KENYA VISION 2030

# WILDLIFE MIGRATORY CORRIDORS AND DISPERSAL AREAS

## Kenya Rangelands and Coastal Terrestrial Ecosystems

# WILDLIFE MIGRATORY CORRIDORS AND DISPERSAL AREAS:

Kenya Rangelands and Coastal Terrestrial Ecosystems

## Kenya Vision 2030 Flagship Project

"Securing Wildlife Migratory Routes and Corridors"

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# Message from the First Lady

Our precious wildlife supports livelihoods of our people and the economy of the Country. In addition, our wild lands and natural resources are a cornerstone for attainment of Sustainable Development Goals (SDG). However, we face a major challenge in securing connectivity and dispersal areas to allow wildlife to move freely across landscapes, while at the same time protecting other key land use activities such as agriculture, settlements and infrastructure development.

This Report is a milestone achievement as it provides a great opportunity to guide spatial planning at both the national and county government levels, towards securing wildlife corridors and dispersal areas for the benefits of the people and wildlife in Kenya.

It is my appeal that all government sectors - national and county, private sector, development partners, and local communities shall endeavor to play their respective roles in the implementation of this important report. In this way, we shall be in a position to sustain our wildlife heritage for prosperity.

**FIRST LADY, MARGARET KENYATTA**

# Foreword

The environment and its biophysical components contribute immensely to human well-being by providing essential ecosystem goods and services including provisioning (food, water and medicines), regulatory (climate, diseases, pests, and soil quality), cultural (tourism and ethical values), and supportive (nutrient and water cycles, primary production). Over the years, human beings have exploited natural resources and degraded the environment to the extent that ecosystem processes are now adversely affected, resulting in massive loss of wildlife habitats and decline in their population. There is growing evidence of escalating wildlife loss in Kenya, with a drastic decline of wildlife populations between 1977 and 2013 – on average by 67%. These declines have been attributed to rapid growth in human population and associated pressures on resources (land use change, infrastructure development, and poaching), institutional and market failures, impacts of climate change and variability, and lack of development in the rangelands. Several interventions have been suggested for averting and reducing wildlife declines, notably through securing dispersal areas and migratory corridors, strengthening and investing in local communities and landowners to create and develop community and private wildlife conservancies, and diversification of rural livelihoods through benefiting from ecosystem services, among others.

The Kenyan development blueprint - the 2010 Constitution and Vision 2030 – recognizes the importance of sustainable use of natural resources, reducing loss of biodiversity, and maintaining ecosystem processes. The Vision 2030 flagship project on conservation aims at promoting and safeguarding the state of the environment for economic growth. To ensure that all wildlife is fully protected, it identified the two components of wildlife dispersal areas and migratory corridors and sustainable tourism under its economic and social pillars. The wildlife dispersal areas and migratory corridors are mainly found in human- and livestock- dominated landscapes, but form important habitat connectivity that links the animals to their resources i.e. food and water, breeding sites, and avoidance of predation, among other factors. Most of these habitat connections have been disrupted by or lost to human activities, and their restoration will greatly increase ecosystem resilience and space for wildlife, while enhancing conservation and reducing human-wildlife conflicts.

Biodiversity, and especially wildlife, contributes immensely to Kenya's economy. The tourism industry, which earned the country KShs 97.9 billion in 2010, provides economic benefits at all levels, including support to sustainable livelihoods for rural communities. For example, local communities benefit directly from numerous payments for wildlife conservation through partnerships with tour operators in community-based conservancies across the country.

This report provides a comprehensive synthesis of the wildlife dispersal areas and migratory corridors in Kenya's rangeland and coastal terrestrial ecosystems. It explicitly identifies and maps wildlife habitat connectivity and associated conservation issues and concerns. It also suggests salient recommendations on strategies for securing the dispersal areas and migratory corridors within the specific context of different regions and landscapes. The proposed Conservation Connectivity Framework (CCF) suggests a number of mechanisms (legal, economic, and others) to engage local communities, private land owners, counties, and national government in a collaborative conservation process for the key wildlife areas. Working together, we can secure space for wildlife and healthy ecosystems for biodiversity conservation and sustainable development.

**Hon. Prof. J. W. Wakhungu, EGH**
Cabinet Secretary, Ministry of Environment, Natural Resources and Regional Development Agencies

# Preface

Wildlife resources contribute immensely to the social and economic development of the nation through ecological, aesthetic, spiritual, and research values. Kenya has a large population of wildlife that exist both inside and outside protected areas, with the majority (over 65 %) of large wild herbivores occurring outside the parks and reserves either permanently or seasonally. Here they interact with human activities, including competition with pastoralists' livestock for space, water and forage. The wildlife may cause damage to agricultural fields, kill livestock, and even cause injury and death to humans, which has contributed to a negative attitude towards wildlife conservation and the escalation of human-wildlife conflicts. The diminishing wildlife ranges is a result of human pressure on land resources and is aggravated by land tenure changes, agricultural encroachment along rainfall gradients in the rangelands, and high density settlement and livestock numbers in key wildlife dispersal areas. Integrated land use planning and effective policies and legislation are prerequisite interventions in reversing the loss of wildlife range and restoring the health of ecosystems. This response requires credible scientific data to understand the drivers, pressures and impacts of land use change and the human-wildlife-environment interaction, to mitigate the resource use conflicts and declining wildlife populations in their former ranges. The first step to secure wildlife dispersal areas and migratory corridors interfered with by human activities, as envisioned in the Vision 2030 flagship project, is the identification and mapping of landscapes and resources used by key species.

This report is a product of consultative collaboration of many institutions, conservation development partners and stakeholders and local communities. It characterizes and maps the spatial extent of wildlife dispersal areas and migratory corridors in the Kenya rangelands and coastal terrestrial ecosystems, and it highlights the conservation opportunities in the context of integrated land use options and diversification of rural livelihoods through creation of conservancies, benefiting from ecosystem services and goods, reducing human-wildlife conflicts, and increasing species populations. The report has proposed a Conservation Connectivity Framework (CCF) and has provided guidelines for its implementation and actualization that require fast-tracking of existing policies and legislation on land use and wildlife conservation. Viable wildlife habitats in human- and livestock-dominated landscapes should be secured to increase spaces for wildlife that have diminished, threatening the survival of species. The use of legal and economic intruments will be critical in negotiations with the local communities and landowners in areas perceived as wildlife dispersal and migratory corridors to release their land for conservation purposes.

The Ministry of Environment and Natural Resources express sincere gratitude to all the institutions, stakeholders, and individuals involved in the production of this report, and for the remarkable effort in contributing to wildlife conservation and informing policy formulation. Any form of support that would facilitate implementation of the proposed Conservation Connectivity Framework in Kenya is highly welcome.

**Dr. Margaret W. Mwakima, (PhD), CBS**
Principal Secretary, State Department for Natural Resources, Ministry of Environment and Natural Resources

# Acronym and Abreviations

| | |
|---|---|
| ACC | African Conservation Centre |
| ASAL | Arid and Semi-Arid Lands |
| AWF | African Wildlife Foundation |
| CBS | Chief of the Burning Spear |
| CBD | Convention on Biological Diversity |
| CCF | Conservation Connectivity Framework |
| CDM | Clean Development Mechanism |
| DRSRS | Directorate of Resource Surveys and Remote Sensing |
| DPSIR | Drivers, Pressures, State, Impacts and Responses |
| FAO | Food and Agriculture Organisation |
| EGH | Elder of the Golden Heart |
| EPZ | Export Processing Zone |
| FEWSNET | Famine Early Warning Systems Network |
| FoNNaP | Friends of Nairobi Park |
| GCA | Game Controlled Area |
| GDP | Gross Domestic Product |
| GIS | Geographic Information System |
| GR | Game Reserve |
| ILRI | International Livestock Research Institute |
| IUCN | International Union for Conservation of Nature |
| KARI | Kenya Agricultural Research Institute |
| KFS | Kenya Forest Service |
| KNBS | Kenya National Bureau of Statistics |
| KMD | Kenya Department of Meteorology |
| KWS | Kenya Wildlife Service |
| NEMA | National Environment Management Authority |
| NMK | National Museum of Kenya |
| NR | National Reserve |
| NP | National Park |
| MBS | Moran of the order of the Burning Spear |
| MDG | Millennium Development Goals |
| MENR | Ministry of Environment and Mineral resources |
| MEP | Mara Elephant Project |
| MME | Masai Mara Ecosystem |
| MMNR | Masai Mara National Reserve |
| PES | Payments for Ecosystem Services |
| REDD | Reducing Emissions from Deforestation and forest Degradation |
| ROK | Republic of Kenya |
| SDG | Sustainable Development Goals |
| SME | Serengeti-Mara Ecosystem |
| SOLARO | South Rift Landowners Association |
| TENP | Tsavo East National Park |
| TWNP | Tsavo West National Park |
| UNEP | United Nations Environment Programme |
| WMA | Wildlife Management Area |
| WRI | World Resource Institute |
| WRUA | Water Resource Users Association |

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# Executive Summary

Kenya is endowed with an extraordinary wealth of mammals, birds and other biodiversity, a unique heritage for the people of Kenya. Kenya's development blueprints on ensuring environmental sustainability – the Constitution (2010), Vision 2030, and Sustainable Development Goals (SDG) – recognize the importance of sustainable resource use, reducing biodiversity loss, and maintenance of ecosystems processes. In the Vision 2030, under the conservation strategic thrust, the flagship project on *securing wildlife dispersal areas and migratory corridor*s features prominently as one of the economic and social pillars.

All over the country, wildlife populations have declined dramatically over the last few decades. Ecosystems are failing to provide ecological services such as water storage, soil protection and climate moderation. At the same time, human-wildlife conflict has increased. To reduce and reverse this trend, it is urgent to assess and secure Kenya's wildlife dispersal areas and migratory corridors as a way to restore balance to our country's superb environment.

This study is based on the recognition that a significant proportion of Kenya's wildlife seasonally or permanently exists outside protected areas and is exposed to increasing human pressures that have negative impacts on species' populations, dispersal areas and migratory corridors. The process of mapping wildlife dispersal areas and migratory corridors aims at developing a Conservation Connectivity Framework (CCF) that will facilitate formulation of an inclusive and collaborative strategy for securing and managing all the wildlife space that exists in human- and livestock- dominated landscapes. As a key step towards achieving the goals of biodiversity conservation and sustainable ecosystems, the identification and mapping of wildlife dispersal areas and migratory corridors will help the country's spatial planning and guide the process of securing wildlife areas already interfered with by human activities.

The first phase of the mapping process focused on the southern Kenya rangeland ecosystems comprising six contiguous sub-ecosystems - Maasai Mara; Eburu Forest and Lakes Naivasha-Elmentaita-Nakuru Conservation and Ecological Area; Athi-Kaputiei and Nairobi National Park; South Rift; Amboseli and west Kilimanjaro; and Tsavo Conservation Area (TCA). The second phase focused on the northern Kenya rangelands and coastal terrestrial ecosystem comprising the greater Ewaso ecosystem, South Turkana-Mt. Elgon ecosystem, northeast Kenya landscapes, and coastal terrestrial ecosystems. A total of eight keystone species – namely elephants, wildebeest, Burchell's (Common or Plains) zebra, Grevy's zebra, giraffe, buffalo, topi and oryx were selected for this study on the basis of their body weights, migratory nature, foraging habits (i.e. grazer, browser and mixed feeder), their role in conservation and endangered status.

Wildlife migratory corridors connect core habitats and are critical for species' survival and long-term viability of ecosystems. In the African savannah, animals disperse or migrate across landscapes in response to intrinsic factors (e.g. breeding); external or environmental factors (drought, floods, diseases, fires), to access vital resources such as pasture, water, breeding grounds; to reduce the risks of predation; and to enhance genetic health (mating), among others. Migration is essential for sustaining resilience of large populations in the face of variable rainfall, which is highly correlated to availability and shortage of forage. Connectivity conservation recognizes the importance of physical connection and linkages between isolated habitats that increase the effective area available to wildlife. Restoration of wildlife habitats helps to improve the integrity of ecosystems; and are an essential strategy in maintaining landscape patterns and ecological processes that promote the survival of species in environments modified by both natural events and anthropogenic activities, and reverses the effects of habitat fragmentation. Wildlife dispersal areas and migratory corridors are key elements in the conservation connectivity framework proposed.

In the assessment of wildlife dispersal areas and migratory corridors, the conservation connectivity framework (CCF) has used a variety of data sources, scales and analyses in the context of inclusiveness and collaborative stakeholder involvement. The datasets include remote sensing maps on land cover/use, sample and total counts from low-level aerial surveys, ground counts, wildlife collar tracking, expert knowledge, and interviews with key informants. Geotechnologies were used for spatial analysis and modeling. Specific wildlife habitats were characterized and defined based on the DPSIR (drivers, pressures, state, impacts and responses) framework to understand socio-ecological and economic interactions as they relate to resource planning and decision-making, as well as to prioritize opportunities, threats and desired actions. A total of 58 migratory routes and corridors were identified in the southern Kenya rangeland ecosystems: Maasai-Mara ecosystem (17); Eburu Forest and Lakes Naivasha-Elmentaita-Nakuru conservation and ecological area (8), Athi-Kaputiei and Nairobi National Park (7), South Rift (8), Amboseli and west Kilimanjaro (8), and the Tsavo

Conservation Area (10). Fifty-two migratory routes or corridors were identified in the northern Kenya rangelands and coastal terrestrial ecosystems, with the majority found in the greater Ewaso ecosystem. More salient routes and corridors used by other wildlife species also exist in the Kenya rangelands, but were not considered and need further investigation.

Almost all the wildlife dispersal areas and migratory corridors in the Kenya rangelands have been interfered with by human activities to an extent; some are highly threatened or have been completely blocked. For example, the collapse of wildlife populations in the Athi-Kaputiei area and subsequent curtailment of their movement from the Kajiado plains into Nairobi National Park has been attributed to high-density settlements, fences and subdivision along the Kitengela-Namanga highway. The main threats to habitat connectivity are incompatible land use in wildlife areas, including expansion of crop cultivation along the rainfall gradient, high-density settlements, fences, mining and quarrying, woodland clearing, wetland drainage, high-density livestock presence, and poaching. The rapidly escalating human population and high levels of rural poverty are mainly to blame; these are often associated with land tenure and land use change, sedentarization, sub-divisions, and habitat fragmentation.

To address the foregoing impacts on wildlife dispersal areas and migratory corridors, the following broad recommendations are proposed:

- *Develop, expand and implement the proposed CCF:* Establish an all-inclusive, collaborative and transparent consultative process between the national and county governments, stakeholders and development partners, landowners and the local communities in areas perceived as wildlife migratory corridors.

- *Identify, prioritize and secure wildlife dispersal areas and migratory corridors:* Wildlife migration and movement corridors identified should be secured immediately through a prioritized scheme involving short-, medium- and long-term action plans, using legal and economic instruments that are already in place.

- *Promote an integrated land use for spatial planning:* Biodiversity conservation planning has to take a holistic approach that encompasses a multi-faceted landscape dimension that not only considers the ecological processes and ecosystem functions, but also takes into account the matrix of social, economic, biophysical and natural resources.

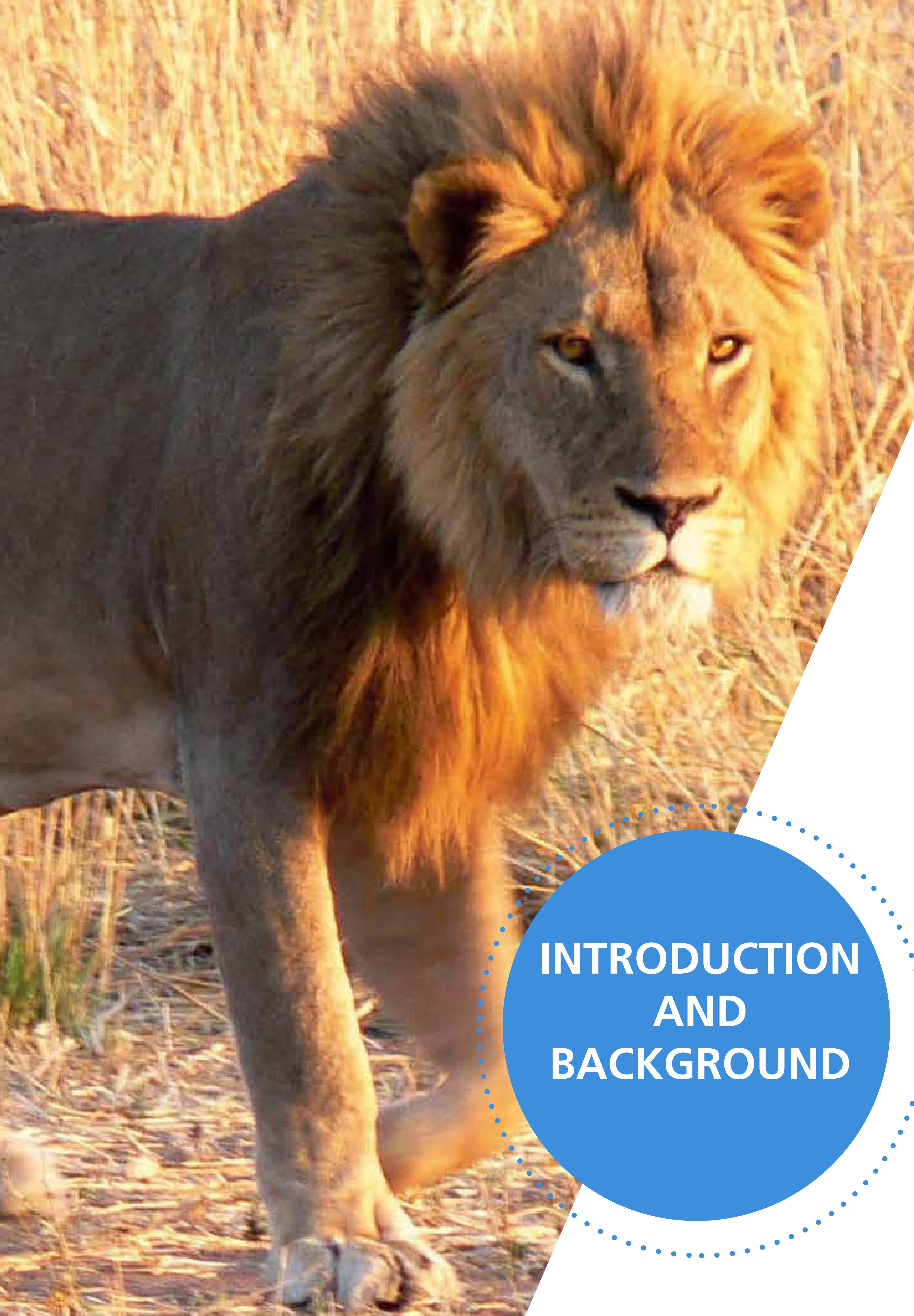
- *Review policies and legislation: Rationalize and implement* the policies, laws and regulations related to land use, wildlife conservation, forestry, water, and agriculture.

- *Promote community participation in biodiversity conservation:* Planning and implementation of conservation agendas in non-protected areas should involve local communities in decision-making. Programmes and initiatives that involve local communities in conservation and management of wildlife are essential components for sustainable development. Community-based conservancies, wildlife scout associations, and partnerships with tour operators are economic instruments that provide benefits from wildlife to local communities and landowners.

- *Implement management of conservation connectivity:* Effective management of wildlife dispersal areas and migratory corridors require thorough research and monitoring systems with stakeholder collaboration at all levels. Habitat connectivity is species-specific, with the most effective management strategy enhancing resilience, ecological processes, species diversity and abundance, reducing human-wildlife conflicts, and providing direct benefits to local communities and landowners.

- *Source and provide resources for conservation connectivity management:* Sufficient financial resources and highly skilled personnel should be allocated to manage the wildlife dispersal areas and migratory corridors to ensure viability and sustainability.

- *Carry out monitoring and evaluation: regular monitoring* and evaluation is required for effective management of wildlife dispersal areas and migratory corridors.



# INTRODUCTION AND BACKGROUND

# Chapter I

# Introduction and Background

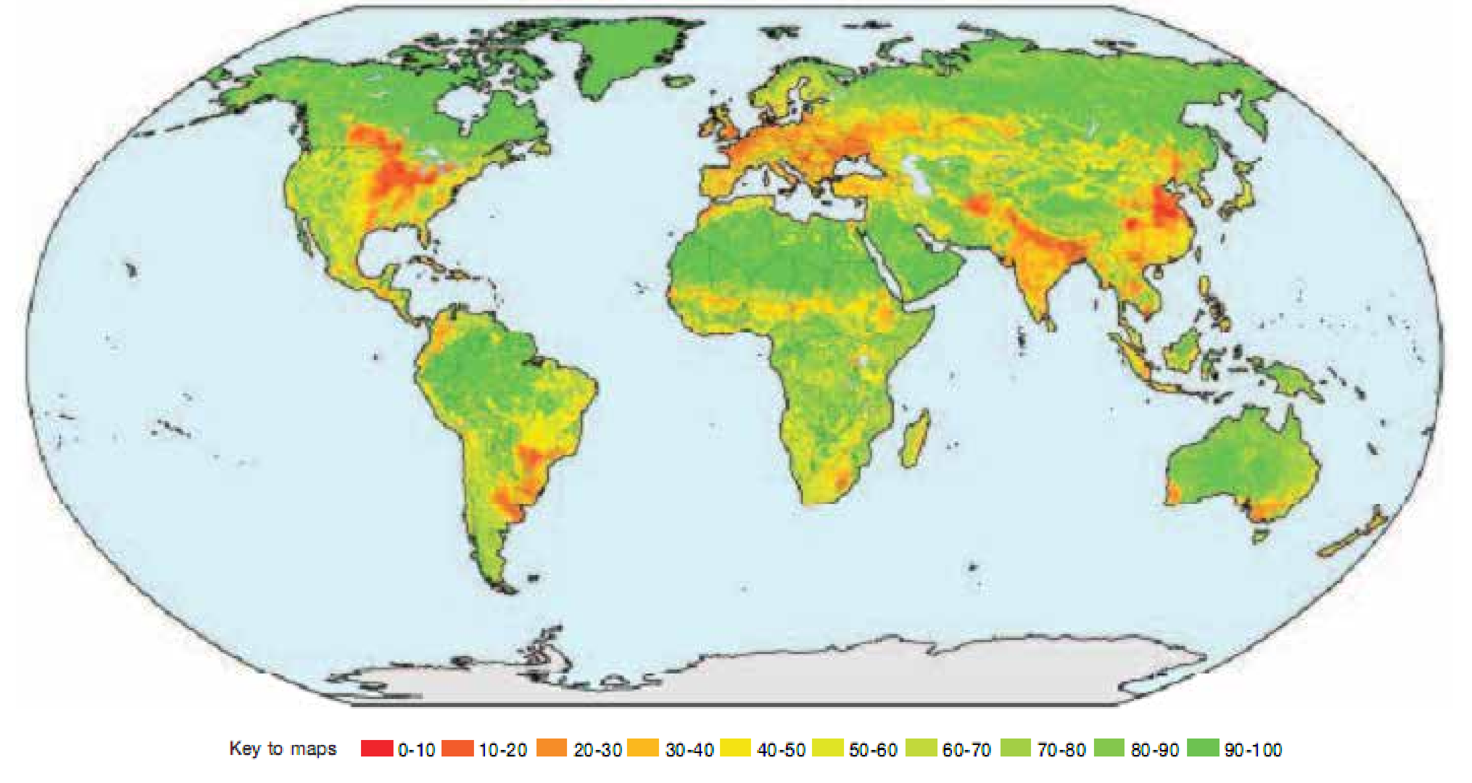
## 1.1. Global and Continental Biodiversity

Biological diversity encompasses animals, plants and micro-organisms, the genes within them, the ecosystems in which they live, and the interactions among them. Biological diversity is not uniform nor equally distributed around the globe, and obviously, does not follow national boundaries. Loss of biodiversity is acute in certain terrestrial and coastal ecosystems (Map 1.1) faced with particular threats related to ecological, historical, social, and economic structures.

Biodiversity loss has escalated on a global scale due to human activities, with only about 73 % of natural biodiversity left by the year 2000 (The Economics of Ecosystems and Biodiversity (TEEB), 2008). The temperate and sub-tropical grasslands and forests where the first human civilizations developed depict the highest declines (McNeill and McNeill, 2003). A further 11 % of land biodiversity is expected to be lost by 2050, including in desert, tundra and polar regions (Map 1.1).

Pristine habitats and rangelands will continue to be converted to agricultural land with the rising human population, expansion of settlements and infrastructure; and loss of biodiversity exacerbated by increasing effects of climate change. Worldwide, the loss of natural areas between 2000 and 2050 is projected to 7.5 million km$^2$

**Map 1.1:** Status of biodiversity in 2000 - Biodiversity loss in the Cost of Policy Inaction (COPI) study is measured by the mean species abundance indicator recognized by the Convention on Biological Diversity.




*Source: The Economics of Ecosystems and Biodiversity (TEEB), 2008.*

**Table 1.1:** Major taxonomic group of species assessed as threatened.

| Taxonomic Group | Species described (Estimate No.) | Evaluated (No.) | Threatened (No.) | Threatened as % of described | Threatened as % of evaluated |
|---|---|---|---|---|---|
| Mammals | 5488 | 5488 | 1141 | 21% | 21% |
| Birds | 9990 | 9990 | 1222 | 12% | 12% |
| Reptiles | 8734 | 1385 | 423 | 5% | 31% |

*Source: IUCN Red List, 2008*

(Economics of Ecosystems and Biodiversity, 2008). Natural ecosystems are expected to undergo land use changes that will result to massive decline of biodiversity around the globe (Table 1.1).

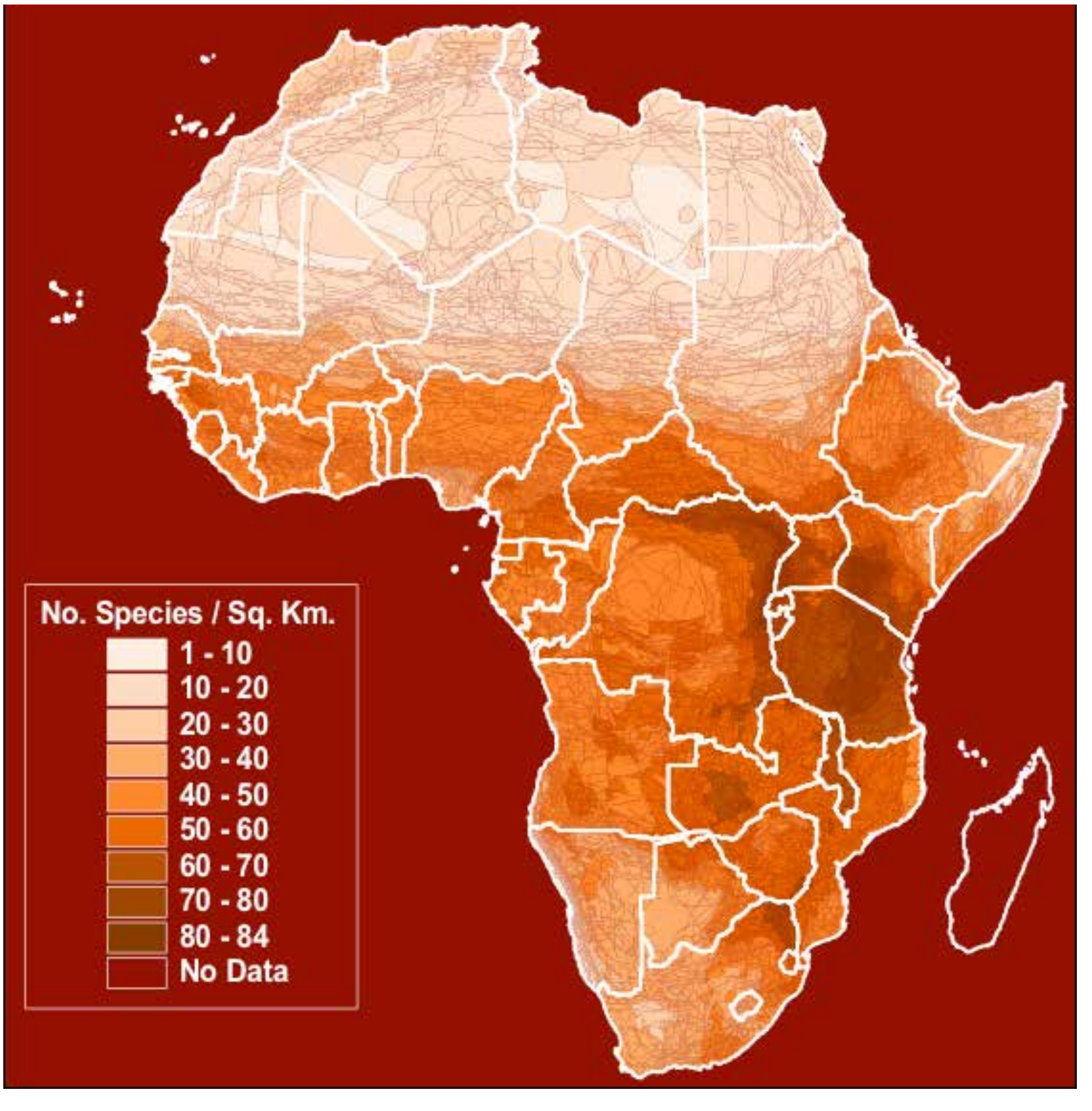
The rapid growth in human population and therefore demand for more food, energy and other resources, has led to resource over-exploitation (WRI 2005b). This is mainly responsible for land-use changes and consequently the diminishing of habitats for species and the degradation of ecosystems, the loss of dispersal areas and migratory corridors, and increasing human-wildlife conflicts (WRI 2005a; CBD 2010).

## 1.2. Kenya's Biodiversity

In the pastoral lands of East Africa where wildlife occurs in high concentrations, people have lived side by side with animals for centuries (Lusigi, 1981; Peden, 1987; Homewood and Rodgers, 1991; Homewood and Brockington, 1999; Homewood et al., 2001). Until recently, the human population was manageable and resources were abundant. Now, exponential population growth and rapidly expanding anthropogenic activities are making huge demands on land resources, resulting in over-exploitation and human-wildlife conflicts.

Ecosystems are providers of critical goods and services necessary for livelihoods and sustainable development. Over the years, the conservation of biodiversity had focused mainly on species and habitat preservation. Now, the focus has to evolve to a landscape approach and take a holistic view encompassing a multi-faceted dimension that not only considers the ecological processes and ecosystem functions, but also takes into account the social, economic and cultural aspects. Biodiversity conservation has greater scope, and management should aim at maintaining ecological and ecosystem functions rather than species numbers and distribution.

**Map 1.2:** High diversity and density of large mammals occur in East and Central Africa.




*Source: ILRI*

Kenya is a mega bio-diverse country, containing more than 35,000 species of flora and fauna (Thaxton, 2007). It has a variety of natural ecosystems that range from marine to mountains, grasslands and forests to savannahs. Kenya's total land area covers about 582,646 $km^2$, of which about 10-12 % has been designated for biodiversity conservation. The elaborate system of parks, reserves, and sanctuaries was established to protect and conserve wildlife populations for the critical ecological functions they perform, as well as for their scientific, aesthetic, and economic values.

Protected wildlife areas, which cover only 8 % of Kenya's land area, include 29 national parks, 36 national reserves, seven sanctuaries, four marine national parks and six marine national reserves, and 203 forest reserves (KWS, 1996 b). Other conservation areas include numerous private and community-based wildlife conservancies and sanctuaries.

The Kenya rangelands contain the majority of protected areas in the country, and are home to 32.6 % of the nation's human population (12,582,028 of 38,610,097 people in 2009), who belong primarily to pastoralist communities, and who are therefore important both for extensive livestock production and for wildlife conservation (Map 1.3). Rangelands contribute more than 50 % of the nation's livestock production, raised mainly for meat and milk. Over 70 % of protected wildlife reserves and parks occur in the rangelands; however, most (65-70 %) of the terrestrial wildlife populations are found in human-modified landscapes outside protected areas (Western et al., 2009; Ottichilo et al., 2001a).

A significant proportion (more than 60 %) of large wild herbivores in the country reside outside the protected areas throughout the year (Sindiga, 1995; ROK, 2012; Wargute, 2005; Western et al., 2009). In most cases, the delineation of protected area boundaries did not take into account the total habitat used by wildlife or the ecological needs of species, such as seasonal dispersal areas outside protected areas (Lusigi, 1981). There is increasing realization that in spite of the traditional land uses outside the protected areas, wildlife may fare better in these areas, provided good conservation and management strategies are put in place and implemented.

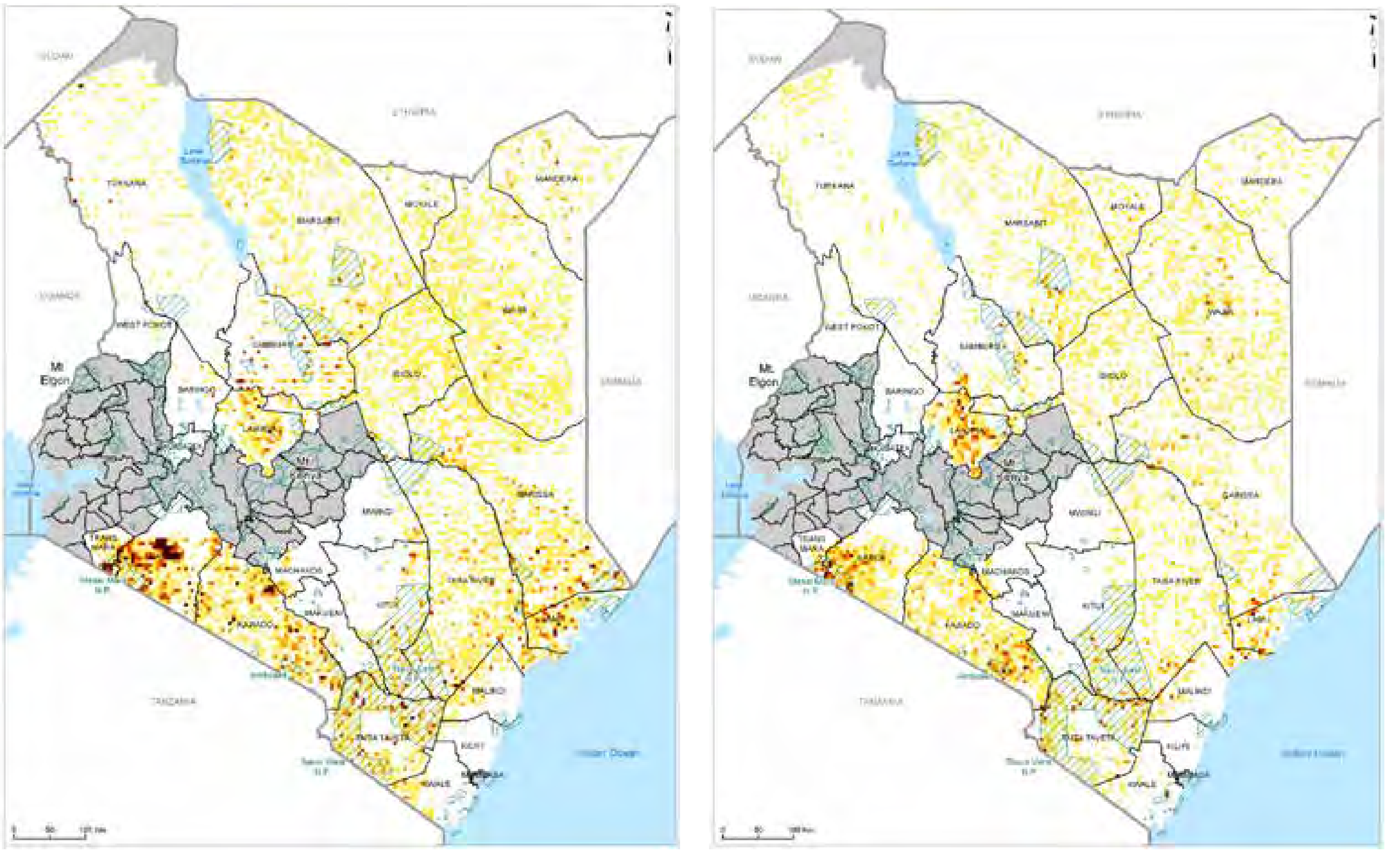
The protected areas are increasingly becoming isolated and surrounded by settlements, agriculture and high livestock densities, as the human population continues to grow, and demand for agricultural land shifts along rainfall gradients in drylands or rangelands. Furthermore, sedentarization is now common among pastoral communities that have been forced to change their lifestyle from nomadism to permanent settlements, with associated changes in grazing patterns and a shift to crop cultivation. The rapid decline of wildlife populations and the increase in human-wildlife conflicts over the past few decades are attributed to loss or fragmentation of habitats, and are driven by human population pressure and anthropogenic activities (ROK, 2012).

## 1.3. Relevance and Importance of Biodiversity

Biodiversity affects human development directly, despite its rarely being linked to human population indices. Biodiversity sustains about 40 % of the global market of goods and services, and the World Commission on Forests and Sustainable Development (WCFSD) views it as the foundation of human development by focusing on its long-term sustainability rather than on short-term economic growth. The impact of forests on natural processes and human life is massive and varied. Forests play a vital role in water storage and purification, soil conservation, climate moderation, carbon sequestration, and as sources of food, shelter, medicine, energy and industrial raw materials, in addition to genetic resources for the biotechnology sector, and intangible benefits such as spiritual and aesthetic values, knowledge systems and innovation, among others. Scientists and environmentalists agree that biodiversity conservation, particularly in primary forests, is necessary in order to stem further loss of species and to avert economic decline in tropical countries. The green revolution that continues to support agriculture through biotechnology and improvements in crop cultivars or development of new varieties depends on harnessing genes from wild species. Indeed, in the last 50 years, the inter-breeding of crop strains with different beneficial traits has doubled crop production around the world. It is critical to maintain some level of crop diversity to ward off emerging diseases and crop pests, and to adapt to climate change.

Kenya exploits her biodiversity through primary industry, which includes food processing, tourism, and ecosystem goods and services. The country has a wide scope for profitable exploitation of its local biodiversity, with great potential for bio-prospecting research and other applications. Biodiversity conservation is the base for tourism at the national and county level, an important revenue earner and source of employment. In recent times, the income generated from tourism activities in Kenya has continued to be a good source of national revenue, with wildlife-based safaris and photography ranking among the leading industries, contributing about 13.7 % of the gross domestic product and generating more than 10 % of national formal sector employment. For example, in 2011 wildlife-based safaris contributed about US$ 1.16 billion to national revenue (GOK, 2012).

**Map 1.3:** A comparison of wildlife densities in the 1970s (left) and 1990s (right) shows a decline in the southern Kenya rangelands, and particularly in Narok and Kajiado Counties, while wildlife numbers have increased in Laikipia County. Grey shading shows unsurveyed areas (high potential areas in central and western Kenya, and the northern extension).



*Source: DRSRS*

## 1.4. Trends in the Population of Wildlife in Kenya

According to a recent study by Ogutu *et al.* (2016), the population estimates for wildlife and livestock in 20 counties in the Kenya rangelands between 1977 and 2013 show a striking increase in numbers of shoats and camels, and concurrent extreme declines in the numbers of 15 of 18 common wildlife species. The aggregated numbers of sheep (*Ovis aries*) and goats (*Capra a. hircus*) across the rangeland counties increased markedly by 62 %, followed by 20 % for camels (*Camelus dromedarius*) and 1.2 % for donkeys (*Equus asinus*), while the number of cattle (*Bos taurus*) dropped by 30 %. In sharp contrast to the increasing trends or moderate declines in livestock numbers, the aggregated numbers of the common wildlife species declined precipitously, and for certain species catastrophically, over the same period. The declines were pervasive and extreme, despite contrasting feeding and foraging guilds, body sizes, gut morphology, and distribution among counties with widely varying rainfall patterns.

Rates of decline between 1977 and 2013 varied markedly among species, but averaged 67.3 % (1.8 % per year) for the aggregated wildlife species. The declines were particularly extreme (71-100 %) for Thomson's gazelle (*Eudorcas thomsoni*), warthog (*Phacocoerus africanus*), eland (*Taurotragus oryx*), lesser kudu (*Tragelaphus imbermbis*), oryx (*Oryx gazella beisa*), topi (*Damaliscus lunatus korrigum*), impala (*Aepyceros melampus*), waterbuck (*Kobus ellipsiprymnus*) and hartebeest (*Alcelaphus buselaphus*); severe (51-70 %) for buffalo (*Syncerus caffer*), wildebeest (*Connochaetes taurinus*), Grevy's zebra (*Equus grevyi*), giraffe (*Giraffa camelopardalis*), gerenuk (*Litocranius walleri*) and Grant's gazelle (*Nanga granti*); and moderate (30-50 %) for ostrich (*Struthio camelus*), Burchell's zebra (*Equus Burchelli*) and elephant (*Loxodonta africana*) (Fig. 1.4 ).

