Managers' perceptions of threats to the protected areas of Kenya: prioritization for effective management

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Abstract In Kenya knowledge of the relative severity of threats to protected areas and the vulnerability of these areas to any threats is lacking. Such information is required, however, for assessment of the effectiveness of management of the country's protected areas, and to help identify critical management and policy weaknesses and priorities for improving management and allocating resources. We therefore studied the relative severity of threats to Kenya's 50 protected areas and their relative vulnerability to such threats based on the perceptions of protected area managers. Ten threats were identified by these managers, of which the most severe were illegal bushmeat hunting, poaching of large mammals, human–wildlife conflicts, human encroachment, and loss of migration corridors and dispersal areas. Thirty-two (64%) protected areas were vulnerable to over half of the threats, 54% vulnerable to over six of the threats and 32% vulnerable to over seven of the threats. Protected areas in marine, forested/montane and inland wetland ecosystems were regarded as highly vulnerable to the perceived threats. Protected areas adjacent to urban/industrial and agricultural areas were vulnerable to most of the threats. Our findings demonstrate that protected areas in Kenya are increasingly threatened, that major threats needs to be mitigated, and that prioritization of protected areas for strategic actions is required for effective management.

Keywords Bushmeat, Kenya, management effectiveness, protected areas, severity, threats, vulnerability.

Introduction

The establishment of Nairobi National Park in 1946 was a milestone in the preservation of wildlife species and their habitats in Kenya. Since then many protected areas have been designated (Sindiga, 1995; Sarkar, 1999) and these areas are important both for their biodiversity and for their support of the country's economy through tourism (Mugabe, 1998; Mugabe *et al.*, 1998; Okello *et al.*, 2001; Kameri, 2002). Conservation remains one of the key national obligations of the Kenya Government (Mugabe *et al.* 1998; Kameri, 2002) but the country's protected areas are facing many threats (Smith, 1999; Johnstone, 2000; Okello & Kiringe, 2004).

Most of these threats are associated with the increasing human population (Mwale, 2000). Since the 1970s the demand for agricultural land has shifted to savannah rangelands of low agricultural potential that are also prime wildlife ecosystems (Galaty, 1992; Fratkin, 1994; Sindiga, 1995; Mwale, 2000). Consequently, where agriculture is the predominant land use there has been substantial alteration and loss of wildlife habitats (Kameri, 2002). This has also created problems such as competition for water, human-wildlife conflicts, habitat fragmentation, blocking of wildlife migratory routes and dispersal areas, and negative perceptions of both wildlife and conservation (Nyeki, 1993; Sindiga, 1995; Norton-Griffiths, 1997; Campbell *et al.*, 2000; Ottichilo, 2000).

The Kenya Wildlife Service has limited resources to manage the country's protected areas, and would benefit from information that could facilitate the prioritization of management activities based on the severity of threats and the vulnerability of protected areas. An alternative approach would be for the Wildlife Service to strengthen strategies that address the plight of rural communities living adjacent to protected areas by integrating conservation and local community development needs (Beresford & Phillips, 2000). This latter paradigm has been popularized by IUCN, which has developed categories of protected areas that allow resource extraction by local communities (Locke & Dearden, 2005). Nevertheless, Locke & Dearden (2005) caution that this new paradigm could undermine the role of protected areas in conserving biodiversity.

There exists a variety of tools (Hockings, 2003; Parrish *et al.*, 2003; Stolton *et al.*, 2003) and case studies (Singh, 1999; Bruner *et al.*, 2001; Diqiang *et al.*, 2003; Ervin,

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2003; Tsering, 2003, Tyrlyshkin *et al.*, 2003) that have addressed the issues of protected area management effectiveness and setting of management priorities. However, most case studies have addressed these issues outside Africa, and only a few (Ervin, 2003; Goodman, 2003) have focused on African protected areas, in particular South Africa. These studies have examined a variety of areas critical for effective management of protected areas: management planning (legal security, objectives of the protected area, design of protected areas, enforcement), inputs (staffing, infrastructure, and finances), processes (research, monitoring, decision making processes), and threats and pressures operating against protected areas. This approach provides protected area managers with important tools that help to assess the effectiveness of protected areas in conserving biodiversity.

