and flows between what is 'nature' and what is 'society' from taking place, both welcome and unwelcome. People often go into the forest to graze their cattle and lions often come into the villages to go after those cattle (Skuja, 2002).

Advantages of zoning are multiple (Linnell et al., 2005). Firstly zoning allows the resources for costly conflict reduction and intensive conservation measures to be concentrated into limited areas. Then it provides for simplified management procedures where responses depend on where conflict occur, and can be initiated without time-consuming investigation. Finally it provides predictability for people, so that they can make long-term plans and economic investments knowing to what extent large carnivores will be part of their future. This may also allow people to become accustomed to the presence of large carnivores, and thereby reduce fear levels (Linnell et al., 2005).

The principal disadvantage of zoning is that it may decrease the tolerance carrying capacity of people towards wildlife: "As local people will rarely welcome being included inside a zone where carnivores are given preference, it will create an atmosphere of an urban majority overruling a rural minority. This will lead to the "us against them" mentality that might result in increased poaching and increased social conflict and increase fear because of the concentration of carnivores" (Linnell et al., 2005). This situation could be alleviated by integrating Community based Natural Resource Management programmes (CBNRM) in the form of land use planning and land use change (WWF, 2005). The approach of an extended multiple-use landscape is important for the survival of carnivores population, as few protected areas are large enough to host viable populations of large carnivore species (Woodroffe and Ginsberg, 1998 in Breitenmoser et al., 2005). The multi-use is a concept where compatible land uses occur in the same area.

In addition to socio-economic and biological constraints, land use planning also requires the development of legislations and politics necessitating complicated negotiations when dealing with several countries (e.g. wildlife corridor or transborder wildlife areas). For those reasons, land use planning and any changes in land use that are agreed can take several years to negotiate and implement (WWF, 2005).

Research is also essential and could help in landscape management by producing simulations and models as well as by identifying potential human and wildlife hotspots. Predicting spatial aspects of human-wildlife conflict was done before for the elephant (Sitati et al., 2003). Effects on the global ecosystem should also be investigated. As an example, concentration of large carnivores into an area, especially if multiple species are zoned sympatrically, may increase the competition between games hunter and large carnivores themselves (Linnell et al., 2005).

III. DECISIONAL FRAMEWORK

1. INVESTIGATION METHODS

The first obvious step before choosing any of the above mitigation methods when a depredation case occurs is to investigate on the specific identification of the “killer”. Is it a lion or not? Stock losses from predation necessitate the correct identification of the culprit for the appropriate control measures to be initiated. It is difficult to get an accurate identification of the individual problem. Radiotracking can help identifying the real culprit (radio-tracking) in hot spots. There is a need to enhance knowledge on category animal (young males, female with cubs are more likely than other to kill livestock) (Frank & Woodroffe, 2002). Various predator species co-exist in many areas and it is possible that more than one species may be implicated at a carcass. In addition the fact that a carnivore fed on a carcass does not necessarily mean that it killed the animal.

A five step investigation procedure was proposed by (Bowland et al. 1994). The method was developed for caracal, cheetah, brown hyena, leopard, domestic dog and black-backed jackal kills, but it could be applied for lion:

1. Step 1: the first and most important step is to determine whether the prey animal was killed by a predator or had died from other causes of death. Indeed lions may scavenge, thus one can find a lion feeding on a prey carcass which has not been killed by itself. Be always careful when examining remains: the animal may have already been dead and merely scavenged, not killed;
2. Step 2: define the size of the prey, *i.e.* small, medium or large;
3. Step 3: examine the various parts of the carcass carefully and systematically, remember to turn the carcass over and inspect both sides: *head, neck, forelimbs, hindlimbs, and body*;
4. Step 4: Look for specific behavioural traits of predator like claw marks on the carcass, bite on the throat;
5. Step 5: Search around the area surrounding the carcass for: hair tufts caught in the barbs of pasture fence, paw prints, stomach content and droppings.

Here is a list of detailed criteria indicated the presence of lion:

- **Lion spoors:**

Paw without claws cat like: each foot has single large pad with two indentations on the posterior edges, which usually but not always show in the track. Only four toes on each foot come into contact with the ground and they are clearly separated from the main pad. No claw marks are normally visible in the tracks as claws are held in sheaths during normal movement; they are

unsheathed only to gain purchase when jumping or for holding down prey (Stuart & Stuart, 2000).