The wildlife species that suffered the most extreme declines in all rangeland counties were giraffe, lesser kudu, impala, waterbuck, and hartebeest. The declines have reduced the populations of many species, notably of lesser kudu, waterbuck and hartebeest, to levels that now critically threaten their future population viability or survival, unless urgent, drastic and sustained remedial steps are taken to restore the depleted populations (Ogutu *et al*., 2016). Other wildlife species, while declining severely in most counties, registered increases in some counties: in Isiolo (warthog and eland), Kajiado (elephant), Machakos (wildebeest, zebra), Kitui (buffalo, Thomson's gazelle), Taita-Taveta (buffalo), Kwale (ostrich, elephant, warthog), Tana River (Thomson's gazelle), Lamu (gerenuk, buffalo), Baringo (ostrich), Laikipia (Burchell's

).

zebra, Grevy's zebra, Grant's gazelle, buffalo, elephant, and oryx), Turkana (Burchell's zebra, gerenuk), Marsabit (ostrich, topi), Garissa (ostrich, buffalo, warthog) and Wajir (warthog).

The likely causes of wildlife declines suggested by various earlier studies that focused on particular counties or parts of :the counties are

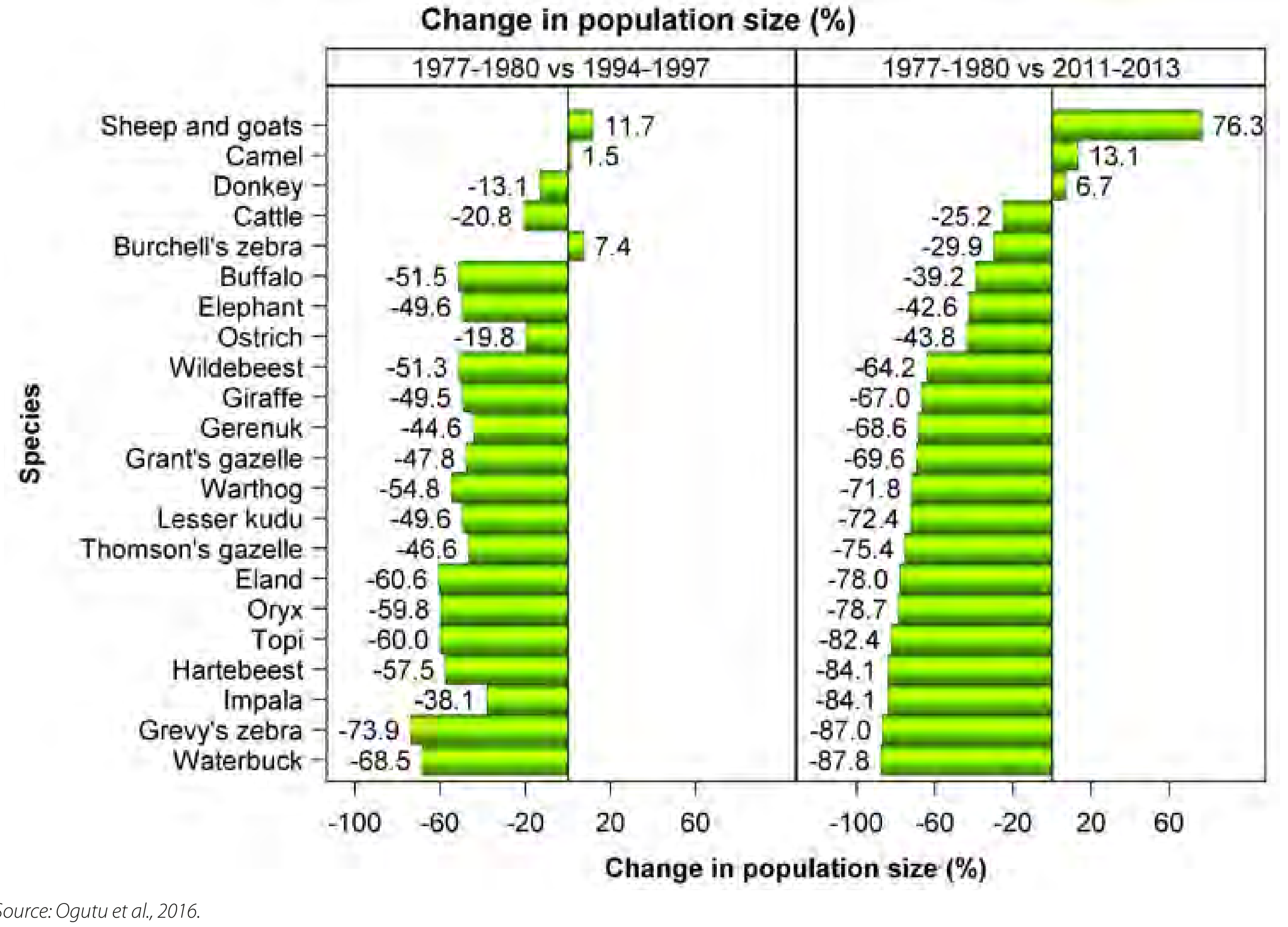
(1) Rapid human population growth and its ramifying effects on the rangeland ecosystems. Kenya's human population grew nearly five-fold from 8.1 million in 1960 to 44.4 million in 2013. The annual average human population growth rate in 2013 was estimated at 2.9 % (World Bank, 2014). The pastoral regions are also experiencing a significant population increase, a trend forecasted to continue in the coming years (Pricope et al., 2013). Associated with the rising population pressures are browning trends in vegetation condition in the pastoral regions, signalling progressive habitat degradation or loss. Habitat degradation, fragmentation and loss are attributed to land-use and cover changes associated with unregulated expansion of agriculture along rainfall gradients and settlements, land-use intensification, over-stocking and over-grazing, unsustainable range management, unregulated wood harvesting for firewood and the charcoal trade, and unregulated spread of urban centres and infrastructural development.

(2) Changes in government land policies and rapid population growth progressively discourage pastoralism and promote privatization of land tenure, leading to land sub-division, sedentarization and cultivation, and resulting in habitat degradation, fragmentation and loss, constrained seasonal mobility and displacement or exclusion of wildlife from pastoral lands, with the result that wildlife is increasingly confined to the few protected areas. Agricultural development and settlement policies that promote farming in rangelands exacerbate the destruction of habitats and exclusion of wildlife.

(3) Escalating human-wildlife and land-use conflicts and poaching associated with increasing human population size and expansion of settlements and cultivation into the rangelands.

(4) Inadequacy of national parks and reserves to sustain viable populations of large mammals, and diminishing opportunities for expanding existing protected areas.

**Figure 1.4:** Overall trends in wildlife and livestock populations in Kenya between 1977 and 2013




*. Source: Ogutu et al., 2016.*

(5) Climate change and variability, which amplifies the effects of land-use and cover changes and other factors. There has been an overall reduction in both the long and short rainy seasons, an increase in spatial and temporal variability of rainfall and increased frequency of droughts in East Africa in recent years.

## 1.5. Vision 2030 on Securing Wildlife Migratory Routes and Corridors

Kenya's development blueprint – Vision 2030 – recognizes the importance of sustainable resource use and development, especially of land, biodiversity, and ecosystems. Vision 2030 accords prominence to a clean, secure, and sustainable environment under its economic and social pillars, and is inspired by the principles of ecosystem integrity and equitable access to resource benefits. In the environment sector, four main strategic thrusts, i.e., conservation, ASALs and high-risk disaster zones, environmental planning and governance, and pollution and waste management, are identified with concrete goals based on their relationship to the economic and social pillars (Fig. 1.5).

Three of the flagship projects envisaged in the Vision 2030 and critical to biodiversity conservation are:

(1) Securing wildlife migratory routes and corridors (especially those impacted by human activities) and reclaiming them as a basis for revenue generation in the tourism sector;

(2) Land cover and land-use mapping (conducting accurate and continually updated land-use maps, and undertaking both livestock and wildlife censuses); and

(3) Water catchment management (rehabilitation of five water towers – the Mau Escarpment, Mt. Kenya, the Aberdare Range, the Cherangani Hills, and Mt. Elgon).

The Directorate of Resource Survey and Remote Sensing (DRSRS) spearheaded the process of mapping wildlife dispersal areas, migratory routes and corridors under its mandate (see Annex 1-1.2) and through its linkages with various government institutions, non-governmental organizations (NGOs), private sector companies and local communities. A task force comprising professionals with diverse backgrounds in conservation ecology and wildlife management, and representing relevant stakeholder institutions, developed a Conservation Connectivity Framework (CCF), which has identified and mapped all the wildlife dispersal areas and migratory corridors in the southern and northern Kenya rangelands and coastal terrestrial ecosystems. The institutions involved were DRSRS, AWF, ACC, KMD, KWS, ILRI, STE, Marwel Wildlife, MRC, and CETRAD (see also Annex 1-1.2).

## 1.6. Study Approach and Report Organization

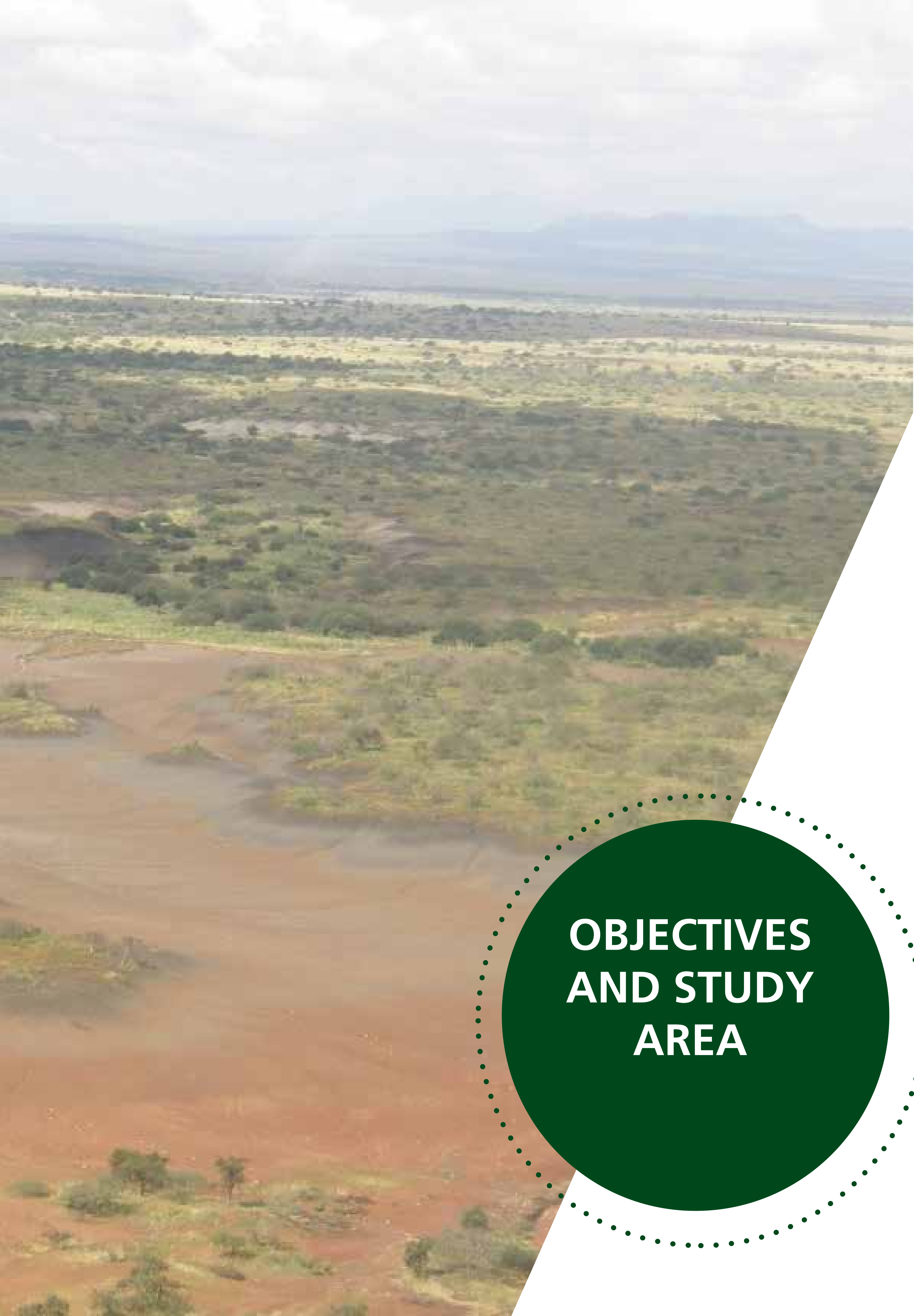
A methodological approach to conservation connectivity was developed. All the data available on wildlife populations, spatial distributions, and movement patterns in Kenya were collated and analysed. A review of published and grey literature, including fieldwork and interviews with key informants, was also conducted. The DPSIR (Drivers, Pressure, State, Impact, and Response) analysis tool for decision-making was adapted for identification and prioritization of the connectivity threats, opportunities and actions needed to restore those wildlife dispersal areas and migratory corridors that are already compromised by human activities.

This task force report is divided into two sections. The first part covers the Southern Rangeland Ecosystems, and the second part covers the Northern Rangeland and Coastal Terrestrial Ecosystems. Chapters 1, 2, 3 and 4 provide introductory background information on objectives and study areas, on the understanding of wildlife movements and connectivity, and on the methodological approach for conserving connectivity. Chapters 5 and 6 describe the specific migratory routes, corridors and dispersal areas in the Southern and Northern Rangelands and Coastal Terrestrial Ecosystems respectively. Chapter 7 is a synthesis of all the findings, and Chapter 8 highlights the overall recommendations and presents a roadmap for addressing the conservation challenges.

**Figure 1.5:** The Vision 2030 overall environmental goals and strategies.

**Vision for 2030**
A nation living in a clean, secure and sustainable environment

| | | Conservation | Pollution and waste management | ASAL and high-risk disaster zones | Environmental planning and governance |
|---|---|---|---|---|---|
| Strategic thrusts | | Conservation | Pollution and waste management | ASAL and high-risk disaster zones | Environmental planning and governance |
| Goals for 2012 | Overall | Promote and safeguard the state of environment for economic growth | | | |
| Goals for 2012 | Specific | ▪ Increase forest cover from less than 3% to more than 4%<br>▪ Ensure that all wildlife ecosystems are fully protected<br>▪ Incorporate natural resource in national accounts<br>▪ Identify 2 new natural resources | • Establish fully functional solid waste management systems in 5 municipalities and in the special economic zones (SEZs)<br>• Sustain enforcement of new regulations on plastic bags | • Achieve significant reduction in losses arising from floods and droughts<br>• National trends and impacts assessment determined<br>• Implement 5 adaptation projects | • Ensure that all environmental regulations and standards are enforced<br>• Attract 5 CDM projects per year |
| Strategies | | • Rehabilitation of degraded forest areas and promotion of farm forestry;<br>• User compensation for environmental services;<br>• Promote biotechnology;<br>• Secure wildlife corridors and migratory routes;<br>• Improve security of boundaries of protected areas;<br>• Intensify exploration of new minerals;<br>• Increase extraction of marine resources | • Develop and enforcement of pollution and waste management and hazardous waste regulations;<br>• Design and application of economic incentive/disincentives;<br>• Public private partnership for municipal waste;<br>• Reduce importation of oil with high Sulphur content | • Shift from disaster response to disaster risk reduction;<br>• Bridge the gap between science of climate change and policymaking;<br>• Aggressively promote adaptation activities to climate change | • Upgrade capacity for enhanced geo-information coverage and application;<br>• Harmonize environmental related laws;<br>• Strengthen institutional capacities;<br>• Use of incentives for environmental compliance;<br>• Strengthen negotiation skills on MEAs and enhance coordination of their implementation |
| Cross cutting issues | | • Education for sustainable development | | | |



# OBJECTIVES AND STUDY AREA

# Chapter 2

# Objectives and Study Area

## 2.1. Objectives

Over the past few decades, escalating human population growth and a concomitant expansion of human activities have led to rapid land-use changes in many areas. These changes have resulted in the loss or fragmentation of wildlife habitats, particularly outside protected areas. Human-wildlife conflicts have increased, and populations of wildlife species have declined. Factors that have contributed to the loss of biodiversity include the impacts of climate change and variability, especially as manifested in the increasing frequency and severity of droughts; the transmission of diseases between livestock and wildlife, and competition between the two for forage and water resources, as well as poaching. This study is based on a recognition of the fact that, for much of the year, most of the wildlife in Kenya is to be found outside protected areas, in habitats which are subject to various human pressures that are negatively affecting wildlife dispersal and survival.

Kenya's Vision 2030 flagship project for securing wildlife dispersal areas and migratory routes/corridors aims to formulate strategies for reclaiming habitat connectivities that have been compromised by human activities. The mapping process is the initial phase of this project, whose objective is to provide unequivocal information on species abundance, distribution, and movement patterns, as well as on constraints to conservation connectivity and opportunities for the establishment of wildlife migratory routes and corridors. In the medium-term plan, the landscapes that are to be secured will increase the range (space) available to wildlife, improve the protection of species, and help in reducing human-wildlife conflicts and in promoting eco-tourism.

The characterization of wildlife habitats is critical in identifying the drivers, pressures, states, impacts, and responses that affect wildlife population dynamics. In the mapping process, various government institutions and conservation stakeholders collaborated in providing expertise, information and datasets from ongoing biodiversity programmes in the country. Eight (8) keystone species were selected and examined on the basis of their conservation or endangered status, body weights, range and migratory nature, and feeding ecology (i.e. browsing, grazing, or mixed feeding). These species are: elephant, wildebeest, Burchell's zebra, Grevy's zebra, buffalo, giraffe, topi, and oryx.

## 2.2. Study Areas

The Kenya rangelands occupy about 512,586.8 $km^2$ and represent 88 % of the country's 582,646-$km^2$ land surface (Map 1.3). These are hot, semi-arid or arid areas with highly variable rainfall, often averaging less than 600 mm per year and are thus drought-prone (Pratt and Gwynne, 1977). The study area comprises several contiguous sub-ecosystems and landscapes represented as the southern rangelands (Map 2.1), the northern rangelands, and the coastal terrestrial ecosystems (Map 2.2).

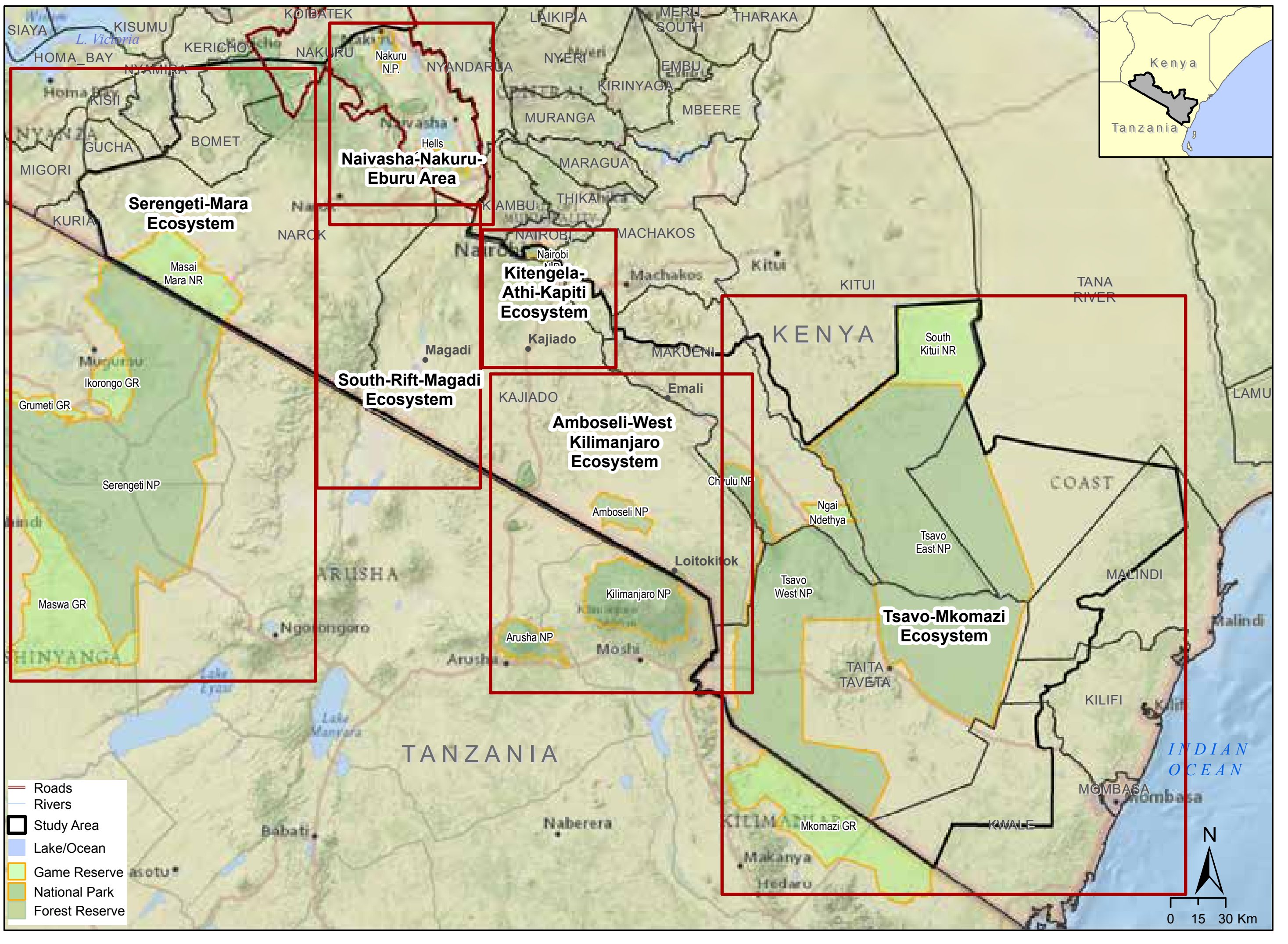
### Southern Kenya Rangeland Ecosystems

The southern Kenya rangeland ecosystems comprise six contiguous sub-ecosystems, namely the Maasai Mara ecosystem; the Eburu Forest and Naivasha-Elementaita-Nakuru lakes ecosystem; Nairobi National Park and the Athi-Kaputiei ecosystem; the South Rift (Magadi and Natron lakes region); the Amboseli and West Kilimanjaro ecosystem, and the Tsavo ecosystem (Map 2.1). All these ecosystems lie between latitudes 33˚55˚59˚E and 0˚14˚29˚S, and between longitudes 40˚08˚02˚E and 4˚43˚28˚S, in covering an area of about 98,011 $km^2$, stretching from the Maasai Mara ecosystem in the west, across the southern Mau highlands and into the Kenyan Rift Valley, before extending south-east to the Taita Hills and the coastal lowlands. The area occupies the whole of Kenya's Narok and Kajiado Counties, and parts of Nakuru, Machakos, Kitui, Taita-Taveta, Kwale, Kilifi, and Tana River Counties (Map 2.1).

### 2.2.1 (A). Nairobi National Park and Athi-Kaputiei Ecosystem

The Nairobi National Park (NNP) is a unique ecosystem, in being the only protected area in the world that is located within the precincts of a capital city. Only 7 km from the Nairobi city centre, it is primarily a savannah ecosystem taking in a range of different types of vegetation cover. Open grassland plains with scattered *Acacia* bushes are predominant, with highland dry forest along the western

**Map 2.1:** The southern Kenya rangeland ecosystem, showing six contiguous sub-ecosystems extending across the Kenya-Tanzania boundary.




Source: DRSRS Database.

edge and riverine forest along a permanent river. The Athi-Kapiti Plains and the Kitengela migration corridors to the south are important wildlife dispersal areas during the wet seasons. Additional habitats within the park include artificial dams and wetlands, which provide favourable sites for bird species and for aquatic biodiversity.

The Athi-Kaputiei Plains are the traditional home of the Kaputiei Maasai pastoralists who depend on livestock keeping. Located to the south of NNP, the plains provide a critical wet season dispersal range for some of the park's wildlife species. The plains extend across the largely commercial ranching enterprises of Machakos County in the east, via the gently descending Emarti valley to the Amboseli National Park in the south. Recently, large parts of the plains have undergone land sub-division and have been converted to high-density settlements by urban dwellers who have purchased residential plots. The emergence of commercial industries, including cement manufacturing, horticulture, steelworks, and an export processing zone, has led to a huge influx of immigrant workers, resulting in the rapid growth of subsidiary towns such as Athi River, Kitengela, and Machakos that are near Nairobi city. Already, plans are under way for the construction of the new Konza ICT city, which will further increase the influx of people onto the Athi-Kaputiei Plains.

### 2.2.1(B). Masai Mara Ecosystem

The Masai Mara Ecosystem (MME) comprises the Masai Mara National Reserve (MMNR) and surrounding community conservancies and group ranches, now mostly privatised. It is connected to the Serengeti National Park (SNP) to the south, across the international border with Tanzania, to form the Serengeti-Mara Ecosystem (SME), renowned for its abundant and diverse assemblages of wild ungulates, and for the seasonal migration of herds numbering some 1.3 million wildebeest, along with 0.6 million zebras and gazelles. Vegetation cover in the MMNR is mainly grassland interspersed with patches of woodland and bushy thickets. Despite the great size of the protected areas within the SME, the area faces various challenges related to land-use changes in adjacent areas that serve as wildlife dispersal areas during the dry seasons. Declining wildlife numbers in the region are attributed to, among other factors, increasing loss of pasture in the dispersal areas to crop cultivation and human settlements, along with poaching in some areas.

### 2.2.1(C). Tsavo Ecosystem

The Tsavo ecosystem spans some 44,000 km2, and is part of what is often called the greater Tsavo Conservation Area (TCA), occupying an area of roughly 60,000 km2 and composed of the Tsavo East NP, the Tsavo West NP, the South Kitui NR and the Chyulu Hills NP in south-eastern Kenya, the Mkomazi Game Reserve in north-western Tanzania, and the surrounding group ranches and community lands. At the centre of the ecosystem lie the Taita Hills, which are densely populated and intensively farmed. The TCA is the largest protected area in Kenya, occupying about 52 % of all the land in protected areas, and about 4 % of the country's land surface area. It holds the largest elephant population in the country, and is one of the largest contiguous protected areas in Africa. Rainfall in the region is bimodal and highly irregular in spatial and temporal distribution, with mean annual precipitation varying locally between 250 mm and 500 mm and falling mostly in March-May (usually highest between the Taita Hills and Kilimanjaro areas), and in November-December (highest in the northern and eastern parts beyond the parks). June through October is relatively cool. This dry season, exacerbated by desiccating winds, is the period of highest nutritional stress for most herbivores (Tyrrell & Coe, 1974; Leuthold, 1978).

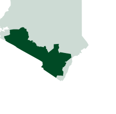
The vegetation consists of remnants of formerly extensive *Commiphora-Acacia* woodlands that have been thinned out by elephants. Elephants prefer forest-edge habitats, or woodlands, bushlands, and wooded or bushed grasslands. Tree and shrub densities are generally lowest near the rivers, except for localised patches of riverine forest and woodland. A detailed description of the vegetation cover is provided by Napier Bax & Sheldrick (1963); Laws (1969, 1970); Cobb (1976), and Belsky *et al*. (1987).

### 2.2.1(D). Amboseli Ecosystem - West Kilimanjaro Area

This landscape includes the Amboseli ecosystem and the West Kilimanjaro region of northern Tanzania, covering about 24,788 $km^2$ and extending from the footslopes of the Chyulu Hills to Lake Magadi, and from the footslopes of Kilimanjaro, through the Arusha NP, to Lake Natron in Tanzania. The Amboseli ecosystem occupies 8,797 $km^2$ and comprises the Amboseli NP (390 $km^2$) and adjacent group ranches, namely Kimana/Tikondo, Olgulului/Olararashi, Selengei/lengisim, Mbirikani, Kuku, Kaputiei, Osilalei, and Mailua. The dominant vegetation is open grassland, interspersed with *Acacia* woodland and with patches of swamp-edge grassland, and with a forest belt on the slopes of Kilimanjaro. The region is characterized by spatial and temporal variations in hydrology, with only a few permanent streams providing surface water. Most water flows from Kilimanjaro are underground, emerging in places in the form of springs and swamps that go on to feed rivers.

The West Kilimanjaro area (3,014 $km^2$) is in the Longido District of Arusha, Tanzania. The Kenya-Tanzania border between Namanga and Irkaswa forms the northern extent, while the Kilimanjaro NP boundary, extending southward to the Sanya Juu community defines the eastern limit.

**Plate 2.2.1:** Section of the West Kilimanjaro area in Tanzania which is connected to the Amboseli ecosystem, showing an expansive erosion waterway and vast open grazing lands.



In the south, this area extends westward from Sanya Juu to the Arusha NP in the north-east and to the Arusha-Nairobi highway. The area is a complex mosaic of diverse natural communities and extensive grazing lands (Plate 2.2.1). In the large agricultural fields at lower elevations on Kilimanjaro, the traditional agro-pastoral Maasai communities graze their livestock and practise subsistence crop cultivation. There are several wildlife conservation areas in the region, including the Kilimanjaro NP (755 $km^2$), the Arusha NP (137 $km^2$), the Longido Game Control Area (1,700 $km^2$), the Ngasurai Open Area (544 $km^2$), and two private conservation areas, namely West Kilimanjaro (303 $km^2$) and the Endarakwai ranches (44 $km^2$).

### 2.2.1(E). South Rift Ecosystem

The South Rift ecosystem includes Lake Magadi and surrounding areas in Kenya, extending southward to Lake Natron in Tanzania. The ecosystem extends as far north as the Ngong Hills, and as far west as the Nguruman Range. The Namanga-Magadi area (5,513 $km^2$) includes the ranches of Meto, Torosei, Mbuko, Elangata Wuas, Olkiramatian, Lorngosua, and Shompole. The area consists largely of gently undulating plains and of hilly landscapes flanking the Rift Valley. The soil is black clay (grumosolic) with a range of calcareous cotton soils and non-calcareous variants. Rainfall is low, bimodal, and highly variable, ranging from 400 mm to 600 mm annually. Pastoralism by the Maasai community and wildlife conservation are the main land uses (Kioko, 2008). The Ewaso Ng'iro River is the only permanent source of water, but there are several seasonal rivers, including the Namanga and the Esokota, which originate from the Namanga and Meto Hills, and the Ol Kejuado River, which emanates from the Ilemelepo Hills and drains into the Kiboko River.

The Lake Natron area (7,047 $km^2$) lies to the west of West Kilimanjaro. The northern part is defined by the Kenya-Tanzania border; the western part is along the eastern side of the Ngorongoro Conservation Area (NCA), and the southern boundary extends from south-east of the NCA to the north-western reaches of the Arusha NP. The region encompasses the hunting blocks of the Lake Natron Game Control Area and the northern portion of Monduli Game Control Area. The vegetation is predominantly semi-arid savannah interspersed with open *Acacia-Commiphora* woodlands and with diverse mosaics of other natural plant communities. There are extensive tracts of well-drained grazing land between the Kiserian-Mriata Ridge in the east and the Gelai (2,942 m) and Ketumbeine (2,858 m) mountains. The rainfall is unpredictable and highly variable (less than 350 mm annually).

### 2.2.1(F). Eburu Forest Ecosystem and Lakes Naivasha-Elementaita-Nakuru Conservation Areas

These conservation areas refer to lands occupied by shallow freshwater Lake Naivasha and by the alkaline lakes of Elementaita and Nakuru, and their immediate riparian surroundings within the Rift Valley basin. Included are the upland landscapes of Mounts Suswa and Longonot, and the Eburu Forest, as well as the adjacent Mau Forests Complex. The latter forest system has immense conservation value, being a vital water tower in the country and the primary area identified for protection under Kenya's Vision 2030 policy blueprint. The greater conservation area includes several protected areas and a number of public and private sanctuaries and ranches with substantial wildlife populations. These include the Lake Nakuru NP, the Mt. Longonot NP, the Hell's Gate NP, Lakes Naivasha and Elementaita (Ramsar-listed sites), the Eburu Forest, the Soysambu Sanctuary, Kedong ranch, Oserian ranch, Kekopey ranch, Ututu ranch, Crater Lake Sanctuary, Hippo Point, and the Mundui, Marula, KARI, and Loldia ranches. The rest of the area is occupied by a mixture of small-scale holdings and private lands under various uses. Historically, the region's main land use was livestock ranching, but this has changed recently to mixed-ranching, of livestock and wildlife, and/or crop cultivation.

The conservation areas are prime tourist destinations, although many of the tourism enterprises are uncontrolled and uncoordinated. Of particular concern to conservation stakeholders in the region is the increasing human population, which is having a visible impact on wildlife populations and their habitats, as well as on the forests and the lake system itself. The lake system is a major source of water. Yet escalating human activity, including expansion of agriculture, horticulture farming and industries, is threatening biodiversity in and around the lakes. Agricultural pesticides and industrial effluents have been blamed for the biodiversity losses. In addition, rampant land sub-division and the fencing of properties have continued to fragment wildlife habitats and to block movement corridors. Only about 10 % of wildlife in the conservation zone is found inside protected areas. The rest of the wildlife, if its populations are to be sustained, depends on community protection. Poaching (especially for bush meat) is reportedly rife in many areas.

## Northern Kenya Rangeland and Coastal Terrestrial Ecosystems

The northen Kenya rangeland and coastal terrestrial ecosystems comprise the entire north (greater Ewaso ecosystem and Turkana-Mt. Elgon landscape) and north-eastern and north coastal terrestrial ecosystems (Mandera, Garissa, Tana River, Kilifi and Lamu landscapes) (Map 2.2).

### 2.2.1(G). Greater Ewaso Ecosystem

The greater Ewaso ecosystem covers much of the central part of northern Kenya and falls within the administrative entities of seven counties, namely Laikipia, Samburu, Isiolo, Meru, Marsabit, Wajir, and Garissa. The landscape occupies a vast area, extending from the slopes of Mt. Kenya and the Aberdare Range in the south-west to the arid lowlands east of the Lake Turkana shoreline and Mt. Marsabit in the north. These are largely arid and semi-arid lands (ASALs) made up of communal pastures, along with several protected areas and wildlife conservancies, ranches, and pockets of cultivation.

Land use in the greater Ewaso ecosystem can be categorized in seven broad classes:

1 ). Pastoralist livestock production, widespread except on the highlands and in protected areas.

2. Mixed livestock production and wildlife conservation, practised on large private ranches in Laikipia, and in existing or proposed conservancies in Samburu, Turkana and Marsabit Counties.

3). Wildlife conservation, restricted to protected areas such as the Marsabit NP; the Meru NP; the Samburu, Buffalo Springs, Shaba, and Kora NRs, and the Laikipia NP.

4). Wildlife conservation, restricted to private properties such as the Ol-Jogi, Lewa, and Solio conservancies

5). Conservation forestry, restricted to forest reserves, although patches of dry forest occur across the landscape.

6). Agro-forestry, mostly in high-rainfall areas outside protected areas.

7). Crop cultivation/livestock keeping and horticulture, on the foot slopes of Mt. Kenya, the Aberdares, and the Mathew's Range. Most of this land is privately owned, and carries livestock of mixed or pure breeds (both indigenous and exotic), while also being used to grow flowers or vegetables, or for wheat production, or subsistence mixed-crop cultivation.

The dominant land use (90 %) is livestock production, practised mostly on communal lands. Private commercial ranches that also practise wildlife conservation account for a substantial portion of land use, on the Laikipia plateau especially. Private land tenure has resulted in the fencing of several of the private ranches, restricting wildlife mobility. Most of the communal or trust lands, by contrast, remain unfenced, allowing the pastoralists to move freely during adverse climatic conditions associated with erratic rainfall and severe droughts. Similarly, the unfenced lands facilitate free dispersal of wildlife in migrations that are occasioned by seasonality or insecurity.

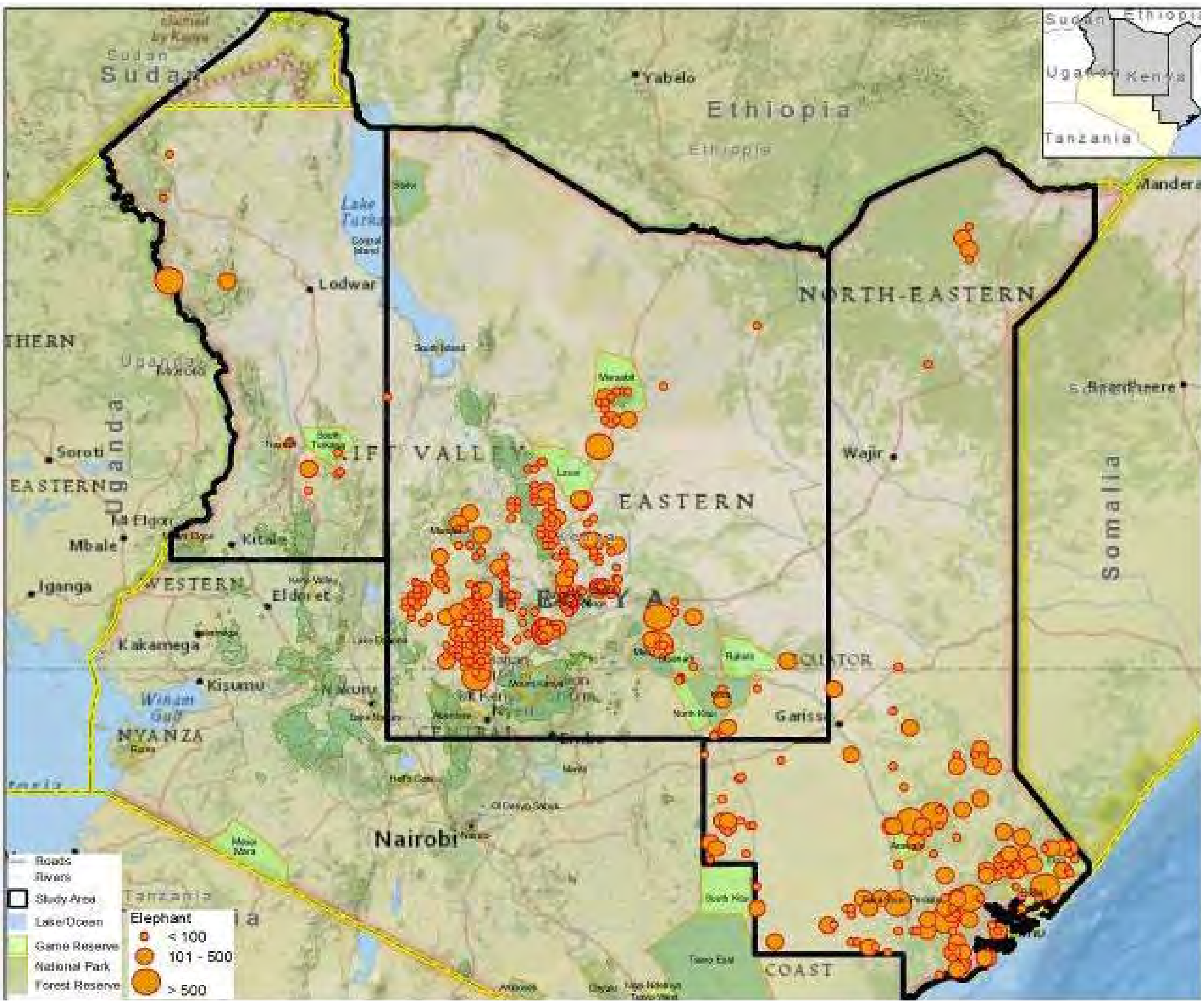
Although the parks and reserves of the northern Kenya rangelands cover less than 10 % of protected areas in the country, they are home to the greatest diversity and density of wild ungulates in East Africa outside the Serengeti-Mara ecosystem (Georgiadis *et al*., 2007; Ojwang' and Wargute, 2009, 2012; Ojwang *et al.*, 2012; Wargute *et al.*, 2012). These areas harbour more than 20 species of indigenous large mammals, including more than 8,000 elephants; the largest remaining populations of Grevy's zebra and Jackson's hartebeest, and the largest national populations of rhinoceros and reticulated giraffe found outside protected areas (Georgiadis *et al*., 2007; Ojwang' and Wargute, 2009).

