

PART 2
STATE OF THE
ENVIRONMENT

CHAPTER BIODIVERSITY 4



Introduction

The Convention on Biological Diversity (CBD) defines biodiversity as 'the variability among living organisms from all sources including, among others, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part [and] includes diversity within species, between species and of ecosystems.' Biodiversity therefore comprises genetic and species diversity of animals and plants as well as ecosystem diversity. Kenya is endowed with an enormous diversity of ecosystems and wildlife species which live in the terrestrial, aquatic and aerial environment. These biological resources are fundamental to national prosperity as a source of food, medicines, energy, shelter, employment and foreign exchange. For instance, agricultural productivity and development are dependent on the availability of a wide variety of plant and animal genetic resources and on the existence of functional ecological systems, especially those that influence soil fertility and water availability. Kenya's biodiversity wealth is integral to the delivery of Vision 2030 as it lies at the heart of the tourism sector, which along with agriculture, manufacturing, wholesale and retail trade, business process outsourcing (BPO) and financial services, is expected to deliver the 10 percent annual growth rate envisaged by the country's long-term development blueprint.

The African Grey Parrot can be found in forests in Eastern Africa

Kenya's rich biodiversity can be attributed to a number of factors, including a long evolutionary history, variable climatic conditions, and diverse habitat types and ecosystems. The major biodiversity concentration sites fall within the existing protected areas network (national parks, reserves and sanctuaries) which are mostly managed by the Kenya Wildlife Service (KWS). However, over 70 percent of the national biodiversity occurs outside the protected areas.

In spite of its immense biotic capital, Kenya experiences severe ecological and socio-economic problems. Drought negatively impacts the country's biodiversity as well as the national economy and people's livelihoods. There are also problems of human-induced environmental degradation, such as destruction of natural landscapes, soil erosion, water pollution and loss of species. Inappropriate policies and political impunity have contributed to nationwide habitat destruction, loss of

Lead Authors

Ali A. Ali and Monday S. Businge

Contributing Authors

S. M. Mutune, Jane Kibwage, Ivy Achieng, Godfrey Mwangi, David Ongare, Fred Baraza, Teresa Muthui, Lawrence M. Ndiga, Nick Mugi

Reviewer

Nathan Gichuki





species and the associated genetic resources. The sustainable management of the country's biological resources is also hampered by lack of a comprehensive biodiversity policy, of a biodiversity inventory and of formal procedures for benefit sharing as well as threats from invasive alien species (MNPDV 2010).

Current status of biodiversity

Overview

Kenya is considered to be one of the countries that are best endowed with biodiversity due to the abundance and variety of species that are manifest in the country's varied ecosystems. The rich biodiversity is partly attributed to the diversity of landscapes, ecosystems, habitats and the convergence of at least seven bio-geographic units (NEMA 2005).

Kenya is home to five hot spots of globally important biodiversity and 61 important bird areas (IBAs). These unique and biodiversity-rich regions include the Indian Ocean Islands of Lamu and Kisite; the coastal forests of Arabuko-Sokoke and the lower Tana River; the Afro-montane forests of Mount Kenya, Aberdare and Mount Elgon; Kakamega's Guineo-Congolian equatorial forest; and the Northern dry lands that form part of the distinct Horn of Africa biodiversity region. These ecosystems collectively contain high levels of species diversity and genetic pool variability with some species being endemic or rare, critically endangered, threatened or vulnerable (NEMA 2009a).

Kenya's known biodiversity assets include 7 000 plants, 25 000 invertebrates (21 575 of which are insects), 1 133 birds, 315 mammals, 191 reptiles, 180 freshwater fish, 692 marine and brackish fish, 88 amphibians and about 2 000 species of fungi and bacteria (NEMA 2009a). Kenya is ranked third in Africa in terms of mammalian species' richness with 14 of these species being endemic to the country (IGAD 2007). The country is famous for its diverse assemblage of large mammals like the African elephant (*Loxodonta africana*), black rhino (*Diceros bicornis*), leopard (*Panthera pardus*), buffalo (*Syncerus cafer*) and African lion (*Panthera leo*) (NEMA 2009a). Protection of these will therefore be crucial to securing livelihoods and to consequently reducing poverty levels—which currently stand at 46.6 percent of the population—by up to nine percent in order to attain social equity at the scale anticipated by the social pillar of Vision 2030.



Kenya is famous for its large mammals such as zebras.

Of the 7 000 plant species occurring in Kenya, 146 species have been assessed according to the IUCN Threat Criteria (2008) and 103 have been categorized as being threatened (critically endangered, endangered or vulnerable). Although the country's flora numbers have shot up due to the influx of invasive alien species, the invasive species pose a major threat to indigenous biodiversity. In order to effectively stem the loss of plant populations and the associated genetic diversity, the country should prioritize development of a national plant conservation strategy.

Nevertheless, much of the country's bio capital remains unknown and even with regard to the recorded species, there are information gaps on the proportion of those that are endemic, threatened, critically endangered or extinct. A contributory factor has been that most of biodiversity research is largely funded by foreign donors which retain the data at the end of the project lifecycles. The situation is exacerbated by the fact that for the last two decades, Kenya has not conducted a comprehensive biodiversity inventory to determine the number of species it hosts or the magnitude of habitat loss. The existence of such bioinformatics would facilitate informed decision making and enable the country to better carry out the niche marketing advocated by Vision 2030 that would increase domestic, regional and international tourism while easing the pressure on over-visited destinations such as Maasai Mara National Reserve, Amboseli National Park and Lake Nakuru National Park.

National forests

Kenya's forests support a large variety of floral and faunal species while the forest ecosystems provide multifarious services to a range of stakeholders. For example, forests are a major source of biomass energy, accounting for approximately 56 percent of the national energy needs. The sector also significantly contributes to foreign exchange earnings from exports of non-timber products such as honey and gum. Forests also sustain vital water catchments on which rivers, hydropower dams and underground aquifers depend for water recharge. They are also a source of herbal medicine, pharmaceutical ingredients and cultural nourishment for local communities. With a forest cover of 1.7 percent which is significantly lower than the internationally accepted threshold of 10 percent, Kenya is considered to be a low forest country. The decrease in forest cover is primarily due to encroachment, expansion of human settlements into previously forested areas, illegal logging, forest fires, agriculture and government excisions (NEMA 2009a).

However, efforts to enhance the protection of forest biodiversity through the gazettement of an additional 19 000 ha of national forest and increased tree seed production are underway. Indeed, between 2005 and 2010, the Kenya Forestry Research Institute (KEFRI) increased tree seed production by 25 percent although owing to a range of intervening factors, the effect of seed production in increasing forest cover has not yet been established (MNDV 2010). Despite these laudable developments, threats to the country's indigenous forests remain substantial. A comprehensive strategy for documenting and monitoring planted tree seedlings therefore needs to be instituted as the present approach is fragmented and uncoordinated. Chapter 5 contains a detailed discussion on forests and woodlands.

Dry lands

Dry lands cover about one third of the earth's total land surface and are the habitat and source of livelihood for about one quarter of the earth's population. They include arid, semi-arid and hyper-arid areas in which annual evapo-transpiration exceeds rainfall and in which agricultural productivity is limited by the low levels of moisture. Kenya's dry land ecosystems have immense scientific, economic and social value as they contain a variety of native animal, plant and microbial species. These species have developed unique strategies to cope with low and sporadic rainfall and the extreme temperature variability that prevails in these ecosystems. They are also highly resilient and recover quickly from disturbances such as fires, herbivore pressure and drought. These attributes and the iterative and complex interactions between desertification, climate change and biodiversity underline the significance of dry lands for the global environment's integrity (Oguge et al 2006).

About 80 percent of Kenya's land area comprises dry lands which support nearly 20 percent of the national population. The prevailing production systems are pastoralism, agro-pastoralism, irrigated agriculture and increasingly, wildlife conservation. Dry land wildlife conservation has, for instance significantly contributed to the socioeconomic development of the Samburu community at Wamba (Nikundiwe and Kabigumila 2006). Despite the significant contribution of dry lands to the country's formal and informal economies, national awareness about them remains appallingly low. As a result, the wealth of dry land biodiversity and indigenous knowledge is not well documented, and has received much less support and advocacy in conservation arenas, media and other national forums. However, this

Kenya's drylands host a variety of native animal and plant species that have adapted to the climatic extremes that prevail.





Dryland biodiversity supports the livelihoods and subsistence needs of nearly 10 million people in Kenya.

may well change if the Vision 2030 goal to enhance wildlife conservation by protecting all wildlife ecosystems, including dry lands, is followed through. Chapter 6 on land contains a comprehensive discussion on the country's arid and semi-arid lands (ASALs).

Although pockets of healthy dry land biodiversity exist, biodiversity that inhabits the country's ASALs has to confront a number of threats. Key among these is land degradation which leads to the loss of a spectrum of species and genes as well as the ecological services these provide. The most threatened dry lands are located in the north eastern, upper eastern and north portions of the Rift Valley province.

The environmental degradation facing the dry lands is largely anthropogenic in nature and can be classified into demographic failure (phenomenal population growth caused by advances in medical science), information failure, market failure (mainly with regard to the livestock economy), institutional failure, and educational failure. Other challenges to dry land biodiversity relate to ecosystem and habitat degradation caused by urbanization and other forms of human settlement, commercial ranching and monocultures, industrialization, mining operations, wide scale irrigation of agricultural land, poverty-induced overexploitation of natural resources as well as disincentives and distortions in the operating environment (Jama and Zeila 2005). The synergy, magnitude and frequency of these disturbances overwhelm the traditional resilience of dry land ecosystems and constitute potentially serious threats to dry land biodiversity with the wetlands, oases and groves which form 'micro hotspots' of dry land biodiversity being particularly vulnerable.

Table 4.1: The estimated economic value of different wetland types in Africa

Type of wetland	Area ('000 ha)	Estimated economic values ('000 US \$ per year)
Mangrove	3 686	84 994
Unvegetated sediment	4 632	159 118
Salt/brackish marsh	487	2 466
Freshwater marsh	48	334
Fresh water woodland	310	9 775
Total wetlands	5 477	256 687

Source: WWF 2004

Because dry lands are not well-incorporated in the conservation debate, it is difficult to provide a definitive picture of their biodiversity status and trends. The absence of comprehensive and regular inventorying of biodiversity resources has led to a dearth of information in this area. As the custodian, regional repository and reference centre for biodiversity research and heritage conservation in the country, the National Museums of Kenya (NMK) should be supported to take the lead in plugging these information gaps. More specifically, it is recommended that the issues relating to dry lands biodiversity be addressed from two parallel fronts; addressing potential and actual biodiversity loss through documentation, advocacy, capacity building and improvement of the operating environment; as well as highlighting and scaling up the success stories.

Wetlands

In Kenya, wetlands were the first ecosystems to receive international attention through the Ramsar Convention which was ratified in 1990 and Lakes Nakuru, Naivasha, Bogoria and Baringo, which cover a combined area of 1 045 km², have since been designated as wetlands of international importance (Ramsar sites). The process to designate Yala swamp, Tana River delta, Lakes Natron and Kiunga as Ramsar sites is currently underway. Figure 4.1 maps out the locations of the country's important wetlands.

Although wetlands are one of the most undervalued ecosystems, they provide a range of vital services. They host a range of floral and faunal species, provide food and filter water, making it safe for drinking and foster inter-communal unity. For example, in addition to the traditional uses such as farming, transportation and fishing, the Pokomo and Wardei communities use the Tana River delta to meet the communities' security and socio-cultural needs with these being an important incentive for conservation (Terer et al 2004).

The Ramsar Convention has estimated the global wetland area to be 12.8 million km² with their total economic value topping US\$70 billion per year although the Millennium Ecosystem Assessment gave wetlands a value of US\$15 trillion in 1997. Table 4.1 summarizes African wetlands by type and estimated economic values.