Bruner *et al.* (2001) and Parrish *et al.* (2003) noted that protected area managers are increasingly being compelled to assess their effectiveness in enhancing biodiversity conservation. Such assessments require both a strong scientific basis and a practical approach, and should facilitate comparisons between protected areas. The effectiveness of protected areas is closely related to certain basic aspects of management such as compensation for local communities who partly shoulder problems emanating from wildlife, intensified security and law enforcement, and allocating sufficient financial resources for management purposes (Bruner *et al.*, 2001; Parrish *et al.*, 2003).

Here we examine the effectiveness of protected area management in Kenya by focusing on threats and pressures. Our specific objectives were to: (1) establish the relative severity of threats previously identified by protected area managers, (2) prioritize and rank protected areas based on their relative vulnerability to these threats, and (3) explore the implications of these findings for the management of Kenya's protected areas.

Methods

We assessed the relative severity of threats to Kenya's protected areas using the perceptions of protected area officers, i.e. we used expert opinion to assess the effectiveness of protected area management, an approach that has been used in a similar way elsewhere (Ervin, 2003; Goodman, 2003; Stolton *et al.*, 2003). Four officers from each protected area were interviewed in person: the park warden, community warden, senior ranger, and a research scientist. These officers had all served continuously for >5 years. Interviews were conducted over 6 months in 2002, following a preliminary study (Okello & Kiringe, 2004).

The threat categories used (Table 1) were developed in a preliminary study (Okello & Kiringe, 2004) of the

perceptions of the same protected area officers. In the present study we requested them to score, independently of each other, the relative severity of each threat, on a scale of 1–5 (1, no threat; 2, mild threat; 3, moderate threat; 4, high threat; 5, severe threat), to the protected areas they served. We assumed that protected area managers' collective but independent scoring of threats would provide a representative score for a particular threat in a given protected area. The officers only scored the level of severity of threat factors associated with their own protected area. All 50 protected areas (Parks and Reserves) in Kenya were included so as to provide a national ranking of protected areas based on the perceived severity of threats.

We calculated three indicators of the level of threat and the vulnerability of protected areas to these threats: (i) mean score of each threat = sum of all the scores for a threat / the total number of respondents (200); (ii) relative severity of each threat = the mean score for a threat / the maximum possible score (5); (iii) relative vulnerability of a protected area = total score of the 10 threats for a given protected area) / total responses (40). A ranking system based on relative severity was used to indicate which of the threats were more serious across all protected areas, and a ranking based on relative vulnerability was used to show which protected areas were most vulnerable to the identified threats. The relationship of each of the 10 threats with relative vulnerability was examined with a non–parametric Spearman rank correlation (Zar, 1999). Comparisons of the vulnerability of protected areas in different ecosystem types and the predominant adjacent land uses was carried out using a non–parametric Kruskal–Wallis test followed by a box–and–whisker multiple comparison procedure (Zar, 1999). All statistical analysis was carried out with *STATGRAPHICS v. 4.0* (StatPoint, Inc., Herndon, USA).

Results

The protected areas of Kenya face 10 major threats (Table 1) with a range of relative severity of 0.29–0.84 (Table 2). Thirty-six (72%) of the 50 protected areas had a relative vulnerability of ≥0.5, 21 (42%) ≥0.6, and 10 (20%) ≥0.70 (Table 3). The threats with the highest relative severity (i.e. >0.5), from higher to lower, were illegal bushmeat hunting, poaching of large mammals, human–wildlife conflicts, loss of migration corridors and dispersal areas, human encroachment, overexploitation of natural resources, and agriculture expansion and other land use changes (Table 2). A majority of Kenya's protected areas were vulnerable to most of the 10 threats. Thirty-two (64% of protected areas) were vulnerable to >5 of the threats, 27 (54%) to >6 threats,

Table 1 The 10 main threats to Kenya's protected areas, as perceived by the expert opinion of protected area managers (from Okello & Kiringe, 2004), with the activities and causes associated with each threat. The phrase in bold for each threat is the short name of the threat used in Table 2 and for discussion in the text.