○ **Droppings :**

Sausage-shaped droppings tapered at one end and usually segmented. Fresh lion's droppings will show segmentation. Droppings made up mainly of digested blood and flesh retain dark colour but those containing much calcium from bones whiten when they dry. Although the droppings look like those of hyena, they are scattered at random. The diameter is usually more than 40 mm, but be aware that there is much variation (e.g. p. 161 in Stuart & Stuart, 2000).

In addition, evidence of a lion attack on a herd is characterised by the obvious signs of nervousness amongst the remaining animals the following morning of the attack. Usually animals are found in open ground where they can more easily observe any approaching predator. Evidence of the herd having stampeded is clearly observed by the herd continuing to crowd against fences, sometimes even breaking them, as well as by flattened grass over a wide area where the attack took place (Lagrange, 2005).

One obvious necessity to quickly react and investigate is that of having an efficient information system to report incidents, and in addition, a centralized database to identify hot spots, recurrent animal problems. The long-term success of an information system will depend on who employs the enumerators. Ideally, the enumerators should be employees of the CBO. However, the recording of human-wildlife conflict incidences is generally seasonal. The CBO must then decide how long to employ the enumerators for (WWF 2005).

Some areas there may not be available data on the "before" situation. Regular monitoring will produce results where the success of managing human-wildlife conflict can be measured. An excellent example of such a monitoring system is the "Event Book" approach. This is presently being introduced in Botswana and Zambia, but has already been successfully used and gained wide acceptance in Namibia and Mozambique. The system was developed by WWF, Namibia Nature Foundation, and the Ministry of Environment and Tourism. Essentially, the community decides what they want to monitor. The technicians from the above mentioned organisation develop the monitoring structure accordingly and the entire process, including analysis, happens locally. The approach concentrates on measuring effort and is based on the use of icons and visual displays, that allow illiterate people to participate (WWF 2005).

2. SUMMARY OF MITIGATION TECHNIQUES AND LOGICAL FRAMEWORK

When the culpability of the lion has been proven, then mitigation methods can be implemented. Harmonious relations and co-operation between domestic stock farmers and conservation authorities has been suggested to be of crucial importance to promoting conservation practices in non-proclaimed areas and areas adjoining conservation areas (Martin, 1984; Stander, 1990; 1993; Mills, 1991). The following table (Table #) summarizes the diverse modes of intervention previously presented in details in part II. Each mode falls under specific objectives which depend themselves on the type of intervention people want to have implemented. This table thus form the basis of a decisional framework from which concrete actions can be chosen, in a sequential manner.

Table 9: Typology of mitigation methods for carnivores/livestock conflict (Chardonnet et al., 2000)

Type of intervention	Objectives of the intervention		Intervention modes		
"Laisser-faire", let predation on livestock or even increase it. « HUMAN MANAGEMENT »	Increase the tolerance of breeders		Environmental education		
			Money compensation	Subventions	From State
					From NGO
	Positive breeder behaviour	Valorisation of lions	Viewing tourism		
			Capture tourism		
			Hunting tourism		
Limit predation on livestock	Intervention on livestock « LIVESTOCK MANAGEMENT »	Modify herding practices	Birth synchronisation		
			Specific management of calves		
			Less extensive breeding		
			Intensified human vigilance		
	Intervention on lions « LION MANAGEMENT »	Dissuade lions	Livestock Guarding Animals (LGAs)		
			Electric enclosures		
		Reduce lion populations	Expose calves with electrical collars		Translocation
			Extraction	Control hunting	
	Others (poisoned collars, contraception, etc.)				
	Intervention on the environment « ENVIRONMENTAL MANAGEMENT »	Increase alternate preys	Domestic species		
Feral species					
Wild species					
	Landscape arrangement	Pasture away from lion habitats			
Eliminate predation on livestock	Separate livestock and lions	Exclude breeding	Integral protected areas		
			Protected areas of sustainable use		
	Exclude lions	Elimination of lions: lethal control method			
		Translocation of lions			

3. SOME CONCLUSIONS FROM THE LION TASK FORCE

Besides the list of mitigation methods and logical framework, an “official” decisional framework in case of human/lion conflict must be available for authorities, managers and local populations. Such a framework must help people to implement the appropriate management strategy which may differ depending on the conditions (environmental, socio-economic, etc.).

For example Anderson (2005) has proposed a decision “tree-shaped” process to determine the actions to be taken to mitigate human-lion conflict areas (see figure # below). Recently, the African Lion Working Group has officially adopted a decision tree quite similar to the one presented in by Anderson (2005).