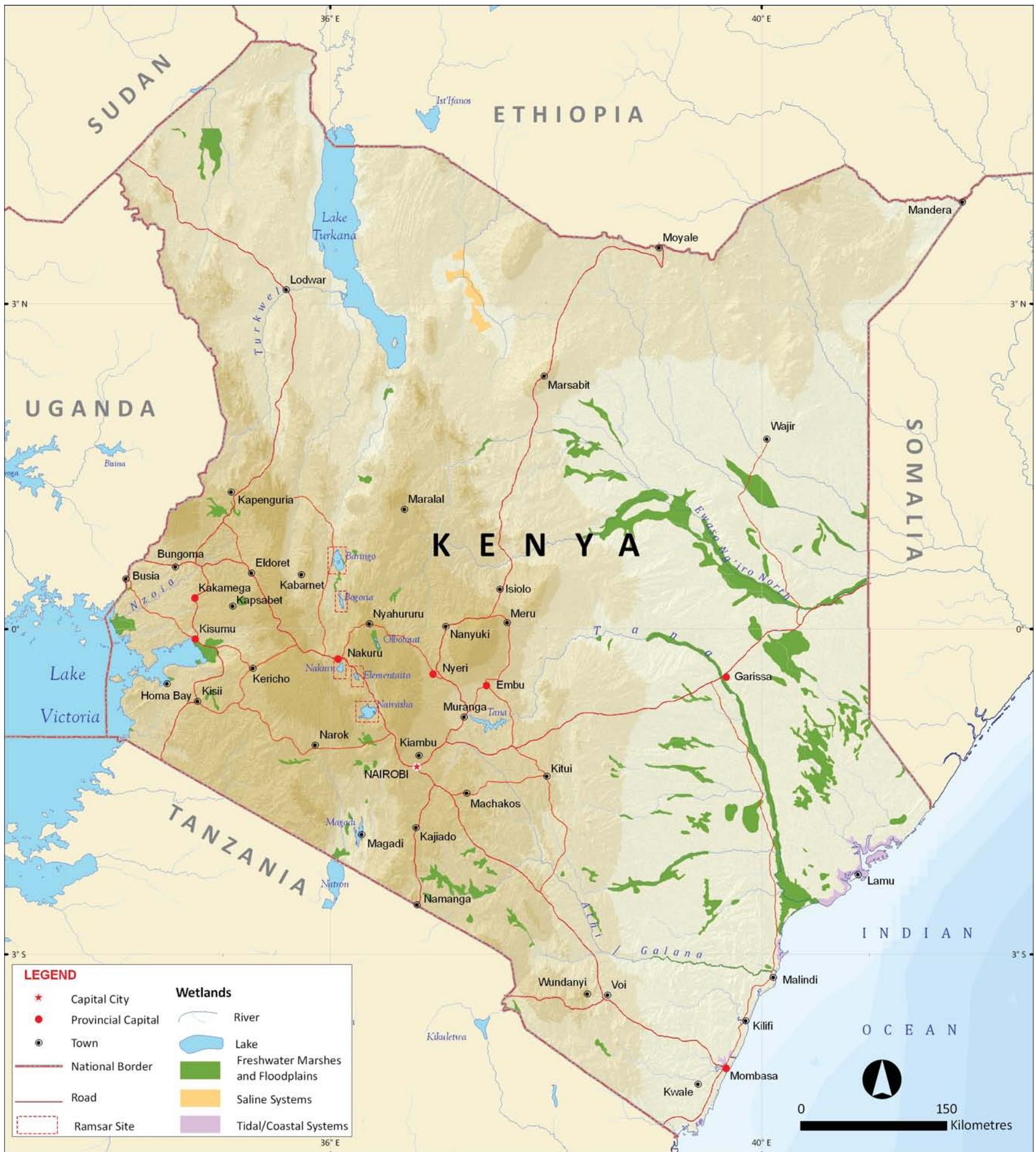


Figure 4.1: Location of Wetlands and Ramsar sites in Kenya

Source: UNEP WCMC 2006

The above estimates also include the economic value of Kenya wetlands, since the country is home to five Ramsar sites. Kenya's Shompole wetland, located south of Ewaso Ng'iro South River has an estimated economic value of US\$ 2 505 463 931 per year (Ndungu 2009) broken down as follows:

- Water cleansing—US\$ 2 492 051 429 per annum
- Flood and storm protection to Lake Natron (which is as a flamingo breeding site)—US\$ 11 819 091 per annum
- Habitat service provision to biodiversity (wildlife, fish and birds)—US\$ 1 340 978 per annum
- Nutrients storage and cycling (nitrogen only)—US\$ 577 396 per annum.

Due to the immense significance of wetlands, it follows that their sustainable use will be indispensable to improving Kenyans' welfare, which is the overarching goal of Vision 2030. It is therefore important to provide policy strategies to develop and support public education and awareness programmes so as to promote better understanding and appreciation of the values and multiple uses of wetlands.



Simon Chapman/Flickr.com

Kenya's coastline has beautiful, soft and sandy beaches that are popular holiday spots.



Johannes Akiwumi/UNEP

Sea urchins are part of Kenya's coastal and marine biodiversity.

Coastal and marine biodiversity

Kenya's coastal and marine ecosystems support some of the most spectacular coral reefs, seagrass beds, mangroves, salt marshes and salt flats and exhibit remarkable levels of species richness and endemism. Coral reefs are important feeding and breeding grounds for numerous marine species, including fish and provide recreational activities for tourists (IGAD 2007) although owing to capacity constraints, the lucrative opportunities these offer for deep sea fishing and water sports remain largely untapped. The coastal and marine resources' potential for agriculture, fishing and mining is also underutilized. Given the importance of tourism and agriculture to the Kenyan economy and that these are earmarked as key growth sectors in the long term development blueprint, the optimal use of the country's attendant coastal and marine biodiversity will determine whether tourism and

agriculture, complemented by coastal fishing and mining, contribute to attaining and maintaining the 10 percent annual economic growth rate envisaged by Vision 2030. Coastal and marine resources are discussed in greater detail in Chapter 7.

Species biodiversity

Large mammals

This section discusses the state and trends of large mammals in selected protected areas namely; the Meru Conservation Area, Amboseli National Park and Maasai Mara National Reserve.

Meru Conservation Area

The Meru Conservation Area covers an estimated area of about 4 008 km². It includes Meru and Kora National Parks, Bisinadi and Mwingi (North Kitui) National Reserves, Rahole Game Reserve and the northern grazing area. According to the 2007 wet season aerial count for large mammals in the Meru Conservation Area, there was a general increase in the number of mammals in the Meru Conservation Area compared to the 2006 count. There was also a notable increase in the population of large mammals like the giraffe, buffalo, eland, Burchell zebra, lesser Kudu, impala, Grants gazelle, gerenuk and elephant with the latter growing from 504 in 2006 to 747 in 2007.

Amboseli National Park

Amboseli National Park is a wooded savannah ecosystem that is rich in both flora and fauna. It covers an area of 392 km² and is part of the larger 5 000 km² Amboseli savannah ecosystem. The ground game count which was conducted in the February-April 2010 wet season and July-September 2010 dry season showed a marked decline in the large mammal population and trends.



Eugene Apindji Ochieng/UNEP

The Giraffe population is on the rise in the Meru Conservation Area.

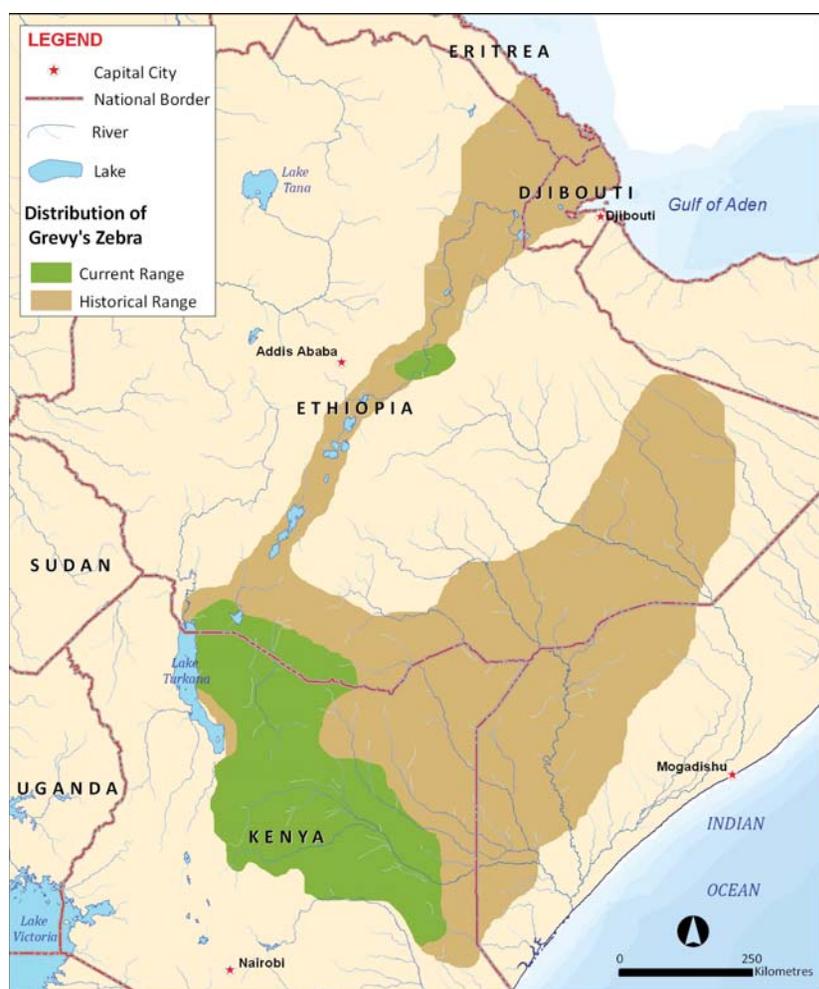


Figure 4.2: Distribution of Grevy's Zebra in the Greater Horn of Africa Source: KWS 2010

Animal	2007	2009	2010
Buffalo	730	320	179
Zebra	7 579	2 686	2 052
Wildebeest	12 974	5 435	1 141
Giraffe	56	55	81
Water buck	69	54	18

Table 4.2: Ground counts of selected large mammals in 2007, 2009 and 2010 Source: KWS 2010

The total number of individuals counted during the September 2010 exercise was 6 205 compared to 11 148 counted in September 2009 and 25 918 in September 2007. During the 2010 counts, wildebeest, buffalo and zebra numbers showed a sharp decrease from the previous counts. For instance between September 2007 and September 2010, buffalo populations decreased by 75 percent, zebras by 73 percent, wildebeest by 91 percent while waterbuck decreased by 74 percent. Table 4.2 shows the ground counts of selected large mammals while Figures 4.2 and 4.3 show the trends in the distribution and number of Grevy's zebra respectively. The plummeting wildlife population in the park is largely attributable to the severe drought that affected the entire Amboseli ecosystem. However, a few large mammals, such as the giraffe, weathered the climatic trauma to increase by 45 percent between 2007 and 2010. Nevertheless, the general declines in Amboseli National Park—which is one of only

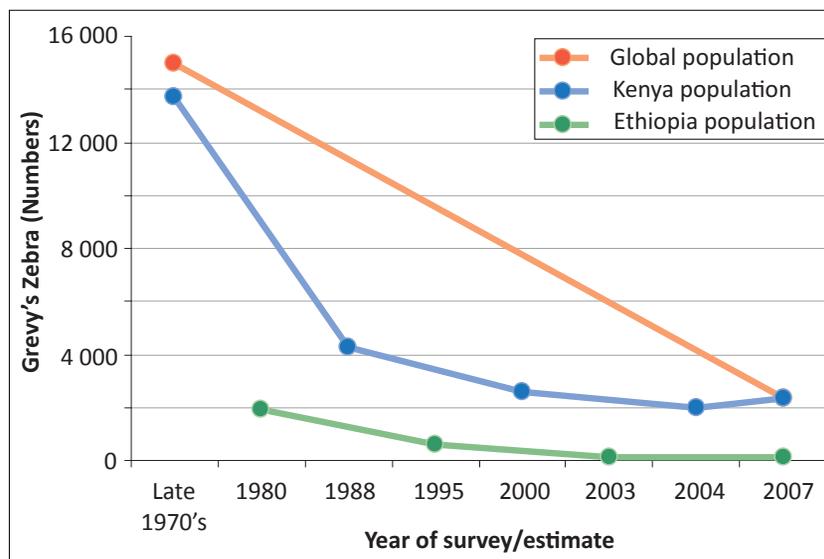


Figure 4.3: Trend in distribution and numbers of Grevy's Zebra in Kenya Source: KWS 2010

three premium wildlife parks in the country —highlights the need to, in line with the aspirations set out in Vision 2030, diversify the tourism product by tapping the underutilized potentials of the wildlife-sensitive eco-tourism and the wildlife-neutral conference and business tourism.