Extreme variations in altitude are a feature of the greater Ewaso ecosystem, which ranges from 5200 m above sea level on Mt. Kenya to 138 m above sea level in Garissa County. The greater Ewaso watershed makes up the largest drainage basin in the country, spanning an area of roughly 210,226 $km^2$. The catchment area feeding the Ewaso Ng'iro River alone covers an area of 83,847 $km^2$. Its headstreams, emerging from the slopes of Mt. Kenya and the Aberdares Range, drain into the Lorian Swamp. The sub-surface flow continues eastward, however, to recharge rivers in Somalia, before eventually draining into the Indian Ocean. A large number of ephemeral rivers and luggas that originate from the Mathews Range and from Mt. Marsabit, and which carry surface water only for short periods after the rains, occur in drier parts of the catchment area.

Rainfall over much of the Ewaso ecosystem is unpredictable and variable. Most areas receive significant rainfall only in April and December. The upper elevations around Mt. Kenya receive high rainfall (more than 1,200 mm per year), but at lower elevations, including parts of Laikipia and most of Samburu and Isiolo Counties, annual rainfall drops to 300-600 mm, while the easternmost parts of Isiolo and Garissa Counties receive less than 300 mm of rainfall per year. Most lower-lying areas are dry in January and February, and from June to September. The seasonality of rainfall varies across the ecosystem, with Marsabit and North Horr receiving long rains in March-May and short rains in October-December. The higher parts of Laikipia and Samburu Counties have a trimodal rainfall pattern, with long rains in April-June, short rains in October-December, and a third but more unpredictable rainy peak in July-August.

Predictability of rainfall varies with topography. In the highlands, rains are more predictable, occurring almost daily during the rainy season, owing to the orographic uprising of humid air. In the lowlands, the rainfall is highly unpredictable, and may occur in just a few intermittent thunderstorms, brought on as convectional moisture-

**Map 2.2:** A contiguous landscape of Turkana-Mt. Elgon, greater Ewaso Ng'iro, north-eastern rangeland, and north coastal terrestrial ecosystems, showing elephant density (1978–2012).




*Source: DRSRS Database.*

laden air blows over the heated land. Conversely, potential evapotranspiration (PET) is relatively low in the upper high-rainfall areas, amounting to less than 1,200 mm per year in parts of the catchment area. By contrast, PET is greater than 1,800 mm per year over the dry lowland areas. Except for the Mt. Kenya region, the entire Ewaso catchment has a water deficit of varying seasonal intensity.

The people of the greater Ewaso ecosystem are ethnically diverse. Higher-lying areas (of Meru, Nyeri, and Laikipia Counties) are home to the Meru and Kikuyu, who practise agribusiness side by side with the European ranchers, and the Mukogodo Maasai, who are pastoralists. The Turkana, Pokot, Samburu, Gabra, Rendille, and Boran, who are traditionally pastoralists, inhabit northern areas, while the Boran, Somali, Samburu, and Rendille (all pastoralists), and the Meru and Tharaka (agribusiness) are predominant in the lowlands to the east.

The Ewaso ecosystem faces numerous challenges related to increasing human population, tenure and land-use changes, climate change and variability, land degradation, and diminishing wildlife ranges, as well as insecurity. Land degradation has occurred primarily as a result of changing lifestyles among pastoralists from nomadism to sedentarism; high stocking densities; land sub-divisions, agricultural expansion; deforestation, and the increasing frequency of droughts, all of which have negative implications for biodiversity conservation (Ojwang' and Wargute, 2009).

### 2.2.1(H). Turkana-Mt. Elgon Ecosystem

The Turkana-Mt. Elgon ecosystem in north-western Kenya borders the Republic of South Sudan to the north and Uganda to the west, stretching southward, via Lake Turkana and along the Kerio Valley, to the Kitale area. The ecosystem covers an area of 81,651 km2 within the administrative Counties of Turkana, West Pokot, Trans-Nzoia, and Elgeyo Marakwet.

The ecosystem is made up predominantly of low plains with protruding isolated mountain ranges and hills disposed in a north-south direction. From 900 m above sea level in the north, the plains slope to 369 m above sea level in the east. The mountains in the north rise 1,500–1,800 m above sea level. Loima, the largest massif in the north, forms an undulating table covering 65 $km^2$.

Four prominent geographic features of the ecosystem as a whole are Mt. Elgon in the west, the Lotikippi Plains in the north, the Kaloko/Turkwell gorge, and the Kerio lowlands south of the Lake Turkana/Suguta basin. Sand- and clay-based soils cover much of the terrain, which includes former lakebeds and floodplains. Volcanic rocks derived from various ash complexes and from superficial lava flows cover about one-third of the area. Stone mantles on the plains range from large boulders to fine gravels. The main sources of surface water are Lake Turkana, the Kerio, Tarach and Turkwel Rivers, and numerous seasonal streams. The vegetation is sparse, except on the slopes of the mountains and hills, where high woody cover is prominent, and along the main watercourses, where evergreen or semi-deciduous vegetation occurs. Sparse bushland, dwarf shrubland, and grassland characterize the plains, depending on the elevation. Dominant trees along the rivers include *Acacia tortilis* and *Acacia senegal*.

Nomadic pastoralism is the main land use. Over substantial areas, though, biodiversity conservation is a priority. Recent developments include quarrying (for cement production) and oil exploration. Arable farming is continuing to expand rapidly in the Turkwell and Kerio Valleys through irrigation. Pastoralism based on livestock production (cattle, sheep, goats, camels, and donkeys) forms the main livelihood system, but it faces numerous constraints, including aridity and drought; insecurity due to inter-ethnic cattle rustling and raids; diseases, and problems associated with livestock marketing. Biodiversity conservation is practised mainly in the protected areas, including the Southern Turkana, Nasolot, Rimoi and Chepkitale NRs, and the Mt. Elgon and Saiwa NPs.

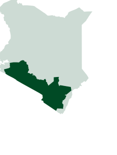
### 2.2.1(I). North-Eastern Rangeland and Coastal Terrestrial Ecosystems

The north-eastern rangeland and north coast terrestrial ecosystems border the Republics of Ethiopia and Somalia, to the north and east respectively, and the Indian Ocean to the south. The ecosystems are predominantly low plains with protruding isolated ranges and hills, within the administrative Counties of Mandera, Garissa, Tana River, Lamu, and Kilifi. Sources of surface water include the Tana River, the Lorian Swamp, and numerous seasonal luggas. Nomadic pastoralism, biodiversity conservation, and arable agriculture are the main land uses. Pastoralism based on livestock production (cattle, sheep, goats, camels, and donkeys) is the main livelihood system. However, this faces numerous constraints, including droughts, insecurity, diseases, and difficulties associated with livestock marketing. Protected areas include the Malkamari, Dodori, Boni, Arawale, and Tana River Primate NRs. Arable agriculture is expanding rapidly, especially along the Tana River delta and on the coastal lowlands.

The Arawale NR covers an area of 533 $km^2$ between the Tana River in the west and the Garissa-Lamu road in the east. The reserve and its surroundings are a critical refuge for a range of wildlife species, including the critically endangered Hunter's hartebeest (*Damaliscus hunteri*) or Hirola (endemic to north-eastern Kenya and south-western Somalia), Grevy's zebra (*Equus grevyi*), wild dog (*Lycaon pictus*), cheetah, topi, buffalo, lesser kudu, giraffe, and occasionally elephant (Bunderson, 1976, 1979, 1985; Kingdon, 1997). There is a small translocated hirola population in the Tsavo East NP. Alarming declines in wildlife numbers in the Arawale NR have been attributed to poaching, competition from livestock, drought, habitat changes (associated with the spread of bushlands, owing to less frequent visits by elephants), and diseases. In the past, banditry and inaccessibility have restricted studies in the region.

The Dodori and Boni NRs are located in the far north of Kenya's coastal region, close to the border with the Republic of Somalia. Gazetted in 1976, the two adjacent reserves cover an area of roughly 2,590 $km^2$, of which the Dodori NR occupies about 877 $km^2$ in extending from the north-east of Lamu County to Kiunga. The vegetation consists of mangrove swamp, lowland dry forest, and marshy glades (Oduori, 1990), and is bisected by the Dodori River, which drains into the Indian Ocean at Dodori creek, a breeding ground for the dugong (*Dugong dugon*). The Dodori NR is a major breeding ground for topi, but a few elephants, buffaloes, giraffes, duikers, and lesser kudus are also found in the reserve. The area is also rich in birdlife.

The Boni NR, covering an area of roughly 1,358 $km^2$, lies south of Garissa County on Kenya's north coast, alongside the border with the neighboring Republic of Somalia. The climate is humid to semi-humid year-round, and the area receives an average rainfall of 560 mm per year. Temperatures range from 20°C to 29°C, and the average relative humidity is 75 %. The sandy soils in this semi-arid area are covered by thick wooded vegetation. The reserve was once a major sanctuary for the east Lamu and south Garissa elephant populations, but nearly all these animals have disappeared in recent times. The Boni people are hunter-gatherers who make use of the reserve for water collection and for gathering wild honey, fruits, and medicinal plants. Their shrines are common in the Boni forest.



The Tana River Primate NR, covering an area of roughly 171 $km^2$, is located in the evergreen/semi-evergreen riverine forest of a floodplain on the Tana River, which flows from central Kenya highlands to the Indian Ocean. The reserve provides the only remaining habitat for two endemic and endangered primate species, the Tana River red colobus (*Procolobus badius*) and the Tana River crested mangabey (*Cercocebus galeritus*) (IUCN, 1976). Other primates protected in the reserve are the yellow baboon (*Papio cynocephalus*), the Sykes monkey (*Cercopithecus mitis albotorquatus*), the vervet monkey (*Chlorocebus pygerythrus*), the greater galago (*Galago crassicaudatus*), and the lesser galago (*Galago senegalensis*). Recent records (Butynski, unpubl.) show that the vulnerable Zanzibar Galago (*Galago zanzibaricus*) is also present. The land surrounding the reserve is occupied by four primary ethnic communities, one predominantly agricultural (the Pokomo) and the others predominantly pastoral (the Orma, Wardei, and Somali).

Arabuko-Sokoke was proclaimed a crown forest in 1932, and was gazetted in 1943. In the late 1960s it was re-gazetted as a strict nature reserve covering roughly 370 $km^2$. The reserve is the largest coastal forest in East Africa and lies a few kilometres inland from the Kenyan coast between Kilifi and Malindi, some 110 km north of Mombasa. Average annual rainfall ranges from 900 mm (in the relatively dry and scrubby north-west) to 1,100 mm (in the east). The relatively flat eastern section lies on Pleistocene lagoon sands and clays, separated from the ridge of red Magarini sands that form the western part of reserve by a wide band of apparently riverine sandy deposits (Robertson and Luke, 1993).

Arabuko-Sokoke is rich in rare and range-restricted wildlife species. Butterflies in the forect include six taxa that are endemic to the East African coast. Three near-endemic mammals – the golden-rumped elephant shrew (*Rhynchocyon chrysopygus*), Ader's duiker (*Cephalophus adersi*, found only in Sokoke and Zanzibar), and the distinctive Sokoke bushy-tailed mongoose (*Bdeogale crassicauda omnivora*) occur in the forest. Elephants (*Loxodonta africana*) are also present. Unusual reptiles include the green keel-bellied lizard (*Gastropholis prasina*), and endemic coastal amphibians include Bunty's dwarf toad (*Mertensophryne micrannotis*) (Drewes, 1997). Robertson and Luke (1993) list 50 plant taxa that are rare, either globally or regionally.

More than 230 bird species have been recorded in Arabuko-Sokoke Forest (Fanshawe, 1995), including 25 of Kenya's 30 African East Coast biome species. Birds found in the forest include the southern-banded snake eagle and Fischer's turaco, which are near threatened, the Sokoke scops owl and the spotted ground thrush, both endangered, Clarke's weaver (vulnerable), and the Sokoke pipit, the East coast akalat, the Amani sunbird, the plain-backed sunbird, Ayres' hawk eagle, the crowned eagle, the African pitta, and the scaly babbler, all of which are regionally threatened.

# Chapter 3

# Understanding Movements and Connectivity

## 3.1. Animal Movements - Dispersal and Migrations

Migration is essential in enabling wildlife species to sustain viable populations that can withstand the vagaries of rainfall patchiness, disease, and predation. Animals may migrate from one area to another, or disperse, in response to two main impulses. First, there are intrinsic factors, such as breeding or avoiding inbreeding; and second, there are external factors, such as drought or floods, wildfires, resource limitation or competition (over food and water, for example), predation avoidance, and diseases (e.g. parasitism and epidemics) (Stenseth & Lidicker, 1992; McEuen, 1993). The ultimate function of wildlife migration or dispersal is enhancement of species survival (Sinclair, 1992).

Migration is defined as the periodic movement of animals from one spatial unit to another, with a return trip (Sinclair, 1992; Stenseth & Lidicker, 1992; Bolen & Robinson, 1995). Regular movements of animals to breeding grounds and/ or in search of food and water occur in response to spatial and temporal variability of rainfall and forage availability in terms of quality and quantity (Bolen & Robinson, 1995). Fryxell & Sinclair (1988) have suggested that large herbivores migrate in response to seasonal variability of available resources as a means to enhancing access to high quality food and reducing the risks of predation.

Dispersal among large mammals leads to the widespread distribution of populations. Animals may move on a daily basis (local resident movement) or change habitat seasonally (migration and dispersal) due to patchiness of resource distribution in their home ranges (Western, 1975; Sinclair, 1992). Western (1975a) recognizes three patterns of animal movement: namely migration, residential movement, and dispersal, where dispersal refers to the wet season spread and dry season concentration within a range. Today, many wildlife populations exist in isolation, and some have have been separated completely, as most of their habitats have been degraded, fragmented, or lost to human activities. Thus dispersal areas and migratory routes or corridors are essential in connecting such habitats and sustaining populations.

## 3.2. Biological Significance of Animal Movements and Theory

The best-documented movement of African ungulates is seasonal migration (Western, 1975a; Sinclair, 1979; Fryxell & Sinclair, 1988). Some migratory wildlife species show considerable movements, while others show strong seasonal concentration and resident movement within their home range. The seasonal dynamics of large herbivores and their habitat use has been widely studied in the Mara-Serengeti ecosystem (Stelfox *et al.,* 1986; Broten & Said, 1995; Ottichilo, 2000; Homewood *et al.,* 2001) and in the Amboseli ecosystem (Western, 1973; 1975).

Ungulates usually migrate in response to seasonal changes in the quantity and quality of available water and forage (Bourliere & Hadley, 1970; Pennycuick, 1975; Frxyell & Sinclair, 1988). However, sometimes they migrate to satisfy the need for access to food resources of better quality (Kutilek, 1979). Seasonal changes in the nutritional quality of forage may also result in forage selection, and serve as a stimulus for movement (Bourliere & Hadley, 1970; Western, 1973; McNaughton, 1979). Some non-migratory ungulates are successful because they utilize a wide range of food resources at specific sites on a seasonal basis (Kutilek, 1979).

Water is an indispensable resource that also regulates the quantity and quality of forage supply, thereby determining the distribution and abundance of wildlife species. Populations of large herbivores may increase or decline dynamically with changing rainfall patterns. High rainfall improves range conditions by enabling rapid vegetation growth and providing ready access to surface water. This may lead to population increases, but excess water in the form of floods may cause population declines, directly or indirectly, through waterlogging and reduced availability of food. In East Africa, the *El Niño* phenomenon of 1998 claimed both human and animal lives through excessive rainfall and flooding.

Droughts have disruptive effects on the vegetation, not only directly, through species selection, but also in lowering primary forage production (Norton-Griffiths, 1979). The increasing frequency of droughts, then, has enormous implications for wildlife movements and population dynamics. Other factors, such as the availability of minerals (Child *et al.,* 1971; Ayeni, 1977; MacNaughton, 1983), predation avoidance, and competition for resources (Hitchcock, 1996) also influence animal movements.

In arid and semi-arid environments, the availability of water determines the survival of many animals. Lamprey (1964) has suggested that access to water is the most important limiting factor to wildlife abundance and distribution on the East African savannahs, especially during the dry season. Most wildlife species concentrate around water sources in the dry season, and spread out during the wet season. The seasonal movement of animals in response to rainfall and food supply is well documented in the Serengeti-Mara ecosystem (Sinclair & Norton-Griffiths, 1979; Maddock, 1979; Sinclair & Arcese, 1995; Ottichilo, 2000), where wildebeest, Burchell's zebras and Thomson's gazelles migrate between their dry season and wet season ranges. The most water-dependent species are grazers, while browsers tend to be relatively water-independent (Western, 1975). Availability of ephemeral water sources during the wet season permits the dispersal of animals (Western, 1975; Ayeni, 1975).

Differences in migratory patterns reflect variations in food requirements. Animals may move to certain areas to obtain protein, energy, or minerals (Kreulen, 1975; MacNaughton, 1976, 1979), but may avoid other areas, owing to floods or drought, or pests such as the tsetse fly. Migration reduces competition between species at critical times of the year, especially among grazers (Maddock, 1979; Hilborn & Sinclair, 1979). Other biological processes that influence herbivore dynamics are competition and predation. Intra- and inter-specific competition occurs where dietary requirements overlap.

The diversity and abundance of herbivore communities in African savannah ecosystems is attributed to resource partitioning, niche differentiation, and spatial and temporal use of habitats through different feeding strategies (habitat preference or selection) (Lamprey, 1963; Jarman & Sinclair, 1979). The feeding strategies of some species enhance food availability for othes through a process of facilitation (Vesey-Fitzgerald, 1960; MacNaughton, 1983), which is evident for instance among mixed herds of migrating wildebeest, Burchell's zebras and Thomson's gazelles (Jarman & Sinclair, 1979; Van de Koppel & Prins, 1998). Movements (annual, seasonal, and daily) of wild and domesticated herbivores lead to systematic exploitation of environmental discontinuities (MacNaughton, 1985; MacNaughton & Georgiadis, 1986; Scoones, 1993).

Predation is a factor in regulating ungulate populations. Among the larger herbivores (e.g. elephant, buffalo, and rhinoceros), food supply, rather than predation, may be primarily responsible for regulating populations (Sinclair, 1985; 1995), owing to the size of these animals and their correspondingly large food needs.

Disturbance through human activities such as encroachment by cultivation and settlements causes natural habitats to shrink, resulting in reduced space for grazing (Sinclair, 1979; Ottichilo, 2000; Homewood *et al*., 2001; Thompson & Homewood, 2002; Lamprey & Reid, 2004). Morrison *et al.* (1992) have noted that no single factor has caused greater declines in wildlife populations than the loss of habitat, and that habitat fragmentation is, for most species, the single biggest threat to population viability. Livestock grazing may also alter the composition and the physiognomy of rangeland vegetation communities at the expense of wildlife. Some plants may decrease with grazing, while others may increase.

## 3.3. Definition and Importance of Corridors

Habitat fragmentation and loss constitute the greatest of all threats to biodiversity (Hanski, 1998). Fragmentation or loss of habitats reduces spaces available to wildlife, and often disrupts wildlife dispersal and migration patterns, leading to changes in the composition of plant communities and the disruption of vital ecological processes. Habitat connectivity helps reduce the adverse impacts of fragmentation. For the continued survival of species, it is necessary to maintain existing wildlife dispersal areas and migration routes/corridors, and to restore previous such areas that have been interfered with or lost.

Corridors reduce the chances of inbreeding and of over-exploitation by predators. The theoretical basis for habitat corridors is grounded in the theory of metapopulation extinction (Richard Levins, 1969; Hanski & Gilpin, 1991; Hanski, 1998); in the theory of island biogeography (McArthur and Wilson, 1967), and in Leopold's law of dispersion put forward in the early 1930s. In biodiversity conservation, connectivity is essential in all landscapes for attaining metapopulation stability and sustainability (Hanski, 1998).

By linking historically connected natural habitats, corridors facilitate movement between areas that may now be isolated (McEuen, 1993). Connectivity is the degree to which a landscape facilitates or impedes movement between resource patches (Taylor *et al.,* 1993, in Bennett, 2003). Wildlife corridors are the prime means of securing habitat connectivity, serving as important conduits that preserve access to the larger habitat, while reducing inbreeding and improving genetic viability. Connectivity also enhances the security of wildlife populations through providing avenues for predation avoidance, while ensuring that essential ecological processes can continue (McEuen, 1993; Bennett, 2003).

Arguments against corridors suggest, among other things, that they might act as avenues for spreading diseases, fires, and predation, while at the same time incurring high management costs (Simberloff *et al.,* 1992). And yet, despite these criticisms, corridors are widely seen as the best option for protecting and conserving wildlife and wildlife habitats (McEuen, 1993). The use of corridors in wildlife conservation and management has proved especially effective in preserving biodiversity in fragmented habitats (Bennett, 2003). Corridors are also important for the maintenance of ecological processes in environments that have been modified by human impacts (Bennett, 2003).

The planning and design of wildlife corridors is of great importance in determining whether or not the corridors will succeed. Several criteria must be taken into account. These include an understanding, in the case of each corridor, of the ecological needs and movement patterns of species that are expected to use that corridor. The ecological needs of species (food and water requirements, shelter, breeding behaviour, predation, and so on) and their movement patterns (dispersal, migration, or home range) will determine what form a particular corridor should take, in terms of habitat cover, and length and breadth, among other considerations (Beier & Loe, 1992; McEuen; 1993; Harrison, 1992; Lindenmayer & Nix, 1992; Bennett, 2003). Provision for management strategies that include monitoring of human activities within wildlife corridors is another important consideration (Bennett, 2003).

## 3.4. Wildlife and People: Conflicts and Conservation

Biodiversity is facing increasingly intense and widespread competition from humanity for space and resources (Pimm *et al*., 1995; Balmford *et al*., 2001). Conflict between people and wildlife is increasing as a result. Some of the large mammals most frequently in conflict with people are either endangered or are of species whose populations and ranges have declined rapidly in recent times (Woodroffe & Ginsberg, 1998; Kanga *et al.,* 2012). Such animals include carnivores (lions and leopards) and mega-herbivores (elephants and hippopotamuses). The African elephant may inflict great harm on people through crop damage or even loss of life, but the demand from people for ivory has simultaneously rendered it highly endangered (IUCN, 2000).

Protected areas, the cornerstone of modern biodiversity conservation, have gone some way towards mitigating human-wildlife conflict (Bruner *et al*., 2001). Such areas have not entirely succeeded, given that it has not always been possible to exclude destructive human impacts (Liu *et al*., 2001). Equally, protected areas often secure only a small part of an ecosystem or species range, making no allowance for dispersal into adjacent rangelands where conflict has increasingly occurred (Woodroffe & Ginsberg, 1998). Even as alternative forms of land use, such as community conservancies, are implemented in a bid to increase space for wildlife and to derive sustainable benefits from the wildlife, conflicts are likely to persist (Roe *et al*., 1997; Goodwin *et al*., 1998).

Wildlife is part of Kenya's national heritage and one of the country's economic pillars. Today, though, in protected areas, wildlife is practically confined. Its protected habitats are surrounded by a human population that is growing rapidly and expanding its settlements and agricultural activites along rainfall gradients. This confinement puts pressure on the resources in protected habitats. As resources dwindle in the protected areas, wildlife species, the large herbivores especially, are compelled to disperse, often across human-dominated landscapes, in search of forage and water. The large carnivores, following the herbivores, often prey instead on livestock, bringing them into conflict with pastoralists. The fencing of protected areas puts further pressure on the resources therein. Most of the larger protected areas are not fenced, so wild animals dispersing from these areas will inevitably come into contact with humans and human activities.

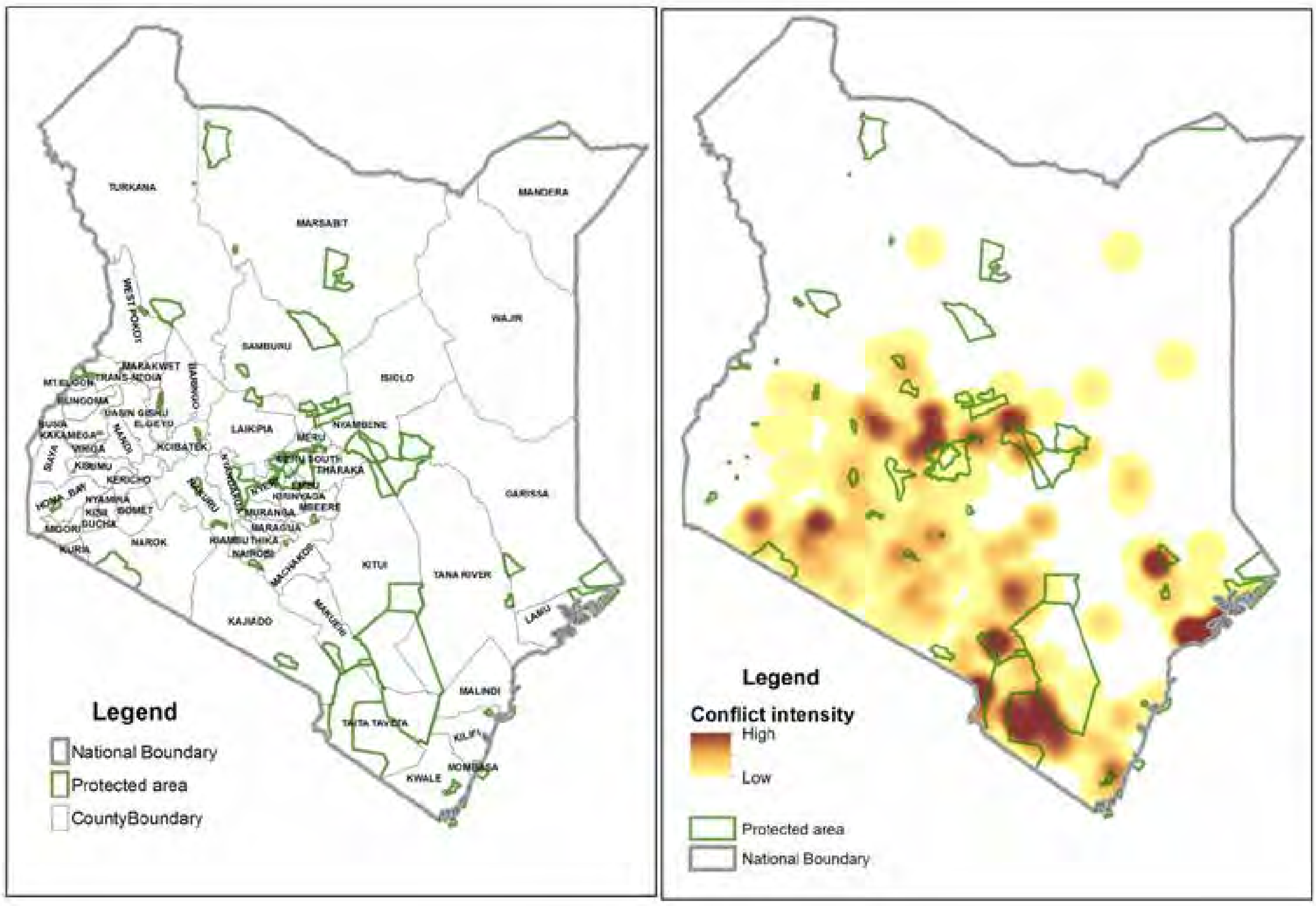
Human-wildlife conflict in Kenya takes various forms, including crop damage, livestock predation, human injury or even death, and zoonotic disease transmission. All these conflicts may lead to animosity towards protected areas and wildlife conservation in general. An analysis carried out by KWS has shown that human-wildlife conflicts are continuing to increase around many protected areas, with 'hotspots' of high intensity observed around Tsavo West-Chyulu, the Masai Mara NR, the Laikipia plateau (near Rumuruti especially), Ol Donyo Sabuk, and in the south-west of Lamu County (Map 3.1).

The key to resolving the problem of human-wildlife conflict around protected areas lies in developing effective strategies for securing wildlife dispersal areas and migratory routes/corridors. Such strategies should include conflict-mitigation measures, the promotion of compatible land uses, and incentives that will encourage community participation in conservation efforts through ensuring that local people benefit from conservation.

## 3.5. Key Wildlife Species

Wildlife corridors are usually designed with umbrella species in mind. In this study, eight key species were selected, namely elephant, wildebeest, Burchell's (plains)

**Map 3.1:** Human-wildlife conflict 'hotspots' in Kenya. Conflict incidences (crop/property damage, livestock predation, human injury/death) and wildlife mortalities among elephant, buffalo, baboon, hippo and crocodile from 2008 to 2010.




*Source: KWS*

zebra, Grevy's zebra, giraffe, buffalo, topi, and oryx. These species represent different feeding ecologies, migration strategies, body sizes, life history characteristics, and vulnerability to human disturbance, in the study areas of the southern and northern Kenya rangelands and the coastal terrestrial ecosystems. Along with livestock, these species all have a significant influence on the ecological dynamics of savanna ecosystems, and play a crucial role in shaping the habitat mosaics that underpin the diversity and abundance of species.

### 3.5.1. African Elephant *(Loxodonta africana, Blumenbach)*

The elephant, the world's largest terrestrial mammal, once populated the entire African continent, including until recently most of sub-Saharan Africa (Mauny, 1956; Douglas-Hamilton, 1979, in AWF, 1996). Today, Kenya's largest remaining elephant populations are in conservation areas in the Tsavo and Mara ecosystems and the Laikipia-Samburu complex. Medium- and low-density populations are still found in unprotected landscapes, where human impacts are diffused over large areas, such as the northern Kenya rangelands. Isolated populations occur in protected highland forests, such as those on Mt. Kenya, Mt. Elgon, the Aberdares Range, and Mt. Marsabit.

The African elephant is a charismatic and gregarious animal, living in herds of 10-50 animals and spending about 16 hours a day feeding. It has a life expectancy of 60 years. Males may weigh as much as 6 tons (6,000 kg), and females 2.7 tons (2,700 kg). The gestation period is 20-22 months. Calves, born throughout the year, weigh about 120 kg at birth and are weaned at 3-8 years of age. A cow can give birth every 3-4 years. Elephants are generalized herbivores (mixed feeders) relying on widely distributed resources. Although mainly browsers, they feed on grass, leaves, twigs, terminal shoots, bark, roots, fruits, and flowers (Archie *et al*., 2006; Osborn, 2005; Rode et al., 2006; Wittemyer *et al*., 2007; Feldhamer *et al*., 2007). Elephants require a large home range to satisfy their huge nutritional demands (Galant *et al*., 2006; Jackson and Erasmus, 2005; Whitehouse and Schoeman, 2003). Their daily forage intake is between 4 % and 7 % of body weight, and they may drink as much as 160 litres of water a day. They occur in woodlands, forests, wooded shrubland, and wooded grassland habitats (Simberloff, 1998). They play an important ecological role in savannah and forest ecosystems and they maintain suitable habitats for numerous species (Stephenson, 2007). Their habit of stripping bark from trees and pulling down trees to access fodder modifies vegetation dynamics, leading to the creation of savannah-woodland mosaics (Richmond-Coggan, 2006).

Plate 3.1: Matriach elephant and young crossing a stream. Photo: courtesy Michael Nichols.

In Kenya, the elephant's range covers some 109, 071 km², of which almost 80 % is outside protected areas (Hoare, 1999; Blanc *et al*., 2003). Apart from being widely distributed on the Kenya rangelands, elephants are also found in colder highland areas such as the Mt. Kenya Forest, the Mt. Elgon Forest, and the Aberdares Range. The elephant population in eastern Africa is believed to be increasing as a result of improved conservation and security measures (Blanc *et al*., 2005; Poole *et al*., 1992). In the late 1960s, Tsavo's estimated elephant population was 35,000–40,000 animals (DRSRS data; Poole *et al*., 1992). About 6,000 of these elephants died during the severe drought of the early 1970s (Leuthold and Sale, 1973; Ottichilo, 1981). By 1980, poaching had reduced the remaining population drastically, to no more than about 12,000 animals, declining further in the 1980s to 5,363 animals (KWS; DRSRS; Douglas-Hamilton *et al*., 1995). Elephant numbers have shown a marked increase since the early 1990s, to 10,397 animals in 2005 (KWS counts).

Elephant populations are considered to be vulnerable and to be faced with an increasingly threatened future (African Elephant Specialist Group, 2004), as their survival depends largely on adequate protection and on the availability of extensive habitats free from human habitation (Biru and Bekel, 2011). Reductions in the range of elephants as a result of habitat encroachment by agriculture has aggravated human-elephant conflict in many regions (Afolayan, 1975; Kasiki, 1998). Elephant populations have declined in many regions due to land-use change (loss of habitat and fragmentation), droughts, and poaching for ivory (Feldhamer *et al*., 2007; Hoare and Du Toit, 1999; Areendran *et al*., 2011). Escalating human population growth poses a major challenge for the conservation of elephants, which are directly threatened by burgeoning human activities (including high-density settlements, the expansion of agriculture, increased livestock numbers, the burning of charcoal, wild fires, fences, and the depletion and pollution of water sources.

### 3.5.2. Wildebeest *(Connochaetes taurinus mearnsi)*

The blue or common wildebeest is a large antelope that can attain a body mass of 168-274 kg. Wildebeest are territorial, highly gregarious in mobile aggregations, or dispersed in sedentary herds (Estes, 1991). Females reach sexual maturity at age three, and males at age four. The gestation period is about 8.5 months. Calves are able to stand within seven minutes of birth and can run with the herd in less than two hours. Wildebeest are water-dependent, requiring a long drink every day or two, and they must have access to water within a 15-25 km radius. They have blunt muzzles, equipped for biting short green grasses, usually on alkaline or volcanic soils.

Wildebeest often graze alongside other species, including Burchell's (plains) zebra, Thomson's gazelle, Grant's gazelle and kongoni, for mutual protection. Most wildebeest migrate seasonally (often with zebras), but some remain behind as residents. Their migration generates, through grazing activities, optimal conditions for other species, in a process known as 'facilitation' (Bell, 1970, 1971; Prins

**Plate 3.2:** Breeding and foaling every year keeps wildebeest numbers up, generation after generation. Predators and scavengers get easy meals from stranded calves.

and Olff, 1998). The interaction with zebras is particularly beneficial, as the zebras mow down the taller grasses, leaving the wildebeest to forage on the newly exposed, nutritious shorter grasses which they prefer.

In East Africa, the wildebeest's range borders on Lake Victoria in the west and on the low, arid *Acacia-Commiphora* bushland areas east of the high plains (Estes, 1991). Wildebeest are found in open, shrub- and bush-covered savannahs, thriving in areas that are neither too wet nor too arid. They occur in open woodlands and on floodplains, but they prefer grasslands, which they sometimes overgraze. Large herds numbering in the hundreds of thousands may be observed in the Serengeti equatorial plains of Tanzania during their annual migration to Kenya's Mara region. The Serengeti boasts more than 1.4 million wildebeest. Migratory herds of wildebeest range over an area of 30,000 km$^2$, moving from the short grass plains in the dry season to seek higher grasses in wetter areas. Grasslands bordering alkaline lakes or pans are their preferred dry season habitat.

In Kenya, wildebeest are found in Narok and Kajiado Counties, where they occur both inside protected areas, such as the Amboseli NP, the Nairobi NP and the Masai Mara NR, and outside, on communal lands. The wildebeest's range has shrunk over the decades, and their populations have declined, as a result of changing land uses outside protected areas (expansion of agriculture, high livestock densities, settlements, and fences).

The Mara ecosystem's resident population has declined drastically since the 1970s, owing to land-use change, particularly as a result of mechanized large-scale wheat farming in the Ngorengore area (Serneels and Lambin, 2001; Ogutu *et al*., 2009). Populations in the Nairobi NP, the Athi-Kaputiei plains and Amboseli nearly crashed in the 2009 drought, which also affected other large wild grazers and pastoralist livestock.

### 3.5.3. Burchell's Zebra *(Equus burchelli, Gray)*

The plains or Burchell's zebra is a common species throughout East Africa, where numbers may reach 0.6 million (Thirgood *et al*., 2004). Individuals weigh up to 350 kg, with males slightly larger than females. Plains zebras are highly social and live in groups ('harems') consisting of one stallion and up to six mares and foals. Bachelor males either live alone or in bachelor groups until old enough to challenge a breeding stallion. Adults drink at least once a day, but lactating females may require two daily trips to water points. This limits their range to the vicinity of reliable water sources (Coe, 1972).

The plains zebra typically inhabits wooded grasslands, feeding almost exclusively on grasses, which make up 90 % of its diet (Gwynne & Bell, 1968; Lamprey, 1963; Grubb, 1981), but occasionally eating shrubs, herbs, twigs, leaves, and bark. Plains zebras tend to be the first grazers to move in the grazing succession, thereby opening up the herb layer for other grazers. They show low selectivity, relative to other grazers such as wildebeest and kongoni (Grubb, 1981). On the Athi-Kaputiei Plains, they eat 17–20 species of grass, with greater variety during the dry season (Casebeer and Koss, 1970).

Plains zebras are found in cooler environments with abundant water from sea level to over 4,400 m a.s.l., avoiding only deserts, dense forests and permanent wetlands (Coe, 1972; Hack *et al.,* 2002). Most populations migrate seasonally, travelling hundreds of kilometres annually to track vegetation flushes caused by rainfall, as

**Plate 3.3:** Group of Burchell's zebra. *Photo Courtesy: AWF/Philip Muruthi*

in the case of the Serengeti-Mara migration (Maddock, 1979). However, some individuals remain behind as year-round residents. In Kenya, plains zebras are found in Narok, Nakuru, Kajiado, Machakos, Kitui, Taita-Taveta, Tana River, Garissa, Kwale, Kilifi, Lamu, Laikipia, Samburu and Isiolo Counties, with the highest concentration in the Mara and Tsavo ecosystems (Ogutu et al., 2016).

### 3.5.4. Grevy's Zebra *(Equus grevyi)*

Grevy's zebra is the largest wild equid in Kenya and is the most endangered of three zebra species (the other two are the plains zebra, *Equus burchelli*, and the mountain zebra, *Equus zebra*). Early records of Grevy's zebra distribution in Africa indicate that the species was widely dispersed across the Horn of Africa, including in Djibouti, Eritrea, Somalia, Ethiopia, and Kenya, and with reported sightings in Sudan (Kingdon, 1997). Their range has subsequently undergone one of the most substantial reductions of any of the larger mammals. Today's remaining population persists only in parts of northern Kenya (home to 1,700–2,800 animals), and in Ethiopia (100–250), where they are legally protected.

Grevy's zebra is listed as endangered by the IUCN/SSC Equid Specialist Group (IUCN, 2003), but this status is under revision (Moehlman *et al.*, 2008), which may result in a critically endangered listing. Grevy's zebra is listed on Appendix I of the Convention on International Trade in Endangered Species (CITES), which accords the species the highest level of protection against trade. The species is legally protected in Ethiopia, and since 1977 it has been protected by the hunting ban in Kenya. The Kenyan government is currently revising the species' conservation status from 'Game Animal' (under the first schedule, Part II, in CAP 376 of the Wildlife Conservation Management Act) to 'protected animal'.

Kenya's Grevy's zebra population suffered a catastrophic decline both in numbers and in the extent of its range between the 1970s and the 1990s. During this time, the population plummeted from an estimated 15,000 animals to fewer than 2,500 (Wargute and Said, 1988). The decline in Kenya, as in other parts of its natural range in eastern Africa, was mainly due to poaching, habitat degradation and habitat loss. Recent population estimates for Grevy's zebra in Kenya range from 1,700 to 2,800 animals, and mainly occur in the Laikipia, Samburu and Isiolo landscapes, with two sub-populations having been introduced to Oserian (Kajiado) and to the Tsavo West NP. A large population that once roamed the Marsabit, Garissa, and Wajir Counties has been reduced to infrequent sightings of about 15 animals near Garissa.

The rapid decline in the Grevy's zebra population was initially catalyzed by the demand for their skins by fashion houses, and subsequently compounded by game control policies that removed wildlife in preparation for cattle ranching. More recently, poaching for skins and oils (thought to have medicinal properties), along with habitat

**Plate 3.4:** Grevy's zebras in morning light. *Photo Courtesy: Margaret Kinnaird*

degradation and loss, and competition with pastoralist livestock for grazing and water resources have been the major threats facing the species.

The giraffe is the largest and tallest ruminant, standing at 5-6 m. Males may weigh as much as 1,200 kg, and females 830 kg. Giraffes are noted for their extremely long necks and legs, and for their prominent horns. Adult do not have strong social bonds, although they do gather in loose aggregations if they happen to be moving in the same general direction. The males establish social hierarchies through 'necking', which are combat bouts wherein the neck is used as a weapon. Dominant males gain mating access to females, which bear sole responsibility for raising young.