Threat	Threat activities	Causes of identified threats
Illegal bushmeat hunting for local or regional markets	Hunting by local people using snares, bows & arrows, & other crude weapons	Depressed local livelihoods; availability of illegal market outlets for bushmeat; desire for alternative source of protein
Human–wildlife conflicts endangering biodiversity	Spearing & poisoning of wildlife in retaliation; displacement of wildlife by snaring & fencing; blocking of routes to minimize wildlife-related damages	Crop raiding by herbivores; livestock depredation by large carnivores; transmission of wildlife diseases to livestock; human injury & death; destruction to other property (e.g. water pipes & shelters); competition for water & forage with man & livestock
Poaching of large mammals for international commerce	Killing of wildlife, especially elephant, rhinoceros, lion & leopard, for trophies & other products	Existence of international black market for wildlife trophies & products; insufficient resources for enhancing wildlife security; poor monitoring & enforcement of international laws on movement, sale & trade in wildlife trophies & products
Human encroachment around protected areas	Increasing human settlements & associated infrastructure in the vicinity of protected areas; illegal grazing of livestock in protected areas	Increased human population & diminishing land resources; increase & confinement of livestock in pastoral communities due to changes in land tenure; conservation model that excludes human settlement & use of most protected areas
Loss of migration corridors & dispersal areas, including conversion & degradation	Diminishing wildlife dispersal areas outside protected areas; loss of migration routes to dispersal areas; degradation of wildlife dispersal areas	Increased human population & diminishing land resources; increase & confinement of livestock in pastoral communities due to changes in land tenure; land use changes incompatible with wildlife conservation; desire for alternative or additional sources of income
Overexploitation of natural resources, including unsustainable use of & demands for water, plant resources & minerals by government & local communities	Illegal extraction of medicinal plants, timber, firewood, wood carving, thatching & construction materials; extraction & diversion of water resources by local communities; extraction, prospecting of minerals & quarrying by government in protected areas	Conservation model that excludes human settlement & use of most protected areas; increased human population & diminishing land resources; poor rural populace that is dependent on natural resources for basic needs; diversification & expansion of revenue base for governments & individuals; commercial interests in the timber industry
Agricultural expansion & other land use changes incompatible with requirements of biodiversity	Expansion of agricultural activities in unsuitable open wildlife rangelands; increase in market, settlement centres & associated infrastructure in wildlife ranging areas	Diversification & expansion of revenue base for government & local communities; increased human population & associated food needs; poor rural populace that is dependent on natural resources for basic needs
Pollution from sources external to a protected area that harms biodiversity directly or indirectly	Fertilizers & pesticides from agricultural activities outside protected areas; industrial & domestic effluents into wetlands, streams & rivers	Commercial interests of local & multinational companies; expanding urban human population & associated infrastructure; poor enforcement of existing laws & policies or lack of them for safe disposal of waste
Negative tourism impacts on the welfare of biodiversity & habitats	Off road driving & associated destruction of fragile habitats; harassment of megafauna by tourists; hotel discharge of sewage & garbage in protected areas; feeding of wildlife; destruction & modification of wildlife habitat for construction of tourist lodges, campsites & tented camps	Poor enforcement of park rules by protected area authorities; poor environmental & conservation ethics & disrespect for park rules by some tour companies, tour drivers & tourists; interest in commercial gains by tourism investors rather than concern for conservation objectives & goals; poor enforcement of environmental impact assessment & audit requirements for tourist facilities
Fencing entirely or in part of a protected area & the interference of this in wildlife movements	Fencing for conflict mitigation, and to protect wildlife from highway mortality & poaching	Mitigation of human–wildlife conflicts; protection & security of wildlife & protected area

16 (32%) to >7 threats, and 3 (6%) to >8 threats. Table 3 lists the 50 protected areas by relative vulnerability, ranked from the most (Masai-Mara National Reserve) to the least (Mt Longonot National Park) vulnerable.