Maasai Mara National Reserve

The Kenyan portion of the Serengeti-Mara ecosystem which covers an area of 4 761km² encompasses the Maasai Mara National Reserve—regarded as the crown jewel of the country's wildlife parks—and the adjacent Lemek, Koyiaki and Siana Group Ranches.

According to the 2010 aerial count of large herbivores, the ecosystem is home to 3 162 elephants, 4 649 buffaloes, 1 619 giraffes

and 1 283 elands, 15 031 impala, 5 133 Grant's gazelle, 14 414 Thomson's gazelle, 36 487 zebra and 18 825 wildebeest. The elephant and buffalo population increased by 43.5 and 2.7 percent respectively over the last 3 years, possibly due to improved habitat protection by the local communities and government. The declines witnessed for other wildlife species have been primarily attributed to predation, poaching, migration, human-wildlife conflict, loss of habitat due to land fragmentation and unfavorable weather conditions.

Bird biodiversity

Kenya is home to 61 Important Bird Areas (IBAs) dispersed over 22 forests (20 of which lie in protected areas); 18 wetlands (5 of which are protected); 12 arid and semi arid areas (7 of which are protected); 6 moist grasslands (3 of which are protected); and 3 unprotected sites. 46 of these IBAs shelter globally threatened bird species, 29 host range-restricted birds, 32 contain biome-restricted bird species, and 13 IBAs hold globally important congregations of birds (Bennun and Njoroge 1999). Some of the birds found in these IBAs include the Lesser Flamingo whose principal breeding site in East Africa is Lake Natron. Other large birds that abound in Kenya are the ostrich, Kori bustard, Crowned cranes, Goliath heron, Saddle-billed stock, Spoon-billed stock, African fish eagle and the Lammergeyer (NMK 2010). Figure 4.4 shows the important bird areas in Kenya.

Birds play an important role in Kenyans' social, cultural and economic life. Many of the species aesthetically enrich landscapes, attracting international ornithologists. Bird watching, photography and art earn the country revenue some of which filters through to the

The Maasai Mara National Reserve is Kenya's preeminent wildlife park.



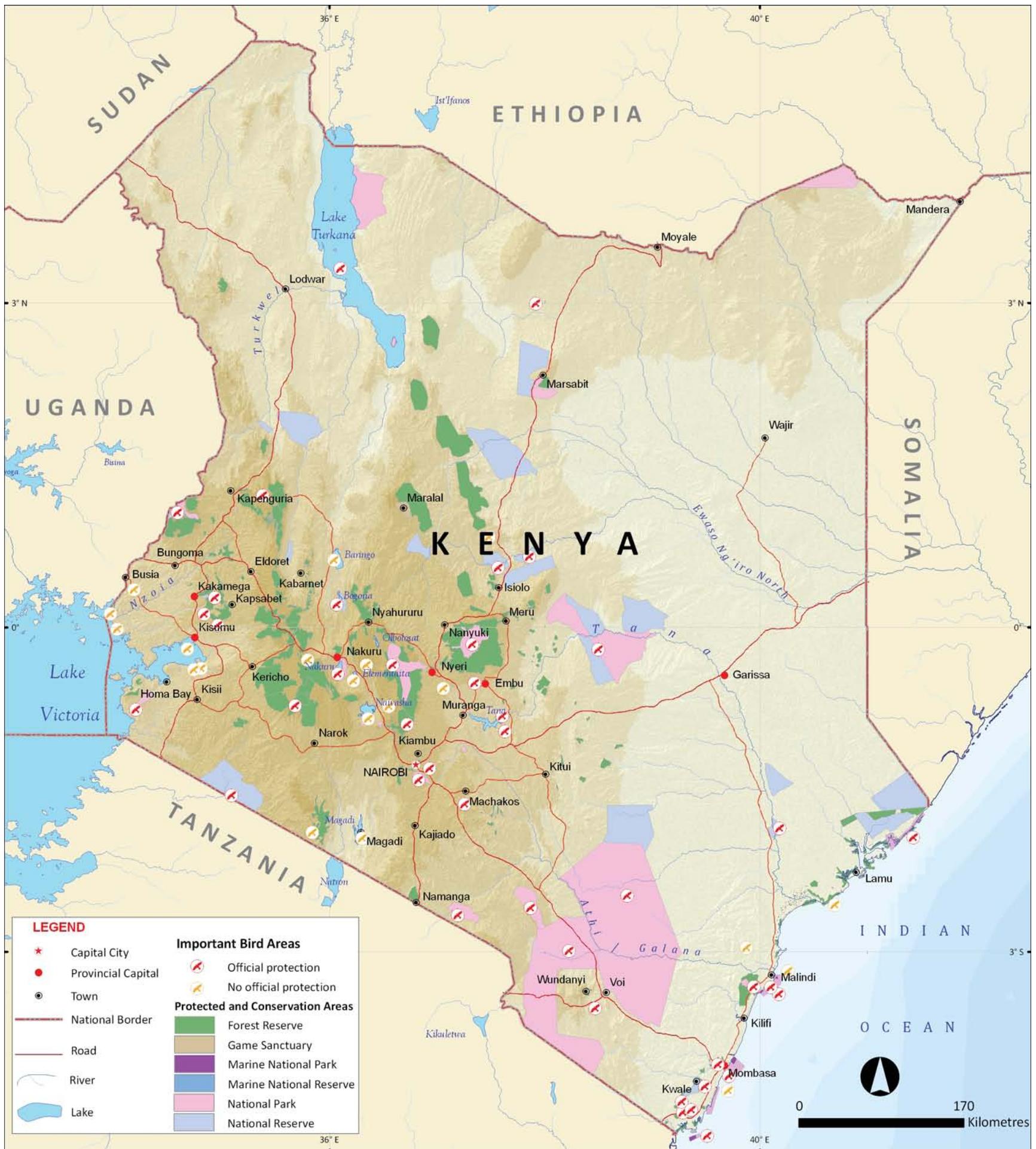


Figure 4.4: Kenya's Important Bird Areas

Source: KWS 2010

grassroots Kenyans who are employed as driver-guides and at various levels in the country's burgeoning hotels and lodges. Other birds, such as the ostrich, are an important source of livelihood with ostrich farms abounding in Kajiado, Naivasha, Elementaita and Laikipia. Individuals are also increasingly domesticating wild birds such as the quail and duck as these are sources of both food and income.

Policy and legislative implementation failures resulting from weak institutional capacity, inadequate human and financial resources, encroachment into bird habitats, pollution, and climate change-induced habitat loss however continue to impede bird conservation in Kenya. An assessment of some of Kenya's IBAs notably; Yala swamp, Kiyanaga

valleys and Busia grasslands reveals that some sites deteriorated during 2009 due to drought and overexploitation. Plans to convert the Dakatcha woodlands, Tana River delta and Yala swamp into large-scale food and bio-fuel plantations pose additional threats to these IBAs. Further, diversion of water from Lake Natron which is designated as a Global Biodiversity Hotpoint because it is the only known breeding spot of the Lesser flamingo is threatening the very existence of these avian species.

Birds are an important aspect of biodiversity in Kenya and efforts to address threats to their survival should be intensified. Community awareness should be enhanced to increase public participation in bird

Fresh Water Fish	2005		2006		2007		2008		2009	
	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000
Lake Victoria	133 526	6 948 611	143 908	7 766 074	117 231	7 451 781	111 369	9 429 765	120 231	9 834 716
Turkana	2 493	99 245	4 559	120 783	5 122	245 366	8 070	229 171	9 118	288 545
Baringo	43	2 285	68	2 079	173	4 872	262	10 065	211	9 682
Naivasha – Commercial	108	5 738	189	6 396	203	12 416	225	13 384	197	12 998
Jipe	74	3 932	109	3 998	96	5 636	109	6 740	89	5 867
Rivers and Dams	950	50 474	1 024	52 447	1 112	23 455	1 302	62 205	974	62 515
Fish Farming	1 047	55 627	1 012	58 577	4 245	226 259	4 452	917 860	4 897	971 120
Others	785	41 707	842	45 891	706	13 842	883	48 729	812	47 723
Total	139 026	7 207 619	151 711	8 070 557	128 888	7 983 627	126 672	10 717 649	136 529	11 233 166

Table 4.3: Quantity and value of fish landed by freshwater body, 2005-2009

Source: Economic Survey 2010

Marine Fish by District	2005		2006		2007		2008		2009	
	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000	Quantity Metric ton	Value to Fishermen KShs '000
Lamu	1 309	77 077	1 309	76 515	1 801	80 654	2 028	92 920	2 037	94 123
Tana River	57	3 117	55	3 171	163	11 296	89	5 593	136	6 893
Malindi	1 132	55 515	1 192	60 527	1 160	84 419	1 345	113 667	1 367	122 007
Kilifi	434	20 746	435	22 746	729	57 539	817	66 647	890	69 524
Mombasa	1 221	66 819	1 225	65 428	680	66 457	676	76 086	712	81 068
Kwale	1 709	82 597	1 750	84 011	1 822	121 681	2 606	186 031	2 669	199 176
Total	5 862	305 871	6 023	334 624	6 355	422 046	7 561	540 954	7 811	572 791

Table 4.4: Quantity and value of marine fish landed by district, 2005-2009

Source: Economic Survey 2010

conservation. National and regional partnerships revolving around international obligations should be scaled up for better management of the country's IBAs. Institutions responsible for bird biodiversity should diversify their bird counts to better enable them to identify emerging trends well before these become crises. The above measures would, of course, necessitate the scaling up of bird conservation financing, particularly in the IBAs.

Fish biodiversity

Fishery production in Kenya mainly comes from the country's freshwater bodies and the Indian Ocean which accounts for the majority of the marine fish and aquaculture. The main fisheries resources are Lake Victoria and the western Indian Ocean although these are complemented by the country's major rivers, other freshwater lakes, dams and ponds. At 96 percent in 2008, capture fisheries accounted for the bulk of the national nominal production. Although fish landed increased from 136 355 metric tonnes in 2007 to 145 532 metric tonnes in 2009, it is still considerably lower than the 158 670 of the fish landed in 2006 (GoK 2010). With 120 231 metric tonnes of fish landed in 2009, which represented 82.6 percent of the national catch and 88.1 percent of the freshwater catch, Lake Victoria accounts for the largest proportion of the fisheries sub-sector and its role in meeting the protein and income needs of adjacent communities cannot be overemphasized as this has positive effects for the attainment of the Vision 2030 economic and social pillar goals. Table 4.3 shows the fish production by freshwater body between 2005 and 2009.

Marine fisheries have the potential to significantly contribute to the national economy through employment creation, foreign

exchange earnings, poverty reduction and food security but this potential is yet to be realized particularly in the Exclusive Economic Zone (EEZ). Artisanal fishermen predominantly fish in the inshore areas within the reef ecosystem because they lack the capacity to venture offshore to exploit the fisheries resources in the EEZ. Aquatic ecosystems continue to be heavily exploited, imperilling the sustainability of food supplies and biodiversity. So even though the marine fish catch has been rising as detailed in Table 4.4, the underutilization of the EEZ highlights the huge untapped potential in the sub-sector. Any additional licensing of fishing activities in Kenya's EEZ waters must however be accompanied by strong monitoring and surveillance measures to prevent overexploitation and use of abusive fishing practises.

The sustainability of the country's fisheries resources depends on ecological processes that enable reproduction of different fish species and renewal of water, organic matter and nutrients in the freshwater and marine ecosystems. Anthropological activities have the potential to negatively impact the ecological balance in Kenya's water bodies as happened in Lake Naivasha with the introduction of

Table 4.5: Threatened species of higher plants, mammals, birds, reptiles, amphibians and fish in Kenya

Source: MOPND 2010

Species	Year	Total known	Year	Threatened species (Number)
Higher plants	1992-2002	6 506	2002	98
Mammals	1992-2002	359	2002	51
Breeding birds	1992-2002	344	2002	24
Reptiles	1992-2002	261	2002	5
Amphibians	1992-2002	63	2002	X
Fish	1992-2002	314	1992-2002	18

Box 4.1: Human activities and the ecological balance in Lake Naivasha

Lake Naivasha supports a small commercial fishery based on three fin-fish species and one crustacean species which include *Oreochromis leucostictus* (*Tilapia zillii*), *Micropterus salmoides* (black bass), *Cyprinus carpio* (common carp) and *Procambrus clarkii* (crayfish) as the only crustacean. *Barbus amphigramma* and *Lebistes reticulata* (guppy) are also present in the fish population of Lake Naivasha but are not commercially exploited. The recent accidental introduction of Common carp (*Cyprinus carpio*) and mirror carp has created a shift in lake fish production. The Common carp is believed to have come from fish farms in Nyandarua highlands during the 1998-1999 El Niño period. According to the Fisheries Annual Statistical Bulletin 2009 it accounted for over 90 percent of the total fish catch of Lake Naivasha. It is imperative for government and research institutions to understand the effect of the Common carp on the other fish species in the lake's ecosystem.