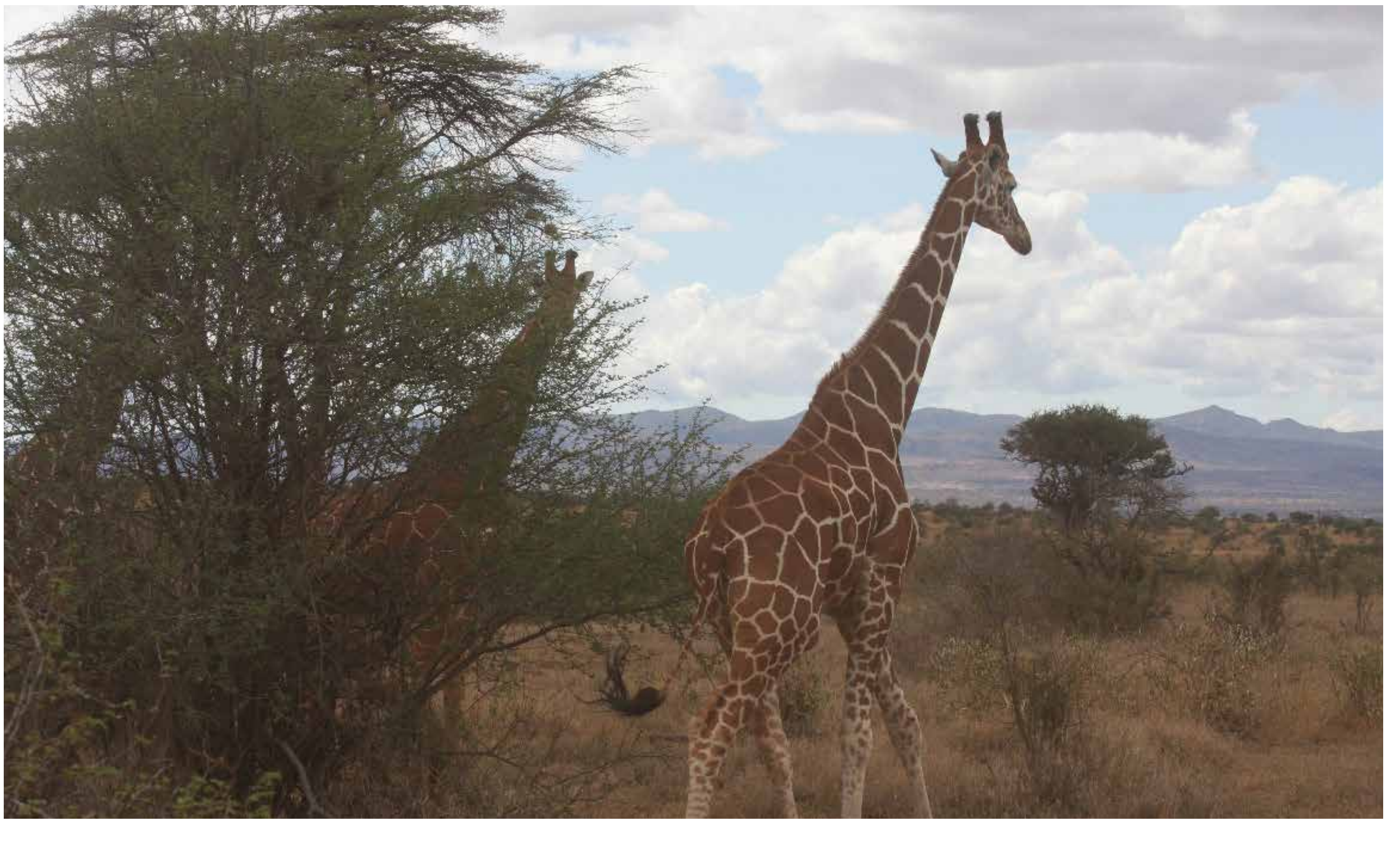
The giraffe is an ideal species for examining the feeding ecology of animals because it can reach high foliage unavailable to most other herbivores. In being primarily a browser, the giraffe inhabits open woodlands and wooded savannahs and grasslands. Giraffes traverse large distances within their home ranges and use a wider variety of vegetation types than most other browsers, consuming plants of more than 20 species (Parker & Bernard, 2005). They prefer the leaves of leguminous plants and particularly the foliage of members of the genus *Acacia* (Leuthold and Leuthold, 1972; Field and Ross, 1976; Kok and Opperman, 1980).

Three of the nine subspecies of giraffe found in Africa occur in Kenya. The Maasai giraffe occurs in southern Kenya (in the Mara, Athi-Kaputiei, Amboseli and Tsavo ecosystems, as well as throughout Tanzania). The reticulated or Somali giraffe is native to north-eastern Kenya, southern Ethiopia and Somalia. Rothschild's giraffe, once widely distributed across western Kenya (as well as in parts of eastern Uganda and South Sudan), now survives in only a few isolated pockets of habitat.

The Maasai giraffe's Kenya population is fairly stable, relative to the other subspecies, although reports highlight rapid declines in recent years (KWS website). Data on numbers and range for the reticulated giraffe are limited and incomplete, but indications are that as few as 3,000–5,000 individuals may now remain in the wild, and that numbers are declining rapidly. In Laikipia, studies have shown a population decline from 6,398 animals in 1977 to 2,903 in 1997 (KWS, 1998). Kenya's giraffe population as a whole numbered some 100,000 animals in the 1970s, but began to decline in the 1980s. Today's estimated population stands at 25,000 animals, with the steepest declines observed in Marsabit and Samburu Counties. Giraffes are killed for their meat and their skins, which are used for making water containers.

Rothschild's giraffe is the second most endangered of all giraffe subspecies. Fewer than 670 individuals remain in the wild. Having been extirpated from much of its former range in western Kenya, eastern Uganda and South Sudan, the subspecies now survives only in a few small and isolated populations. Kenya is home to almost 60 % of the global population of wild Rothschild's giraffes. The

**Plate 3.5:** Reticulated giraffe in the Laikipia plateau. *Photo Courtesy: Kes Smith*



Ruma NP has the country's single largest sub-population (130 individuals). The Lake Nakuru NP has 65 individuals, the Soysambu Conservancy 63, and the Kigio Wildlife Conservancy 32. Various other places, including Giraffe Manor in Karen, the Mount Elgon NP, Murgor Farm in Iten, the Mwea NR, Sergoit-Kruger Farm in Iten, Kitale Farm, and the Nasalot GR have populations of fewer than 20 individuals (KWS website). The giraffe is still classified as being of least concern (IUCN). However, it has been extirpated from many parts of its former range and some subspecies are now classified as endangered. Kenya's giraffe population has declined sharply in all rangeland counties (Ogutu *et al*., 2016).

### 3.5.6. African or Cape Buffalo *(Syncerus caffer)*

The African or Cape buffalo (*Syncerus caffer*) is a large bovid standing up to 1.7 m at the shoulder and with a body length of about 3.4 m. Adults weigh 500-900 kg, with males normally larger than females (Nowak, 1991; Estes, 1991). Both sexes have horns, of variable size and shape. Buffaloes may breed throughout the year, but births tend to be seasonal where rainfall is limited (Nowak, 1991). They are highly gregarious, living in mixed herds of 20-40 animals, but sometimes form large herds of several hundred (Withers and Hosking, 2000; Estes, 1991). Within the herds are a number of smaller social groups made up of several females and their most recent offspring (Buchholtz, 1990; Nowak, 1991). The African buffalo is active throughout the day, spending 18 hours moving and foraging. Herds usually drink in the morning and at dusk. Buffaloes are grazers, preferring areas close to water sources, where they feed on grasses, herbs, swamp vegetation, and occasionally browse on leaves (Buchholtz, 1990; Nowak, 1991; Kingdon, 1997; Wither & Hosking, 2000). Preferred grasses include species in the genera *Cynodon*, *Sporobolus*, *Digitaria*, *Panicum*, *Heteropogon*, and *Cenchrus* (Kingdon, 1997).

Buffaloes can subsist on grasses that are too tall and too coarse for most other ruminants. They are also less partial to tender young shoots than most other grazers. As a consequence, buffaloes play a pioneering role in the savannah grazing succession, reducing grassland to heights that are preferred by more selective feeders. Seasonal changes in vegetation quality and water availability influence buffalo movements and feeding habits. Typical buffalo habitats include thickets, reeds, and forests, although herds may also live in open woodlands (Estes, 1991; Buchholtz, 1990; Nowak, 1991; Kingdon, 1997).

Buffaloes are highly mobile, and rarely linger on trampled or depleted pasture, as long as good stands of grass are available within their range (Sinclair, 1977). They tend to be non-migratory, inhabiting a range that is largely exclusive to the group (Nowak, 1991). Their home ranges vary in size from 126 $km^2$ to 1,075 $km^2$, depending on herd size and resource availability (Estes, 1971). The African buffalo is increasingly threatened by land-use changes, habitat loss and fragmentation, droughts, and hunting pressures (Kingdon, 1997; IUCN Antelope Specialist Group, 2008).

**Plate 3.6:** A herd of buffaloes in Tsavo East NP. *Photo Courtesy: AWF/Philip Muruthi*

**Plate 3.7:** Fringe-eared oryx *Photo Courtesy: AWF/Philip Muruthi*

### 3.5.7. Beisa Oryx *(Oryx beisa beisa)* & Fringe-eared Oryx *(Oryx beisa callotis)*

The East African oryx (*Oryx beisa*) is an antelope with two subspecies: the common beisa oryx (*Oryx beisa beisa*) found in the arid bushland and grassland throughout the Horn of Africa and north of the Tana River, and the fringe-eared oryx (*Oryx beisa callotis*), which occurs south of Tana River and in southern Kenya and southern Tanzania. The East African oryx feeds on grasses, leaves, fruit, and buds. These animals are able to store water by raising their body temperatures to avoid perspiration. They gather in herds of five to 40 animals, often with females moving in front and a large male bringing up the rear. Some older males are solitary.

The oryx formerly occurred widely in semi-arid and arid bushlands and grasslands. The oryx population has declined significantly, and its range has also shrunk. A few groups are still found around the margins of their historic range, in unprotected areas of the northern and eastern Kenya rangelands, where human and livestock densities are low. The beisa and fringe-eared subspecies are separated by the Tana River. The largest surviving populations of beisa oryx are in Kenya's northern rangelands. Major sub-populations occur in the rangelands of Marsabit and Wajir Counties and in the Sibiloi NP. The fringe-eared oryx is most abundant in the rangelands of Kajiado and Kilifi Counties, and in and around the Tsavo NPs, although numbers have decreased markedly since the 1970s.

### 3.5.8. Topi *(Damaliscus lunatus)*

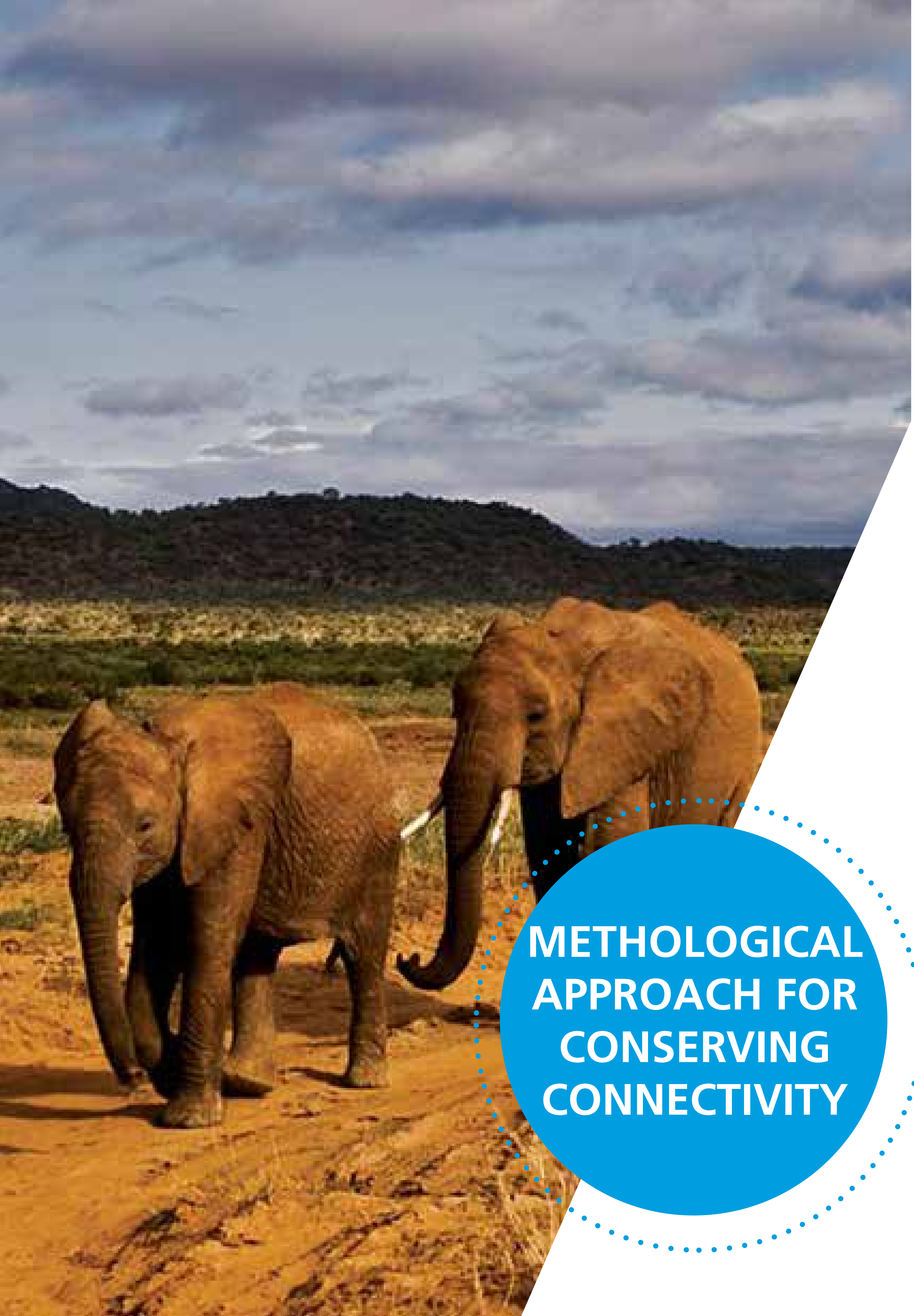
Kenya's topi population is confined to three geographically distinct regions: the Sibiloi NP in Marsabit County; the Mara Ecosystem in Narok County, and the coastal area straddling Lamu, Garissa and Tana River Counties. The Narok population is decreasing for unknown reasons, but the other two populations are apparently stable. Topi occur at moderately high densities in the Sibiloi NP (where they are known as tiang'), and in the Boni and Dodori NRs (coastal topi), as well as in the Masai Mara NR and Ruma NP (western topi).

Topi are grazers and highly social antelopes. They resemble hartebeest (kongoni), but they are darker in colour and do not have sharply angled horns. Males tend to be larger and darker than females. They are extremely gregarious and live in herds of 15–20 animals, although in some places it is possible to see herds of hundreds. Their social structure is flexible, with sedentary populations displaying the usual residence pattern: a small herd led by a dominant male. During the migratory period, large numbers of topi may congregate indiscriminately. They are selective feeders, using their narrow elongated muzzles

**Plate 3.8:** Topi grazing in a shrubland clearing. *Photo Courtesy: AWF/Philip Muruthi*

and flexible lips to forage. They live primarily in grasslands on open plains or in savannahs, but they also occur along woodland fringes and in shrublands, utilizing tree cover in hot weather. Topi forage solely on grasses, preferring swards of medium length. In the dry season, they tend to congregate near water sources, where the grass cover is least depleted.

Topi have a wide but patchy distribution. They favor floodplain habitats, but they are sometimes also found in dry savannahs and open, grassed woodlands. Hunting and habitat degradation have isolated their populations. Cattle and other grazers out-compete them in their dry season grazing ranges. The topi's main predators are lions, leopards, cheetahs, and spotted hyenas, as well as jackals, which feed on their newborns. Among antelopes, topi tend to suffer a relatively low predation rate.



# METHOLOGICAL APPROACH FOR CONSERVING CONNECTIVITY

# Chapter 4

# Methodological Approach for Conserving Connectivity

## 4.1. Overview

The development of a clear, concise, repeatable and robust methodology for conserving habitat connectivity is one of the key steps in maintaining and preserving biodiversity. In this study, we outline a methodology for developing a sustainable, collaborative and integrated strategy to protect Kenya's unique natural heritage through connectivity conservation. The methods described below build on expert knowledge and on the experiences of conservation practitioners around the world, while recognizing the unique challenges and opportunities within the country. At the heart of the proposed conservation connectivity framework is an iterative and shared process that seeks to balance human development priorities with the goal of maintaining healthy ecosystems, biodiversity and natural capital as the essential foundation for human well-being.

This chapter describes the general methods proposed for mapping wildlife dispersal areas and migratory routes/ corridors across the country. There is less emphasis on the details of generating the datasets, although appropriate references are provided.

## 4.2. Conservation Connectivity Framework (CCF)

The mapping process has adopted varied methodologies to meet the specific objectives outlined in Chapter 2. The proposed Conservation Connectivity Framework (CCF) is based on a collaborative and consultative strategic process bringing together a variety of data sources, including sample and total wildlife counts, high-resolution telemetry, habitat status and expert scientific and local indigenous knowledge, into a flexible, iterative and adaptive process (Fig. 4.1). Described below are the key steps in the identification, development and implementation of this strategy.

### 4.2.1. Establishing the Context and Purpose – Need for Connectivity

The first step in mapping wildlife dispersal areas and migratory routes/corridors is to establish the context and purpose for conservation connectivity. Landscape patterns that promote connectivity for species, communities, and ecological processes are crucial in areas suffering from the effects of human activities. Bennett (2003) suggests that emphasis be placed on the values of connectivity, rather than on the corridors themselves. The concept of connectivity relates to how the spatial arrangement and quality of elements in a landscape affect the movement of organisms among habitat patches (Forman, 1995).

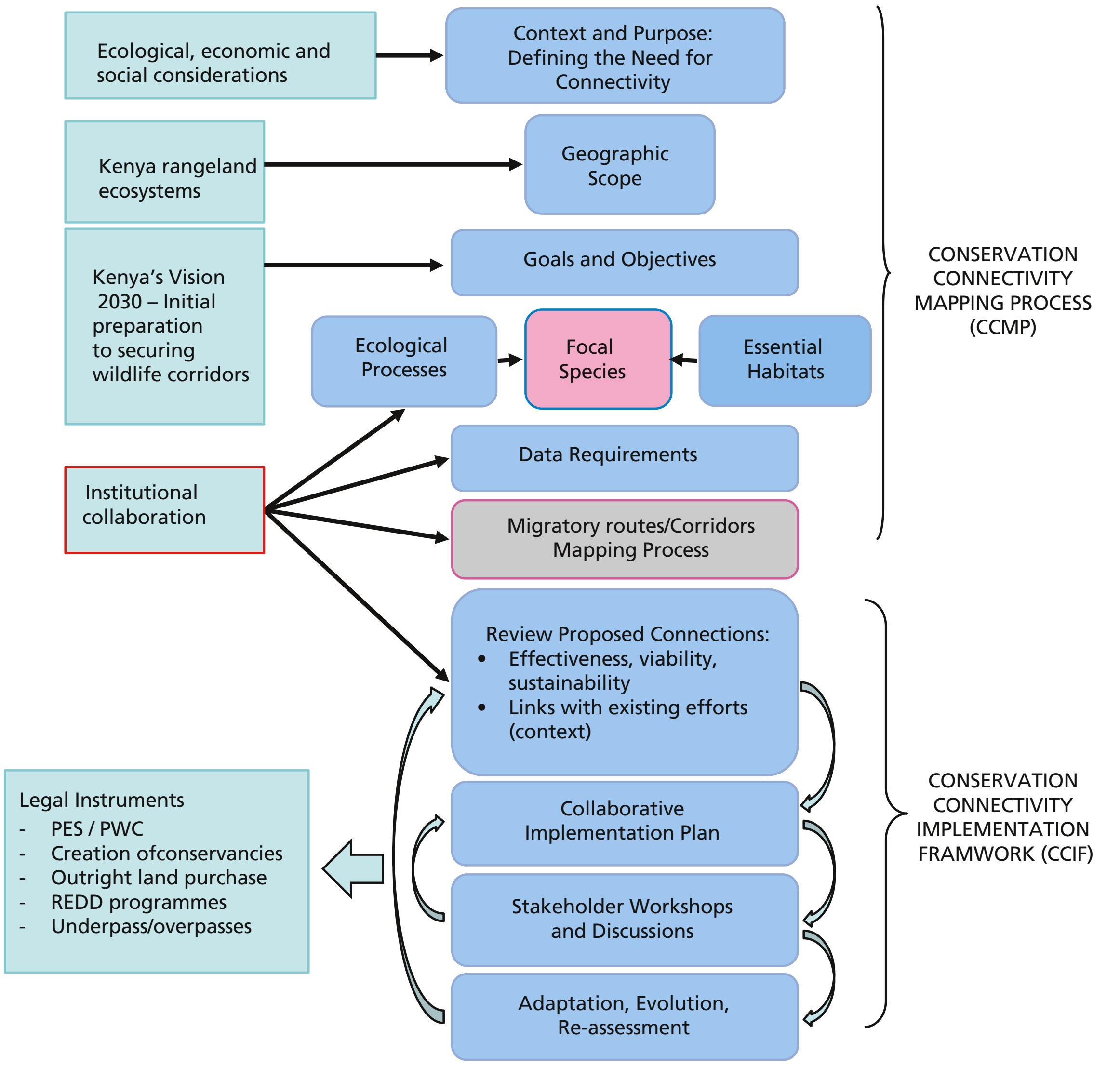
At the landscape level, connectivity is "the degree to which the landscape facilitates or curtails movement among resource patches" (Taylor *et al.*, 1993). Different species perceive a landscape differently; therefore the degree of connectivity varies between species and among communities. A landscape or local area with high connectivity is one in which individuals of a particular species can move freely between areas of suitable habitat with favoured types of vegetation for forage, or where different habitats are required for forage and for shelter. A landscape with low connectivity is one in which individuals are severely constrained from moving between selected habitats (Bennett, 2003). While the effects on ecological processes of enhanced connectivity between essential habitat patches and ecosystems has been noted, it is still not clear how these might affect:

i. Genetic diversity through enhanced gene flow, and overall meta-population survival in connected patches that provide refuge for herbivores, but which are subject to predation;

ii. Buffering of population fluctuations due to seasonal and inter-annual variations in conditions, and accommodation of range shifts necessitated by climate change and variability.

Beyond the ecological reasons for establishing connectivity, it is critical to establish its social, economic, and political imperatives. In Kenya, the government and other stakeholders have recognized the need to promote ecological linkages for conservation and socio-economic development. Thus, the initiative to *secure wildlife dispersal areas and migratory routes/corridors* was identified in the Vision 2030 national strategic plan.

**Figure 4.1:** Conservation Connectivity Framework (CCF) is an iterative and collaborative process for the mapping of wildlife migratory routes and corridors




Provision of security in wildlife areas is beyond the scope of this study, but the identification and mapping of dispersal areas and migratory corridors outside protected areas is a major step towards the reclamation and maintenance of such areas. The mapping process has been a collaborative effort, involving various government departments, conservation agencies, and local communities living alongside the protected areas. This has been done in the wider context of ongoing projects in Kenya's biodiversity programme, including the national biodiversity atlas, land reforms, development of land-use policy, the national spatial plan, climate change mitigation, and compilation and review of Kenya's natural capital. Furthermore, connectivity conservation has enormous social and economic benefits in that it supports key ecological processes that provide the essential ecosystem goods and services on which environmental sustainability depends. It also plays a role in reducing human-wildlife conflict, for example in allowing pastoralist livestock production in wildlife grazing areas where compatible multiple land-use options are practised.

### 4.2.2. Geographical Scope

The second step is to delineate the geographical scope of the study. Inherent in this process is the recognition that conservation connectivity is a multi-scale phenomenon with unique challenges and opportunities across different scales. This study highlights the importance of a multi-scale approach to conservation connectivity involving landscapes with contiguous ecosystems. Chapters 5 and 6 present the results and provide recommendations based on analyses on the status of wildlife, and the threats to habitat connectivity and linkages across the entire study area, on the regional and ecosystem scales.

The CCF employs a hierarchical approach to assess patterns and processes on three spatial scales: national, regional, and site level. This is in order to achieve, effectively, the overall goal of defining and implementing a National Strategy for Conservation Connectivity (NSCC). The conservation connectivity assessment for the northern Kenya rangelands and the coastal terrestrial ecosystem have been developed with a particular focus on the greater Ewaso Ecosystem, the Turkana-Mt. Elgon ecosystem and the north-east Kenya rangelands and North Coast ecosystem (see Chapter 2).

### 4.2.3. Defining Goals and Objectives – Components of Connectivity (Species, Habitats and Processes)

The CCF not only provides a process for building linkages within today's context, but also recognizes the importance of historical and future scenarios. Indeed, effective connectivity strategies often require that historical connections be restored, and that the impacts of future changes in climate and land use be taken into consideration. Similarly, an effective long-term strategy for conserving biodiversity and natural capital through enhancing linkages has to look beyond the large mammals. The large mammals play an important role in determining the structure and function of East African ecosystems, and they also make an important contribution to Kenya's economy, but they are only one facet of our diverse natural heritage.

This report highlights a strategy for securing wildlife dispersal areas and migratory routes/corridors interfered with by human activities in the northern Kenya rangelands and the coastal terrestrial ecosystem. The CCF recommends a gradual extension of the exercise to include a comprehensive assessment of the following three primary ecological components: 1). Biodiversity; 2). Habitats and Ecosystems: natural features of particular importance as movement facilitators; key resource areas with essential minerals, water, dry season grazing, calving and breeding grounds; habitat mosaics and heterogeneity, and rare and endangered habitats; and 3). Ecological Processes, including water and nutrient cycles, carbon sequestration, and the role of species movements.

The CCF is a step-by-step, evidence-based collaborative process using diverse datasets and expert scientific and local knowledge to design linkages for sustainable ecological futures. An essential component of the framework is the recognition of flexibility and of the role of uncertainty associated with land use and climate change and variability. The CCF process involves the identification of current, historical and potential future areas of ecological importance; patterns of species movement and flow, and threats and opportunities – all with the goal of ensuring sustainable connectivity.

This framework addresses the status, trends, interactions, and spatial configuration of the following principal elements: wildlife core areas, important areas, dispersal areas, and linkages. For example, in a model corridor consisting of transitional habitat and facilitating dispersal and migration movements of passage species only, length and optimal width are critical parameters. Increasing the length and width beyond optimum levels reduces the chances of dispersers reaching a connected patch (McEuen, 1993).

Other essential elements of any conservation connectivity design include the assessment of linkage attributes such as habitat/matrix interactions, boundaries and edge effects, and movement barriers. In addition, the design process has to prioritize species' needs in making viability and sustainability assessments of proposed linkages. A critical examination of the potential challenges, risks, and negative impacts of connectivity, such as the spread of invasive alien species, source-sink population dynamics, and disease transmission, as well as the need to maintain local genetic variation, is also essential. Finally, the CCF advocates full recognition and evaluation of key social, political, and economic costs and benefits.

### 4.2.4. Ecological Components

Sustainable long-term conservation of biodiversity and of the ecosystem benefits derived from natural resources requires a comprehensive assessment of conservation connectivity based on three main ecological components: status of biodiversity, status of key habitats, and interaction of ecological processes. Five focal species – elephant, wildebeest, Burchell's zebra, giraffe, and buffalo [Box 1] – were selected to represent the different feeding ecologies, migration strategies, body size, life history characteristics, and vulnerability to human disturbance. All are influential in driving the ecological dynamics of ecosystems, and play a critical role in shaping the habitat mosaics that underpin species diversity in the northern Kenya rangelands and coastal terrestrial ecosystem.

Given the challenges of arriving at a comprehensive assessment for all species utilizing movement corridors, selection of the above-named species was based on the following criteria: considered either a flagship, keystone, or umbrella species; breadth of range (wide or narrow), and sensitivity to habitat fragmentation. Other considerations include abundance and distribution in critical habitats; persistence in specific habitats; diminishing range; movement patterns, and life history traits.

### 4.2.5. Data Needs and Requirements

The design, development, and implementation of effective conservation connectivity require a variety of datasets on multiple spatial and temporal scales. The following section outlines some of the general requirements for a sustainable connectivity strategy, including some of the key information needs. The inherent flexibility and adaptive nature of the CCF also recognizes the importance of bringing together unique and unusual datasets in devising novel approaches. Data requirements are determined by the goals and the objectives of the study (see Chapter 2).

A comprehensive conservation connectivity analysis is a multi-step process that includes: 1) mapping of the abundance, distribution, and movement patterns of the focal species; 2) assessment of their habitats; 3) assessment of known threats and opportunities; and 4) combination of the above into a connectivity viability and prioritization layer. Where possible and appropriate, each of these steps may be supported by modelling to identify potential future land uses that are compatible with biodiversity conservation, and which are resilient to the effects of climate change.

Datasets used in the mapping of conservation connectivity in the northern Kenya rangelands and coastal terrestrial ecosystems include:

- Abundance and spatial distribution of wildlife and livestock populations (sample, total, and ground counts), and trends;
- Habitat characteristics including vegetation cover types (natural and modified), and water bodies;
- Biophysical attributes, including elevation/terrain models;
- Socio-economic and political factors, including historical and current land use (specifically nomadic pastoralism, agro-pastoral, ranching, crop cultivation); infrastructure developments (roads, towns, railways, airports); demography and settlement, and administrative boundaries
- Conservation boundaries including parks and reserves, conservancies and ranches;
- Historical and current movement patterns of focal wildlife species based on GPS collar telemetry;
- Wildlife movement barriers and obstructions such as fences, highways, and agricultural landscapes;
- Climate change and variability; and
- Expert scientific and local knowledge

i. *Species abundance, distribution and movements*
Identification of credible datasets was critical. Various government institutions and conservation stakeholders provided most of the required information, including data on wildlife population numbers and spatial distribution on different scales, as well as movement patterns determined through GPS radio-collar telemetry.

ii. *Socio-economic and political*
Socio-economic and political data relating to infrastructure, agriculture, conservation area boundaries, and demography, among other things, were assembled from topographic basemaps (Africover, 2008; KWS, AWF, KNBS), in order to establish impacts on wildlife areas.

iii. *Animal movement and migration patterns*
The initial step was to assemble data on historical and current movement patterns from scientific literature, expert knowledge (telemetry and field observation) and local knowledge, and to establish and verify conservation connectivities, while highlighting important linkages not reflected in other data. This report presents preliminary information on movement pathways, but further research and consultation will be required. As noted elsewhere, an essential next step will be an inclusive, collaborative process of engaging experts to revise and update the information.

iv. *Barriers and obstructions*
Barriers and obstructions are species-dependent. Impediments identified in this report are based on information on infrastructure from topographic basemaps and from detailed maps of fences and property boundaries (land sub-divisions) from topo-cadastre. Agricultural landscapes also act as a barrier in restricting species movements and distribution.

v. *Land cover/use*
The assessment of land use focused on the distribution of agriculture across the northern Kenya rangelands and the north coast region as a major variable affecting wildlife movement, while at the same time being responsible for most human-wildlife conflicts. The viability of core dispersal and linkage areas was also assessed. Data on the distribution of agriculture was derived from Africover (2008). Further information is needed, however, to supplement this aggregated national dataset through inclusion of high spatial resolution at the regional and ecosystem levels.

vi. *Climate change and variability*
Climate change and variability analysis is an essential component of any sustainable conservation strategy in today's dynamic and uncertain world. In this report, the effects of climate change on the effectiveness, viability, and sustainability of the proposed conservation connectivity network is not explicit, but is recognized as an essential next step (see Section 6.8).

#### 4.2.6. Connectivity Mapping and Analysis

At the core of the CCF is an integrated evidence-based assessment of wildlife species distribution and movement patterns, an analysis of threats and opportunities in relation to migratory routes and corridors, and the combination of these assessments to generate maps depicting areas of connectivity priority. The proposed connectivity areas then undergo a comprehensive review process (see below). The following analyses were conducted while mapping the wildlife migratory routes and corridors. Detailed interpretations of each analysis are presented in chapters 5 and 6.

1. Identification of species richness at the regional and ecosystem levels, and mapping of distribution patterns and densities for the selected species;

2. Mapping of protected areas (parks and reserves), wildlife dispersal areas (sanctuaries, conservancies and communal lands), and migratory routes and corridors;

3. Identification of threats to wildlife and obstacles to movement, including demography (human population and settlements), land use (agriculture and livestock density), and infrastructure (roads and other developments);

4. Identification of current interventions and of opportunities for wildlife conservation, including developments within protected areas, creation of community conservancies and sanctuaries, and the implementation of lease, easement programmes, and REDD+ initiatives;

5. Mapping of conservation connectivity across landscapes based on the distribution and movements of species in known or proposed corridors, and threats. Kernel densities were used to identify core species habitats and important dispersal areas. These were then prioritized into low-medium-high, based on threat status. The viability of connectivity equals high conservation value with low threats;

6. Further analyses should include modelling of habitat and linkage suitability, sensitivity to climate change, polarization (characterization/typology), and the efficacy of weighting and prioritization.

#### 4.2.7. Conservation Connectivity Implementation Framework

The migratory routes identified in this study will be assessed for their effectiveness, viability and sustainability, based on ongoing efforts to secure and manage wildlife dispersal areas, while providing for continued stakeholder involvement. Chapter 8 outlines the recommendations of these assessments in the proposed Conservation Connectivity Implementation Framework.

## 4.3. Data Sources - Species Distribution and Movements

Kenya has a rich history of extensive wildlife counts across its rangelands. Between 1977 and 2012, the Directorate of Resource Survey and Remote Sensing (DRSRS) conducted a total of 176 aerial sample surveys of large herbivore populations in the southern Kenya rangeland ecosystems (Narok, Kajiado, Kitui, Makueni, Taita-Taveta, Tana-River, and Kwale Counties). The systematic reconnaissance method was used (Norton-Griffiths, 1978), and population estimates were calculated according to the Jolly II method of unequal transect lengths (Jolly, 1969).

The KWS and the AWF have also conducted total counts of some wildlife species in the Mara, Amboseli, and Tsavo ecosystems. In these counts, the area was stratified into sampling blocks, which are defined by recognizable features such as major roads, rivers, and escarpments (Norton-Griffiths, 1978; Douglas-Hamilton, 1996). Fixed high-wing aircraft (Cessna and Husky) are flown systematically along transects with a sampling resolution of 1x1 km to ensure that all animals can be seen and counted. Waypoints of the animals observed were marked using a hand-held Global Positioning System (GPS).

Save The Elephants (STE) and other organizations provided telemetry tracking data for use in defining the movements and distribution patterns of elephants and wildebeest. The STE, KWS, ElephantVoices (EV) and Mara Elephant Project (MEP) have been carrying out elephant projects in the wider Mara ecosystem since 2011. STE partners closely with KWS in overseeing, collating and analysing real-time tracking of collared elephants and in monitoring elephant mortality. MEP assists and collaborates with KWS and Narok County authorities, running a quick response unit that acts on information gathered through radio-tracking and poaching intelligence, and the EV operates a citizen science-based elephant monitoring programme gathering data on individually known elephants and groups. Collaring targets are selected from individually known elephants and families (Douglas-Hamilton, 1996; Krink *et al*., 2005; Wall, Wittemyer *et al*., 2013).

GPS collars on five elephants in the Tsavo East NP provided details on the outer extent of elephant movements there between March and September 2011 (Ngene and Njumbi, 2011). Similar information came from two collared elephants (a male and a female) in the Magadi area, where local community scouts (ACC) have provided additional data based on tracks and signs. The movements of elephants between the West Kilimanjaro region and the Amboseli NP from 2005 to 2008 were monitored through eight radio-collared elephants (3 bulls and 5 females) (KWS, AWF).

Wildebeest movements between May 2010 and November 2011 were mapped with the help of 15 GPS collars fitted to animals in the Mara and on the Loita plains; 12 GPS collars in the Nairobi NP and on the Athi-Kaputiei plains; 9 GPS collars in the Amboseli NP and on surrounding group ranches, and a tracking study in the Serengeti (Gnu Landscapes project on wildebeest forage acquisition in fragmented landscapes under variable climates;- http://www.nrel.colostate.edu/projects/gnu/research.php).

Other data sources used relate to demography (KNBS, 1999 Census); land cover/use (Africover, 2008 by WRI, ILRI and DRSRS); livestock densities (DRSRS); fences (ILRI); protected areas (KWS); conservancies (AWF, ACC, MMWCA), and rainfall and temperature (KMD). These were necessary for understanding the state of conservation areas, in addition to modelling potential threats to habitat linkages.

## 4.4. Geospatial Analysis and Modelling

A Geographical Information System (GIS) platform was used in the spatial analysis, integration, and modelling of datasets obtained from different sources at various scales. Map layers on kernel densities, telemetry tracks, species density and distribution, land cover/use, demography, and infrastructure were used to model surface overlays and to determine the migratory routes and corridors.

### 4.4.1. Regional Species Richness and Densities

The first step was to delineate the study area boundaries, and to map the regional species richness (diversity) and densities for wildlife and livestock. The analysis was based on sample aerial census data. Population estimates for wildlife (47 species) and livestock (4 species) in the study area was generated between 1977 and 2011. The data were merged on a 5-by-5 km grid and averaged estimates derived. The population densities and species numbers (diversity) observed per grid-square were re-calculated to produce density and richness surface maps. Densities were calculated on the basis of the tropical livestock (TLU) units and weights for all the species were derived from the existing literature.

### 4.4.2. Species Distribution - Regional and Site (Ecosystem) Level

Sample counts (DRSRS), total counts (KWS) and telemetry data were used to generate the geospatial distribution data for elephant and wildebeest (STE, KWS, AWF) and for Burchell's zebra, giraffe and buffalo (KWS, DRSRS) on landscapes at both the regional and ecosystem levels. The regional levels are defined by the southern Kenya rangelands ecosystems and by the northern rangeland and coastal terrestrial ecosystems (see Schematic Diagrams 4.1 and 4.2). Sites in the southern Kenya rangelands are the Mara Ecosystem, the Eburu Forest Conservation Area and the Lakes Naivasha-Elementaita-Nakuru ecosystems, the Nairobi NP-Athi Kaputiei Ecosystem, the South Rift (Lake Natron-Magadi area), the Amboseli-West Kilimanjaro Ecosystem, and the Tsavo Ecosystem.

### 4.4.3. Dispersal Areas and Migratory Routes/Corridors

A number of spatial datasets (species richness, density distribution, and movement pathways based on telemetry) were used in mapping the wildlife dispersal areas and migratory corridors. A review of the literature was also conducted, and expert opinion sought from field workers and local communities.