The protected areas most vulnerable were marine ecosystems (mean relative vulnerability of 0.72 ± SE 0.01) followed by forested/montane ecosystems (0.64 ± SE 0.02), inland wetlands (0.60 ± 0.07) and savannahs (0.52 ± SE 0.02). Overall, relative vulnerability differed significantly between ecosystem types (Kruskal–Wallis, H = 15.68, P = 0.0013), and there were significant differences in relative vulnerability between marine and savannah ecosystems (P <0.005). In terms of surrounding land uses, protected areas with adjacent urban/industrial areas were the most vulnerable (with a mean relative vulnerability of 0.72 ± SE 0.02), followed by those with adjacent agriculture (0.61 ± SE 0.02) and pastoralism (0.47 ± SE 0.02). There were significant differences in the relative vulnerability of protected areas with differing adjacent land uses (H = 28.0029, P <0.001).

There was a positive and significant correlation between the relative vulnerability of protected areas and human encroachment (r = 0.90, P <0.001), agricultural expansion and other land use changes (r = 0.75, P <0.001), overexploitation of natural resources (r = 0.73, P <0.001), pollution (r = 0.59, P <0.0001), negative tourism impacts (r = 0.46, P = 0.012), fencing (r = 0.38, P = 0.0084), and human–wildlife conflicts (r = 0.28, P <0.0049). Relative vulnerability of protected areas was best predicted by human encroachment (accounting for 75.73% of vulnerability), followed by overexploitation of natural resources (9.01%) and human-wildlife conflicts (4.94%).

Table 2 The mean score and relative severity (see text for details) of 10 threat factors (Table 1), as assessed by the expert opinion of four protected area officers (see text for details) in each of Kenya's 50 protected areas, ranked from high to low relative severity.

Threat	Mean score ± SE	Relative severity
Illegal bushmeat hunting	4.20 ± 0.12	0.84
Poaching of large mammals	3.70 ± 0.20	0.74
Human–wildlife conflicts	3.40 ± 0.17	0.68
Loss of migration corridors & dispersal areas	3.34 ± 0.19	0.67
Human encroachment	3.26 ± 0.21	0.65
Overexploitation of natural resources	2.94 ± 0.24	0.59
Agricultural expansion & other land use changes	2.60 ± 0.22	0.52
Pollution	1.84 ± 0.21	0.37
Negative tourism impacts	1.66 ± 0.20	0.33
Fencing	1.44 ± 0.17	0.29
Mean ± SE	2.84 ± 0.09	0.57 ± 0.06

Discussion

Direct threats to biodiversity in Kenya, such as illegal bushmeat hunting, poaching of large mammals, and human–wildlife conflicts, were perceived by protected area officers as being greater than indirect threats. However, analysis of the relationship between relative threat severity and protected area relative vulnerability revealed that indirect threats (such as human and agriculture encroachment, tourism impacts and pollution) were the most serious. Generally, direct threats will more strongly influence perceptions of the severity of threats than indirect threats but the effects of the latter are more long-term. Whereas direct threats may harm biodiversity alone, indirect threats affect both biota and their habitats.

In a similar study Ervin (2003) identified key threats for protected areas in South Africa as invasion by alien plant species, protected area isolation, poaching, land use changes and tourism impacts. Goodman (2003) reported alien species, protected area isolation, land use changes, diseases, bush encroachment and resource utilization as key threats to protected areas in KwaZulu–Natal in South Africa. The threats and pressures identified in these two studies are mostly indirect, and thus consistent with our results.