This decision process could be used as a guideline by the wildlife authorities, in collaboration with the diverse stakeholders, to resolve conflict with lion. In fact, defining “problem animals” and the appropriate “problem animal management actions” should be determined at local community level, by the community-based organisation in partnership with the relevant government representatives. And the discussions should include any private sector hunting or tourism operators within the areas where the conflicts occur. Any system for the reporting of incidences and the development of appropriate action, should, ideally, have been agreed upon by all stakeholders.

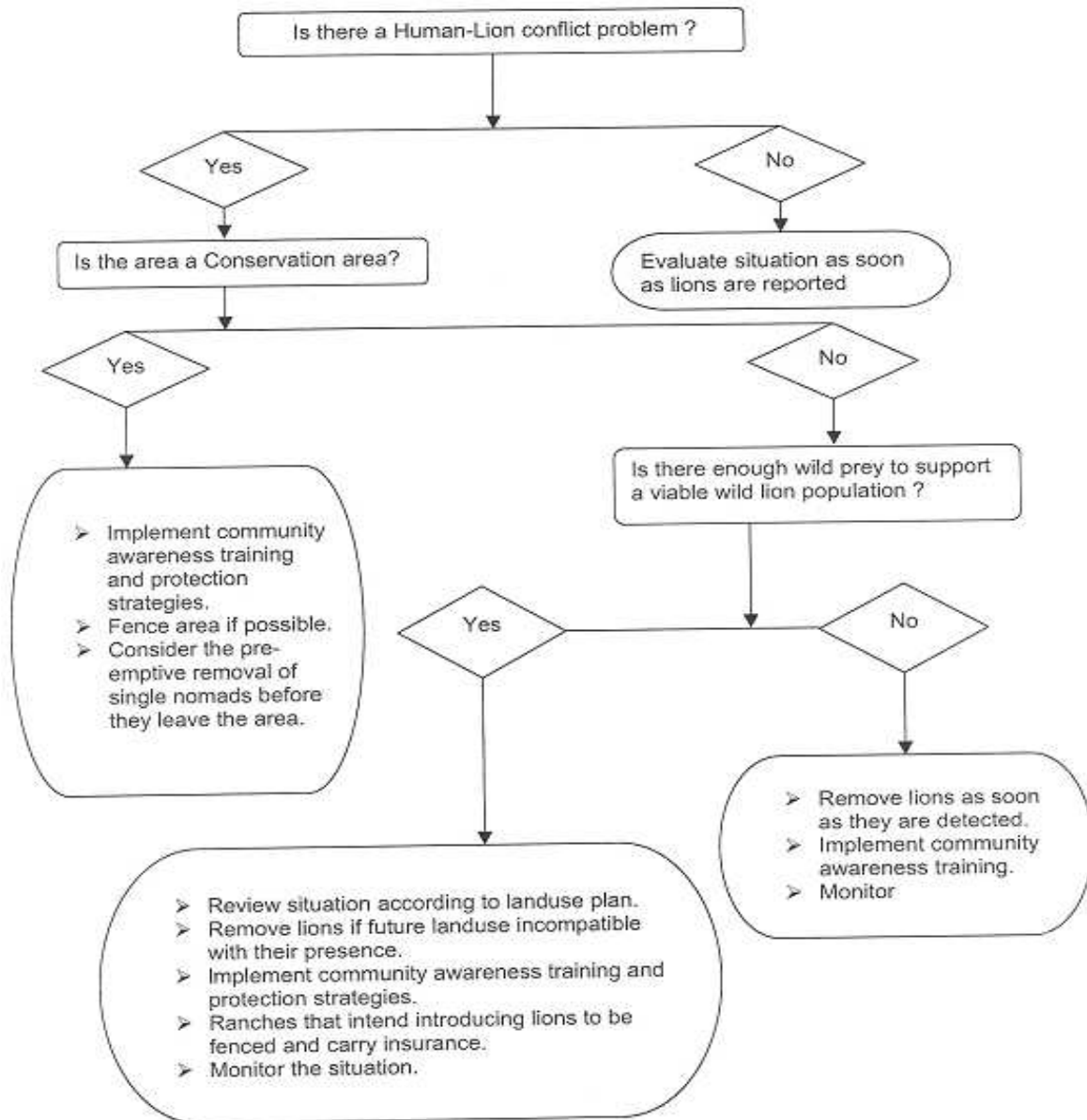


Fig 10 : The decision process to determine the management actions to resolve Human-Lion conflict (Anderson, 2005).

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