Percentage of species composition of Lake Naivasha catches in 2008

Fish catches from Lake Naivasha, 2000-2009

Source: DFO 2010

Species	Trends in fish catches by weight									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Common carp	-	-	910.0	5 858.0	45 912.5	100 312.0	178 629.5	191 745.5	200 868.5	655 453.5
Mirror carp	-	-	-	-	-	-	-	6 784.5	7 053.5	22 418.5
Black bass	13 742.0	-	25 138.0	7 315.0	4 344.5	9 184.5	8 363.5	4 719.0	1 924.0	1 882.5
Oreochromis leucostictus	363 445.0	-	1 734.0	20 091.0	3 197.5	1 880.5	222.5	127.5	14 828.5	341.5
Tilapia zilli	865.0	-	20 717.0	5 428.0	1 400.0	485.5	31.5	69.5	119.0	4.5
Total finned fish	384 735.0	-	91 178.0	38 690.0	60 384.5	111 851.5	192 097.5	202 933.0	222 793.5	680 095
Crayfish	6 885.0	-	35 316.0	No data	5 015.0	No data	555.0	2 153.0	2 149.0	No data

Common name	Scientific name	Habitat
Black rhinoceros	Diceros bicornis	Woodlands
White rhino	Ceratotherium simum simum	Wooded grassland
Hirola	Beatragus hunter	Woodlands
Tana crested mangabey	Cercocebus galeritus	Gallery forest
Roan antelope	Hippotragus equines	Wooded grasslands
Sable antelope	Hippotragus niger	Upland grasslands
Grevy's zebra	Equus grevyi	Wooded grasslands
African elephant	Loxodonta Africana	Woodlands and forests
Eastern bongo	Tragelaphus eurycerus isaaci	Montane Forests
African lion	Panthera leo	Wooded grasslands
Leopard	Panthera pardus	Woodlands
Cheetah	Acinonyx jubatus	Open grasslands
Sitatunga	Tragelaphus spekii	Freshwater swamps
Rothschild's giraffe	Giraffacamelopardalis rothschildi	Woodlands

Table 4.6: Threatened mammal species and their habitats in Kenya

Source: MOPND 2010

the Common carp. This is described in Box 4.1. and further elaborated on in Chapter 9.

In order to increase available fish stocks, efforts to eliminate use of destructive fishing gear and methods need to be scaled up. In addition, fishing communities which depend on overexploited resources

such as Lake Naivasha need to be provided with alternative livelihood options in order to reduce pressure on the fisheries resources. Further, freshwater and marine fish breeding programmes need to be intensified. It is particularly important to encourage marine fish production which amounted to only 7 811 metric tonnes in 2009 (GoK 2010) with the total area under aquaculture standing at a mere 722 ha. As the area suitable for fish farming in Kenya is over 1.14 million ha, if this is fully utilized, it has the potential to produce up to 11 million metric tonnes per annum, which would accelerate the delivery of the economic, social and political goals set forth in Vision 2030. This would, in turn create enormous employment opportunities for artisanal fishermen and spur the growth of fish feed manufacturing, processing, trading and exporting enterprises.

Threatened ecosystem and species biodiversity

Threatened species are those classified by the IUCN as endangered, vulnerable, rare, indeterminate or insufficiently known. In Kenya, KWS has documented approximately 50 endangered or threatened ecosystems of national and global importance. There are major concerns on five of them due to their critical contribution to the national economy and community livelihoods. These are the Maasai Mara National Reserve, Lake Naivasha and the Nairobi, Lake Nakuru and Tsavo National Parks. A number of water towers and associated ecosystems have also been earmarked



Frédéric SALEIN/Flickr.com

The weaver bird, one of the avian species that abounds in Kenya, derives its name from its intricately woven nests.

for conservation. These include Mount Kenya, Aberdare, Mount Elgon, Mau Forest Complex, Cherangany Forests, Shimba Hills, Chyulu Hills, Taita Hills, Mount Marsabit, Matthews Range, Mua Hills, Loita Hills and Ndundori Hills. The other important water catchments are forest reserves at Kibwezi, Ngong, Karura, Kakamega, Bonjoge as well as Ol Donyo Sabuk National Park. To address these issues, several national parks are developing environmental management plans although the implementation of these is hampered by stakeholder conflicts. Moreover, there is no effective mechanism for enforcing compliance with these plans.

The threat to ecosystems obviously impacts the species therein. The number of large mammal species and genetic biodiversity are declining in both distribution and abundance. 51 mammals, some of which are found in Kenya, have been identified as endangered or threatened (IUCN 2002). Table 4.5 provides a summary of the known threatened plant and major animals groups in Kenya while Table 4.6 lists some of the threatened mammal species and their habitats in Kenya.

According to data obtained from KWS and Nature Kenya, 27 breeding birds were identified as endangered or threatened in 2010. The Taita apalis (*Apalis fuscigularis*) and Taita thrush (*Turdus helleri*) which are endemic to the upland forests of the Taita Hills in south-east

Kenya are critically endangered. Other endangered and threatened breeding birds found in the country are the Madagascar pond-heron (*Ardeola idae*); Saker falcon (*Falco cherrug*); Egyptian vulture (*Neophron percnopterus*); Sokoke scops-owl (*Otus ireneae*); Aberdare cisticola (*Cisticola aberdare*) and the Basra reed-warbler (*Acrocephalus griseldis*).

The endangered and threatened amphibians and reptiles in Kenya include:

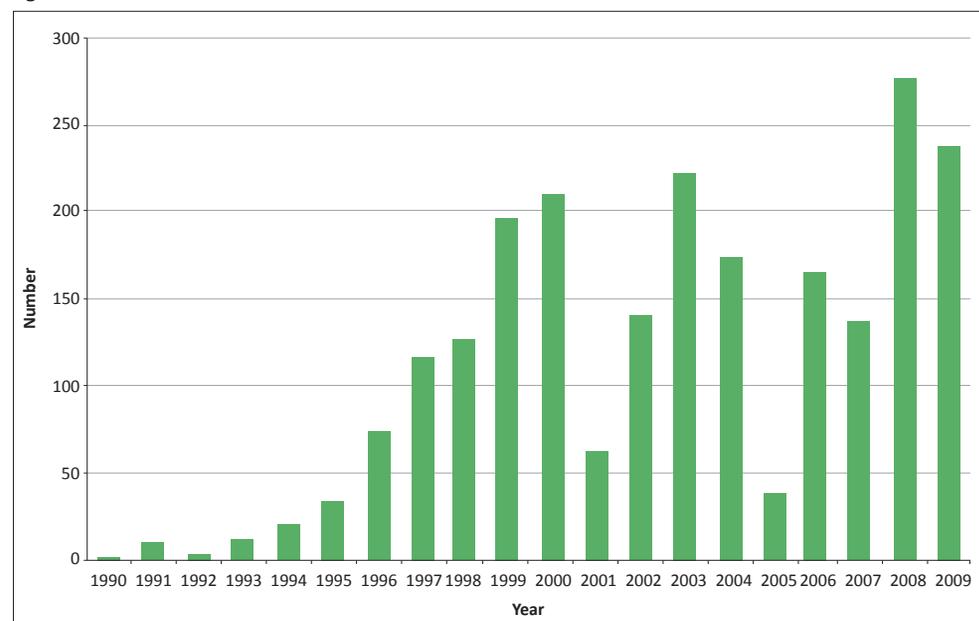
- Du toit's torrent frog (*Petropedetes dutoiti*)
- Shimba hills banana frog (*Afrixalus sylvaticus*)
- Shimba hills reed frog (*Hyperolius rubrovermiculatus*)
- Forest frog (*Afrixalus sylvaticus*)
- Hawksbill turtle (*Eretmochelys imbricata*)
- Green sea turtle (*Chelonia mydas*)
- Olive ridley (*Lepidochelys olivacea*); and the
- Rock python (*Python sebae*).

The programmes initiated for conservation of sea turtles at the Kenyan coast are predicated on the grim reality that the Green sea turtle and Hawksbill Turtle, which nest in the Lamu archipelago are two of the world's most endangered sea turtles. The most recent of these programmes is the launch of the country's national sea turtle conservation strategy in March 2011 (KWS 2011). It provides a coordinated framework for the conservation of sea turtles and their

habitats in Kenya using a raft of tools that includes advocacy, education, public awareness, communication, targeted research and monitoring as well addressing the threats to their survival. This will likely add momentum to initiatives such as the Kenya Sea Turtle Conservation and Management Trust (KESCOM) which, cognizant of the importance of community participation in stemming the wanton killing of turtles and the destruction of their nesting habitats, was formed to support sea turtle conservation in collaboration with local communities at the coast. The conservation strategy is also likely to boost the efforts of the Lamu Marine Conservation Trust (LAMCOT), a community based organization whose primary objective is to support local community actions in sustainable management of coastal ecosystems. As illustrated in Figure 4.5, LAMCOT's efforts which include physically guarding sea turtle nests, offering

Figure 4.5: Annual number of sea turtle nests recorded at Lamu from 1990-2009

Source: KESCOM 2009



incentives to local fishermen to reduce turtle by-catch, educating school children and the general public on the value of turtles as well as tagging turtles and monitoring their movements, have resulted in the steady increase of successful sea turtle nesting.

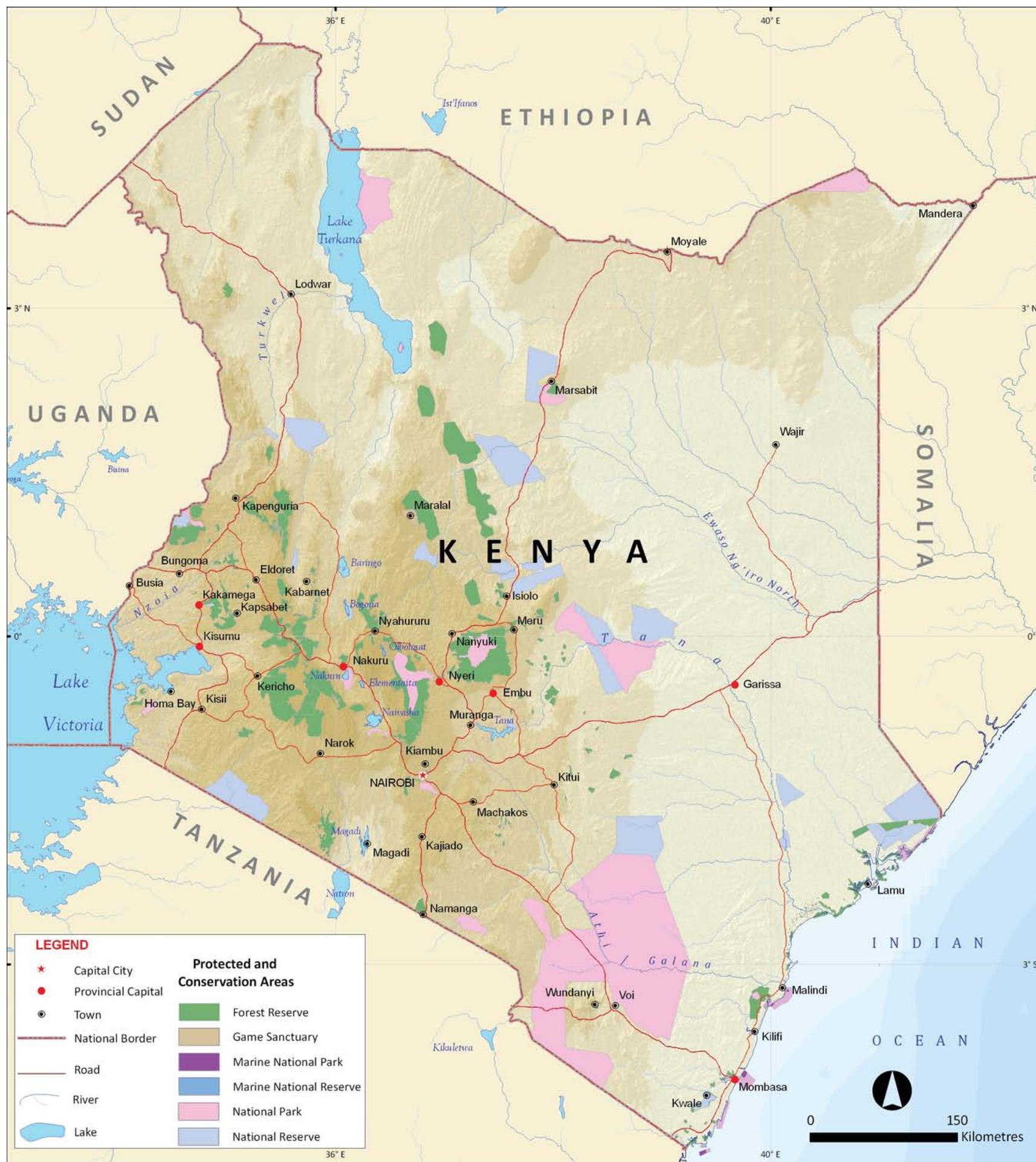
In 2010, KWS classified 26 fish species as threatened with local extinction. The species include Singidia tilapia (*Oreochromis esculentus*); Lake Chala tilapia (*Oreochromis hunteri*); Jipe tilapia (*Oreochromis jipe*); Victoria tilapia (*Oreochromis variabilis*); Rainbow sheller (*Ptyochromis sp.*); Lake Victoria deepwater catfish (*Xenoclaris eupogon*); Montane dancing-jewel (*Platygypha amboniensis*); Magadi tilapia (*Alcolapia alcalicus*); Giant wrasse (*Cheilinus undulatus*); and Victoria stonebasher (*Marcusenius victoriae*). Because of inadequate data, many species have