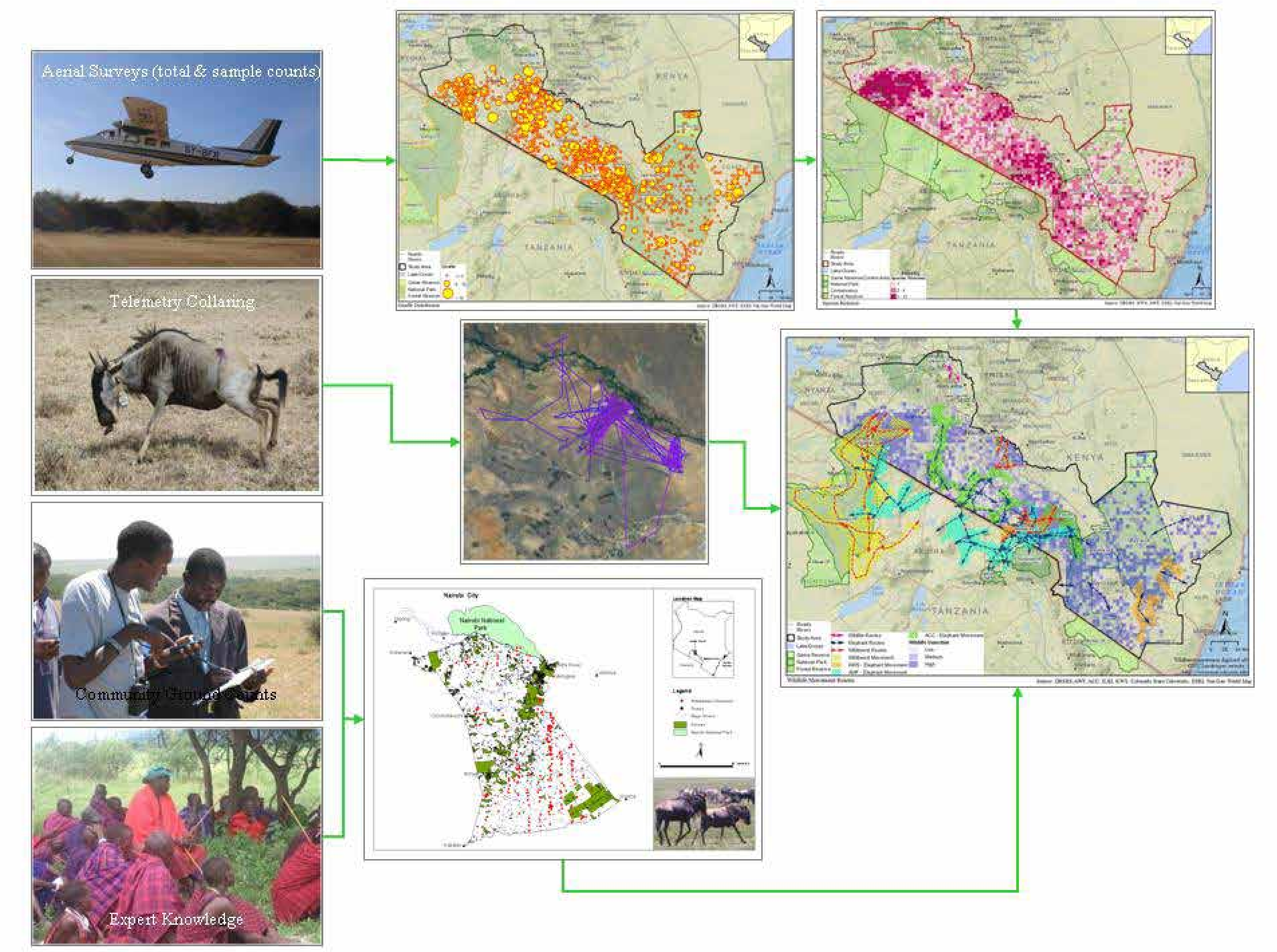
### 4.4.4. Threats to Conservation Connectivity

Threats to conservation connectivity are a central focus of this study. Major threats stem from human population density, agriculture, livestock density, infrastructure development, and encroachment on protected area boundaries. Threatened wildlife areas were mapped with buffer zones around the parks and major roads. These maps were then integrated with the above-mentioned layers to create a model of threat surfaces of different weights, showing the relative pressures on migratory routes/corridors. Weights used range from 0 to 1, where zero represents no threats and 1 indicates that a corridor is either blocked or lost (Schematic Diagram 4.3).

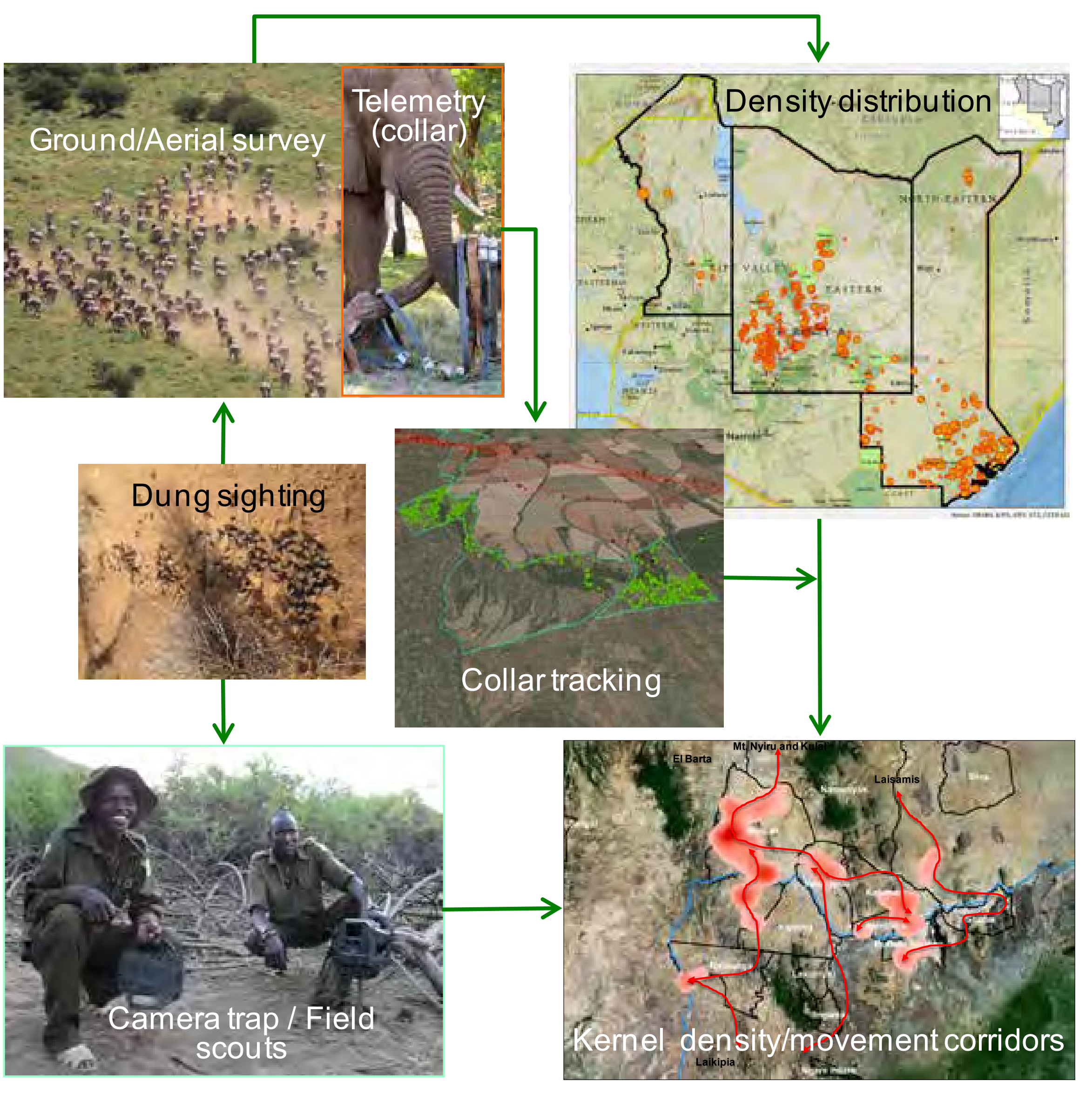
### 4.4.5. Current Interventions and Opportunities

A number of conservation interventions and initiatives are being implemented by local communities living around protected areas in the southern Kenya rangelands. These include the development of conservancies and community-based wildlife areas, wildlife and livestock ranches, and the REDD+ programmes. In this study, core areas of connectivity outside parks and reserves are identified. Through a process of overlaying maps and datasets, it was possible to produce a map showing areas of high conservation potential that are as yet unprotected. Most of these areas are in dispersal zones between critical habitats. Local communities have taken advantage of the conservation potential in some of these areas through adopting multiple land uses that are compatible with conservation.

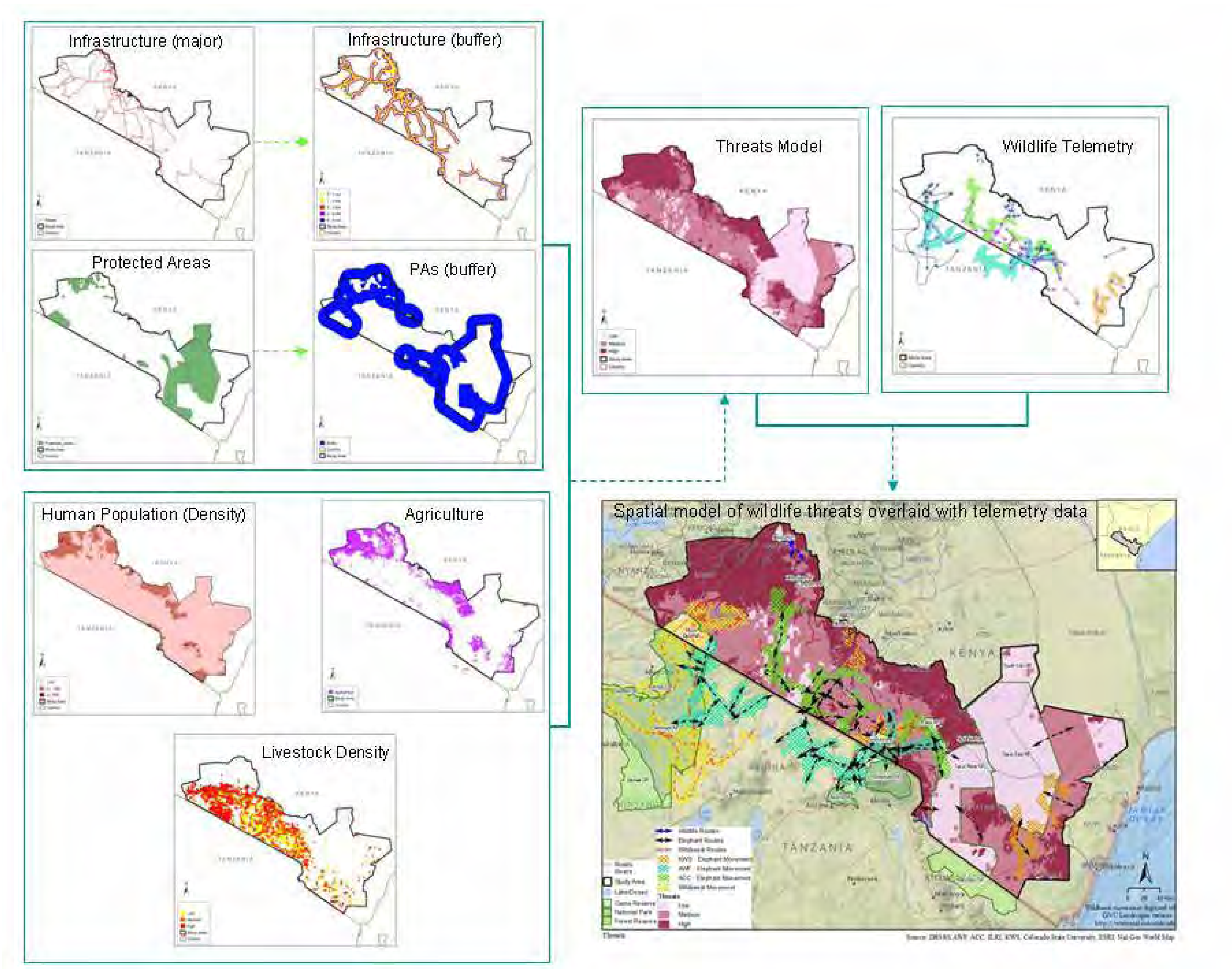
**Schematic Diagram 4.1:** Data collection and spatial analysis in southern Kenya rangeland ecosystems.



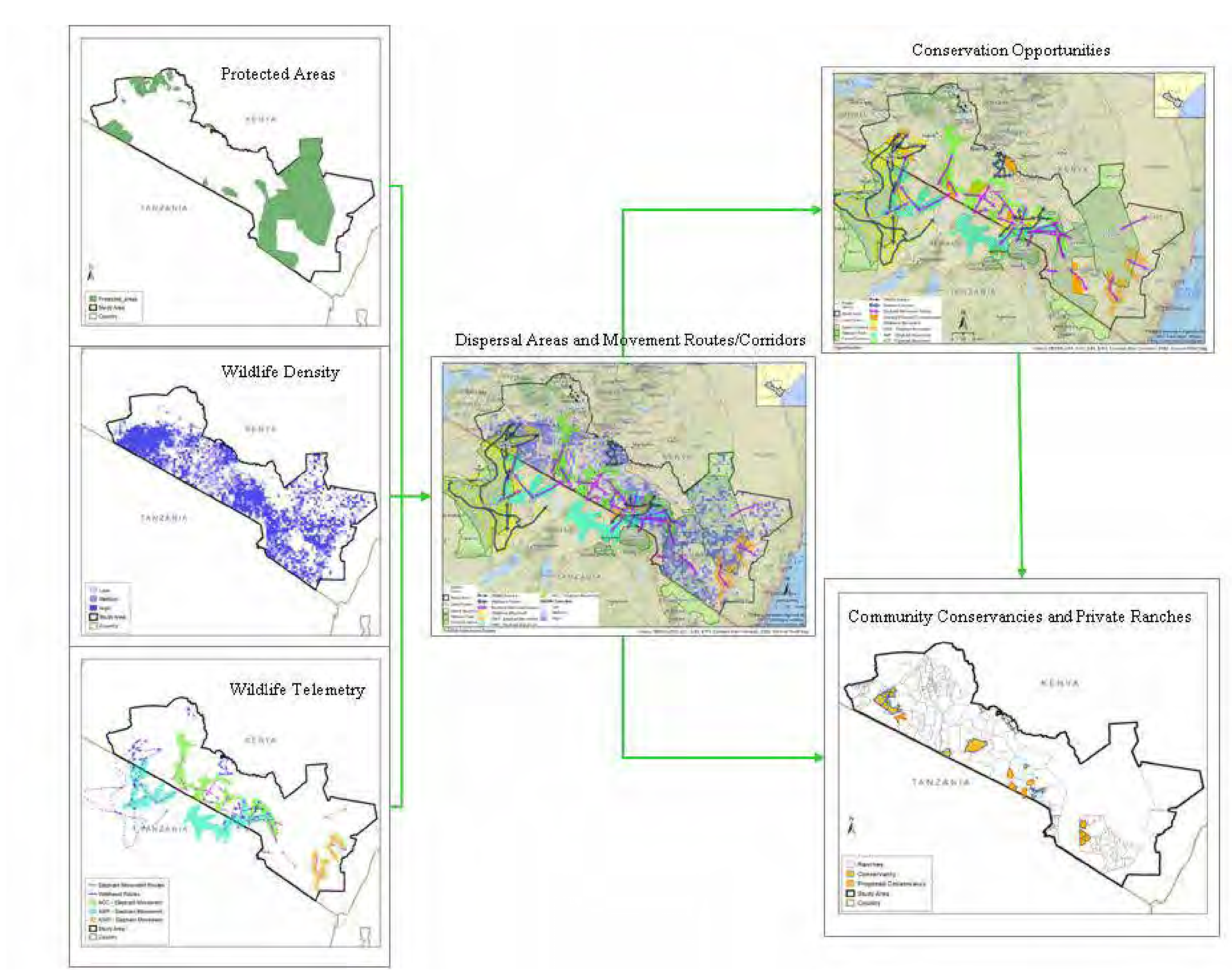

**Schematic Diagram 4.2:** Spatial modeling to develop conservation threats surfaces.



**Schematic Diagram 4.3:** Data collection and spatial analysis in northern Kenya rangeland ecosystems.




**Schematic Diagram 4.4:** Spatial integration of data to identify conservation potential outside protected areas which can be developed as community-based conservancies.



# Chapter 5

# Migratory Corridors for Conservation in Southern Kenya Rangeland Ecosystems

## 5.1. Regional Species Diversity and Densities

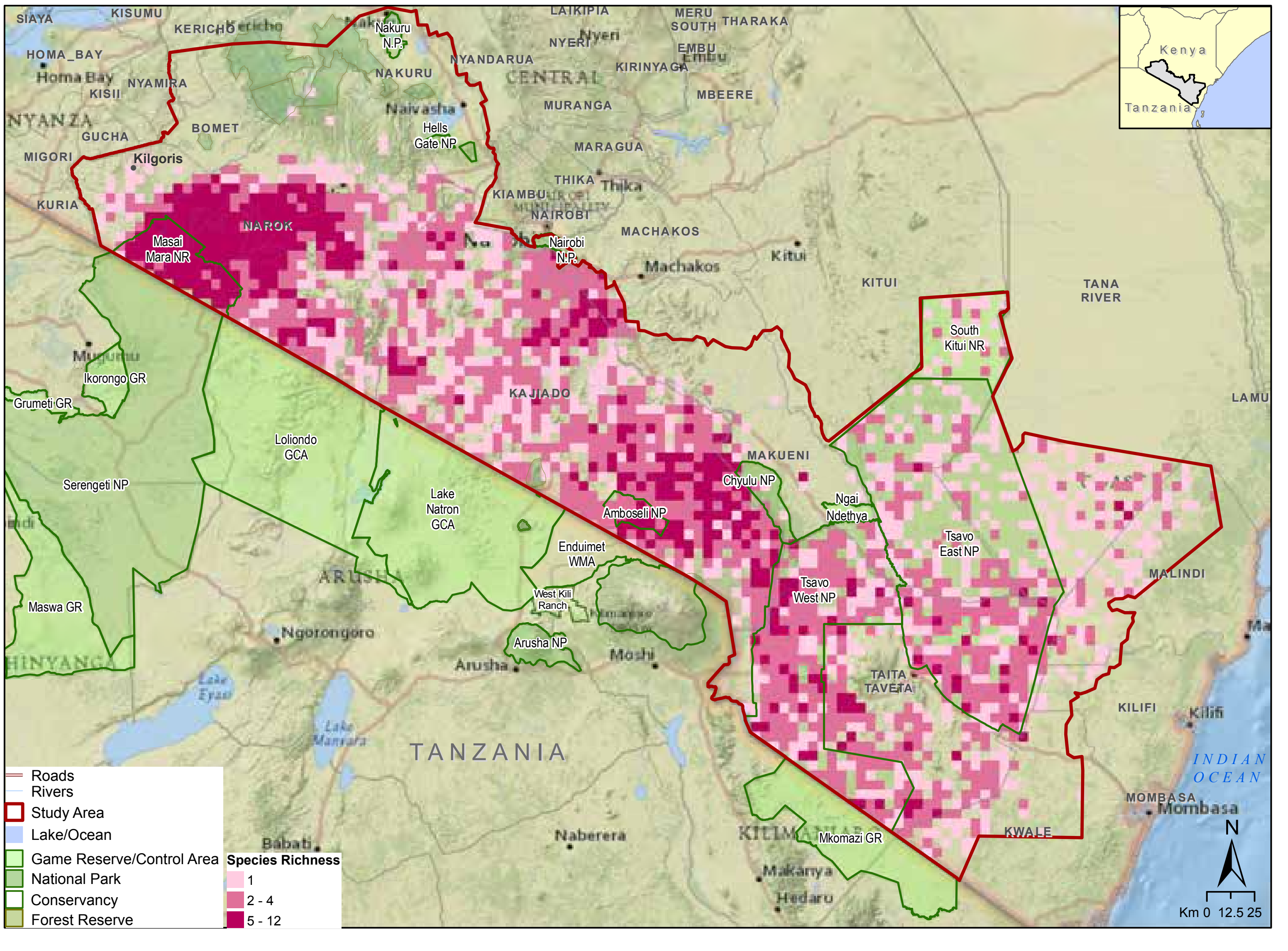
Kenya is endowed with a wide variety of ecosystems and habitats that contain unique and diverse communities of flora and fauna. The country has an extraordinary biodiversity of large mammals due to its location straddling the equator, its bimodal rainfall pattern, and the heterogeneity of its habitats. Its vast savannah ecosystems are represented both within and outside protected area systems. Species richness among large mammals in the southern Kenya rangeland ecosystems is shown in Map 5.1.

### 5.1.1. Regional Species Richness

In the southern Kenya rangeland ecosystems, the Masai Mara NR and its surrounding group ranches and conservancies have the highest species richness in terms of large mammalian diversity. Both the Amboseli ecosystem and the Athi-Kaputiei area also contain high species richness. Other areas with pockets of species richness include the Nguruman area and the Tsavo Conservation Area, especially the Tsavo West NP and south of Tsavo East NP.

Although species diversity is highest within the core wildlife areas, there are still wildlife populations of high diversity and density outside the protected areas, in a range of landscapes and habitats. However, most of the

**Map 5.1:** Species richness (diversity) of large wild herbivores in the southern Kenya rangeland ecosystems. Species diversity has been mapped from DRSRS sample counts (1978–2011) on a 5x5 km grid.




*Source: DRSRS database.*

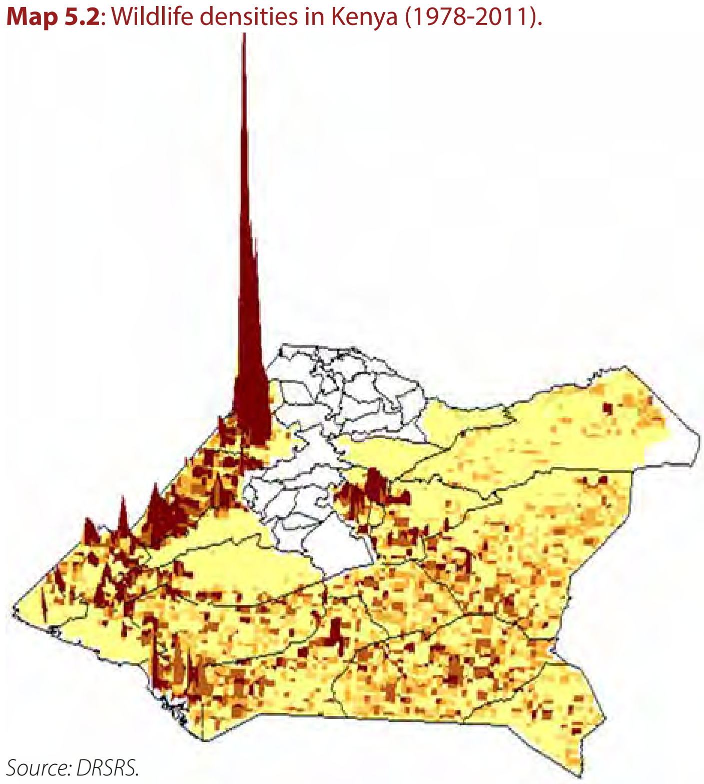
lands outside the parks and reserves are now threatened by the expanding activities of a rapidly growing human population. This has resulted in the shrinking of habitats, competition for resources, and human-wildlife condlicts.

### 5.1.2. Regional Wildlife Densities

Wildlife densities (Maps 5.2 and 5.3) correlate strongly with species richness (Map 5.1). Key species that account for the bulk of wildlife densities in the Mara and Amboseli areas are elephant, wildebeest, zebra, giraffe, and various medium-sized antelopes. Elephant, zebra, and smaller antelopes are important in the Tsavo eosystem.

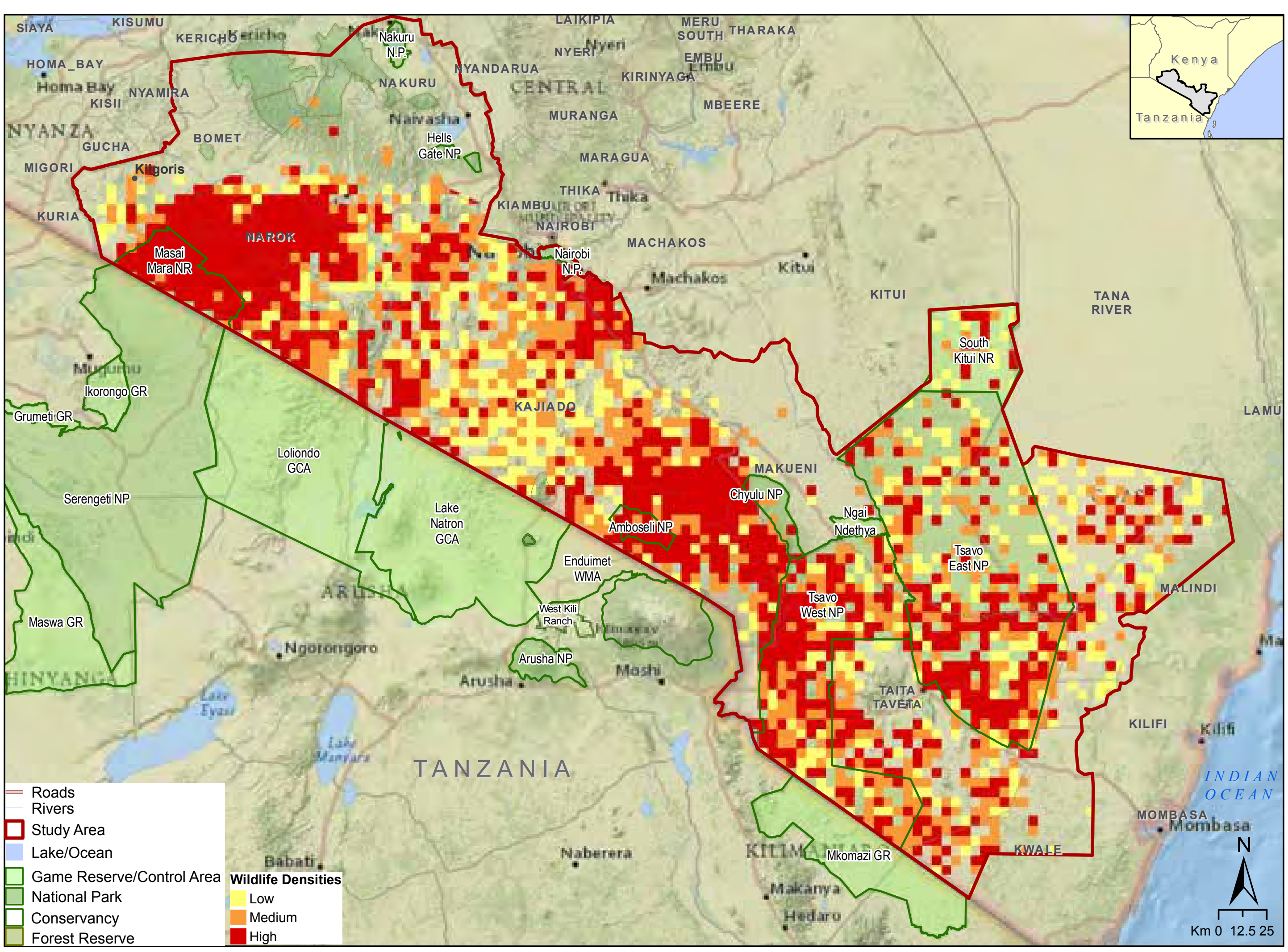
On the southern Kenya rangelands, wildlife densities are highest in the Mara, Amboseli, and the Tsavo West NP, with scattered pockets of high density elsewhere in the region. Species densities in the Masai Mara NR overflow onto the adjacent group ranches (some of which have been turned into conservancies). The Amboseli ecosystem is connected to the Tsavo West NP.

**Map 5.2**: Wildlife densities in Kenya (1978-2011).



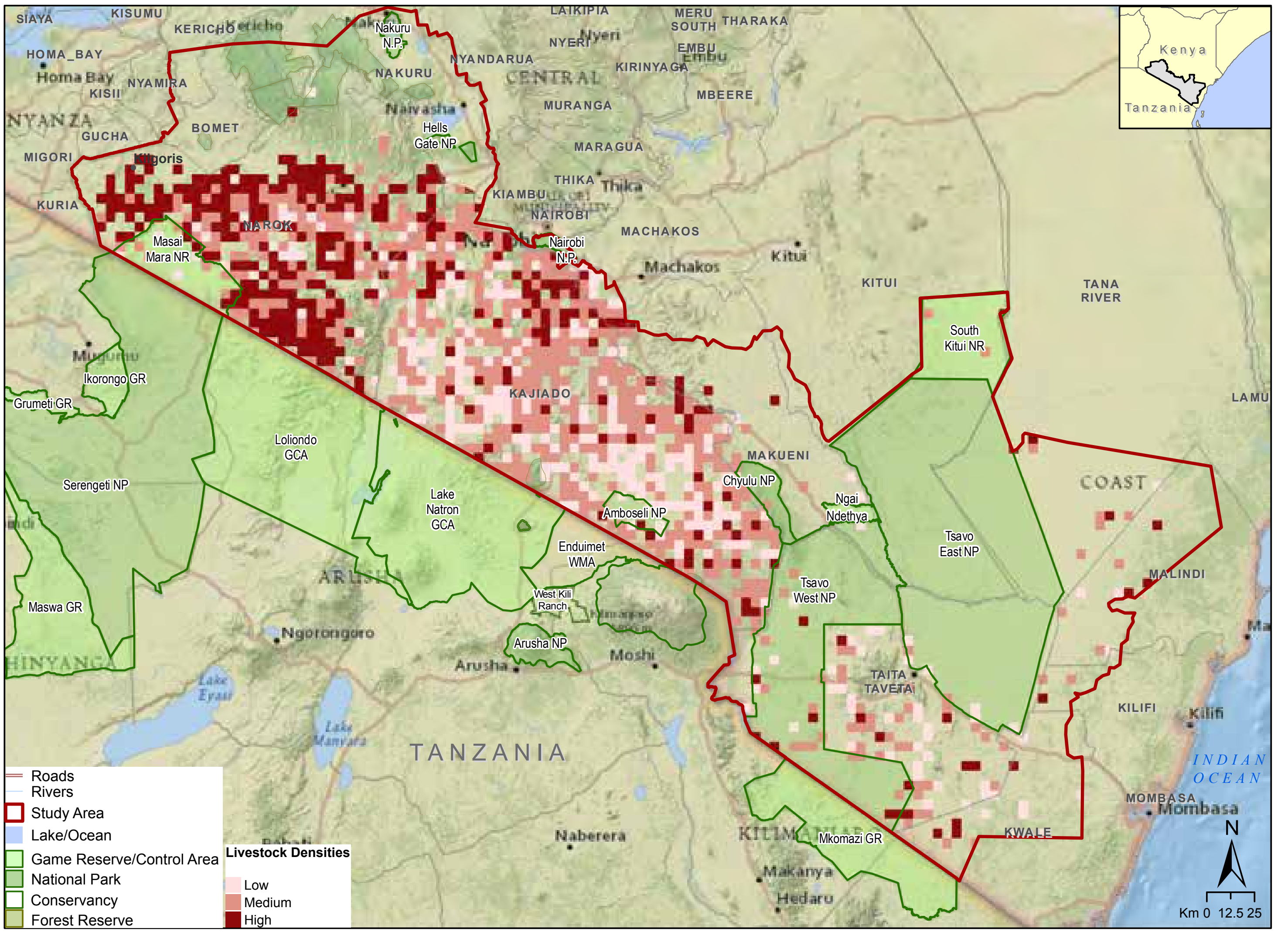
*Source: DRSRS.*

**Map 5.3:** Density distribution of large wild herbivores in the southern Kenya rangeland ecosystems. Species densities are averaged on a 5x5km grid from DRSRS sample counts (1978-2011).




*Source: DRSRS database.*

Map 5.4: Distribution density of livestock (cattle, sheep, goats and donkeys) in the southern Kenya rangeland ecosystems. Livestock densities are averaged on a 5x5 km grid from DRSRS sample counts (1978–2011).




*Source: DRSRS Database.*

### 5.1.3. Regional Livestock Densities

Analysis of long-term livestock densities in the southern Kenya rangeland ecosystems has shown that high numbers of cattle, shoats and donkeys are present both on group ranches and in conservancies in the Mara ecosystem and the Transmara area of Narok County (Map 5.4). There are incursions of livestock at the boundary of the reserve as well as deep inside. A recent count by DRSRS shows an increase in small stock (sheep and goats), while a survey conducted in 2011 found more than one million shoats in the whole of Narok County, which is the highest population recorded within the past 30 years.

Livestock densities are high in the Athi-Kaputiei ecosystem and in parts of Kajiado County. Incursions by livestock into the outer reaches of Amboseli NP and the Tsavo NPs, the southern parts of the latter especially, are well documented. Human-wildlife conflict is likely to increase in the traditional drought refuges for wildlife outside the protected areas, while conflict between pastoralists and park managers is also likely to occur as livestock is taken inside the protected areas during the dry periods.

### 5.1.4. Regional Wildlife Populations

In the past few decades, most areas in the southern Kenya rangelands have undergone massive land-use changes, and have also experienced the effects of droughts, which have negative impacts on wildlife populations and their spatial distribution. Wildlife populations have also suffered from heavy poaching and from diseases, which have contributed to declines in their numbers. This section provides a regional synopsis and site-level analysis of wildlife populations, and compares wildlife numbers inside and outside protected areas in different ecosystems (Table 5.1 a, b, c, d).

Wildlife distribution and densities vary across landscapes. Regional analyses of four species (elephant, wildebeest, zebra, and giraffe) between 1978 and 2011 in the Narok, Kajiado, Machakos and Makueni, Kitui, Taita-Taveta, and Tana River Counties found that 44 % of these animals were inside protected areas and 56 % outside. However, there is a great variation across the study sites, with 66 % of elephants found in Taita-Taveta, 94 % of the wildebeest and 51 % of the zebras in Narok, and 41 % of the giraffes in Kitui County. More than 65 % of all these animals were outside protected areas, except in Taita-Taveta and Kitui

Counties, where fewer than 25 % were in unprotected areas. The highest numbers found outside protected areas were in Kajiado (80 %) and Machakos/Makueni counties (93 %).

In Narok, proportions of the selected species found outside protected areas were as follows: giraffe (84 %), zebra (69 %), and elephant (62 %). The exception was wildebeest (55 % of which were within protected areas). In Kajiado, proportions found outside protected areas were: giraffe (90 %), zebra (84 %), elephant (75 %), and wildebeest (74 %). In Machakos and Makueni, most elephants (72 %) were inside protected areas, but other wildlife species were nearly all outside, including wildebeest (100 %), zebra (90 %), and giraffe (87 %). More wildlife were in protected areas than outside. In Kitui and Taita-Taveta, In Kitui, 92 % of elephants, 91 % of zebras, and 62 % of giraffes were inside protected areas. In Taita-Taveta, 81 % of elephants, 73 % of zebras, and 58 % of giraffes were in the Tsavo NPs. In Tana River, 83 % of the elephants were inside protected areas, while most zebras (66 %) and giraffes (88 %) were outside.

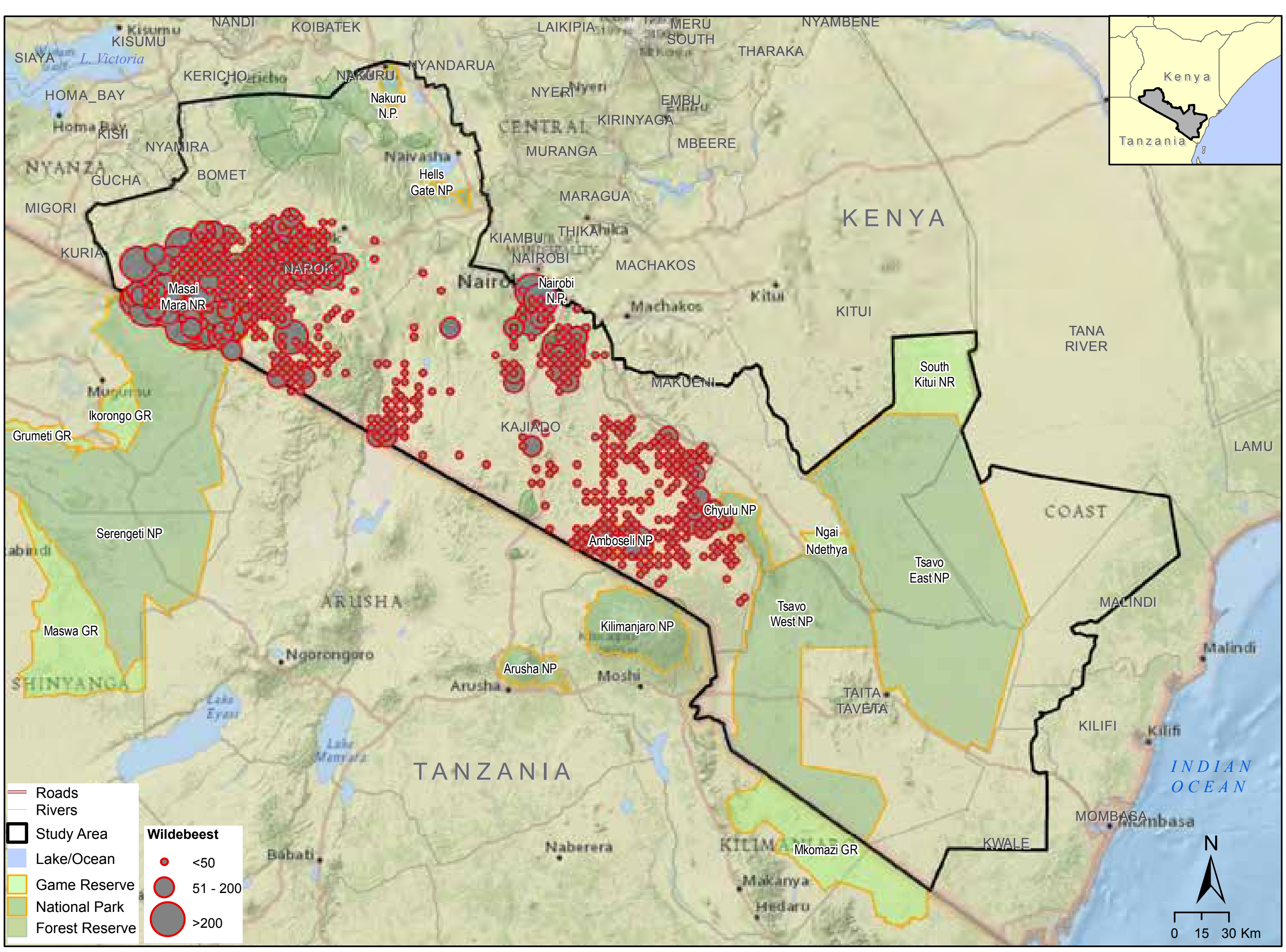
This analysis shows that, in Kenya's southern rangeland ecosystems, most wildlife populations occur outside protected areas, where land-use changes and habitat modification and fragmentation are taking place, with adverse impacts on the populations and on their dispersal areas and corridors.

### 5.1.5. Regional Distribution of Wildebeest

Kenya's wildebeest population is found in the Mara, Amboseli, and South-Rift ecosystems, and in the Nairobi NP and the Athi-Kaputiei area, with a few widely scattered groups in central Kajiado (Map 5.5). The largest concentration of wildebeest is in the Masai Mara Ecosystem (MME), which is home to about 167,000 wildebeest (average migratory and resident population), of which almost 55 % occur in the Masai Mara NR. Steep declines have been observed in the MME resident wildebeest population (from 150,000 to just above 35,000 animals), due to loss of their wet season range.

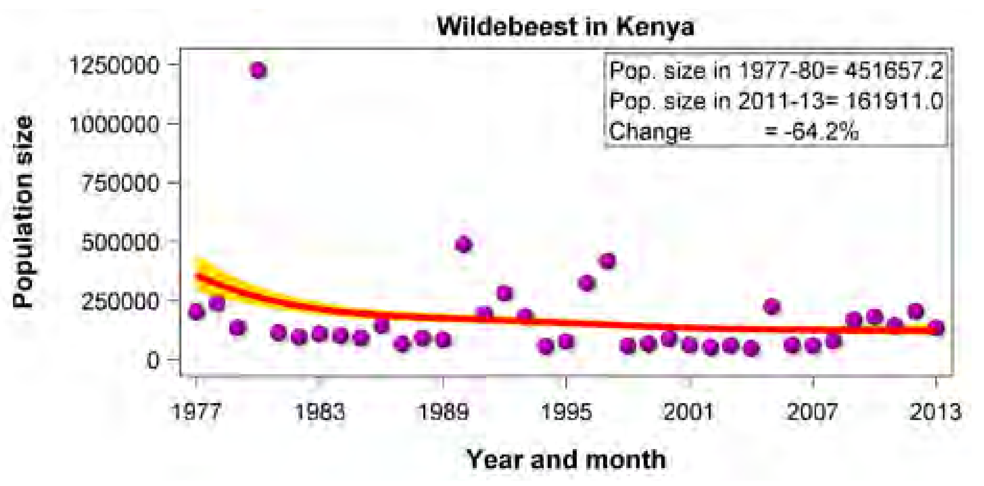
## REGIONAL DISTRIBUTION OF SPECIES

Map 5..5: : Regional distribution of wildebeest in the southern Kenya rangelands (1978–2011).




Source: DRSRS Database.

**Figure 5.1:** Population trends for wildebeest in Kenya (1977–2013).




*Source: DRSRS Database.*

In Kajiado, the average wildebeest population amounts to more than 21,000 animals, with 26 % located inside protected areas and 74 % outside (Table 5.1). In Machakos, 2,300 wildebeest were found on ranches. In the Athi-Kaputiei area, wildebeest numbers have declined drastically, from 30,000 to less than 5,000 animals. This is attributed to rapid loss or fragmentation of their habitat due to urban expansion and the building of fences and settlements. Severe drought was responsible for recent declines in wildebeest numbers in the Amboseli area.