Based on our findings we suggest two strategies to mitigate the threats facing Kenya's protected areas. The first is to manage direct threats (such as poaching and human–wildlife conflicts) across all protected areas to halt direct persecution of wildlife and to secure protected areas as safe enclaves of conservation. The second strategy (which can be pursued concurrently) is to address the long–term threats (such as protected area isolation, human encroachment, conversion and blockage of dispersal areas and migration corridors) through approaches such as direct payments, economic incentives or lease programmes negotiated with land owners (McNeely, 1993; Norton–Griffiths & Southey, 1995; Emerton, 2000; Ferraro & Kiss, 2002), community conservation initiatives (Hackel, 1999; Adams & Hulme, 2001), integrated land use planning (Lusigi, 1981; Mwangi, 1995), and integrating conservation of biodiversity in regional development (Alpert, 1996; Beresford & Phillips, 2000; Newmark & Hough, 2000). Compensation for damage by wildlife and costs to contain poverty and negative attitudes (Sindiga, 1995; Seno & Shaw, 2002) could be part of these strategies.

The consequences of the loss of natural habitats and ranging space (Burkey, 1994; Newmark, 1996; Fahrig, 1997), isolation of protected areas (Western & Ssemakula, 1981; Newmark, 1993, 1996; Western, 1997), land use changes and associated human–wildlife conflicts (KWS, 1994; Sindiga, 1995; Seno & Shaw, 2002), and competition for land and its resources (Makombe, 1993; Campbell *et al.*,

Table 3 Relative vulnerability (see text for details) of Kenya's 50 protected areas (numbers correspond to those in Fig. 1), ranked from the most to the least vulnerable, with the predominant ecosystem type, and predominant land use in adjacent areas.