not been evaluated and hence threatened species could be as high as 71 (Froese and Pauly 2008) and probably include *Haplochromis ishmaeli* which was previously recorded in Lake Victoria. The main threat to these species is predation by Nile Perch, hybridization due to decreased water transparency. The latter is attributed to eutrophication and erosion which lead to increased sedimentation and runoff which in turn interfere with the fish species' mate recognition visual cues (Witte et al 2010).

The threatened plant species in Kenya include the Bauhinia mombassae, Brucea macrocarpa, Combretum tenuipetiolatum, Euphorbia tanaensis, Sorindeia, Voi cycad (*Encephalartos kisambo*); East African sandalwood (*Osyris lanceolata*); Red stinkwood (*Prunus*

Figure 4.6: Protected areas in Kenya

Source: KWS 2010



africana); Meru oak (*Vitex keniensis*); Camphor (*Ocotea keniensis*); Parasol tree (*Polyscias kikuyuensis*); Rat aloe (*Aloe ballyi*); and the Tana river poplar (*Populus ilicifolia*) (KWS 2010). *Combretum tenuipetiolatum*, a small tree found in the Rabai forest, is currently listed as 'critically endangered'. *Bauhinia mombassae*, another tree found in rocky valley along Mwache River in the Shimba Hills National Reserve, is under threat from habitat destruction and intrusion by elephants. *Brucea macrocarpa*, a shrub only found in Kenya's central swampy areas and riverines of Kamiti, Thika Falls, Rojwero Swamp and Kiambu is also fast disappearing because of human population growth and agricultural development in the area.

Euphorbia tanaensis is a critically endangered plant found in the Witu Forest Reserve where there are only 20 mature plants according to the IUCN Red List of Threatened Species (IUCN 2009). Although the forest is a reserve and is therefore legally protected, this has not accorded adequate protection to this and other endangered tree species that it hosts.

The threats to ecosystem and floral and faunal species' biodiversity need to be urgently attenuated because they are likely to undermine the attainment of Vision 2030, which recognizes tourism as a major driver of economic growth and is central to the economic empowerment of the country's impoverished population segments.

Protected areas in Kenya

Kenya has various conservation systems which include national parks, national reserves, conservancies, Ramsar sites, biosphere reserves and world heritage sites. The area covered by protected areas grew from 12.1 percent in 1990 to 12.7 percent in 2007 (UNEP 2009). The national parks and reserves are strategically located in terrestrial and aquatic ecosystems that teem with wildlife and are globally recognized as havens for biodiversity protection. The biodiversity protection accorded by these national parks and reserves is complemented by private conservancies. Table 4.7 and Figure 4.6 show the surface areas covered by the breadth of protected area categories in the country.

However the biodiversity in the country's protected areas still has to grapple with a number of threats principally due to policy and legislation implementation failures which are themselves attributable to lack of sufficient human and financial capacity and political will. These problems are compounded by fragmented bioinformatics data and weak research links (ESEA 2010).

Protected Areas	Area Covered (km ²)	Numbers
National Parks	30,348.3	24
National Reserves	16,478.4	27
Marine National Parks	70.1	4
Marine National Reserves	706.0	6
National sanctuaries	71.3	4
Ramsar sites	286.0	5

Table 4.7: Area covered by protected area systems in Kenya Source: KWS 2010

Biodiversity and livelihoods

Biodiversity performs multiple roles in the daily lives of people through the supply of ecosystem services, food security, tourism, wealth creation and aiding a range of cultural services. As such, the value of Kenya's biodiversity resources cuts across the economic and social and ultimately, the political pillars of Vision 2030.

Box 4.2: Opportunities provided by biodiversity

- Employment
- Livelihoods and income
- Food
- Herbal and Western medicine
- Raw materials, industry
- Recreation, tourism and filming industry
- Research, education and knowledge
- Religious rites and transmission of cultural values
- Sustainability of gene pools and food chains

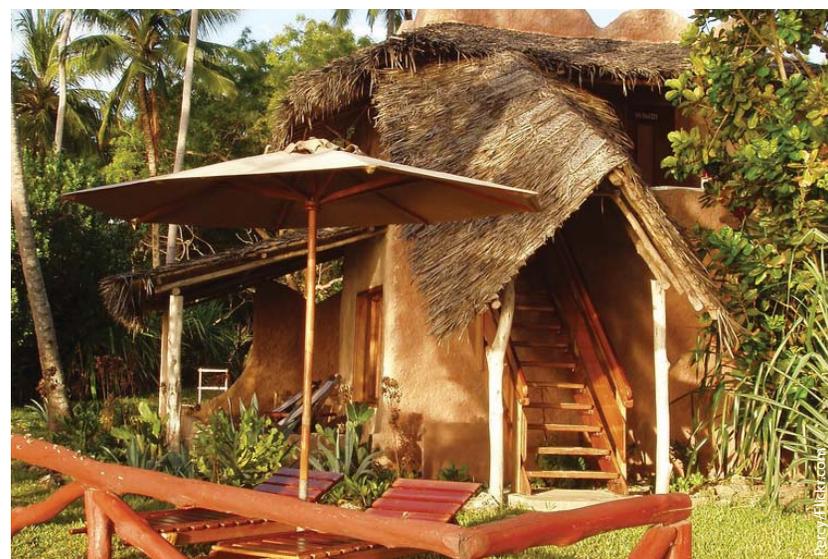
Ecosystem goods and services

Biodiversity supports agriculture by regulating and supporting services through soil formation, the nutrient cycle and pollination. People are dependent on biodiversity either directly or indirectly, for environmental goods and services. Direct benefits include food, medicine, honey, forage, vegetables, hides, skins and other raw materials which play a vital role in the lives of poor people in rural and remote places (UNEP 2007). Bees, for instance, provide honey and beeswax and pollinate crops and wild plants. According to the National Beekeeping Station, honey production increased from 24 940 to 27 000 metric tonnes between 2001 and 2007. However in 2008, it slumped to 14 000 tonnes mainly because of drought. With a kilogram of crude honey currently fetching KSh 200 (MLFD 2010), beekeeping has the potential to lift many Kenyans living in the dry lands out of poverty, which would go a long way in meeting the Vision 2030 overarching goal to improve the welfare of all Kenyans.

Indirect benefits that flow from biodiversity's environmental services include employment, income, nitrogen fixation, natural pollination, maintenance of water cycles, regulation of climate, photosynthetic fixation, protection of soil, storage and cycling of essential nutrients as well as absorption and breakdown of pollutants (Kimenju et al 2010). Because the latter eight are indispensable to sustaining human, wildlife and crop life, biodiversity's integrity is central to increasing agricultural productivity and further growing the tourism sector in order to deliver the projected 10 percent annual economic growth rate. The benefits of these are expected to percolate through to the social and political pillars of Vision 2030, reducing inequalities and fostering national and social cohesion.

Kenya's forests play a vital role in rural livelihoods by providing food and energy for domestic consumption, and watershed regulation.

Many of the hotels along the Kenyan coast are constructed using local materials in order to promote the local culture and blend in with the environment.





Christian Lambrechts/UNEP

Hippos plunge into a pool to cool off.

It is estimated that 80 percent of the country's population uses biomass energy while hydro electric power production heavily relies on the availability of water (NEMA 2009b) that emanates from the country's forests, particularly the five water towers.

The tourist industry which largely depends on the country's biodiversity wealth is a major contributor to Kenya's GDP and is the leading foreign exchange earner. Differentiation of the safari product, encouraging the development of resort cities and of high value niche products such as cultural, eco-sports and water-based tourism are some of the trajectories under which the sector can grow in order to help deliver the 10 percent annual growth rate anticipated by Vision 2030.

The fisheries sector plays an important role in the national economy and contributed 0.6 percent to Kenya's GDP in 2010, up from the 0.4 percent contribution registered in the 2006 to 2009 period (GoK 2010). There is potential for this percentage to grow if aquaculture and coastal fisheries are fully developed and utilized, if value addition at the various stages of the supply chain is scaled up and post harvest losses are minimized. This is an important sub-sector because it supports about 80 000 fishermen directly and nearly 800 000 individuals (processors, traders and other service providers) indirectly (MFD 2008).

Threats to biodiversity

Human-wildlife conflict

As is the case in many parts of Africa, Kenya's protected areas were largely established by the colonial government for purposes of game hunting, photography or securing valuable mineral and timber resources. Many of the local communities were alienated because these protected areas were established without consulting them. In addition, traditional livelihood activities such as honey and wood fuel collection in the protected areas were proscribed, reducing local communities' access to natural resources and exacerbating poverty.

The situation has since been compounded by inadequate public participation in wildlife park management and biodiversity conservation.

In addition, while the costs associated with protected areas are largely borne by neighbouring communities, the benefits are universally shared, which highlights the inherent inequity in cost and benefit sharing. Further, no due attention is paid to the interlinkages between biodiversity and the local people yet these bear the brunt of natural resources' and ecosystems' deterioration. There is therefore need to maintain interactive biodiversity governance dialogue and to adequately address the aspect of biodiversity benefit sharing.

Population increase and development

Kenya's rapidly rising population is causing changes in land use patterns which in turn drive biodiversity loss. It is associated with food shortages, energy insecurity and the consequent unsustainable harvesting of natural resources. For example, to supply the increasing demand for food, wetlands are being converted into agricultural land at an alarming rate. The rising demand for construction materials from wetlands is also triggering unsustainable harvesting levels and compromising the ability of wetlands to provide vital ecosystem services.

To supply the country's growing water and hydropower needs, rivers such as Tana and Kerio have been dammed although the building of impoundments on river valleys affects the diversity of ecosystems and results in reduced water flows. Less water is therefore available for domestic, agricultural and industrial use and leads to loss of pasture for livestock and wildlife. This is especially important given that over a million farmers, fishermen, fishmongers and nomadic pastoralists depend on the flooding regime of the country's rivers for their livelihoods. An estimated 2.5 million livestock heads and millions of biodiversity lives rely on the Tana's floodplain grasslands and water bodies for dry season pasture and water (IUCN 2003). A rising population is therefore likely to increase pressure on these natural resources, with adverse consequences for the country's biodiversity.