### 5.1.6. Regional Distribution of Burchell's Zebra

The southern Kenya rangelands contain the largest population of Burchell's zebras in the country. Their range in this region is similar to that of wildebeest, but extends beyond the Amboseli ecosystem into the Tsavo ecosystem and the coastal counties of Kwale, Kilifi and Tana River. Zebra density is highest in the Mara ecosystem (10 zebras/km$^2$) and the Amboseli ecosystem (7 zebras/km$^2$). On average, about 55,000 zebras (31 % inside the park, 69 % outside) were observed in the Mara ecosystem between 1978 and 2011. In Kajiado County, the zebra population was 36,000 (16 % inside the protected area, and 84 % outside). The population in Machakos was 2,700 animals (90 % outside protected areas, while in Taita-Taveta, almost 73 % of 11,000 zebras were inside the Tsavo NP (Table 5.1 c and d).

Generally, the regional zebra population is declining, but the rate of decline is not as rapid as that of wildebeest. Zebras compete well with livestock, as they can forage on low quality grasses. The population of zebras has increased in parts of the southern Kenya rangelands that have sufficient rainfall.

**Table 5.1 (a):** Population estimates for elephant, wildebeest, plains zebra, and giraffe, as averaged between 1978 and 2011 both inside and outside Masai Mara NR and Narok County.

| Narok County | | | | | |
|---|---|---|---|---|---|
| Protected Area | | Masai Mara NR | | | |
| Species | | Elephant | Wildebeest | Zebra | Giraffe |
| Inside | Pop. Est | 1,059 | 92,735 | 16,986 | 317 |
| | Density | 0.61 | 53.02 | 9.71 | 0.18 |
| | % | 38 | 55 | 31 | 16 |
| Outside | Pop. Est | 1,721 | 74,502 | 38,361 | 1,712 |
| | Density | 0.11 | 4.64 | 2.39 | 0.11 |
| | % | 62 | 45 | 69 | 84 |
| County | (In) % | 35 | | | |
| | (out) % | 65 | | | |

*Source: DRSRS.*

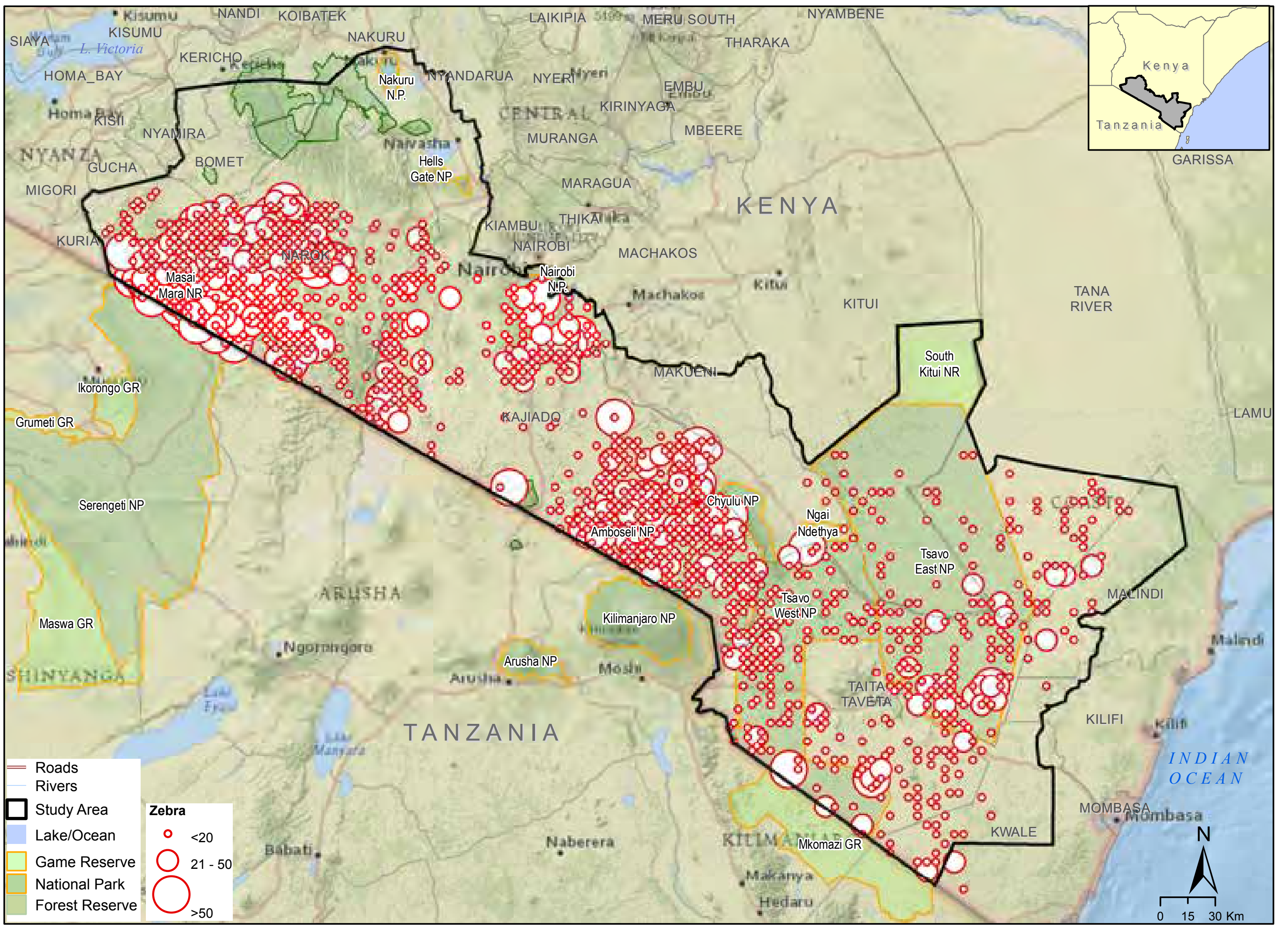
**Table 5.1 (b):** Population estimates for elephant, wildebeest, plains zebra, and giraffe, as averaged between 1978 and 2011 both inside and outside Amboseli and Chyulu NPs and Kajiado County.

| Kajiado County | | | | | |
|---|---|---|---|---|---|
| Protected Area | | Amboseli NP and Chyulu Hills NP | | | |
| Species | | Elephant | Wildebeest | Zebra | Giraffe |
| Inside | Pop. Est | 362 | 5,538 | 5,186 | 532 |
| | Density | 0.5 | 7.59 | 7.11 | 0.73 |
| | % | 25 | 26 | 16 | 10 |
| Outside | Pop. Est | 1,061 | 15,483 | 27,402 | 4,601 |
| | Density | 0.05 | 0.72 | 1.27 | 0.21 |
| | % | 75 | 74 | 84 | 90 |
| County | (In) % | 20 | | | |
| | (out) % | 80 | | | |

*Source: DRSRS.*

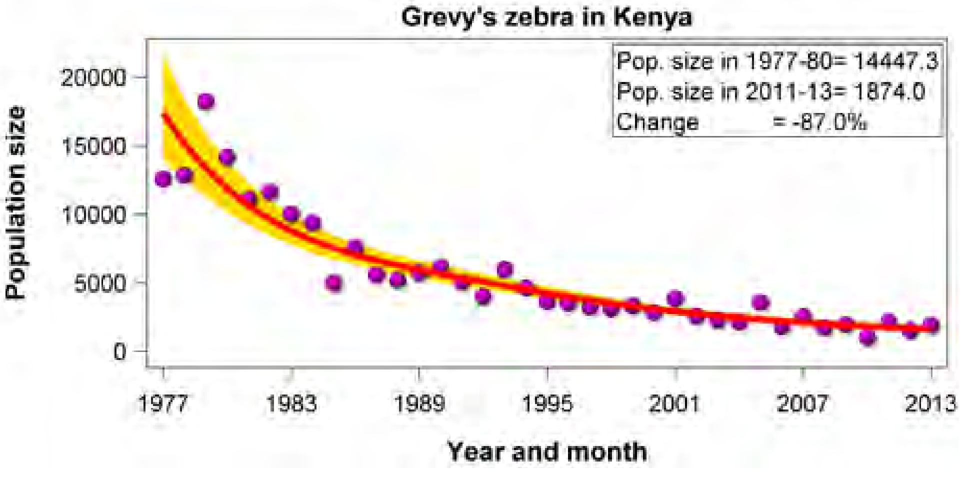
# REGIONAL DISTRIBUTION OF SPECIES

**Map 5.6:** Regional distribution of the plain's zebra in the southern Kenya rangelands (1978-2011).




*Source: DRSRS Database.*

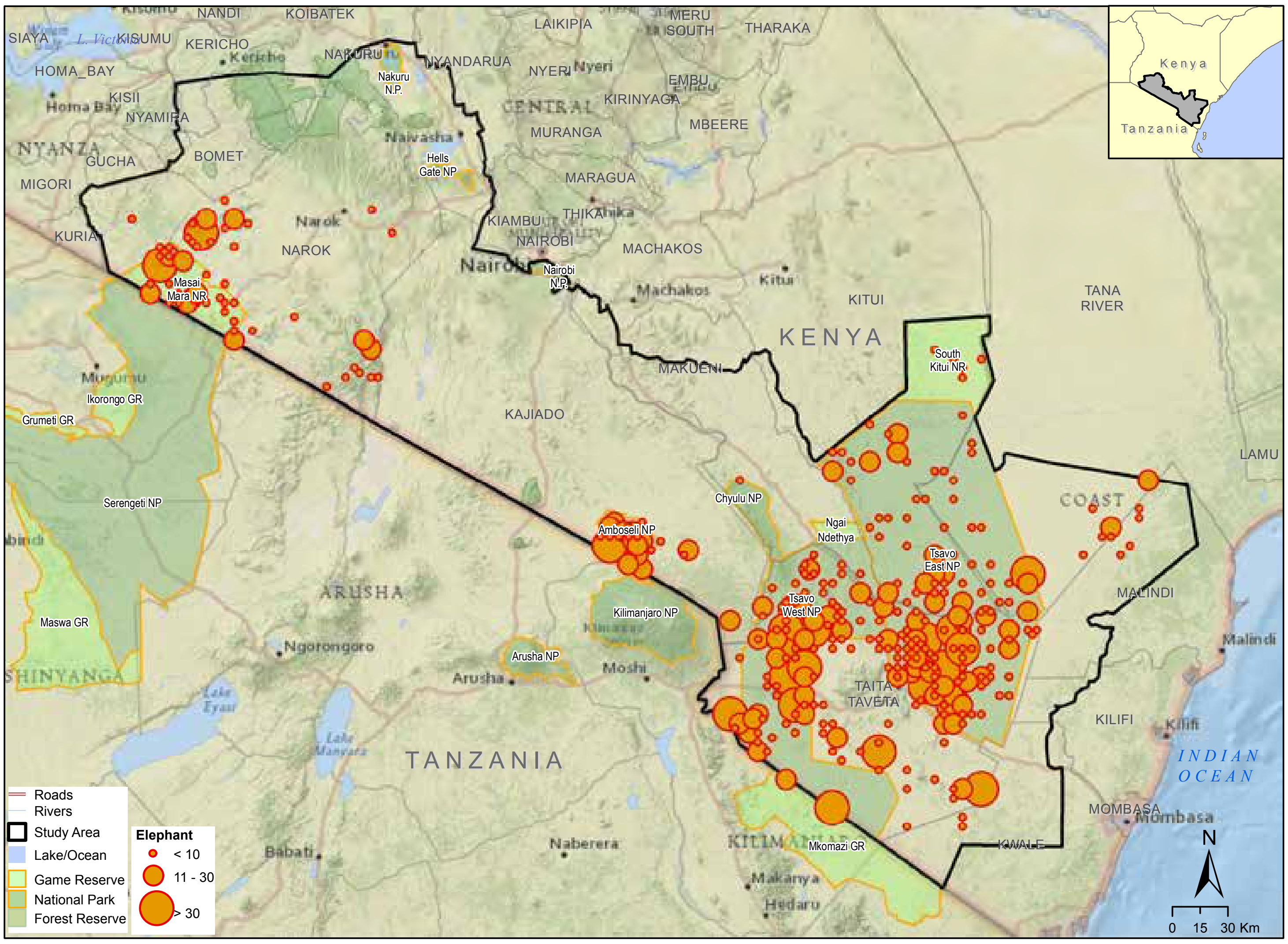
**Figure 5.2:** Population trends of Grevy's zebra in Kenya (1977–2013).




*Source: DRSRS Database.*

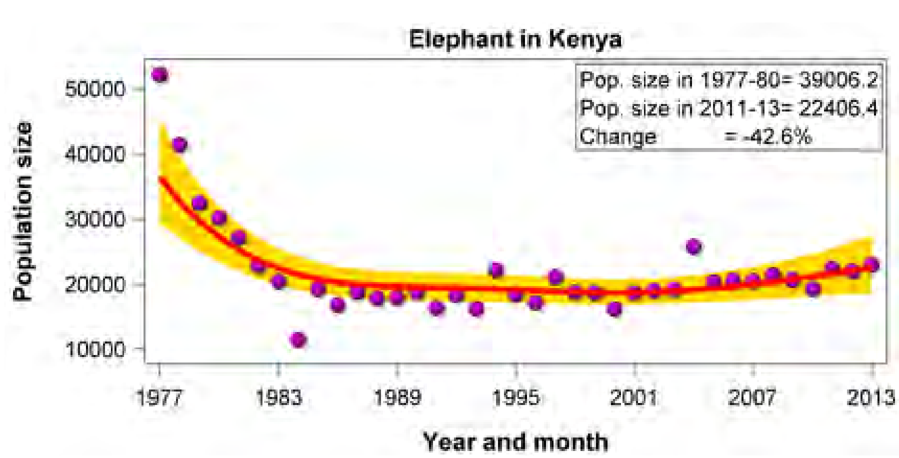
# REGIONAL DISTRIBUTION OF SPECIES

Map 5.7: Regional distribution of elephants in the southern Kenya rangelands (1978–2011).




*Source: DRSRS Database.*

**Figure 5.3:** Population trends for elephants in Kenya (1977–2013).




*Source: DRSRS Database.*

### 5.1.7. Regional Distribution of Elephant

The elephant population in Kenya is slightly above 30,000 animals, of which more than half occur in the southern rangeland ecosystems. The largest population is found in the Tsavo-Mkomazi ecosystem. This population numbered fewer than 8,000 animals in the mid-1980s, but has more than doubled to about 16,000 elephants over the past 20 years. In Taita-Taveta, Kitui, Machakos and Tana River Counties, elephants are found mostly in parks. In Taita-Taveta, more than 80 % occur in the Tsavo NPs, but in the Mara and Amboseli ecosystems, a large population is found outside protected areas (Table 5.1 b). Elephants move widely outside parks and may come into conflict with people, causing crop damage, destruction to infrastructure, and injury or death among humans.

**Table 5.1 (c):** Population estimates for elephant, plains zebra, and giraffe, as averaged between 1978 and 2011 both inside and outside Tsavo East and West NPs and Taita-Taveta County.

| Taita-Taveta County | | | | |
|---|---|---|---|---|
| Protected Area | | Tsavo East and West NPs | | |
| Species | | Elephant | Zebra | Giraffe |
| Inside | Pop. Est | 6,501 | 8,108 | 1,203 |
| | Density | 0.62 | 0.78 | 0.12 |
| | % | 81 | 73 | 58 |
| Outside | Pop. Est | 1,488 | 3,036 | 875 |
| | Density | 0.22 | 0.45 | 0.13 |
| | % | 19 | 27 | 42 |
| County | (In) % | 75 | | |
| | (out) % | 25 | | |

Elephant densities are high in the Mara NR and the Amboseli NP, but overall numbers are low, due to the small size of these areas. Recent declines in the elephant population on the southern Kenya rangelands have been attributed to heavy poaching within the ecosystems and across the border in Tanzania.

### 5.1.8. Regional Distribution of Giraffe

Giraffes are widely distributed in the ecosystems of the southern Kenya rangelands, except in highland and forested areas. In Narok, Kajiado, Machakos, and Tana River Counties, giraffes are found mostly outside protected areas. Kajiado has the highest number of giraffes. Giraffe density in the Amboseli NP is 0.73 animals/km$^2$, for an average population of about 5,300 animals (Table 5.1 b).

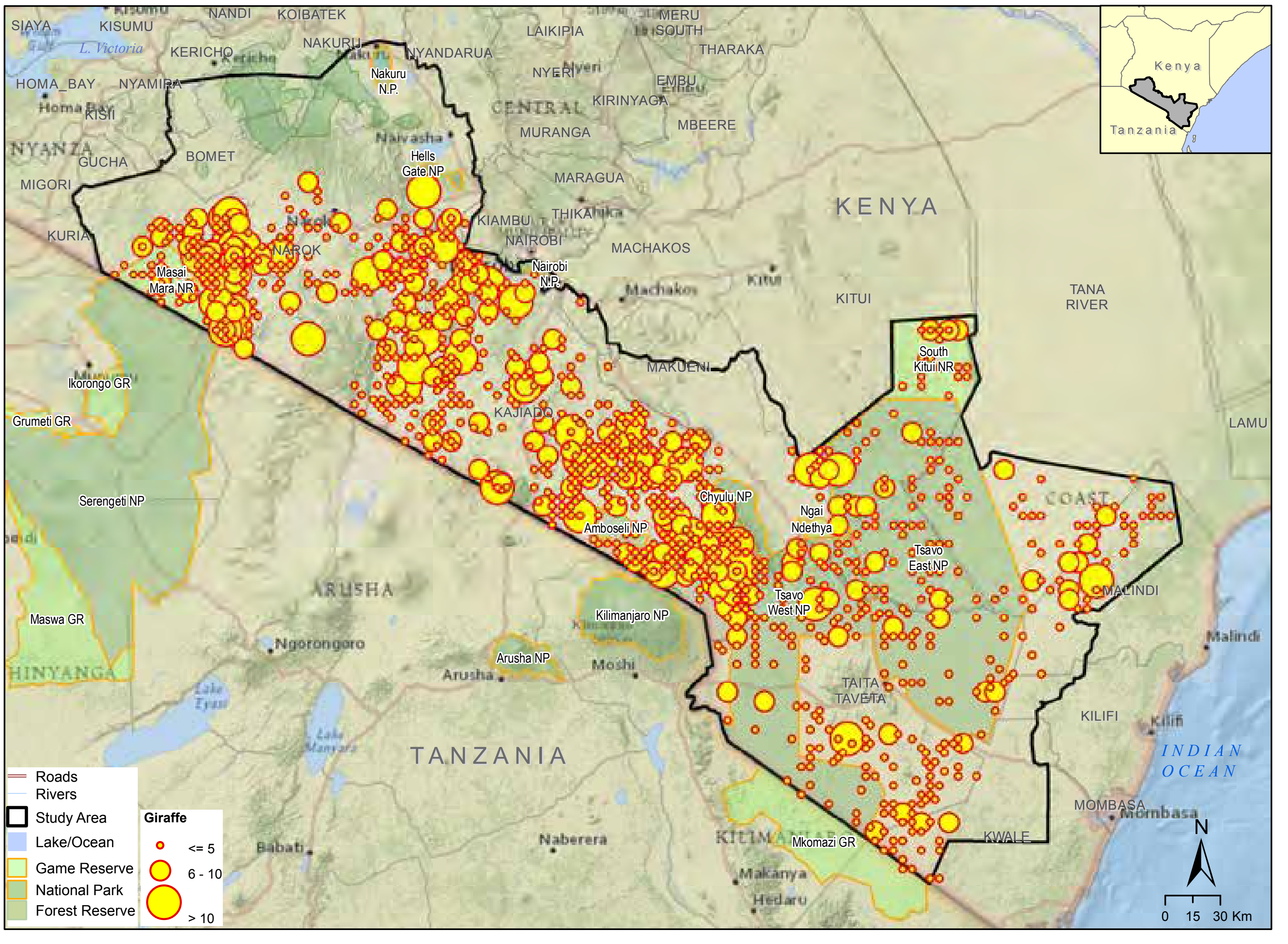
In Taita-Taveta and Kitui Counties, giraffes were found mostly in protected areas, while in Narok almost 84 % were found outside. Key areas for giraffe on the southern Kenya rangelands are outside the Masai Mara NR in the wider Mara Ecosystem, the Nguruman escarpment, the Magadi area, the Olochoro Onyore area, Kaputiei North, Kimana, Kuku, Mbirikani, south-east Amboseli, and parts

**Table 5.1 (d):** Population estimates for elephant, plains zebra, and giraffe, as averaged between 1978 and 2011 both inside and outside Tsavo East and West NP and Kitui South NR, and Taita-Taveta and Kitui Counties. Source: DRSRS Database.

| Taita-Taveta County | | | | | Kitui County | | |
|---|---|---|---|---|---|---|---|
| Protected Area | | Tsavo East and West NP | | | Tsavo East NP and Kitui SNR | | |
| Species | | Elephant | Zebra | Giraffe | EL | ZB | GF |
| Inside | Pop Est | 6,501 | 8,108 | 1,203 | 1,306 | 1,478 | 1,727 |
| | Density | 0.62 | 0.78 | 0.12 | 0.16 | 0.18 | 0.21 |
| | % | 81 | 73 | 58 | 92 | 91 | 62 |
| Outside | Pop. Est | 1,488 | 3,036 | 875 | 109 | 148 | 1,079 |
| | Density | 0.22 | 0.45 | 0.13 | 0.005 | 0.01 | 0.05 |
| | % | 19 | 27 | 42 | 8 | 9 | 38 |
| County | (In) % | 75 | | | 77 | | |
| | (out) % | 25 | | | 23 | | |

# REGIONAL DISTRIBUTION OF SPECIES

**Map 5.8:** Regional distribution of giraffe in the southern Kenya rangelands (1978-2011).




*Source: DRSRS Database*

of the Tsavo ecosystem, including Galana ranch and the South Kitui NR (Map 5.8).

Few giraffes were observed in the Athi-Kaputiei ecosystem, probably due to the fact that large areas of riverine *Acacia* vegetation have been lost to charcoal burning, or through conversion of the land to other uses. Declining giraffe populations across much of the species' former range have been attributed to habitat degradation and poaching.

## 5.2. Ecosystem Patterns: Species Density Distribution

The southern Kenya rangeland ecosystems contain the greatest abundance and highest diversity of large mammals in the country. These areas are home to the country's largest populations of wildebeest, zebra, giraffe, and elephant, as well as various smaller antelopes.

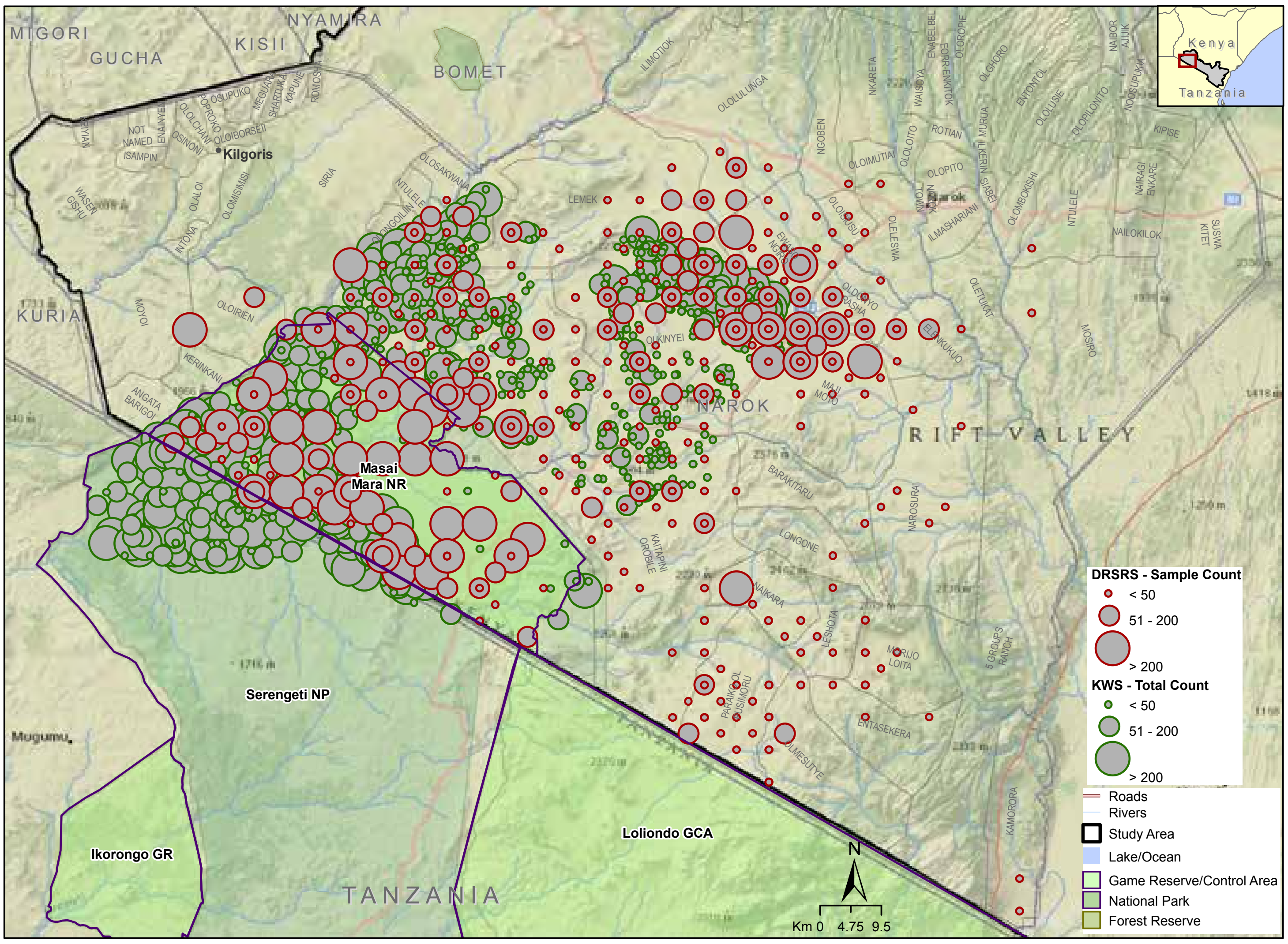
This study has investigated population and distribution trends for keystone species in six ecosystems (sites): namely, the Serengeti-Mara Ecosystem, the Greater Lake Naivasha-Elementaita-Nakuru-Eburu Forest Conservation Area and Ecosystem, the Nairobi NP-Athi Kaputiei Ecosystem, the South Rift (Lake Natron-Magadi area), the Amboseli-West Kilimanjaro Ecosystem, and the Tsavo-Mkomazi Ecosystem.

### 5.2.1. Population and distribution trends for Wildebeest in the Mara Ecosystem

The wildebeest population that crosses from Tanzania into Kenya seasonally, during the annual migration, varies from 200,000 to 800,000 animals. The main factor that determines both the annual movements and the inter-annual variation in population has been assumed to be rainfall, through its effect on food supply during the dry seasons (Mduma *et al.*, 1999). The wildebeest migration to Kenya takes place between July and October, with heavy utilization of the Masai Mara National Reserve (MMNR) and surrounding group ranches, conservancies and private lands.

# SPECIES DENSITY DISTRIBUTION IN THE MARA ECOSYSTEM

**Map 5.9:** Distribution of wildebeest in northern Serengeti and the Mara Ecosystem between 1978 and 2011.




*Source: DRSRS Database*

There are two wildebeest populations that have migration ranges within the Masai Mara Ecosystem (MME) – the Serengeti-Mara and the Loita populations (Stelfox *et al*., 1986). Serneels and Lambin (2001) found that movements of the Loita Plains population is driven mainly by rainfall patterns. The Loita Plains are a wet season range and a calving ground for wildebeest, as its grasses have the high calcium content needed by the animals during lactation.

There exists a wide variation in wildebeest population trends in the Serengeti and the Mara ecosystems. The Serengeti population increased between 1961 and 1978, mainly due to the eradication of rinderpest, but the six-fold increase between 1971 and 1977 was facilitated by dry season rainfall (then consistently more than 250 mm per dry season). The Serengeti population has stabilized at 1.3 million animals. In the Mara, the resident wildebeest population in the late 1970s was 150,000 animals, but by 2001 this had declined to about 33,000 (Serneels and Lambin, 2001). Recent surveys (2011) show a slight increase in the Mara wildebeest population, to about 38,000 animals (Ogutu *et al*., 2011).

### 5.2.2. Population and distribution trends for Burchell's Zebra in the Mara Ecosystem

The Masai Mara Ecosystem has the highest population of Burchell's zebras in Kenya. The occupancy pattern of zebras in the Mara is similar to that of wildebeest, as the two species are highly correlated. However, the zebras are more widespread outside the protected area than the wildebeest. The zebras utilize the Masai Mara NR more during the dry season (July-October), and occupy adjacent ranches in the wet season (March-May). During the migration, both zebras and wildebeest graze the tall grasses, creating lawns of short grass. This process facilitates the utilization of short grasses by medium- and small-sized antelopes in the ecosystem. However, wildebeest are more selective in their feeding habits than zebras, as their dietary requirements differ.

Population trends for zebra in the Mara show declining numbers for both resident and migratory animals. In the late 1970s, the resident zebra population averaged 65,000 animals. By the early 1980s, their numbers had dropped to 47,000 animals. Numbers then declined further, to 37,000 in the early 1990s, and in the late 2000s the population was 36,000. Population decline outside the protected area was low (37 %), compared with inside the reserve (about 76 %). In the dry season, decline was steep (60 %) outside the protected area and low (41 %) inside the reserve. In the late 1970s, the migratory zebra population was about 77,000 animals, which declined to slightly above 40,000 in 2000s (2007-2009).

The plains zebra is much more widely distributed in the Masai Mara Ecosystem (MME) than the wildebeest or any of the other larger wildlife species. Zebras are widespread throughout Narok County, which is composed mainly of shrub savannah, except to the north of the Naivasha-Narok-Bomet road and the Trans-Mara area, which are occupied by highland agriculture (Map 5.10). This is because zebras, which have a hind gut, can sustain themselves on a diet of lower quality than other grazing ruminants. Studies on the dietary requirement of wildlife in the MME indicate that zebras, wildebeest, topi, and Thomson's gazelles have significant dietary overlaps.

However, these species are separated spatially for most of the year, except in the wet season (Hansen *et al.*, 1985). Zebras occur in high densities in the dwarf shrubland and grassland of the Loita Plains in May, and by November they have usually spread out evenly across their range, except in the agricultural areas.

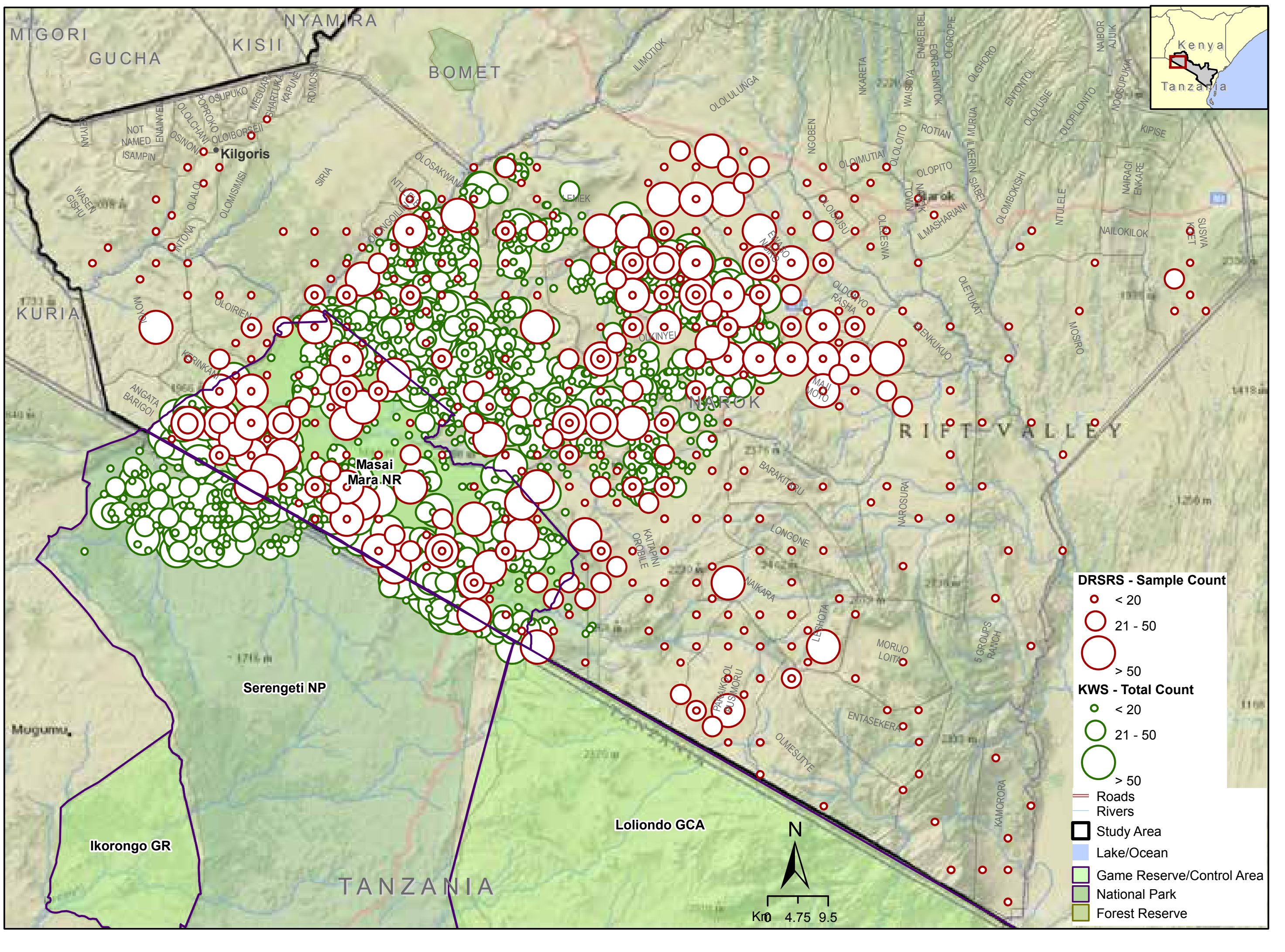
As more grazing areas are lost to agriculture, plains zebras will increasingly be forced to compete with livestock for forage. Already the Mara Ecosystem is under pressure from increasing livestock densities, due to pastoralist sedentarization and diminishing land availability for grazing.

### 5.2.3. Population and distribution trends for Elephant in the Mara Ecosystem

The elephant is a keystone species that plays a major role in shaping and modifying the savannah landscapes of East Africa. In the Serengeti-Mara ecosystem (SME), elephants have been instrumental in opening up woodlands, which

## SPECIES DENSITY DISTRIBUTION AND IN THE MARA ECOSYSTEM

**Map 5.10:** Aggregated distribution of plain's zebra in the northern Serengeti and greater Mara Ecosystem in the period 1978-2011.




Source: DRSRS/KWS.

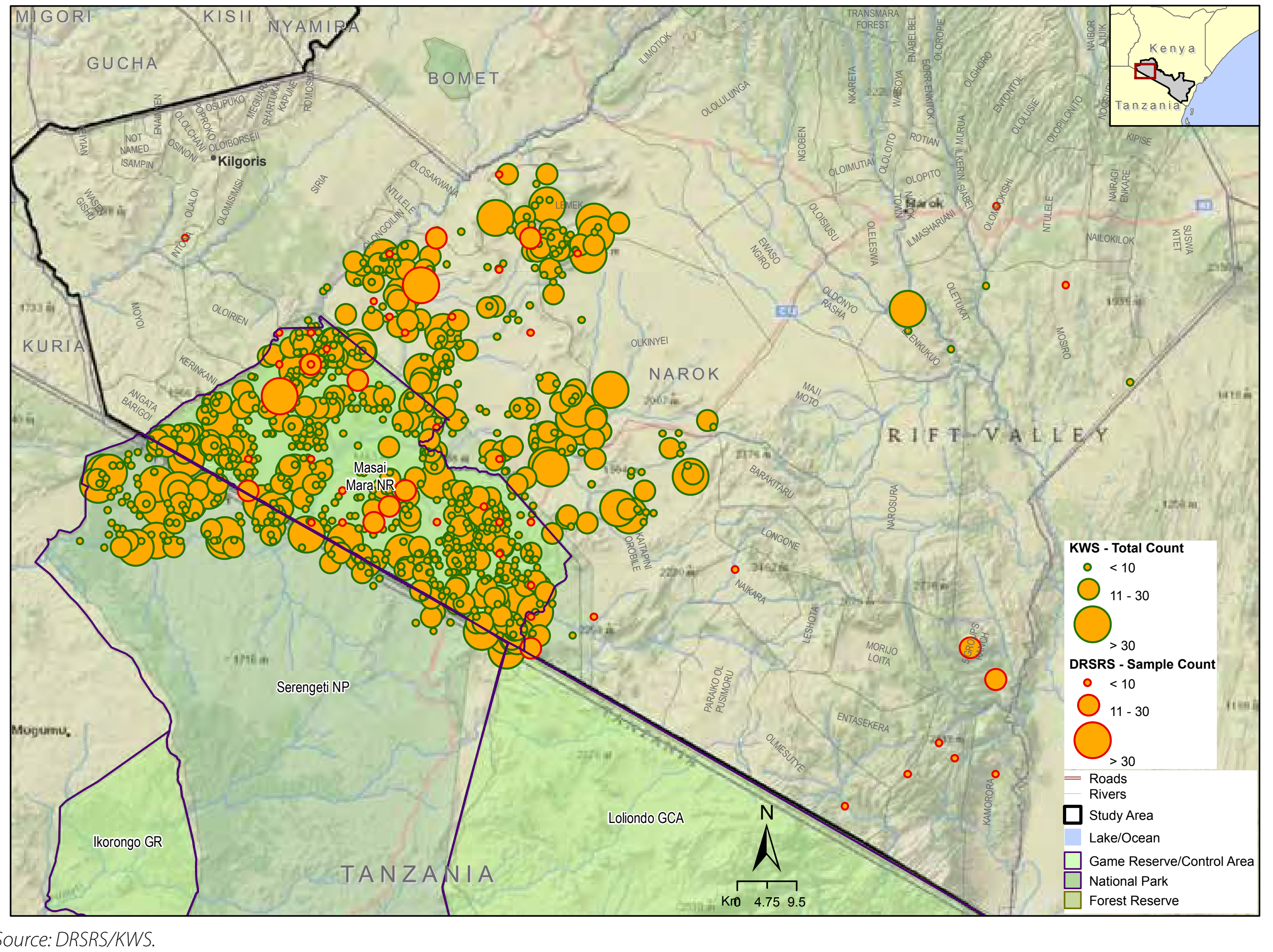
has led to the spread of shrublands and grasslands. It has been hypothesized that elephants and fire are the cause of the multiple stable state of the Serengeti-Mara woodlands. Dublin *et al.* (1990) argue that fire was the perturbation which changed the state of vegetation, but that, once woodland densities had been reduced to low enough levels, elephants were able to keep the vegetation in a grassland state.

Population and distribution trends for elephants in the Masai Mara ecosystem (MME) have changed over the past 50 years. In the mid-1980s, there were about 850 elephants in the Mara, which were widely distributed but almost exclusively within the reserve (Dublin and Douglas-Hamilton, 1987; DRSRS dataset). In the mid-1980s, the Mara population was 19 % higher than mean numbers reported for the period 1965-1977, but the total for northern Serengeti declined by 52 % over the same period (Dublin and Douglas-Hamilton, 1987). This difference was largely the result of heavy poaching in the Serengeti. The poaching activities drove some of the Serengeti elephants to the Masai Mara NR, which was more secure in the early 1990s; hence the increase in population (Dublin and Douglas-Hamilton, 1987; supported by DRSRS data).

The WWF and the KWS have conducted yearly or twice-yearly total counts of elephants in the Mara since 1984. Data collected in the 1990s revealed that elephant numbers in the reserve and dispersal areas varied between 1,031 and 1,705 animals (Mara elephants and ecosystem connectivity report, April 2016). Typically, 60-80 % of these elephants were inside the MMNR and the Triangle (now Mara Conservancy). Mara elephant numbers held relatively steady until 2010, when 3,071 were counted (Kiambi, 2012). This increase in population was observed mainly outside the reserve, where there was a four-fold increase between 1984 and 2007 (Kuloba *et al.*, 2010). An aerial count in June 2014 revealed a marked decline, to 1,448 animals, the lowest count for many years (Mduma *et al*., 2014). This drop is attributed largely to the southerly movement of elephants into Serengeti NP, although poaching was a contributing factor and habitat transformation cannot be ruled out.

## SPECIES DENSITY DISTRIBUTION IN THE MARA ECOSYSTEM

**Map 5.11:** Distribution of elephants in northern Serengeti, the Mara Ecosystem, and the Amboseli region between 1978 and 2011.




Source: DRSRS/KWS.