No.	Protected area*	Relative vulnerability (rank)	Predominant ecosystem	Adjacent land use
1	Maasai Mara NR	0.88 (1)	Savannah	Traditional pastoralism & agriculture
2	Ndeere Island NP	0.78 (2)	Inland wetland	Urban & industrial
3	Aberdare NP	0.74 (3)	Montane/forested	Agriculture
4	Lake Nakuru NP	0.72 (4)	Inland wetland	Urban, industrial & agriculture
5	Kiunga M	0.72 (4)	Marine	Urban & industrial
6	Mombasa M	0.72 (4)	Marine	Urban & industrial
7	Watamu M	0.72 (4)	Marine	Urban & industrial
8	Ruma NP	0.72 (4)	Savannah	Agriculture
9	Kisite-Mpunguti M	0.72 (4)	Marine	Urban & industrial
10	Malindi M	0.72 (4)	Marine	Urban & industrial
11	Ngai Ndeithya NR	0.68 (11)	Savannah	Agriculture
12	Mt Kenya NP	0.68 (11)	Montane/forested	Agriculture
13	Mt Elgon NP	0.66 (13)	Montane/forested	Traditional pastoralism & agriculture
14	Mwea NP	0.66 (13)	Savannah	Agriculture
15	Saiwa Swamp NP	0.64 (15)	Inland wetland	Agriculture
16	Kamnarok NR	0.62 (16)	Savannah	Agriculture
17	Rimoi NR	0.62 (16)	Savannah	Agriculture
18	Nairobi NP	0.62 (16)	Savannah	Urban, industrial & traditional pastoralism
19	Tana River Primate NR	0.62 (16)	Forested	Traditional pastoralism & agriculture
20	Shimba Hills NP	0.62 (16)	Forested	Agriculture
21	Kakamega Forest NR	0.60 (21)	Forested	Agriculture
22	Amboseli NP	0.52 (22)	Savannah	Traditional pastoralism & agriculture
23	Tsavo-West NP	0.58 (22)	Savannah	Traditional pastoralism/ranching & agriculture
24	Nasalot NR	0.58 (22)	Savannah	Traditional pastoralism
25	Chyulu NP	0.58 (22)	Savannah	Traditional pastoralism & agriculture
26	South Turkana NR	0.58 (22)	Savannah	Traditional pastoralism
27	Tsavo-East NP	0.58 (22)	Savannah	Traditional pastoralism/ranching & agriculture
28	South Kitui NR	0.58 (22)	Savannah	Agriculture
29	Lake Bogoria NR	0.58 (22)	Inland wetland	Traditional pastoralism
30	Arabuko-Sokoke NR	0.56 (30)	Forested	Agriculture
31	Oldonyo-Sabuk NP	0.56 (30)	Savannah	Traditional pastoralism & agriculture
32	Hell's Gate NR	0.52 (32)	Savannah	Traditional pastoralism & agriculture
33	Bisanadi NR	0.50 (33)	Savannah	Traditional pastoralism & agriculture
34	North Kitui NR	0.50 (33)	Savannah	Agriculture
35	Rahole NR	0.50 (33)	Savannah	Traditional pastoralism
36	Meru NP	0.50 (33)	Savannah	Agriculture & pastoralism
37	Sibiloi NP	0.46 (38)	Savannah	Traditional pastoralism
38	Marsabit NR	0.44 (39)	Savannah	Traditional pastoralism
39	Losai NR	0.44 (39)	Savannah	Traditional pastoralism
40	Malkamari NP	0.42 (41)	Savannah	Traditional pastoralism
41	Buffalo Springs NR	0.40 (42)	Savannah	Traditional pastoralism
42	Shaba NR	0.40 (42)	Savannah	Traditional pastoralism
43	Kora NP	0.40 (42)	Savannah	Traditional pastoralism
44	Samburu NR	0.40 (42)	Savannah	Traditional pastoralism
45	Dodori NR	0.40 (42)	Savannah	Traditional pastoralism
46	Boni NR	0.40 (42)	Savannah	Traditional pastoralism
47	Arawale NR	0.40 (42)	Savannah	Traditional pastoralism
48	Central Island NP	0.38 (48)	Inland wetland	Traditional pastoralism
49	South Island NP	0.38 (48)	Inland wetland	Traditional pastoralism
50	Mt Longonot NP	0.38 (48)	Savannah	Traditional pastoralism & agriculture

*M, Marine; NP, National Park; NR, National Reserve

2000; Okello, 2005a,b) could already be causing local extinctions in East African protected areas. These challenges require intervention so as to secure protected areas (Osemeobo, 1993).

It is also critical to identify the most vulnerable protected areas, especially where resources and manpower are scarce. Our findings indicate that the Maasai Mara National Reserve, and Ndeeri Island and Lake
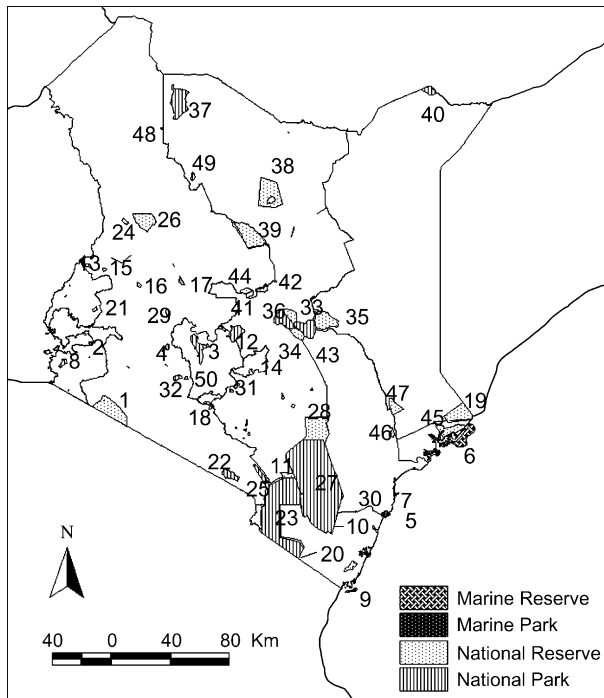
Fig. 1 The network of 50 protected areas (numbered) in Kenya. See Table 3 for names of individual areas and further details.