Box 4.3: Pollution-related biodiversity loss in Lake Nakuru National Park

Lake Nakuru and the area surrounding it comprise Lake Nakuru National Park. It is the second most important National Park in Kenya in terms of earnings from tourism. The national park is a UNESCO designated World Heritage site, Kenya's first Ramsar site, and also Africa's first bird sanctuary (Odada et al. 2005).

Noise, garbage and other hazardous wastes generated in tourist hotels are a source of environmental pollution, especially when they are dumped into poorly managed landfills or creeks. For instance, the raw sewage that is pumped into the lake has substantially damaged water quality, led to the mass death of the Lesser Flamingo and instigated the species' migration to Lake Bogoria. The bird deaths have been attributed to poisoning by heavy metals, pesticides, and algal toxins, bacterial infection, and malnutrition (Ndeti and Muhandiki 2005). Because the Lesser flamingo is a major tourist attraction especially for ornithologists, it is a significant contributor to the local and national economies. There is therefore urgent need for the Ministry of Environment and Natural Resources and KWS to redirect the flow of sewage (Ikiara and Okech 2002) and address the other problems cited above.



Buffaloes, flamingoes and pelicans in Lake Nakuru National Park.

Christian Lambrechts/UNEP

Pollution

Uncontrolled domestic and industrial discharges, pollution and contamination are major threats to the country's biodiversity. In recent years, the Great Rift Valley lakes and coastal areas have experienced heavy pollution loads emanating from increased agricultural, industrial and municipal waste discharge. Wetlands are also used as waste dumps for commercial, municipal and institutional wastes, threatening their ecological integrity. Increased nutrient loads have led to eutrophication and frequent algal blooms in the wetlands near major settlement, industrial and agricultural areas.

Poor agricultural practises along the Sabaki/Tana/Athi River basin complex, such as cultivation close to the river banks has increased soil erosion, the levels of suspended sediment in the rivers and agricultural

chemical run-off. These and other contaminants penetrate into organisms' biological systems and then get magnified and modified (through biomagnifications and bioaccumulation processes) causing irreversible damage to species. This is reported to be happening to the aquatic biodiversity of Lake Naivasha which is continually contaminated by sewage and the discharge from the flower farms. Box 4.3 highlights the effects of pollution in the Lake Nakuru National Park.

Land-based pollution alters ecosystems' productive systems and results in biodiversity loss and adversely affects human health. For example, increased human activity in the dry lands, combined with high velocity winds has increased the prevalence of particulate matter in the air, negatively affecting the human and biodiversity health (Jama and Zeila 2005).

Water pollution leads to water eutrophication and algal blooms which in turn reduce fish catches.



Habitat loss

Habitat loss and the subsequent alteration of ecosystems' composition are among the greatest threats to biodiversity. Assemblages of species and their interactions with the environment are critical for maintaining species diversity and for their evolution and survival. The continued wanton destruction of habitats is an indicator of institutional failure and lacklustre commitment to protecting biodiversity. This is aggravated by lack of a comprehensive national biodiversity inventory and surveillance mechanisms and the absence of synergies among national biodiversity institutions that are integral to synthesizing critical biodiversity issues through joint initiatives.

Biopiracy

Biopiracy is a re-emerging issue which dates back to the colonial period. It has been exacerbated by lack of appropriate legal and regulatory mechanisms such as strict patent laws that would control the exploitation of these renewable resources (Mwandambo 2010, Othieno 2010). As a result of these vacuums, valuable genetic materials are continually exported to developed countries. Examples of these are highlighted in Box 4.4. Kenya needs to increase efforts to control unregulated biological resources exploration and exploitation by first, becoming a signatory to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. Second, Kenya needs to institute a raft of measures to stem biopiracy and ensure that monetary benefits trickle down to the local communities.

Invasive alien species

Invasive alien species are important agents of biodiversity loss and represent a global threat to freshwater habitats and biodiversity because they suffocate, replace and often result in the extinction of indigenous species. Increasing global trade and changing land use patterns are likely to aggravate this problem in the coming years (UNEP 2003).

Water hyacinth on Lake Victoria.

Box 4.4: Examples of loss of genetic materials in Kenya

1. **The Mawingo tree found in Sagalla forest in Taita** is among the strongest hardwood trees and is often used to make railway line slippers as a substitute for steel. It is reported to have been used for making furniture for the British royal family.
2. **Sandalwood from Taita forest** reportedly has immense medicinal value that fetches a premium price. It is frequently exploited and consignments of it are shipped through Tanzania with the connivance of the local administration authorities.
3. **Extremophile microbes, which are endemic to Lake Bogoria** were collected and taken to the US by Procter and Gamble. These microbes produce enzymes which are highly prized by the pharmaceutical industry and are estimated to generate about US\$ 38 billion annually. The lake microbe is also used to convert jean material into popular stonewash shades and this property alone reportedly earns an American textile firm about US\$ 3 billion annually. However, neither the Kenyan government nor the local community at Lake Bogoria has shared any of the ensuing monetary benefits.

Source: Mwandambo 2010, Othieno 2010

There are nearly 34 invasive alien animal and plant species in Kenya (Kedera and Kuria 2005). These include Coypu rat (*Myocastor coypus*), Speckled mousebird (*Colius striatus*), Ring-necked pheasant (*Phasianus colchicus*) and Mute swan (*Cygnus olor*). The most pervasive invasive alien plant species in Kenya include Mathenge (*Velvet mesquite*) (*Prosopis juliflora*), Tick berry (*Lantana camara*), Mauritius thorn (*Caesalpinia decapeltata*) and the water hyacinth (*Eichhornia crassipes*). There is a detailed discussion on the water hyacinth in chapter 9.



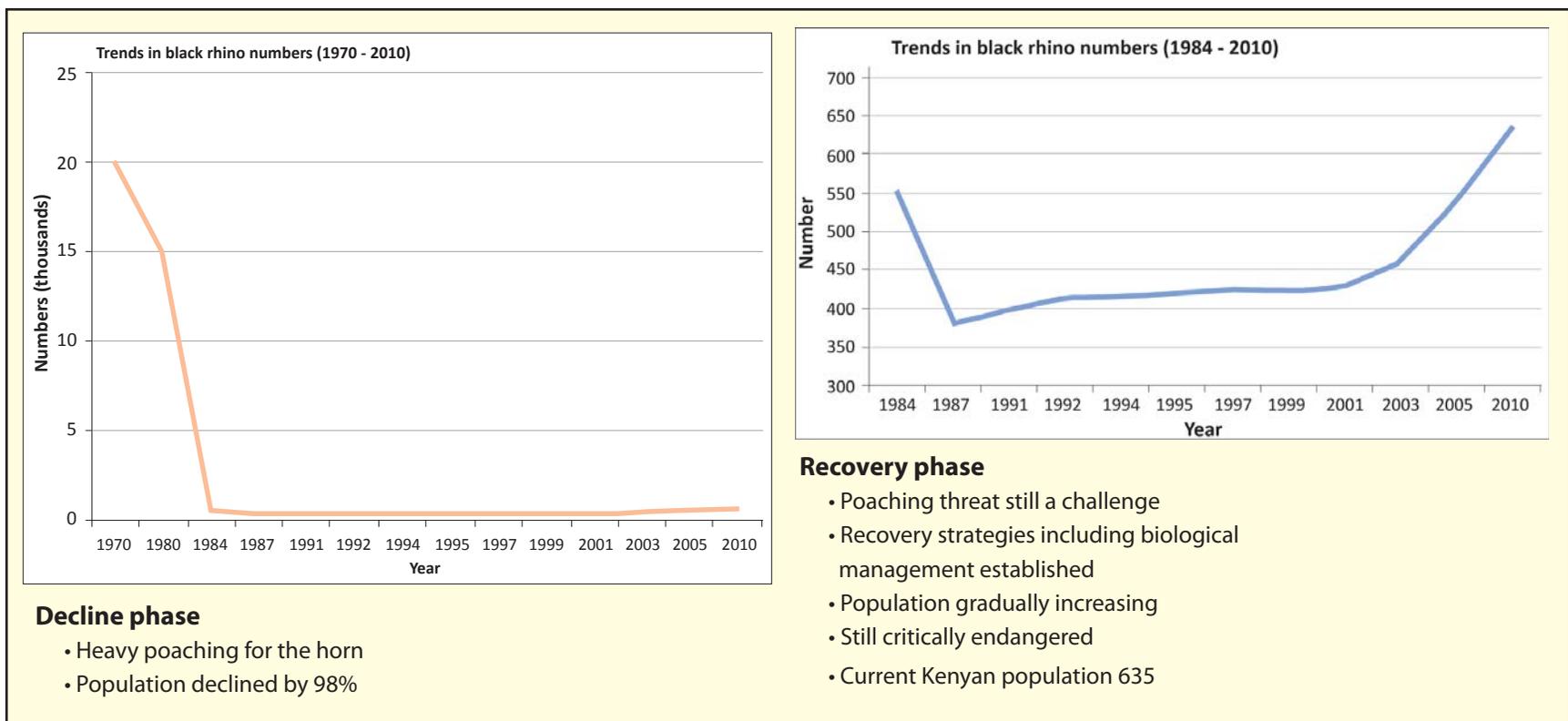


Figure 4.7: Trends in black rhino numbers, 1973-2010

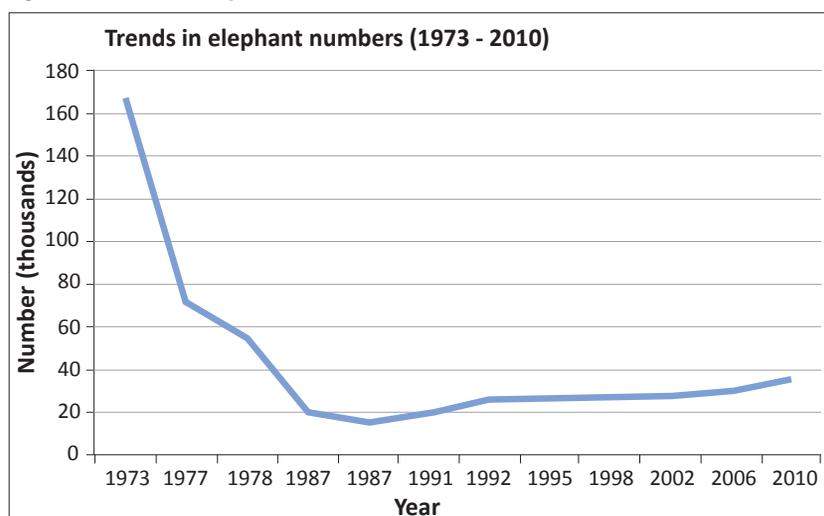
Source: KWS 2010

The introduction and dispersal of alien species in the wetlands and freshwater ecosystems have threatened the ecosystem services provided by the wetlands. For instance, the introduction of the Nile perch (*Lates niloticus*) into Lake Victoria demonstrates the devastating effects a single invasive species can exact. Lake Victoria originally had a high diversity of fish species which included more than 300 cichlid species, 99 percent of which were endemic to it. While the introduction of Nile perch in the 1950s increased fish production nearly ten-fold, the lake's biodiversity was considerably diminished because the Nile perch preys on the smaller native species and 60 percent of the lake's endemic cichlids are feared extinct (EAC 2008).

Effective methods for identifying and monitoring invasive species early in the introduction lifecycle need to be instituted. As such, the regulatory and enforcements challenges need to be addressed and regional and international cooperation stepped up with regard to transboundary challenges such as the water hyacinth. Because invasive species could cause food insecurity and slow economic growth (Howard and Matindi 2003), their potential to derail attainment of the country's Vision 2030 targets should not be underestimated. In addition, there is need to explore and exploit the range of livelihood opportunities that invasive alien species such as *Prosopis juliflora* and the water hyacinth (*Eichhornia crassipes*) present.

Figure 4.8: Trends in elephant numbers, 1973-2010

Source: KWS 2010



The African lion is an endangered species in Kenya.