The range over which elephants in the Mara region are distributed has expanded since the 1980s and 1990s. Elephants are found both inside and outside the reserve, with high densities in the northern parts of the reserve (Map 5.11).

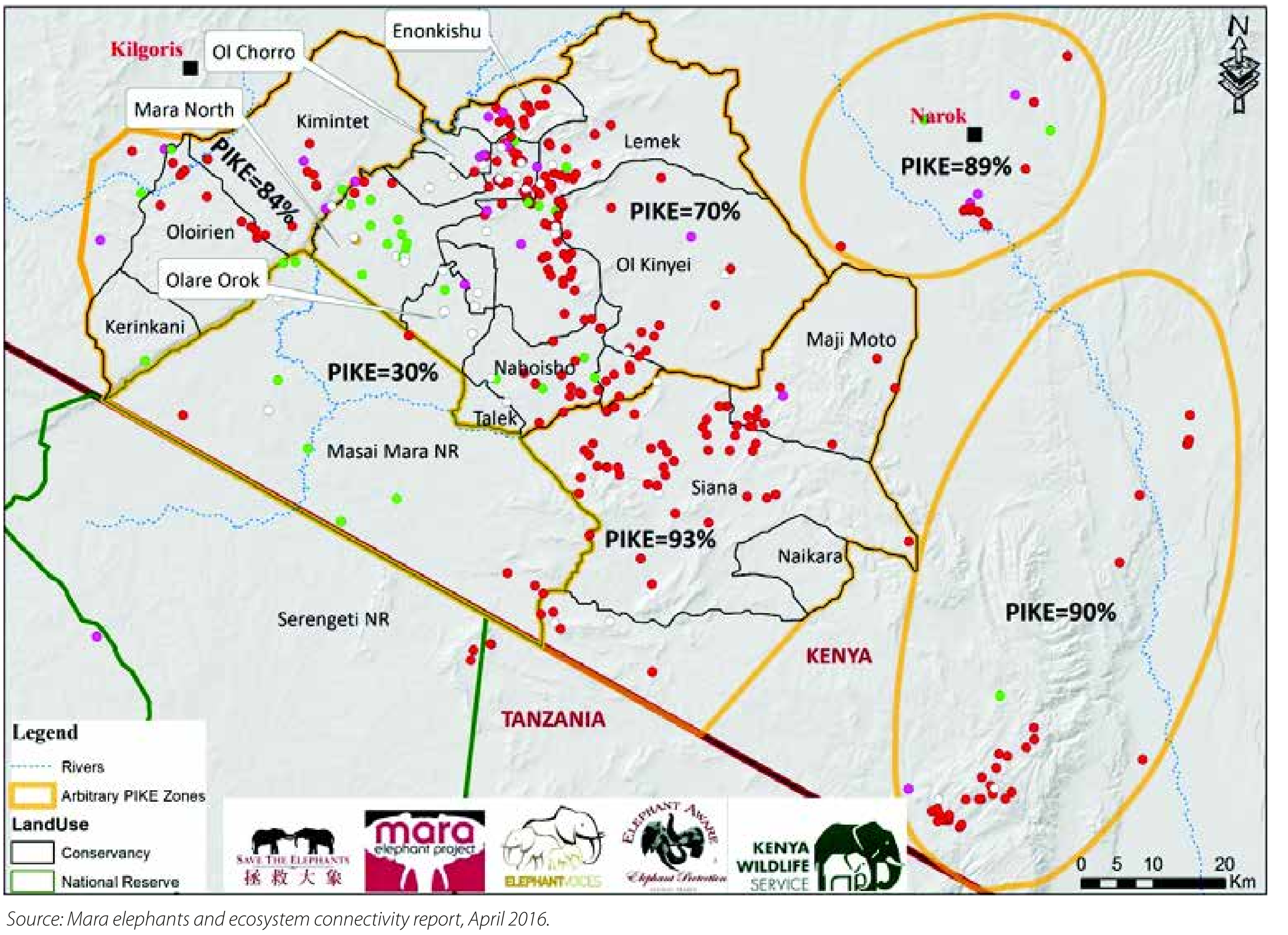
Elephant movements between the MMNR and the Serengeti NP are assured by open borders between and outside these protected areas, but they still face a number of challenges. Human-elephant conflict (HEC) is well documented in the Mara ecosystem (Sitati, 2003; Ariyo, 2008; Kaelo, 2008). As land sub-division continues, and as human settlements and farms expand, escalating conflict between humans and elephants, leading to destruction of property and loss of life, can be expected, unless measures are taken to avoid such conflict.

Primary drivers of human-elephant conflict in the Mara ecosystem correlate with habitat fragmentation, and include:

- **a)**. Isolated farms located in fragmented elephant habitat, bordering core elephant habitat, or adjacent to primary elephant routes;
- **b)**. Subdivision of group ranches into plots on which only a few acres may be farmed;
- **c)**. Settlement and fencing along water-courses that block elephant movement;
- **d)**. Destruction of forested habitat, creating a longer interface between farmland and elephants; and
- **e)**. Competition between people and elephants for the same resources (e.g. grazing grounds, water troughs and wells, and salt licks; Sitati, 2003).

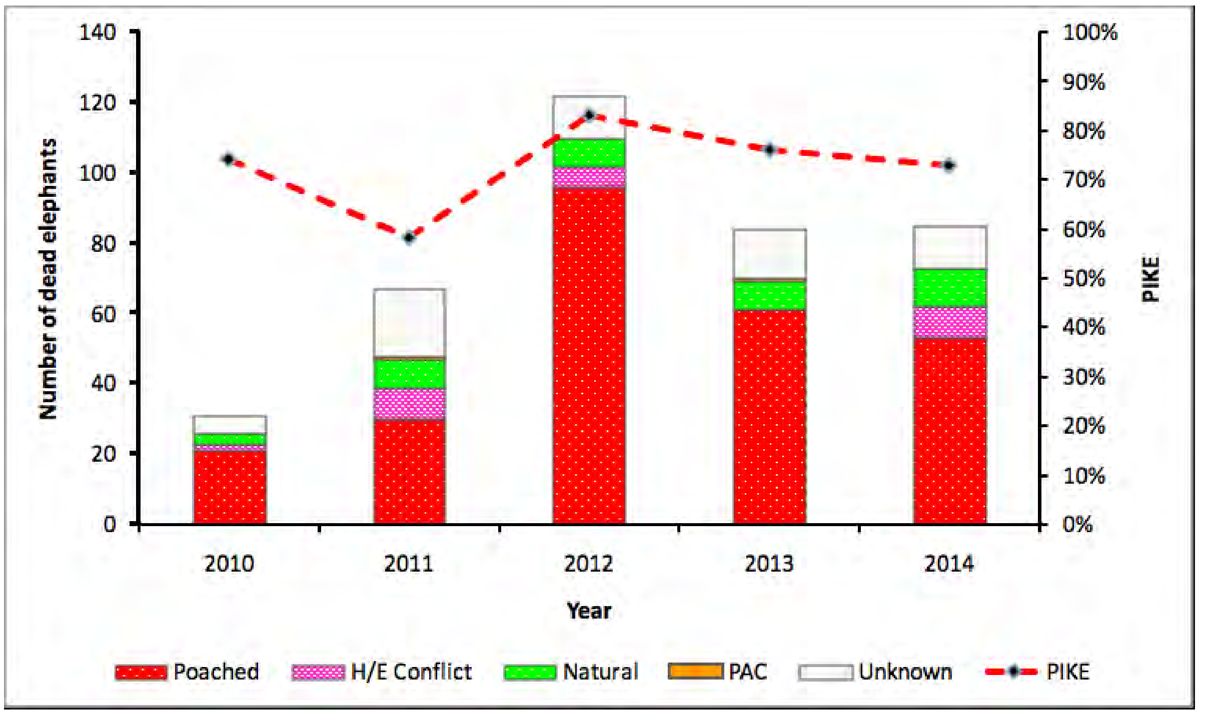
Elephants have long inhabited Narok County, both in the reserve and across a broad swathe of the landscapes beyond. As human settlements and anthropogenic activities expand, elephant ranges are contracting into ever smaller spaces. As livestock grazing in the reserve reaches unsustainable levels, more elephants are being forced out of the reserve to find forage. For grass, they must go to the Serengeti or to the Mara Conservancy, and for browse they must go north and east of the reserve. During the severe poaching of the past four years, the newly formed conservancies have provided safe-havens

**Map 5.12:** Elephant mortality by causes and by distribution of carcasses in the Mara ecosystem from 2010 to 2014. Arbitrary zoning (bold orange polygons) have been included for purposes of comparing average PIKE values between areas. Except in the Masai Mara NR, PIKE values were above 54%, which is indicative of a population in decline from illegal killing




*Source: Mara elephants and ecosystem connectivity report, April 2016.*

**Figure 5.4:** Summary of mortality causes in elephants, and proportions of illegally killed elephants (PIKE) in the Mara Ecosystem. An elephant population is deemed to be in decline as the result of illegal killing when a PIKE of 54 % or above is recorded.




*Source: Mara elephants and ecosystem connectivity report, April 2016.*

for elephants. Here they face competition, though, from high numbers of grazing livestock, which leave little but browse for the elephants, especially in the dry season. The presence of elephants is already changing the appearance of these habitats, and biodiversity loss and declining tourism revenue may be the long-term consequences.

The primary causes of elephant mortality in the Mara have been documented in previous studies as ivory poaching, human-elephant conflict and revenge attacks, problem elephant control and natural causes (Sitati, 2003; Wakoli and Sitati, 2012). Elephants are highly sensitive to changing levels of security, and patterns of their illegal killing influence distribution, group size and behaviour. Although the numbers and the causes of elephant deaths have fluctuated in the Mara region (Fig. 5.4), the Proportion of Illegally Killed Elephants (PIKE), at between 58 % and 83 %, has remained above sustainable limit: A population is deemed to be in decline when a PIKE of 54 % or above is recorded (Wittemyer *et al*., 2014).

Incidences of illegal killing have occurred mainly outside the MMNR, where PIKE values are higher than inside the reserve. Some areas, such as Siana and the Naimina Enkiyio (Loita) Forest, recorded PIKE values of over 90 %, which are among the highest levels of illegal killing of elephants recorded in Kenya (Map 5.12).

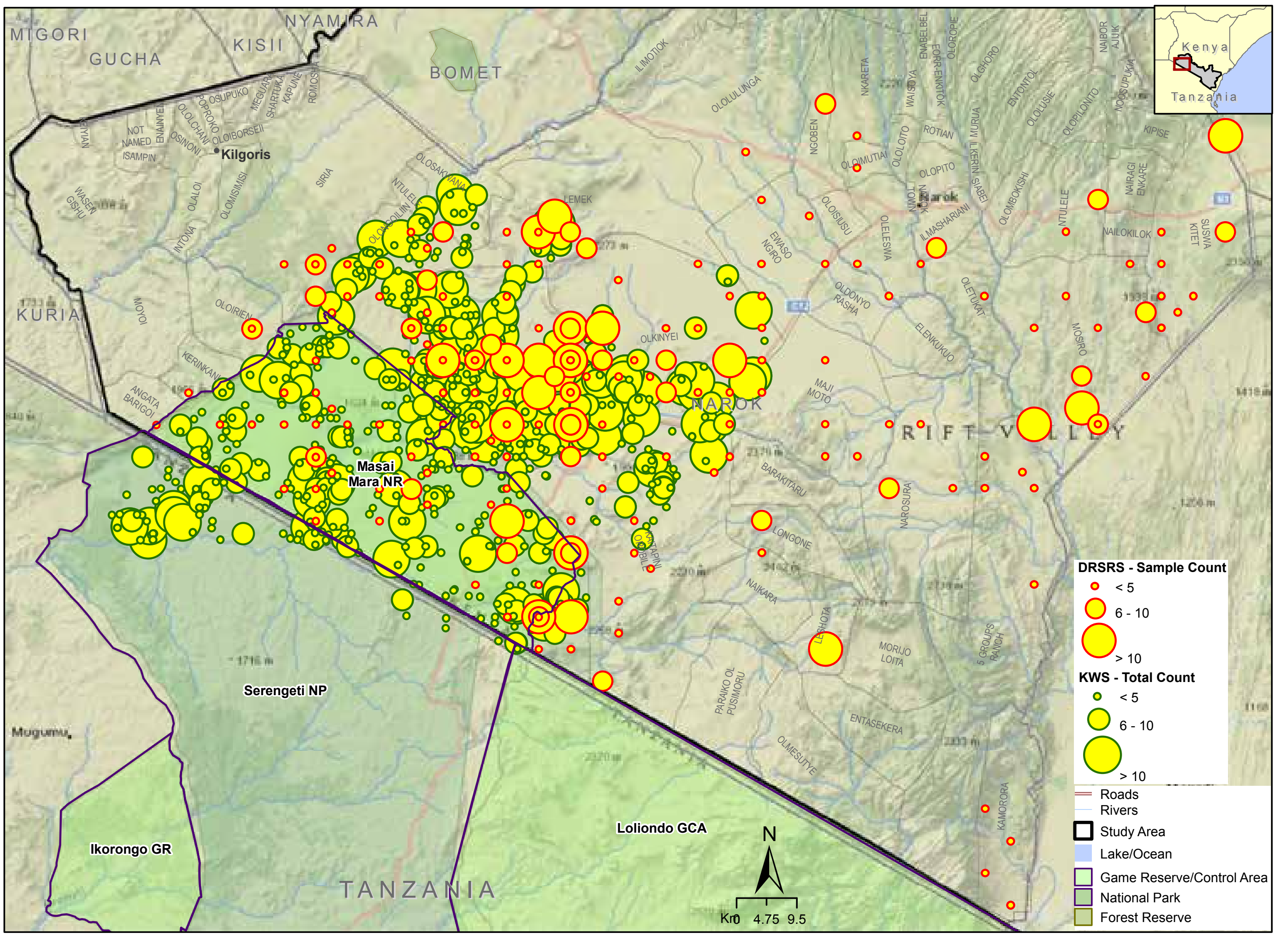
### 5.2.4. Population and distribution trends for Giraffe in the Mara Ecosystem

The Maasai giraffe is found in the southern Kenya rangelands (Masai Mara, Athi-Kaputiei, Amboseli, and Tsavo ecosystems) and throughout Tanzania. Maasai giraffe populations have remained relatively stable, although reports indicate that their numbers have fallen in recent years (KWS website).

Studies by ILRI found that the population of the Maasai giraffe in the Mara fell by up to 95 % between 1989 and 2003, due to rapid expansion of human settlements around the unfenced reserve. The area has traditionally been used by wild animals for seasonal grazing, but has increasingly been converted to livestock husbandry and crop production. The giraffes in the Mara strongly favour the pastoral savannah. ILRI's surveys found that, in both 1999 and 2002, there were more than twice as many giraffe on the group ranches than in the reserve (Reid *et al*., 2003). Most of the giraffes were in a tsetse-infested belt of *Acacia* woodland 7-10 km north of the reserve, while those in the reserve were clustered in riverine areas, the only places with significant numbers of trees (Map 5.13).

# SPECIES DENSITY DISTRIBUTION IN THE MARA ECOSYSTEM

**Map 5.13:** Distribution of giraffes in the northern Serengeti and greater Mara ecosystem between 1978 and 2011.




*Source: DRSRS/KWS.*

### 5.2.5. Population and distribution trends for Buffalo, Burchell's Zebra and Giraffe around Lakes Naivasha, Elementaita and Nakuru and in the Eburu Forest Conservation Area

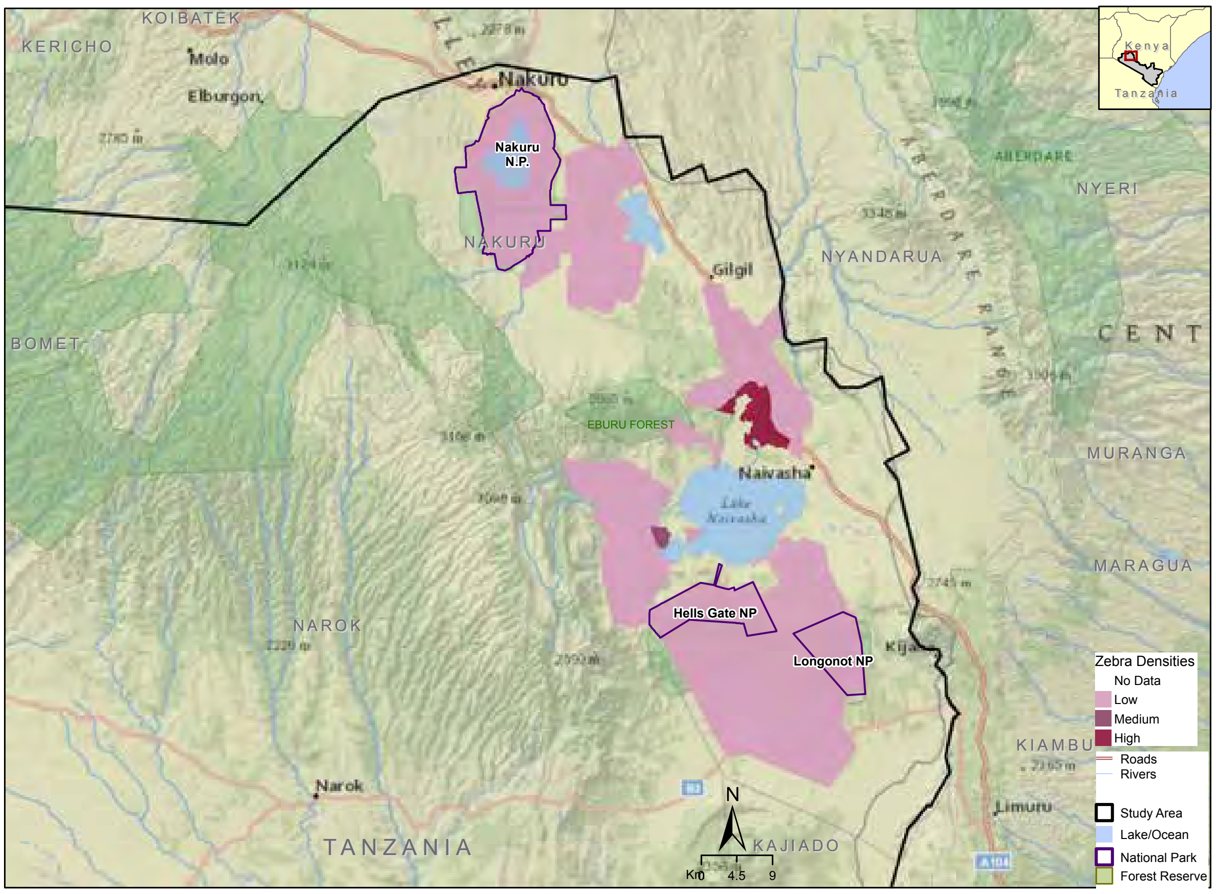
The Mau Eburu forest is one of 22 gazetted forest blocks making up the vast 4,200-km² Mau Forests Complex. It forms part of a wider Rift Valley ecosystem and conservation area encompassing Lakes Nakuru, Elementaita and Naivasha, the Soysambu Conservancy, and the Mt. Longonot and Hell's Gate NPs. The Eburu Forest spans 87 km² of prime indigenous habitat on Mount Eburu, whose highest peak, Ol Doinyo Eburu, stands 2,820 m above sea level, forming part of the catchment for Lakes Naivasha and Elementaita.

The forest has a diverse flora, including extensive stands of African mountain bamboo and trees of species such as *Juniperus procera*, *Podocarpus milanjianus*, *Allophylus abyssinicus*, *Prunus africana*, *Dombeya torrida*, *Nuxia congesta*, *Rapanea melanophloeos*, *Olea capensis* ssp. *macrocarpa*, *Polyscias kikuyuensis*, *Maesa lanceolata*, *Olinia rochetiana*, *Schefflera volkensii*, and *Ekebergia capensis*, as well as (at lower elevations) *Tarchonanthus camphoratus*, *Buddleja polystachya*, and various *Acacia* species. This forest is one of the few remaining haunts of the endangered eastern, or mountain, bongo antelope.

Wildlife species found in the wider ecosystem and conservation area include buffalo, zebra, and giraffe. Plains zebra occur in high densities at Marula (Map 5.14), and giraffe in high densities around the western tip of Lake Naivasha (Map 5.15). Densities are variable elsewhere in the area. Buffalo densities are high in the Loldia and Marula areas; medium in the Lake Nakuru NP and Kekopey, and low in the Conclave, Soysambu, Hell's Gate NP, Longonot NP, and Kedong areas (Map 5.16).

# DISTRIBUTION DENSITY OF SPECIES IN THE WIDER LAKES NAIVASHA, ELEMENTAITA, NAKURU AND EBURU FOREST ECOSYSTEM

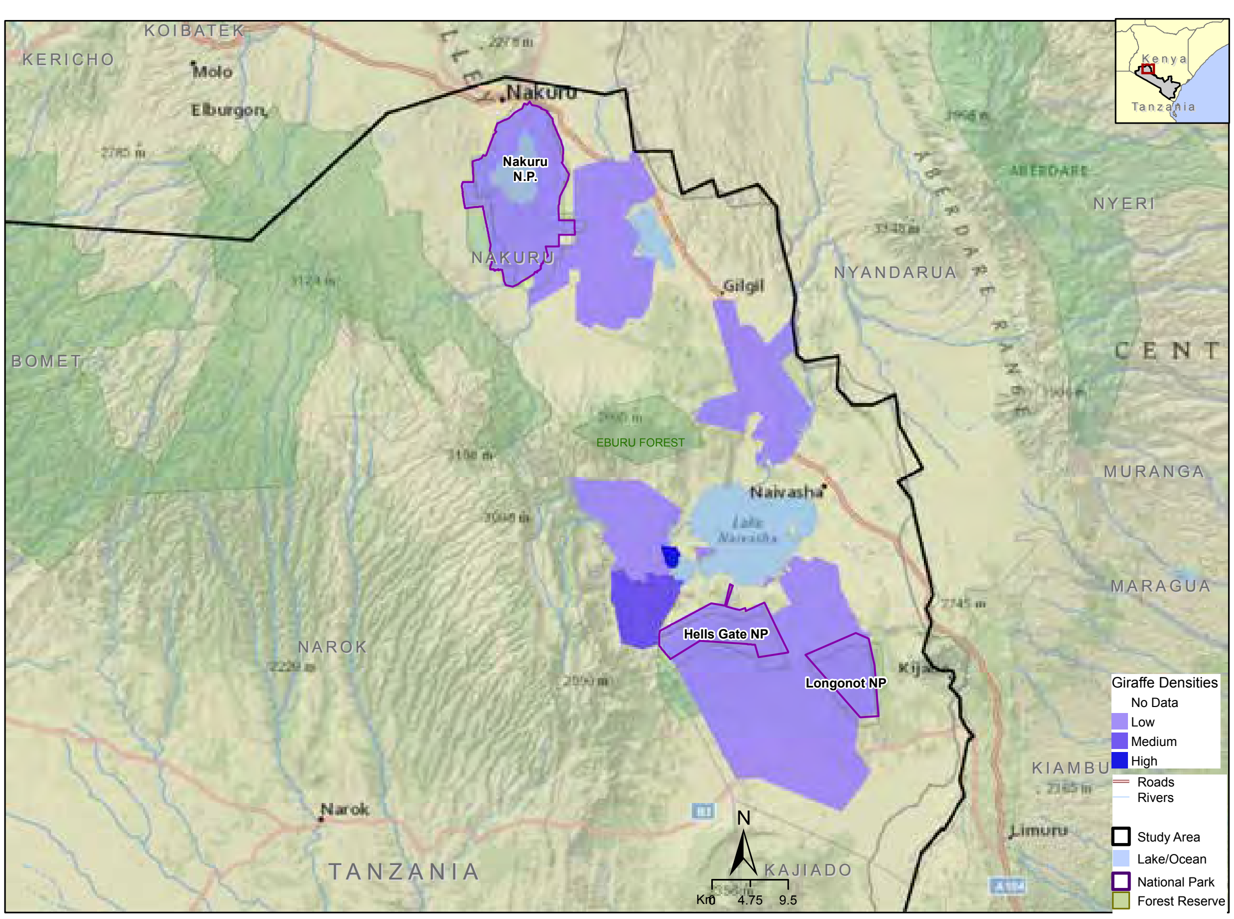
**Map 5.14:** Distribution density of Burchell's zebra in the wider Lakes Naivasha, Elementaita, Nakuru and Eburu Forest Ecosystem.




*Source: DRSRS/KWS.*

# DISTRIBUTION DENSITY OF SPECIES IN THE WIDER LAKES NAIVASHA, ELEMENTAITA, NAKURU AND EBURU FOREST ECOSYSTEM

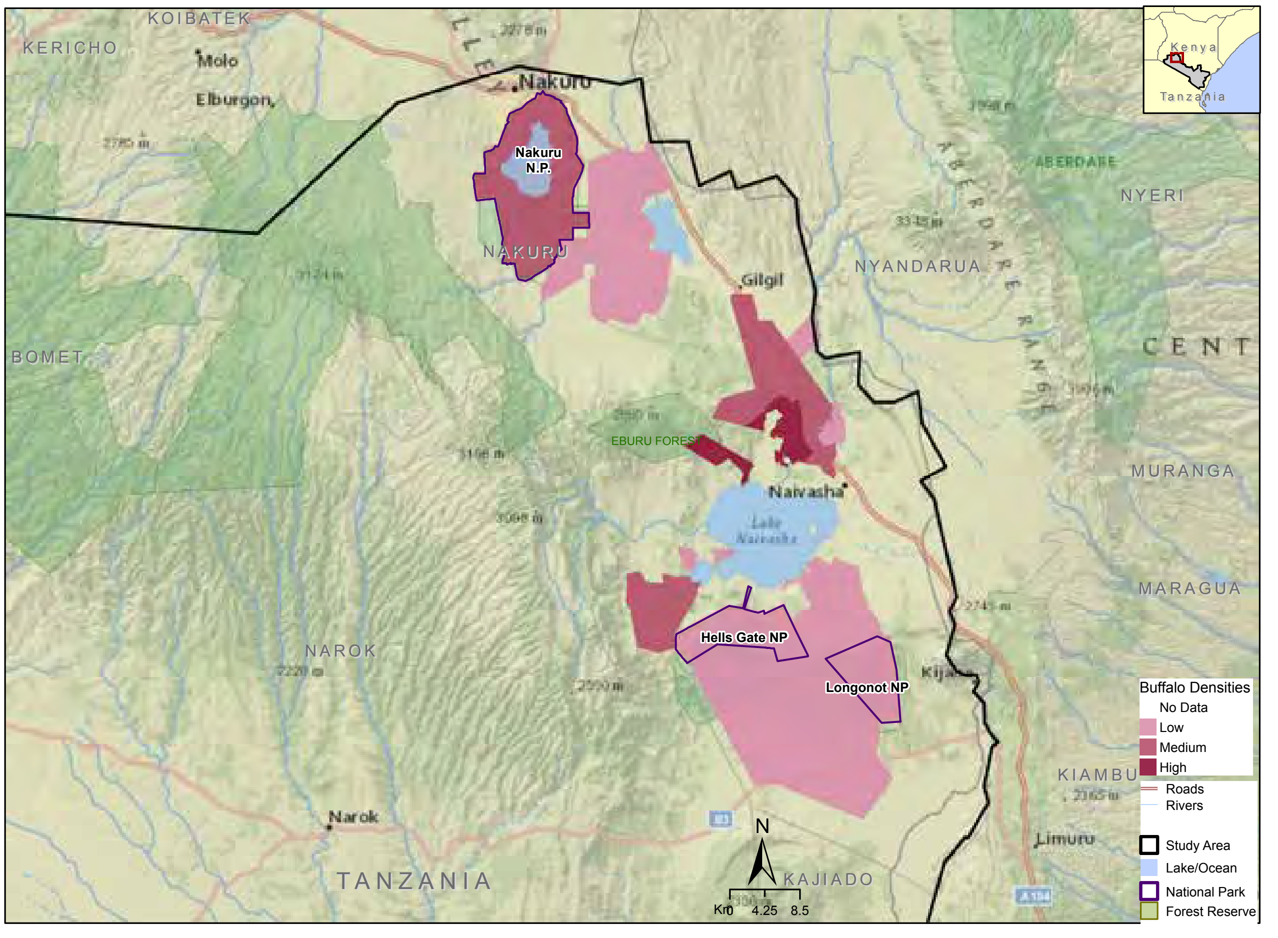
**Map 5.15:** Distribution density of giraffe in the wider Lakes Naivasha, Elementaita, Nakuru and Eburu Forest Ecosystem.




*Source: DRSRS/KWS.*

# DISTRIBUTION DENSITY OF SPECIES IN THE WIDER LAKES NAIVASHA, ELEMENTAITA, NAKURU AND EBURU FOREST ECOSYSTEM

**Map 5.16:** Distribution density of buffalo in the wider Lakes Naivasha, Elementaita, Nakuru and Eburu Forest Ecosystem.




Source: DRSRS/KWS.

### 5.2.6. Population and distribution trends for Wildebeest in the Athi-Kaputiei Ecosystem

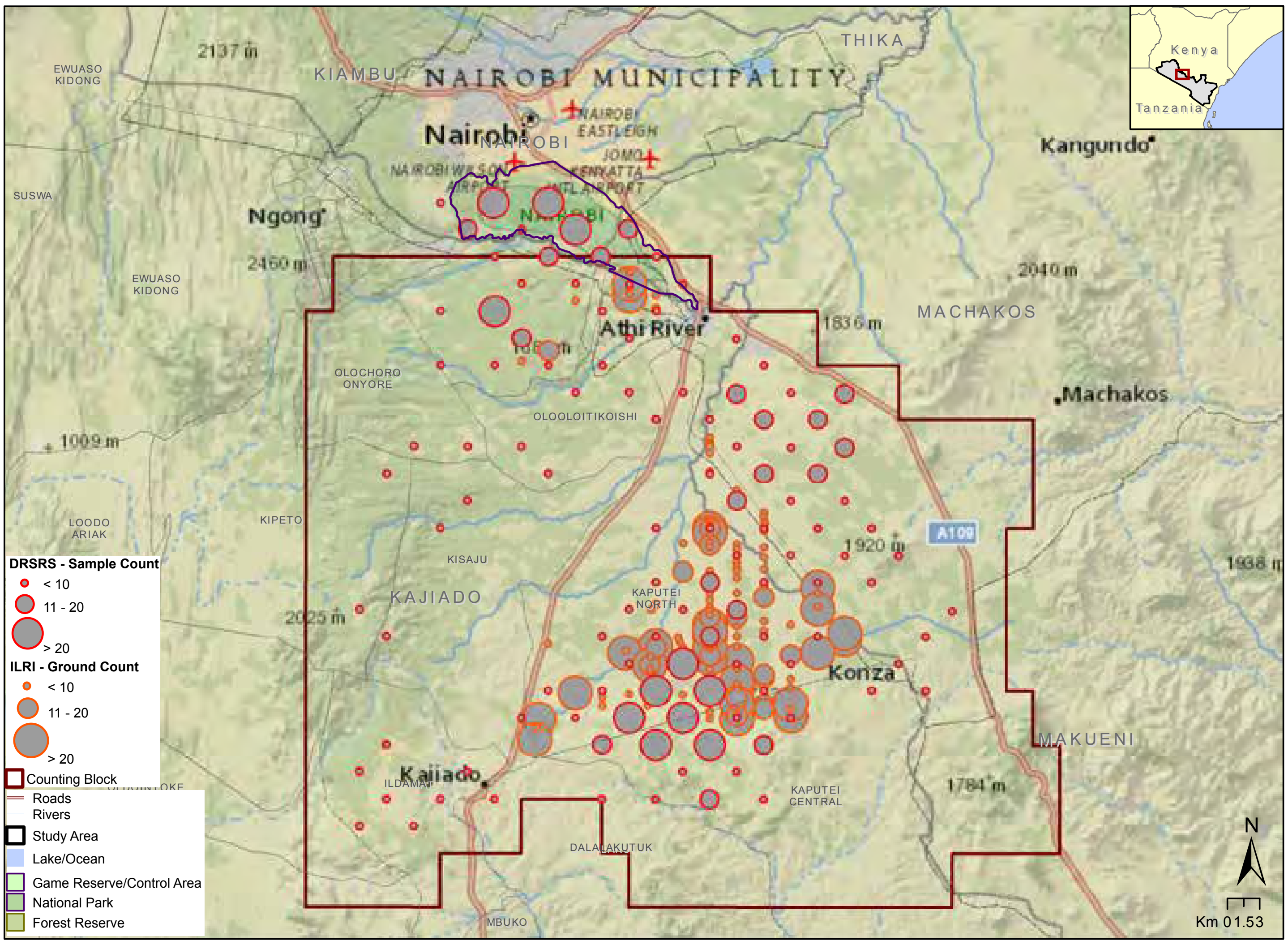
The Athi-Kaputiei ecosystem covers an area of about 2,000 km$^2$ and includes the Nairobi NP (114 km$^2$) and the Kitengela conservation area. In the 1970s, it contained Kenya's second largest wildebeest population (about 30,000 animals) (Ogutu *et al*., 2016), but this population has since declined to fewer than 4,000 animals (DRSRS, 2011 census). The wildebeest and zebras in the ecosystem migrate between the Nairobi NP and their calving grounds on the Athi-Kapiti plains. The Nairobi NP is the dry season refuge for a number of wildlife species, including eland, kongoni, Thomson's gazelle and impala.

Wildebeest migration between the Nairobi NP and the Athi-Kapiti plains has collapsed in recent decades, as the population has fallen from 5,000-10,000 animals to fewer than 800 in 2001-2009 (Ogutu *et al*., submitted). A number of corridors linking the Nairobi NP and calving grounds in Enkirigirr (Kaputiei North) have been lost to settlement and land subdivision or blocked by fences. Historically, the Athi-Kapiti plains provided migration corridors and wet season grazing areas for large wildebeest and zebra herds. The important wildebeest areas border the park and include the calving zones in Enkirigirr and on ranches in the Machakos area (Map 5.17). Land-use changes, the fencing of properties (more than 20 % of the area is now fenced), urban development and gypsum mining have adversely affected wildebeest populations in the ecosystem (Ogutu *et al*., 2016; Said *et al*., 2016).

Further collapse of the wildebeest population in the Athi-Kaputiei ecosystem is imminent unless immediate action is taken to save the animals by connecting the populations in Nairobi NP, Enkirigirr and Machakos ranches. The Athi River-Kitengela-Namanga highway and the intensive development along it has divided the populations (see also section 7.5).

# SPECIES DENSITY DISTRIBUTION IN THE ATHI-KAPUTEI ECOSYSTEM (NAIROBI NP – KITENGELA AREA)

**Map 5.17:** Distribution of wildebeest in Nairobi NP and the Athi-Kaputiei Ecosystem between 1978 and 2011.




Source: DRSRS

## 5.2.7. Population and distribution trends for Plains Zebra in the Athi-Kaputiei Ecosystem

The Athi-Kaputiei hosts a large population of plains zebra, which are widely distributed throughout the ecosystem. Large numbers of zebras occur around Konza in Kaputiei North, in the same range as wildebeest (DRSRS and ILRI counts). Large zebra herds were also seen on escarpments in the western sector of the ecosystem, on the Machakos ranches, and to the south of Nairobi NP (Map 5.18 and Table 5.1 e).

The Athi-Kaputiei ecosystem's zebra population increased from 5,000 animals in 1977 to 18,000 in 1992. This was attributed to high rainfall in the 1980s. Population declines in other parts of the ecosystem have beeen attributed to fences and to high livestock densities. Zebra numbers have not declined as rapidly as those of wildebeest, due to the high mobility of zebras, their non-ruminant nature, and their ability to utilize forage of poor quality (Owaga, 1975).

The pattern of zebra migration between Nairobi NP and the Athi-Kapiti plains is similar to that of wildebeest. The zebra population is higher inside the park during the dry season

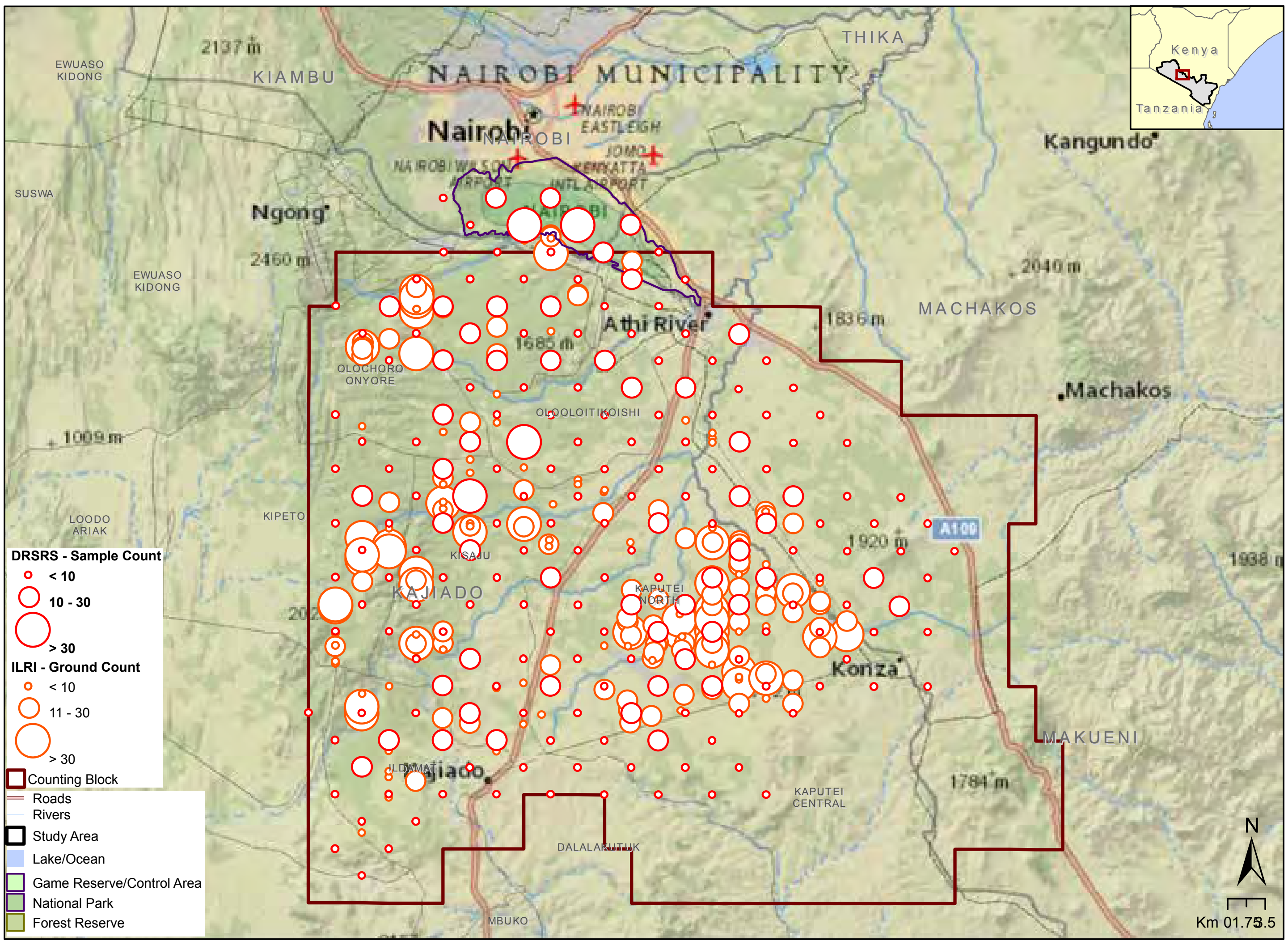
**Table 5.1 (e):** Population estimates for elephant, plains zebra, and giraffe, as averaged between 1978 and 2011 both inside and outside the Tsavo West NP and Ngai Ndethya NR, and Machakos and Makueni Counties

| Protected Area | | Tsavo West NP and Ngai Ndethya NR | | | |
|---|---|---|---|---|---|
| Species | | Elephant | Wildebeest | Plains Zebra | Giraffe |
| Inside | Pop. Est | 66 | - | 276 | 79 |
| | Density | 0.1 | - | 0.43 | 0.12 |
| | % | 72 | - | 10 | 13 |
| Outside | Pop. Est | 26 | 2,313 | 2,497 | 547 |
| | Density | 0.002 | 0.17 | 0.19 | 0.04 |
| | % | 28 | 100 | 90 | 87 |
| County | (In) % | 7 | | | |
| | (out) % | 93 | | | |

Source: DRSRS.