Nakuru National Parks are the most vulnerable. The management issues for Maasai Mara National Reserve include surrounding land use changes, wildlife poaching, bushmeat hunting and negative tourism impacts. Lake Nakuru National Park needs to manage the consequences of being fenced and the pollution from Nakuru town. Of particular concern for this Park, which is a World Heritage Site and a Ramsar wetland site, is that its lake is shrinking because of the destruction of the catchment areas of the rivers that drain into it.

Our analysis did not identify negative tourism impacts, sometimes viewed as a significant threat to biodiversity (Smith, 1999; Johnstone, 2000), as a major threat. This is possibly because only 32% of Kenya's protected areas have tourism potential and only 24% of them have achieved or exceeded this potential (Okello *et al.*, 2001). Tourism is concentrated heavily in a few protected areas that are easily accessible and have tourist facilities and a diverse large mammal fauna (Okello *et al.*, 2005). However, the potential of tourism as a management threat was apparent from its correlation with the relative vulnerability of protected areas. A majority of protected areas popular with tourists ranked high based on susceptibility to this threat. Diversifying tourism to target cultural, historical and archeological sites could help reduce pressure on protected areas (Okello *et al.*, 2005), together with targeting few but

high-paying tourists through price adjustments for vulnerable protected areas such as Amboseli.

Mitigation should also focus on protected areas that represent vulnerable habitats and ecosystems. For example, marine protected areas face a multiplicity of threat factors. The Kenyan coast is one of the hubs of the country's tourist industry but marine biodiversity is particularly fragile and sensitive to human impacts such as pollution, live specimen collection and habitat destruction (McClanahan, 1996). Nesting sites for threatened species such as marine turtles are some of the key sensitive habitats where tourism needs to be regulated. In addition, estuaries have become silted because of increased upstream deforestation of riverine vegetation along major rivers such as the Tana and Galana (Terer *et al.*, 2004).

Other particularly vulnerable protected areas are natural forests, mountains and wetlands, all of which are susceptible to conversion into agriculture and settlement. These ecosystems are critical for providing ecological services. Forests have faced numerous excisions for resettling landless people and for agriculture (Cooper, 1996; Chapman & Chapman, 1996) and are being further degraded through a variety of land uses such as livestock grazing, deforestation and charcoal burning. In particular, three protected areas in the montane forest ecosystem (Aberdares, Mt Elgon and Mt Kenya) and two protected areas in natural forests (Kakamega and Shimba Hills) were categorized as vulnerable by our findings.

Okello & Kiringe (2004) identified the factors threatening Kenya's protected areas, and the present study has examined the relative severity of these threats and the vulnerability of protected areas using expert opinion. The final stage in this process will be to undertake surveys to quantify the magnitude, severity and extent of each of the threats identified for each protected area. To determine the severity of each threat factor appropriately it will be important to identify all manifestations (e.g. number of snares, or number of animals killed per year for bushmeat) and establish which manifestation is the best indicator of the intensity of a given threat factor. However, based on our own observations and our discussions with the officers of each protected area, we believe that our ranking of threat factors will be comparable with actual field assessments.

This information on the effectiveness of protected area management in Kenya can be used by the Kenya Wildlife Service and other protected area authorities (such as county councils that manage game reserves, private wildlife conservancies and sanctuaries) to focus and prioritize management actions to address threats. In April 2007 the Kenya Wildlife Service held a conference that examined research imperatives for biodiversity

conservation and management in Kenya. During the conference the findings from this study were considered critical for the focusing of mitigation strategies to reduce the level of threats to biodiversity in Kenya's network of protected areas.

Acknowledgements

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