Poaching and overexploitation

Poaching, overfishing and uncontrolled harvesting of different plant and animal species are contributing to the decline of biodiversity. Some of the endangered animals species in Kenya are the African elephant, African lion, Black Rhino, Grevy's Zebra, Buffalo, Mangabey, Cheetah, Leopard, Hirola, Green sea turtle, Hawksbill turtle, Tana River Red Colobus, Sokoke scops Owl, Roan antelope and Gigasiphon (UNEP 2009). While biological diversity within the protected areas remains high, incidences of illegal extraction are common. Although the country's rhinos and elephants are kept under close surveillance, poaching remains a major threat to their survival. Thus, while Kenya was home to 20 000 black and white rhinos in the early 1970s, the number now stands at about 900. Elephant numbers also recorded an 85 percent decline over a 15-year period although these are now slowly recovering. Trends in the numbers of the black rhino and elephant are shown in Figures 4.7 and 4.8 respectively.

Poaching is driven by several factors including poverty, availability of lucrative markets and lack of institutional capacity to implement anti-poaching laws. Even though Kenya is a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which bans the trade in wildlife trophies such as elephant tusks

and rhino horns, poaching continues in the country. KWS efforts to stem poaching by fitting rhinos with tracking devices and transmitters in order to monitor them, increased patrolling of protected areas as well as arresting and prosecuting poachers need to be scaled up, particularly in the national reserves which are managed by county councils.

Global climate change

Climate change is a challenge contributing to species population and biodiversity loss, especially with respect to the species with long gestation periods which don't have sufficient time to adapt to the changing weather conditions. Changes and variations in climate pose serious threats to biodiversity in Kenya both in aquatic and terrestrial ecosystems. For example, Amboseli and Tsavo National Parks were particularly hit by a long dry spell as they recorded the highest number of animal carcasses. Climate change also makes wildlife prone to new diseases. Yet, many of the mitigation mechanisms adopted, such as feeding wildlife with a high tourism value with hay, are unsustainable in the long run because of the associated costs and logistical challenges. As such, some of Kenya's plant and animal biodiversity species are on the verge of extinction although the degree of this threat has not been adequately documented. Climate change is discussed in greater detail in Chapter 3. Unless urgent measures are taken to address climate change and variability, any strides made towards alleviating poverty and improving human welfare under Vision 2030's flagship projects are likely to be quickly eroded.

Biosafety concerns

Biosafety is a concept that refers to measures to mitigate or protect human health and the environment from possible adverse effects of modern biotechnology. Modern biotechnology has made great innovations in agriculture—such as the development of drought tolerant and pest and disease resistant strains of Irish potato, cassava, sweet potato, macadamia, strawberry, pyrethrum, sugarcane, vanilla and flowers in Kenya (Olembo et al 2010)—possible. However, because of the uncertainty surrounding genetically modified organisms' (GMOs) long term impacts on human health, the environment and biodiversity, there is need to apply the precautionary principle. While the country's National Biotechnology and Biosafety Policy and the Biosafety Act (2009) are in place, their implementation has been weak and the Act does not yet have legal force. As such, the biosafety mandate continues to be fragmented among a number of institutions and there is growing public opposition to GMOs. Failure to address the biosafety concerns is likely to devastate the horticultural sector because 95 percent of the country's horticultural produce is destined for the EU which has stringent biosafety measures (KBC 2007).

Strategies to improve the state of Kenya's biodiversity

There are a number of strategies that Kenya is employing to address the challenges that the country's biological resources are facing. These include the use of international instruments, regional and national conservation instruments, Vision 2030, regional cooperation blocks, decentralized management of biodiversity, science and technology and initiatives to support community livelihoods.

International instruments

Kenya ratified the Convention on Biological Diversity (CBD) in 1994 and has put in place governance structures with strong policy and legal instruments. More than eight regulations and guidelines on environmental conservation and management including biodiversity have been gazetted and operationalized. The country has also instituted measures to link the CBD, the Ramsar convention on wetlands, the Bonn convention on migratory species, the World Heritage Convention, the United Nations Convention to Combat Desertification (UNCCD), CITES and the United Nations Framework Convention on Climate Change (UNFCCC).

In order to contribute to the global biodiversity conservation targets of 2020 and 2050 and to ensure constant supply of ecosystem goods and services from healthy habitats that benefit people (NEMA 2010), the government revised the old National Biodiversity Strategy and Action Plan of 2000 in 2010 in line with the Nagoya outcomes of the Conference of the Parties to the CBD. The revision seeks to ensure that the country's genetic resources are properly valued and sustainably used, to enhance information sharing and to build institutional capacities. The National Climate Change Response Strategy has also been finalized. KWS is, appropriately, the national focal point for the Ramsar Convention on Wetlands and Bonn Convention on Migratory Species of Animals as it is mandated with conserving Kenya's terrestrial and aquatic natural resources in the gazetted protected areas. In addition, KWS is the lead agency for the management of the country's wetlands and by 2010, five wetlands had been listed as wetlands of international importance (Ramsar Sites). The National Museums of Kenya (NMK) is the focal point for the Global Taxonomy Initiative (GTI), African Network for the International Pollinator Initiative (IPI), Global strategy on plant conservation (GSPC), and Ramsar Convention communication, education, and public awareness in Kenya and it represents the Africa region on the CBD Plants Committee.

In 2006, Kenya joined 22 other nations in signing the Agreement for the Establishment of the Global Crop Diversity Trust. The Global Crop Diversity Trust was established through a partnership between the United Nations Food and Agriculture Organization (FAO) and the Consultative Group on International Agricultural Research (CGIAR). The primary goal of the Global Crop Diversity Trust is the conservation of the agricultural diversity housed in a myriad of gene-banks across Africa and around the world. The mission of the Trust is to ensure the long-term conservation and availability of crop diversity for food security worldwide.

Regional developments

There is considerable on-going work to develop synergies among the existing multilateral environmental agreements, to harmonize reporting frameworks and to develop new legal agreements. Legal instruments and initiatives at the regional level include the African Convention on the Conservation of Nature and Natural Resources, the New Partnership for Africa's Development (NEPAD) Environmental Initiative, African Ministerial Conference on the Environment (AMCEN), and the Protocol on Protected Areas and Wild Fauna and Flora in Eastern Africa. Another important regional development was Kenya becoming a signatory, along with Uganda, Tanzania, Ethiopia and Rwanda, to the Nile River

Basin Cooperative Framework. Besides providing for more equitable use of the waters of the world's longest river, the parties committed themselves to collectively working towards conserving the Nile and implicitly, the vast biodiversity wealth of the Nile basin.

National developments

The government set up the Centre for Biodiversity at the NMK whose primary role is to coordinate country biodiversity studies. In addition, a number of legal instruments (policies, rules, regulations, and acts) have been put in place to enhance conservation and regulate utilization of biodiversity resources. 2010's landmark development however, was the promulgation of the new Constitution which entrenches a range of environmental imperatives and provides an avenue for remedying the land tenure, land use and gender inequity issues that have negatively affected the country's biodiversity. The Constitution also devolves management of a range of natural resources to the nascent county governments. Policy instruments finalized in the course of 2010 include the Revised Kenya National Biodiversity Strategy and Action Plan (2010) and the Integrated Coastal Zone Management Policy (2010). These are expected to complement the growing body of biodiversity-related legal and policy instruments which include the Environment Management and Coordination Act (1999), National Water Policy (1999),

Water Act (2002), Draft Forest Policy (2004), Draft ASALs Policy (2004), Forest Act (2005), Fisheries Policy (2008), Heritage Sites (2006), National Land Policy (2009), Energy Act (2006), Biodiversity regulation (2006), Draft Wildlife Policy (2007), and the draft Minerals and Mining Policy. While many of these instruments were not directly informed by the Vision 2030 objectives, it is clear that any initiative which directly or indirectly helps to conserve the country's biodiversity tacitly helps to meet the specific Vision 2030 poverty alleviation objectives as well as the overarching goal of improving the general welfare of the citizenry. It is also self-evident that a national biodiversity policy and law would be a useful complement to the above operative instruments.

A National Wetlands Standing Committee was established in 2010 to create public awareness, formulate and coordinate the creation of a national wetlands inventory, coordinate Environmental Impact Assessments (EIAs) and give technical advice on wetland issues. The committee is also tasked with drawing up a framework for a national policy on wetlands. It is envisaged that this policy will include policy strategies for securing and managing as well as assessing, inventorying and monitoring wetlands. It is also envisioned that the wetlands policy will also contain strategies for improving the knowledge base related to the protection of wetland functions, guidelines for identifying the

The glaciers on Mount Kenya are under threat due to climate change.





Miguel Ariel Contreras Drake-McLaughlin/Flickr.com

Elephant in the Mwaluganje Elephant Sanctuary.

Box 4.6: The Lumo Community Wildlife Sanctuary

The Lumo community wildlife sanctuary lies at the heart of the Tsavo ecosystem, surrounded by Tsavo East and Tsavo West National Parks and the Taita Game Sanctuary. It is composed of three group ranches namely; Lualenyi, Mramba and Oza all of which decided to pool their natural resources in the interest of sustaining their unique wilderness area that, in addition to its rich biodiversity, offers stunning views of Mount Kilimanjaro and some surrounding hills. The Sanctuary is an ancient elephant migratory route and also serves as an important wildlife corridor for the Tsavo East and Tsavo West National Parks wildlife.

most threatened wetlands and provide for a national platform to enhance communication among various stakeholders.

KWS supports the livelihoods of communities that interact with wildlife and bear the brunt of human-wildlife conflict through three programmes namely; Community Enterprise Development (CED); Corporate Social Responsibility programme (CSR) and protection of people's life and their property from wildlife destruction through a Problem Animal Management Unit (PAMU). The goal of the CED programme is to develop the capacity of communities and private landowners to establish and manage economically viable nature-based enterprises within targeted landscapes. Communities which interact with and host wildlife on their lands are key stakeholders in wildlife protection and are sensitized to wildlife-compatible land use practises. Examples of these are the Mwaluganje Elephant Sanctuary along the Mombasa South Coast and Lumo Community Wildlife Sanctuary, which is described in Box 4.6.

KWS' CSR programme encourages responsible corporate citizenship by encouraging the corporate world to improve the quality of life of impoverished wildlife stakeholders and to fund wildlife conservation. Public education, provision of health facilities and clean water to local communities, strengthening community-based wildlife

conservation and promotion of eco-tourism are the cornerstones of this strategy. PAMU is a rapid response team that responds to distress calls about wildlife human predation and crop raids. Monitoring problem elephants has, for example, been eased by tagging them with special communications devices which transmit signals on their precise locations, making it easy to trace them and drive them back into the protected areas.

Conclusion and recommendations

Kenya is endowed with an enormous diversity of ecosystems and wildlife species. These natural resources are a source of livelihood to Kenyans, are central to the economy and are indispensable to achieving the aspirations outlined in Vision 2030's economic, social and political pillars. Important steps in recognizing the role of biodiversity have been made although a number of challenges remain. It is envisaged that the following interventions will enable sustainable use of the country's biodiversity resources:

- **A national biodiversity policy** should be formulated and a **biodiversity law** enacted in order to provide a robust regulatory framework that balances biodiversity conservation with the need to harness the country's enormous biodiversity wealth for the economic, social and political goals of Vision 2030.
- Mechanisms for sharing and exchanging biodiversity data among Kenyan institutions should be designed in order to ensure **strategic management and planning of all important biodiversity areas.**
- Ensure **centralized coordination of biodiversity conservation and management activities.** This could be achieved through establishing a National Biodiversity Steering Committee with specific mandates and terms of reference.
- **Strengthen national and regional partnerships in implementation of relevant conventions relating to technology transfer to better utilize the country's biological resources.** Issues that have hindered technology transfer since

the ratification of conventions that support technology transfer by Kenya should be identified and appropriate interventions instituted.

- There is need for **capacity building of the NEMA biodiversity focal point and establishment of a national biodiversity panel of experts** to synthesize outputs from lead agencies and the convention secretariat.

References

Alvarez, L. (2009). Plants that are endangered in Kenya. E-How. http://www.ehow.com/about_5456468_plants-endangered-kenya.html

Bennun, L. and Njoroge, P. (1999) Important Bird Areas in Kenya. Nature Kenya, Nairobi.

Dankelman, I. (2002). Introduction: Gender, environment and sustainable development: Understanding the linkages In Gender, Society and Development Editorial Team. Natural Resource Management and Gender: A global source book. Critical Review and annotated bibliography series. KIT (Royal Tropical Institute), Amsterdam.

DFO (2010). District Fisheries Officer Report on Lake Naivasha 2010. District Fisheries Officer (DFO), Naivasha.

EAC (2008). Studies on Rapid Assessment of the Ecological and the Dynamics Status of Water Hyacinth Eichhornia Crassipes (Mart.)Solms-laubach in the Nyanza Gulf of Lake Victoria, Kenya. East African Community (EAC), Arusha.

Earth Watch 2010. Biodiversity: Invasive Species. United Nations System-wide Earth Watch (Earth Watch). <http://www.un.org/earthwatch/biodiversity/invasivespecies.html>

EFTEC (2005). The Economic, Social and Ecological Value of Ecosystem Services: A Literature Review. Final report for the Department for Environment, Food and Rural Affairs, UK. Economics For The Environment Consultancy (EFTEC), London.

ESEA (2010). Summary of Kenya Biodiversity Conference. Ecological Society for Eastern Africa (ESEA), Nairobi. http://www.ecsea.org/index.php?option=com_content&task=view&id=190&Itemid=3

Fontana, M. and C. Paciello (2009). Gender Dimensions of Rural and Agricultural Employment: Differentiated Pathways Out of Poverty – A Global Perspective. Institute of Development Studies at Sussex (England). Paper submitted to the FAO-IFAD-ILO Workshop on 'Gaps, Trends and Current Research in Gender Dimensions of Agricultural and Rural Employment: Differentiated Pathways out of Poverty'. Rome, 31 March - 2 April 2009.

Froese, R. and Pauly, D. (eds). (2008). FishBase. World Wide Web electronic publication. <http://www.fishbase.org> Version (07/2008).

GoK (1999). Environment Management and Coordination Act 1999. Government of Kenya (GoK), Nairobi.

GoK (2007). Kenya Vision 2030: A Globally Competitive and Prosperous Kenya. Government of Kenya (GoK), Nairobi.

GoK (2010). Statistical Abstract 2010. Government of Kenya (GoK), Nairobi.

Howard, G. W. and Matindi, S.W. (2003). Invasive alien Species in Africa's Wetlands. Some threats and solutions. The World Conservation Union (IUCN) Eastern Africa Regional Programme, Global Invasive Species Programme and Ramsar Convention. Nairobi.

IGAD (2007). IGAD Environment Outlook. Intergovernmental Authority on Development (IGAD). Djibouti.

Ikiara, M. and C. Okech (2002). Impact of Tourism on Environment in Kenya: Status and Policy. Discussion Paper No. 19. Kenya Institute for Public Policy Research and Analysis (KIPPRA). <http://www.kippira.org/docs/DP19.pdf>

IUCN (2002). The 2002 IUCN Red List of Threatened Species. The World Conservation Union (IUCN), Switzerland.

IUCN (2003). Case studies in wetland valuation No.6: May 2003 Tana River, Kenya: integrating downstream values into hydropower planning. The World Conservation Union (IUCN), Nairobi. <http://cmsdata.iucn.org/downloads/casestudy06tana.pdf>

IUCN (2009). The 2009 IUCN Red List of Threatened Species. The World Conservation Union (IUCN), Switzerland.

Jama B and Zeila A. (2005). Agroforestry in the dry lands of eastern Africa: A call to action. Working Paper No. 1. The World Agroforestry Centre (ICRAF), Nairobi.

KBC (2007). Salient Key Concerns Regarding the Biosafety Bill, 2007. Kenya Biodiversity Coalition (KBC), Village Volunteers (VV), Seattle, WA. <http://www.villagevolunteers.org/PDFs/Travel%20Documents/Projects%20Library/Agriculture/Key%20Concerns%20of%20the%20Biosafety%20Bill.pdf>

Kedera, Chagama and Kuria, Benson (2005). Invasive alien species in Kenya: status and management in IPPC Secretariat (2005). In Identification of risks and management of invasive alien species using the IPPC framework. Proceedings of the workshop on invasive alien species and the International Plant Protection Convention, Braunschweig, Germany, 22-26 September 2003. Rome, Italy, FAO. pp. 199-204.

Kenya Gazette (2001). Gazette Notice No. 7565 of 2001. In The Kenya Gazette Vol. CIII, No. 69 of 9th November, 2001. The Fisheries (Prohibitions) Regulations, 2003. (Legal Notice No. 214/2003).

KESCOM (2009). Annual Report 2009. The Kenya Sea Turtle Conservation Committee (KESCOM), Nairobi.

Kimenju, J.W., Kahangi, E.M., Rutto, L. and Mutua, G.K. 2010. Biotic constraints to banana production and the remedial measures adopted by farmers in Maragua district, Kenya. Journal of Applied Biosciences (In press).

KWS (2011). US Ambassador Launches National Sea Turtle Strategy. <http://kws.org/info/news/2011/3marchturtle2011.html>

KWS and TWRI (2010). Aerial Total Count Amboseli – West Kilimanjaro and Magadi-Natron Cross Border Landscape. Wet Season, March 2010. Kenya Wildlife Service (KWS) and Tanzania Wildlife Research Institute. (TWRI), Nairobi.

Librata, N.M (undated). Economic valuation of wetland ecosystems: A case of Ondiri Swamp in Kiambu. A case study of Ondiri Swamp in Kiambu. University of Nairobi, Nairobi.

LVFO (2005). The State of the Fisheries Resources of The Lake Victoria and Their Management. Proceedings of the Entebbe Regional Stakeholders Conference. 24-25 February 2005, Entebbe Uganda. ISBN 9970-713-10-2

MFD (2003). Fisheries Annual Reports 2003-2008. Ministry of Fisheries Development (MFD), Nairobi.

MFD (2008). Fisheries Annual Statistical Bulletin 2008. Ministry of Fisheries Development (MFD), Nairobi.

Mikkelsen, C. (2005). Indigenous Peoples, Gender and Natural Resource Management. Danish Institute for International Development Studies (DIIS) Working Paper 5.

MLFD (2010). Annual Report 2010. National Beekeeping Station, Ministry of Livestock and Fisheries Development (MLFD), Nairobi.

- **Strategies should be developed to shield biodiversity resources from biopiracy, negative impacts of global climate change and the impacts of liberalized of global tourism.** It is also important for Kenya to become a signatory to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity and to domesticate its provisions.

MOPND (2010). Millennium Development Goals Progress Report for Kenya, 2010. Ministry of Planning and National Development (MOPND), Nairobi.

MPNDV (2005). Kenya Integrated Household Budget Survey KIHBS 2005/06. Kenya National Bureau of Statistics, Ministry of Planning and National Development.

Mugambi, K. (2010). Kenya: Earnings From Tourism Run Wild. Also available on: <http://allafrica.com/stories/201010140959.html> Daily Nation Web, dated 14th October 2010. Nation Media Group, Nairobi.

Mwandambo, P. (2010). Strict laws needed to guard Kenya's biodiversity wealth. Daily Nation. Talking Point Page. 14, Sunday Nation, October 31, 2010. Nation Media Group, Nairobi.

Nairobi Chronicle (2009). Why Mau Forest Is So Important. July 30, 2009. The Nairobi Chronicle, Nairobi. Also available on: <http://nairobiChronicle.wordpress.com/2009/07/30/why-mau-forest-is-so-important/>

Ndetei, R. and Muhandiki, V. S. (2005). Mortalities of Lesser Flamingos in Kenyan Rift Valley Saline Lakes and Implications for Sustainable Management of the Lakes. Lakes & Reservoirs: Research and Management, 10(1), 51-58.

Ndungu, M.N (2009). Economic valuation of ecosystem services in the Shampole wetland, South Ewaso Ngiro River, Kenya. Africa Conservation Centre, Nairobi, Kenya.

NEMA (2005). State of the Environment Report for Kenya 2004. National Environment Management Authority (NEMA), Nairobi.

NEMA (2009a). National Environment Research Agenda for 2008-2030. National Environment Management Authority (NEMA) and Government of Kenya. Nairobi.

NEMA (2009b). Kenya National Environment Action Plan 2009 – 2013. National Environment Management Authority (NEMA), Nairobi.

NEMA (2010). Summary of the Decisions of the Conference for the Key Areas of Focus Outcomes of the Conference of the Parties to the Convention on Biological Diversity. 18-29 October 2010 in Nagoya, Japan. National Environment Management Authority (NEMA), Nairobi.

Nikundiwe, A.M and Kabigumila, J.D.L (eds) (2006). Dry land Ecosystems: Challenges and Opportunities for Sustainable Natural Resources Management. Proceedings of the RPSUD Regional Workshop held at Hotel Impala, Arusha, Tanzania, 7-9 June 2006.

NMK (2010). Brochure of the Directorate of Research and Collections. National Museums of Kenya (NMK), Nairobi.

Obonyo, E., J. Mogoi, V. Oeba, and P. Ongungo. (2008). Exclusion, poverty and inequality in decentralized Kenyan forests: Bridging the gap. Kenya Forestry Research Institute (KFRI), Nairobi. http://iasc2008.glos.ac.uk/conference%20papers/papers/O/Obonyo_220601.pdf

Odada, E.O., Raini, J. and Ndetei, R. (2005). Lake Nakuru: Experience and Lessons Learned Brief. In: Lake Basin Management Initiative: Experience and Lessons Learned Briefs (on CD). International Lake Environment Committee foundation, Kusatsu, Japan, pp. 299-319.

Oginga Onjala, J. (2002). Managing Water Scarcity in Kenya: Industrial Response to Tariffs and Regulatory Enforcement. Ph.D Dissertation. Department of Environment, Technology and Social Studies. Roskilde University, Denmark

Oguge, N., Mireri C. and Onjala J. (2006). Assessment of Status and Trends of Natural Resource use in Ewaso NyiroBasin, Kenya. Report for DLWEIP. The World Conservation Union (IUCN), Switzerland.

Othieno, J. (2010). Africa should stop being a cry baby and tackle biopiracy wave head-on. The Daily Nation Opinion page 12. Friday November 5, 2010. Nation Media Group, Nairobi.

SciDev Net (2010). Nagoya biopiracy agreement 'is unexpected success'. Science Development Network (SciDev Net), England. Also available: <http://www.scidev.net/en/news/nagoya-biopiracy-agreement-is-unexpected-success-.html>

Space, J.C., B.M. Waterhouse, J. E. Miles, J. Tiobech and K.Rengulbai, (2003). Report to the Republic of Palau on Invasive Plant species of environmental concern. USDA Forest Service, Honolulu.

Terer, T., Nderitu, G., and Gichuki, N (2004). Socio-economic values and traditional strategies of managing wetland resources in Lower Tana River, Kenya. Journal of Hydrologia 527: 3-14, Kluwer Academic Publishers, Netherlands.

The Fish Site (2009). New Feed Protocol To Boost Fish Farming. The Fish Site News Desk, dated Wednesday, December 23, 2009. The Fish Site, Chicago, USA. Also available on: <http://www.thefishsite.com/fishnews/11458/new-feed-protocol-to-boost-fish-farming>

UNEP (2003). Invasive Species. United Nations Environment Programme (UNEP), Nairobi. Also available on: <http://www.un.org/earthwatch/biodiversity/invasivespecies.html>

UNEP (2007). Global Environment Outlook – 4: Environment for Development. United Nations Environment Programme (UNEP), Nairobi.

UNEP (2009). Kenya Atlas of our changing environment 2009. United Nations Environment Programme (UNEP), Nairobi.

UNEP-WCMC (2006). Wetlands. United Nations Environment Programme-World Conservation Monitoring Centre. <http://geodata.grid.unep.ch>

Warutere, P., and Auma, B., (2007). Invasive species can cause serious ecological, environmental and health impact. <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/KENYAEXTN/0,,contentMDK:21565194~pagePK:1497618~piPK:217854~theSitePK:356509,00.html>

Witte, F., de Zeeuw, M.P. and Brooks, E. (2010). Haplochromis ishmaeli. In: IUCN Red List of Threatened Species. Version 2010.4. Also available on: www.iucnredlist.org

World Bank (2007). Strategic Environmental Assessment of the Kenya Forests Act 2005. The World Bank, Washington, DC.

WWF (undated). The value of wetlands. World Wide Fund for Nature (WWF), Gland, Switzerland. (http://www.panda.org/about_our_earth/about_freshwater/intro/value/).

WWF and Living Water (2004). The Economic values of the World Wetlands. Project report for Agency for the Environment, Forests and Landscape. World Wide Fund for Nature (WWF), Gland/Amsterdam, Netherlands. http://www.panda.org/about_our_earth/about_freshwater/intro/value.