# SPECIES DENSITY DISTRIBUTION IN THE ATHI-KAPUTEI ECOSYSTEM (NAIROBI NP – KITENGELA AREA)

**Map 5.18:** Distribution of zebras in Nairobi NP and the Athi-Kaputiei Ecosystem between 1978 and 2011.




*Source: DRSRS*

(July-October) than in the wet season. Zebra numbers in Nairobi NP peaked during the droughts of 1993, 1996-97, 1999-2000, 2005-2006 and 2008-2009 (Ogutu *et al*., 2008).

### 5.2.8. Population and distribution trends for Giraffe in the Athi-Kaputiei Ecosystem

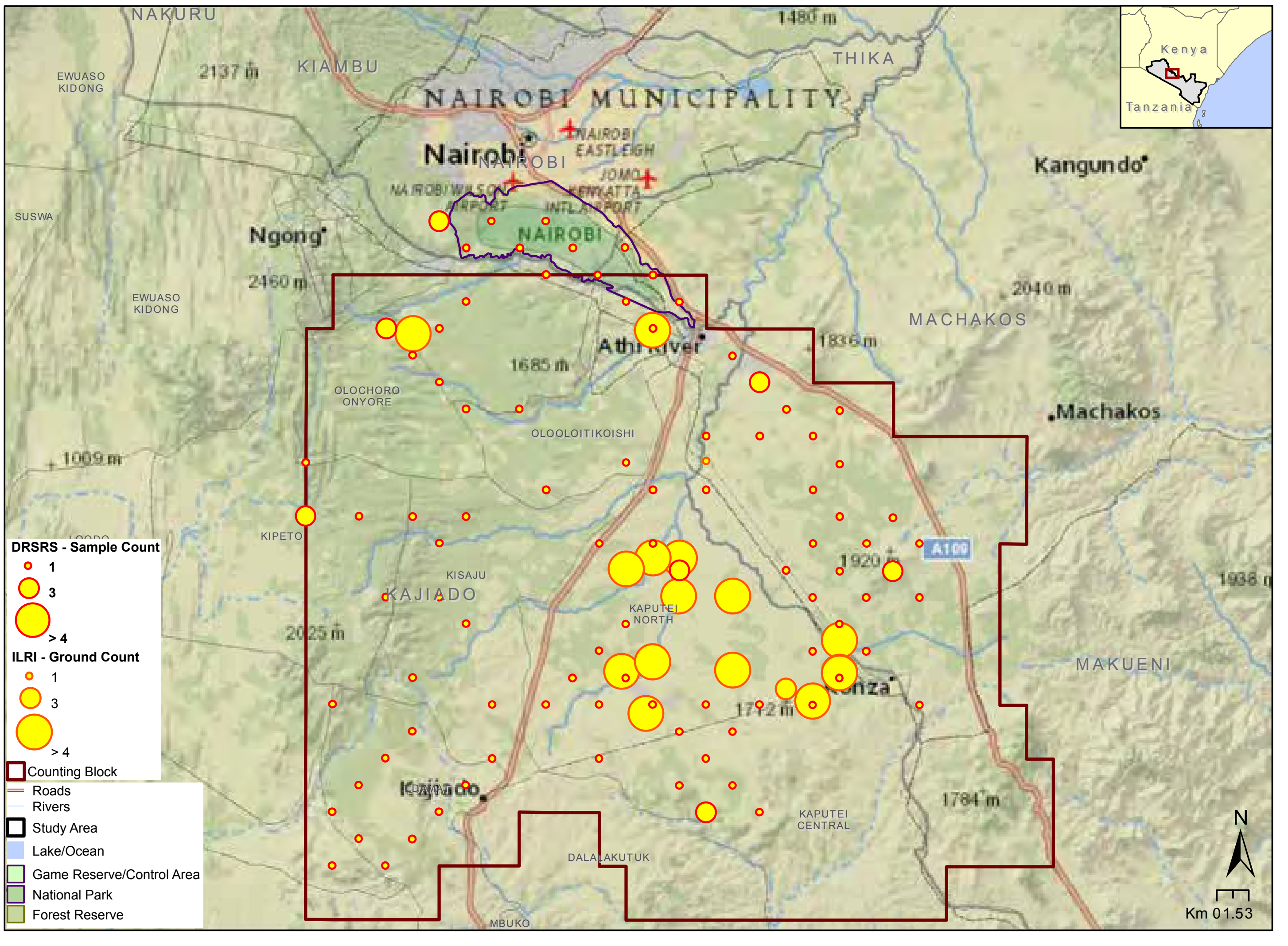
Giraffes are widely distributed across the Athi-Kaputiei ecosystem. High population densities were found in Kaputiei North and around Konza, while low numbers were recorded in the Nairobi NP and on the Machakos ranches (FoNNaP, local communities and ILRI ground counts, 2011). Most of the animals were observed in wooded riverine habitats.

The Athi-Kaputiei ecosystem's giraffe population numbered more than 800 animals in the 1970s, but numbers have fallen drastically over more recent years. Giraffes are highly sensitive to changes in their environment; so recent land-use changes in their range have affected populations, in addition to heavy poaching for their meat and skins. Giraffe numbers inside Nairobi NP (estimated at more than 100 animals) have remained stable, but numbers outside the park have suffered one of the steepest declines anywhere in the southern Kenya rangelands.

Apart from the effects of land-use change and poaching, the abundance of giraffes in the region does not vary with seasonality. Ogutu *et al*. (2008) have shown that the number of newborn giraffes in the Mara-Serengeti ecosystem correlates most closely with average late dry-season rainfall over the preceding five years, and that the number of older giraffes correlates with average wet-season rainfall over the preceding 1-5 years.

# SPECIES DENSITY DISTRIBUTION IN THE ATHI-KAPUTEI ECOSYSTEM (NAIROBI NP – KITENGELA AREA)

**Map 5.19:** Distribution of giraffes in Nairobi NP and the Athi-Kaputiei Ecosystem between 1978 and 2011.




Source: DRSRS

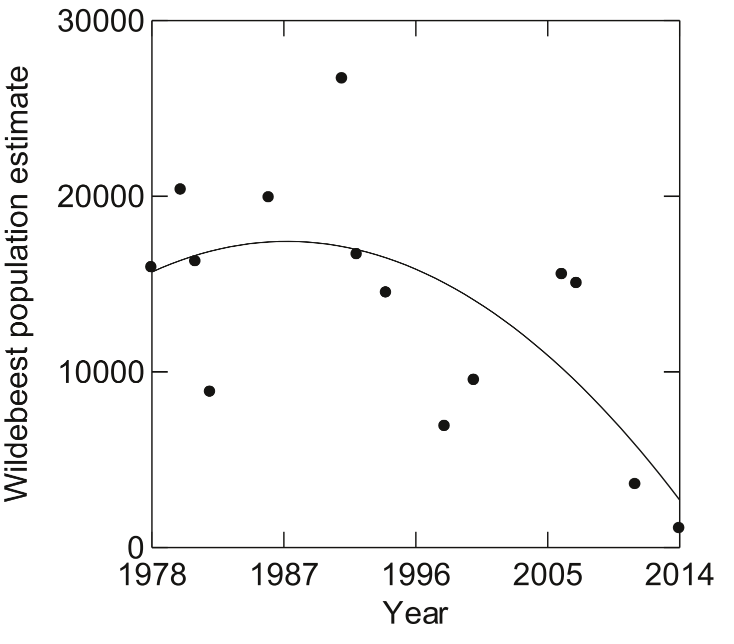
## 5.2.9. Population and distribution trends for Wildebeest in the South Rift and Amboseli Ecosystem

The Amboseli NP and adjacent ranches, Kaputiei South, Mbirikani, Kuku, Kimana, and Shompole, are the key wildebeest areas in the South Rift and greater Amboseli ecosystem. Small, scattered herds are found in Kajiado County (Kenya), with concentrations near Lake Natron and to the west of the Kitu Hills in Tanzania.

In the late 1970s, there were more than 50,000 wildebeest in Kajiado County, but by the late 1980s this population had declined by almost half, to 27,740 animals (Ojwang' *et al*., 2006). In the early 1990s, wildebeest numbers increased slightly, to 31,480 animals, but then declined again, to 24,496 animals, in the late 1990s. In the early 2000s, numbers declined drastically, to just 13,679 animals. The most recent surveys show that wildebeest are the third most abundant wildlife species in the South Rift and Amboseli/West Kilimanjaro ecosystem (KWS, 2010). A total of 7,240 wildebeest were counted, with the highest density in the Amboseli region.

The Amboseli wildebeest population was about 3,098 animals in 2010, which was the lowest observed in more than 30 years (KWS, 2010). The 2009 drought, which was the severest in the country in more than 40 years, had a devastating impact on both wildlife and livestock populations (Western, 2010). The wildebeest population in the Amboseli ecosystem almost collapsed, and populations in the wider landscape declined drastically from the 18,538 animals which had been observed prior to the drought (KWS, 2010).

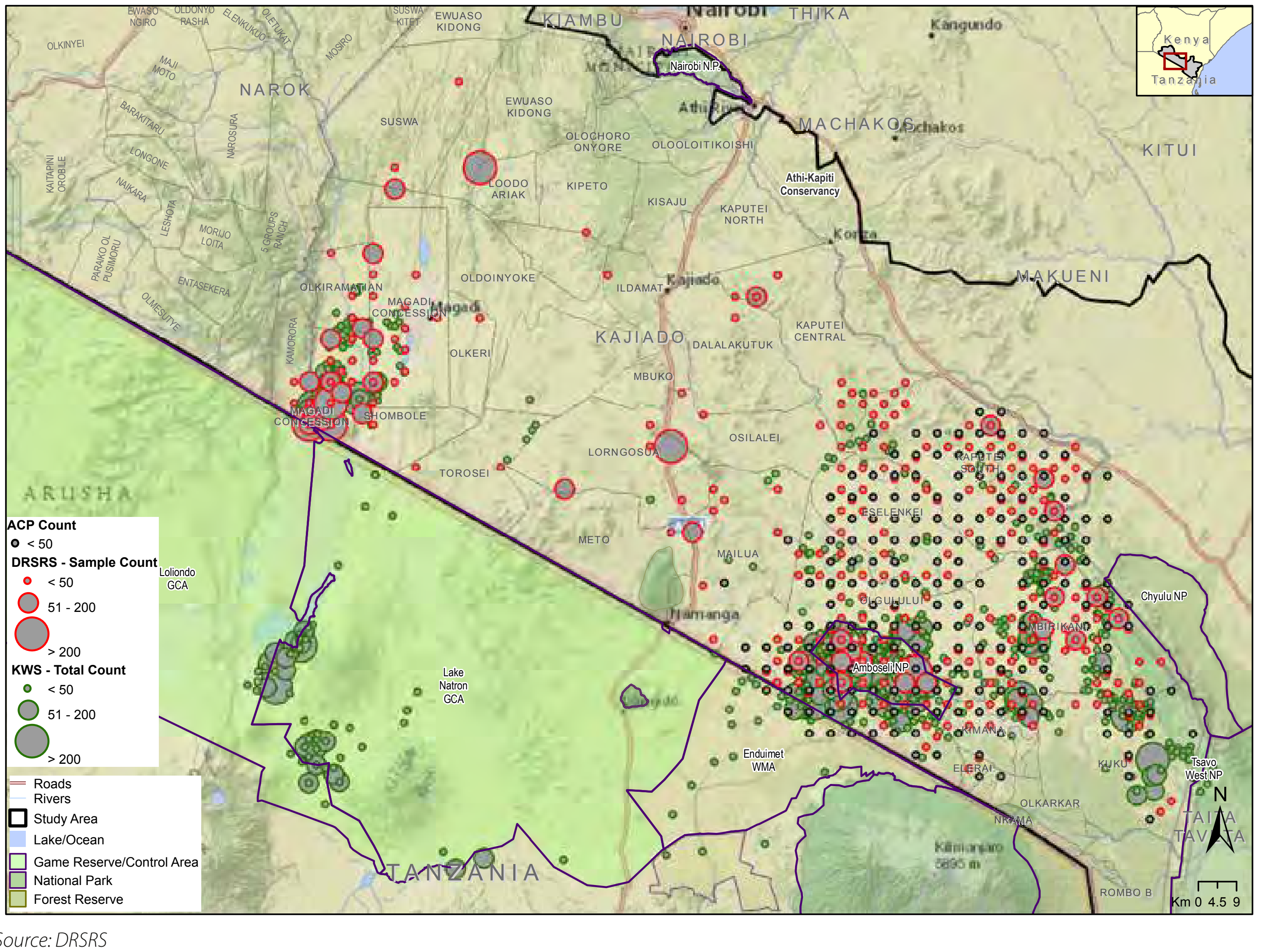
Figure 5.5: Wildebeest population trends in the Amboseli Ecosystem between 1978 and 2014, showing a declining population.




*Source: DRSRS*

## SPECIES DENSITY DISTRIBUTION IN SOUTH RIFT, AMBOSELI ECOSYSTEM AND WEST KILIMANJARO AREA

Map 5.20: Distribution of wildebeest in the Amboseli Ecosystem, Athi-Kaputiei, the Magadi area and West Kilimanjaro between 1978 and 2011.



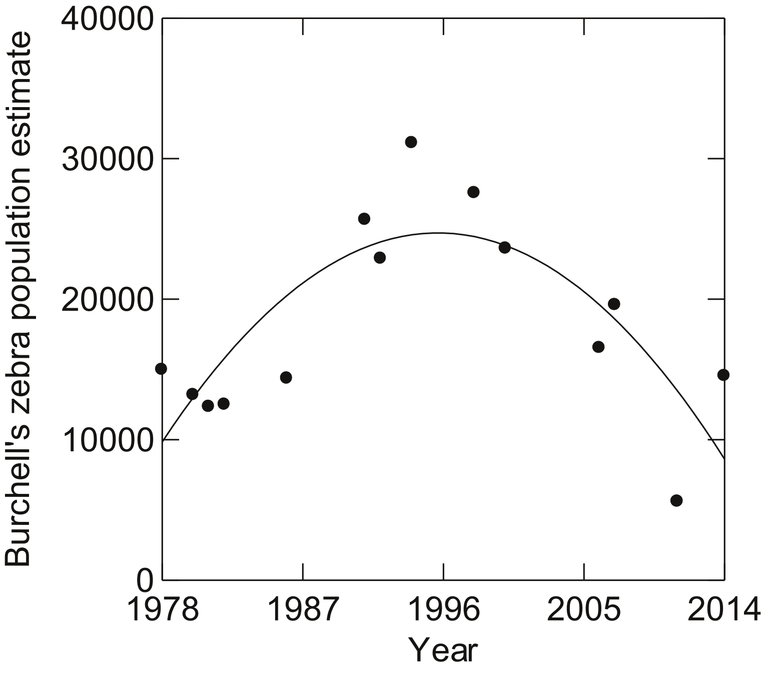

*Source: DRSRS*

### 5.2.10. Population and distribution trends for Plains Zebra in the South Rift and Amboseli Ecosystem

Plains (Burchell's) zebras are widely distributed in Kajiado County (Kenya) and in the West Kilimanjaro region of Tanzania, with large concentrations in the greater Amboseli ecosystem, Kaputiei South, and the Shompole and Magadi concession areas. A large and widely scattered group occurs around the Lake Natron GCA and the Enduimet WMA in Tanzania.

Kajiado County contains the second largest resident population of plains zebras in the country. In the early 1980s, 24,630 animals were counted here (Ojwang' *et al*., 2006). By 2010, this population, in Amboseli and surrounding areas, had declined to 13,740 animals (KWS, 2010). Of the four areas surveyed, Magadi had the highest population density (0.70/km$^2$), followed by Amboseli (0.68/km$^2$), Natron (0.45/km$^2$), and West Kilimanjaro (0.23/km$^2$). The 2009 drought had a devastating impact on the zebra population. The range of zebras coincides with that of cattle, so the impacts of drought are exacerbated by competition with livestock for forage and water resources.

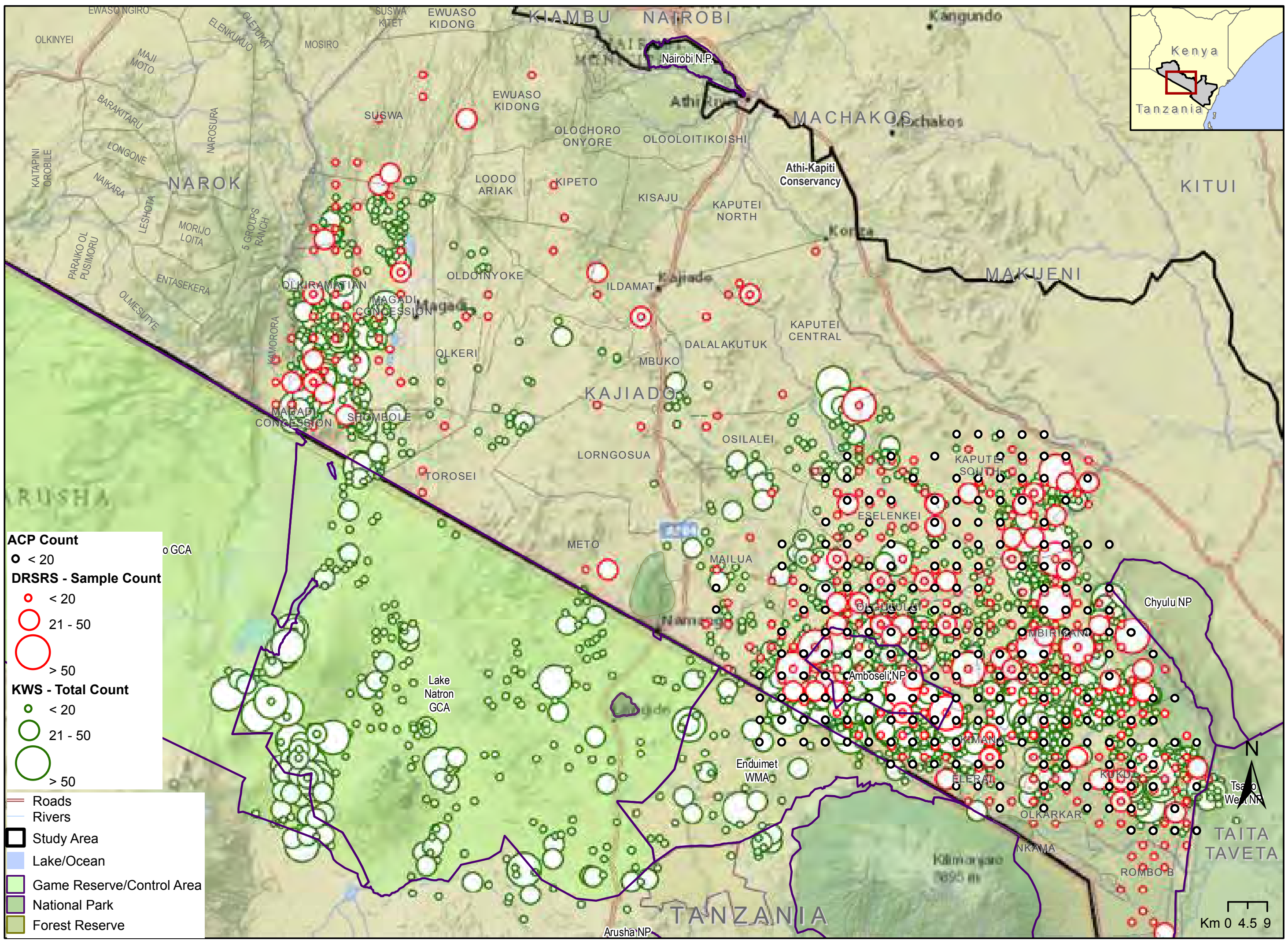
**Figure 5.6:** Population trends for Burchell's zebra in the Amboseli Ecosystem between 1978 and 2014, showing an increase in the 1990s and drastic declines in the 2000s.




*Source: DRSRS Database.*

# SPECIES DENSITY DISTRIBUTION IN SOUTH RIFT, AMBOSELI ECOSYSTEM AND WEST KILIMANJARO AREA

**Map 5.21:** Distribution of plains zebras in the Amboseli Ecosystem, Athi-Kaputiei, the Magadi area, and west Kilimanjaro between 1978 and 2011.




Source: DRSRS/KWS

## 5.2.11. Population and distribution trends for Elephant in the South Rift and Amboseli Ecosystem

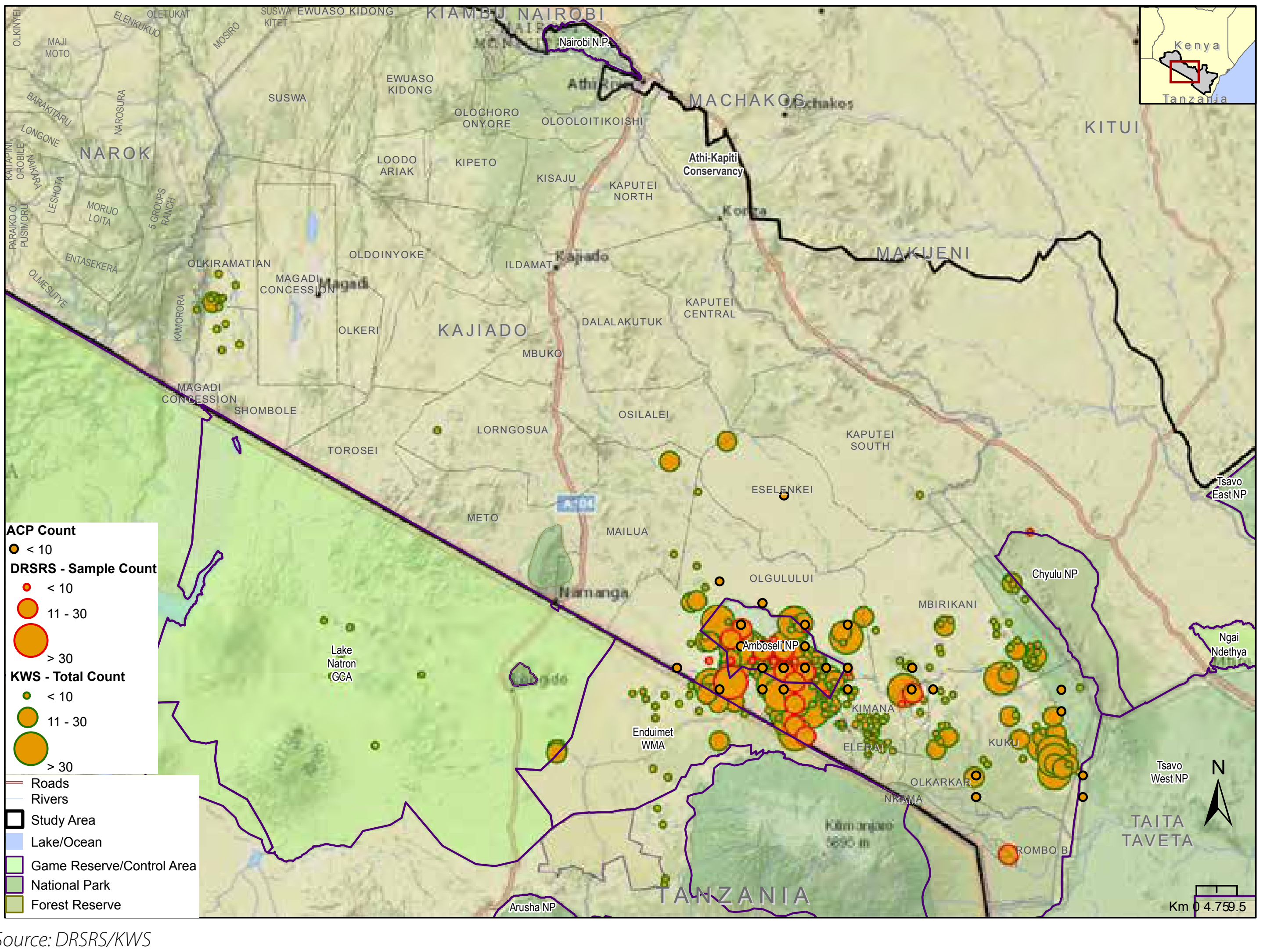
Distribution of elephants in the South Rift, Amboseli and West Kilimanjaro areas shows four important ranges: Amboseli, Kimama-Elarai, Mbirikani-Chyulus, Kamorora-Olkiramatian, and Enduimet WMA. The elephants are found mainly in the Amboseli NP and on surrounding group ranches including Olgulolui, Elarai, Kuku, Kimana and Mbirikani. A few herds occur in the Enduimet WMA and the Lake Natron GCA in Tanzania.

Amboseli's elephants have been the subject of long-term studies by many researchers, so the population is well documented (Western and Lindsay, 1984, Kioko *et al.*, 2006). In the 1970s and 1980s, the Amboseli elephant population numbered fewer than 1,000 animals (DRSRS data; Said *et al.*, 1995), but since the 1990s the population has continued to increase steadily. Recent surveys show a relatively stable elephant population, of slightly above 1,000 animals. The population estimates for 2000, 2002, 2007, and 2010 were 1,087, 1,090, 967, and 1,266, respectively (KWS, 2010).

The elephants in Amboseli traverse wide areas on their seasonal movements outside the park (KWS, 2010). Movements between Amboseli and other areas, including Tsavo, Chyulu, Nguruman, Magadi, West Kilimanjaro, and the Lake Natron GCA have been mapped using radio collars (KWS, 2010). Threats to Amboseli's elephants include displacement by people through conversion of habitat, the impacts of recurrent droughts, and poaching.

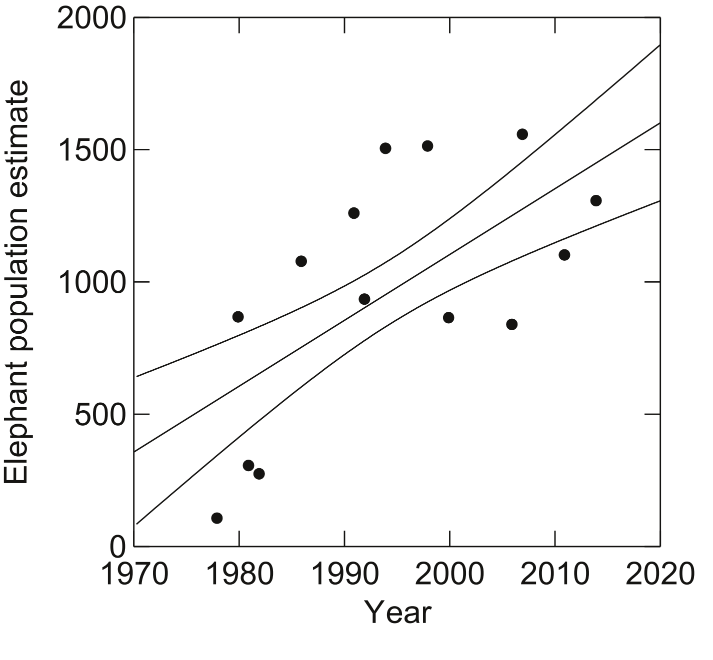
# SPECIES DENSITY DISTRIBUTION IN SOUTH RIFT, AMBOSELI ECOSYSTEM AND WEST KILIMANJARO AREA

Map 5.22: Distribution of elephants in the Amboseli Ecosystem, Athi-Kaputiei, the Magadi area and West Kilimanjaro between 1978 and 2011.




Source: DRSRS/KWS

Figure 5.7: Population trends for elephants in the Amboseli ecosystem between 1978 and 2014 show increasing numbers.




Source: DRSRS Database.

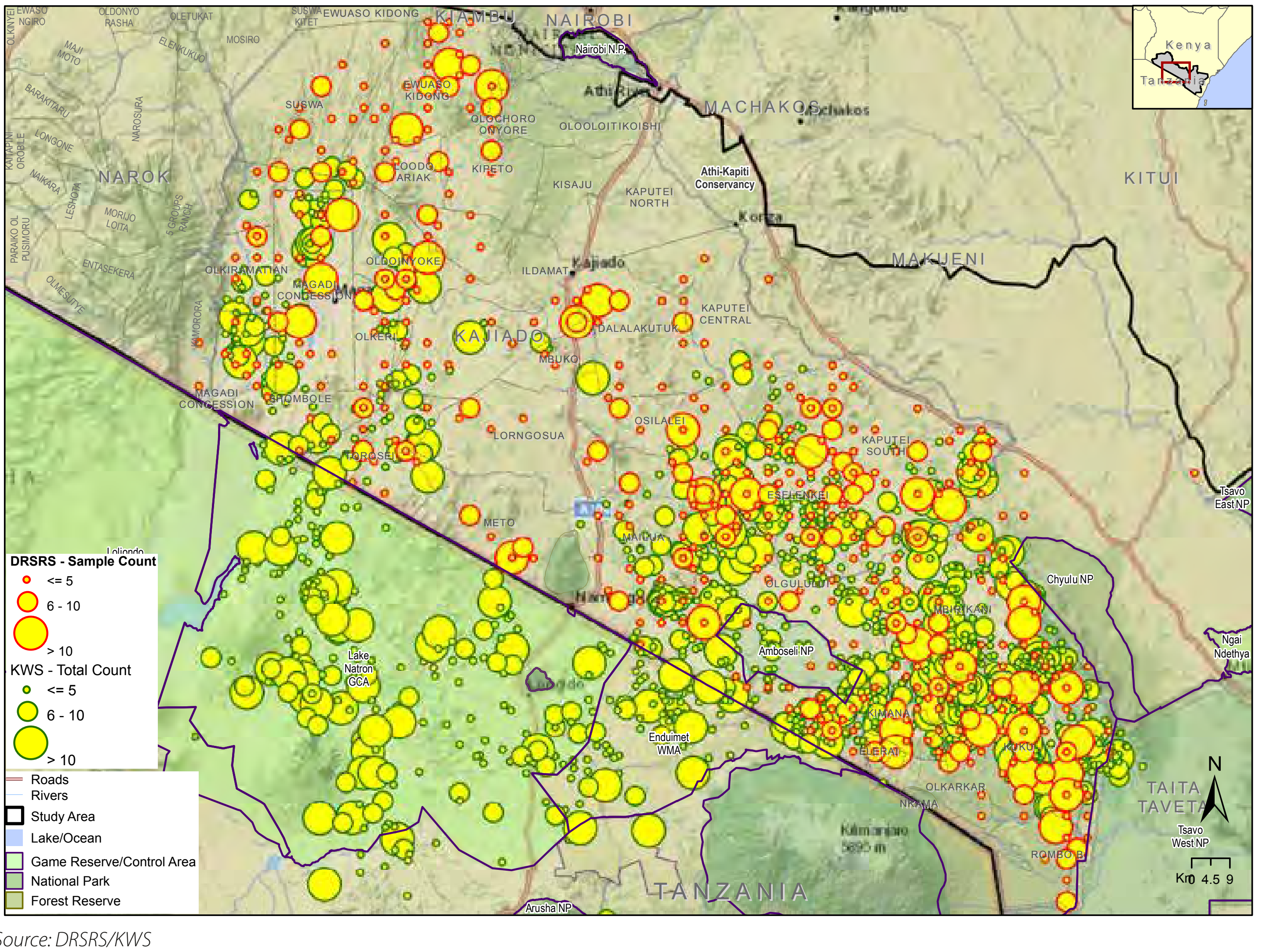
### 5.2.12. Population and distribution trends for Giraffe in the South Rift and Amboseli Ecosystem

Giraffes are widely distributed across the whole of Kajiado County (Kenya) and West Kilimanjaro (Tanzania), but populations are most concentrated outside the Amboseli NP on group ranches including Kuku, Mbirikani and Kaputiei South, the Magadi Concession Area, and the Lake Natron GCA and Enduimet WMA in Tanzania. Based on total counts in 2010, giraffe numbers were highest in Amboseli (2,283 animals), followed by Lake Natron GCA (838), Magadi (780) and West Kilimanjaro (263) (KWS, 2010). Densities varied widely; Amboseli had 0.26 animals/km$^2$, Magadi 0.14 animals/km$^2$, Natron 0.12 animals/km$^2$, and West Kilimanjaro 0.09 animals/km$^2$ (KWS, 2010).

DRSRS datasets show that Amboseli's giraffe population numbered about 7,500 animals in the late 1970s. By 1981, this number had declined to 2,499 animals. Between 1981 and 1991, the population increased to 6,963 animals. In 2007, numbers were found to have declined marginally, to 5,021 giraffes (DRSRS datasets, and KWS, 2010). The severe drought of 2009 had a devastating impact on Amboseli's giraffe population, which dropped to 1,991 animals in 2010, representing a reduction of 61% (KWS, 2010).

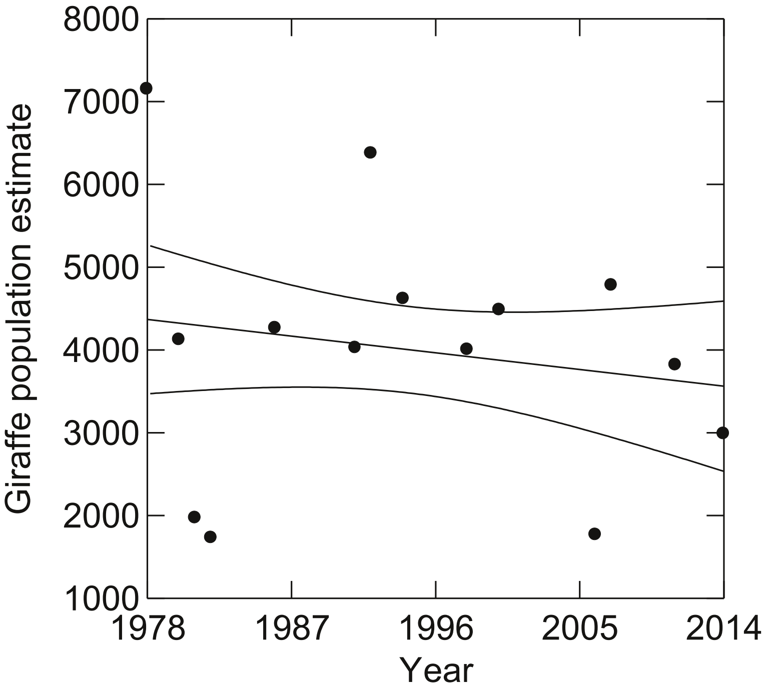
## DISTRIBUTION DENSITY OF SPECIES IN THE ATHI-KAPUTIEI ECOSYSTEM (NAIROBI NP KITENGELA AREA)

Map 5.23: Distribution of giraffes in the Amboseli Ecosystem, Athi-Kaputiei, the Magadi area and West Kilimanjaro between 1978 and 2011.




Source: DRSRS/KWS

Figure 5.8: Population trends for giraffes in the Amboseli Ecosystem, showing a slight decline in the population.




*Source – DRSRS*

### 5.2.13. Population and distribution trends for Burchell's Zebra in the Tsavo Ecosystem

A summary of the Burchell's (plains) zebra population observed in the Tsavo-Mkomazi ecosystem in 2008 and 2011 is given in Table 5.2 and 5.3. The parks contain the highest number of plains zebras (71 %), with 33 % appearing to thrive in the Tsavo West NP during the dry seasons (Ngene *et al*., 2011).

The plains zebra population in the Chyulu NP declined drastically (by 69 %) between 2008 and 2011. Although zebras are widely dispersed across the ecosystem, the majority are concentrated in the southern parts of the Tsavo East NP, the Galana River, and the Tsavo West NP.

**Table 5.2:** Numbers of Burchell's zebras in the Tsavo Ecosystem (2008 & 2011).

| Census Area | 2008 | 2011 |
|---|---|---|
| (Tsavo East National Park (North | 317 | 494 |
| (Tsavo East National Park (South | 885 | 955 |
| Tsavo West National Park | 2,532 | 2,248 |
| South Kitui National Reserve | 231 | 195 |
| Galana Ranches | 134 | 124 |
| Taita Ranches | 532 | 960 |
| Other Blocks | 745 | 835 |
| Outside | 32 | 25 |
| (Sub-Total (Parks | 6,833 | 4,782 |
| (Sub-Total (Non-parks | 1,443 | 1,944 |
| Total | 8,276 | 6,726 |

*Source: KWS total counts.*

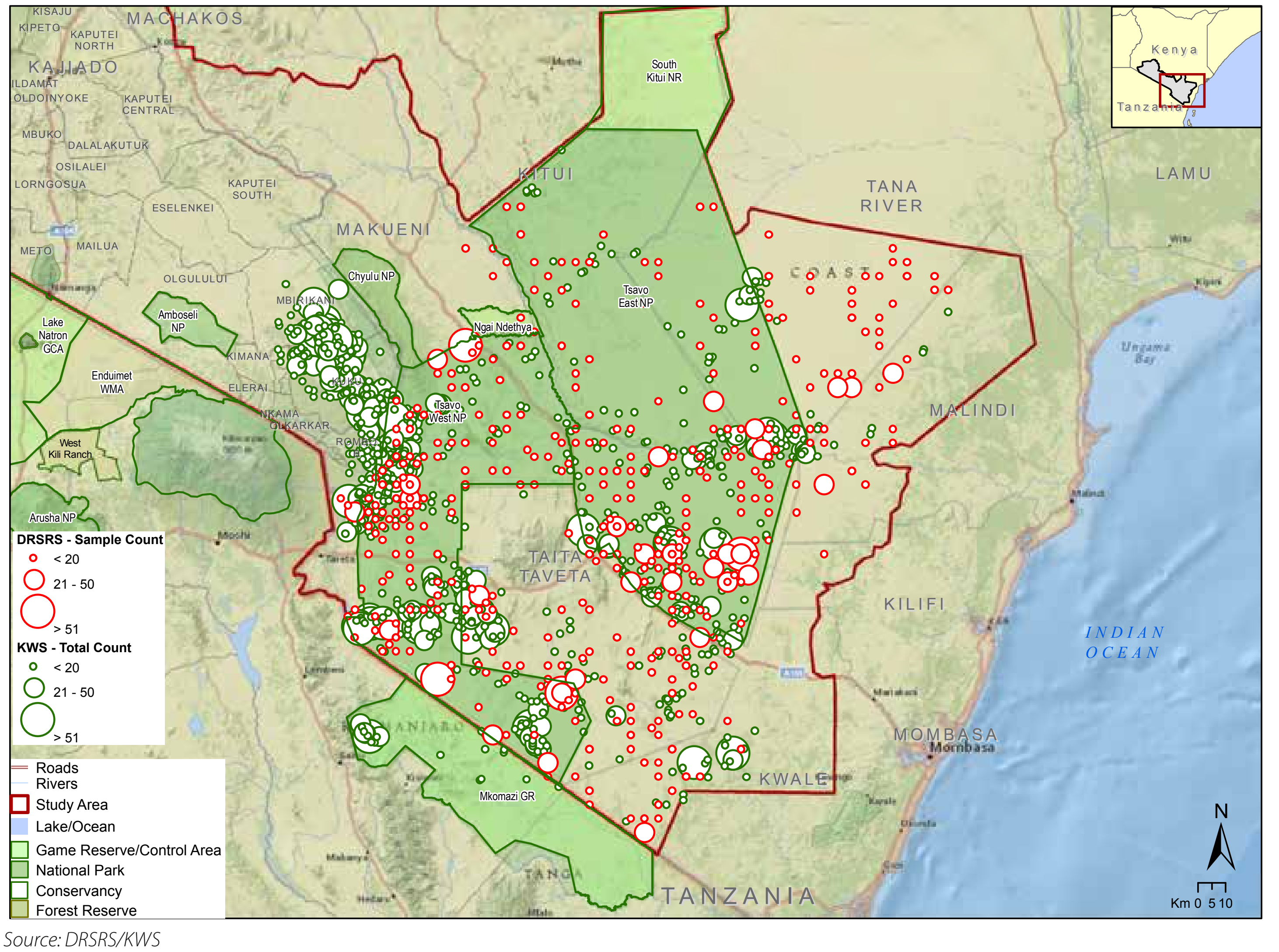
Table 5.3: Population estimates for elephant, plains zebra, and giraffe, as averaged between 1978 and 2011 both inside and outside the Tsavo East NP and Tana River County.

| Tana River County | | | | |
|---|---|---|---|---|
| Protected Area | | Tsavo East NP | | |
| Species | | Elephant | Zebra | Giraffe |
| Inside | Pop. Est | 521 | 1,056 | 381 |
| | Density | 0.18 | 0.36 | 0.13 |
| | % | 83 | 34 | 12 |
| Outside | Pop. Est | 109 | 2,063 | 2,690 |
| | Density | 0.003 | 0.06 | 0.07 |
| | % | 17 | 66 | 88 |
| County | (In) % | 21 | | |
| | (out) % | 71 | | |

*Source: DRSRS.*

## DISTRIBUTION DENSITY AND TRENDS OF SPECIES IN THE TSAVO ECOSYSTEM

Map 5.24: Distribution of Burchell's zebras in the Tsavo Ecosystem between 1978 and 2011.




Source: DRSRS/KWS

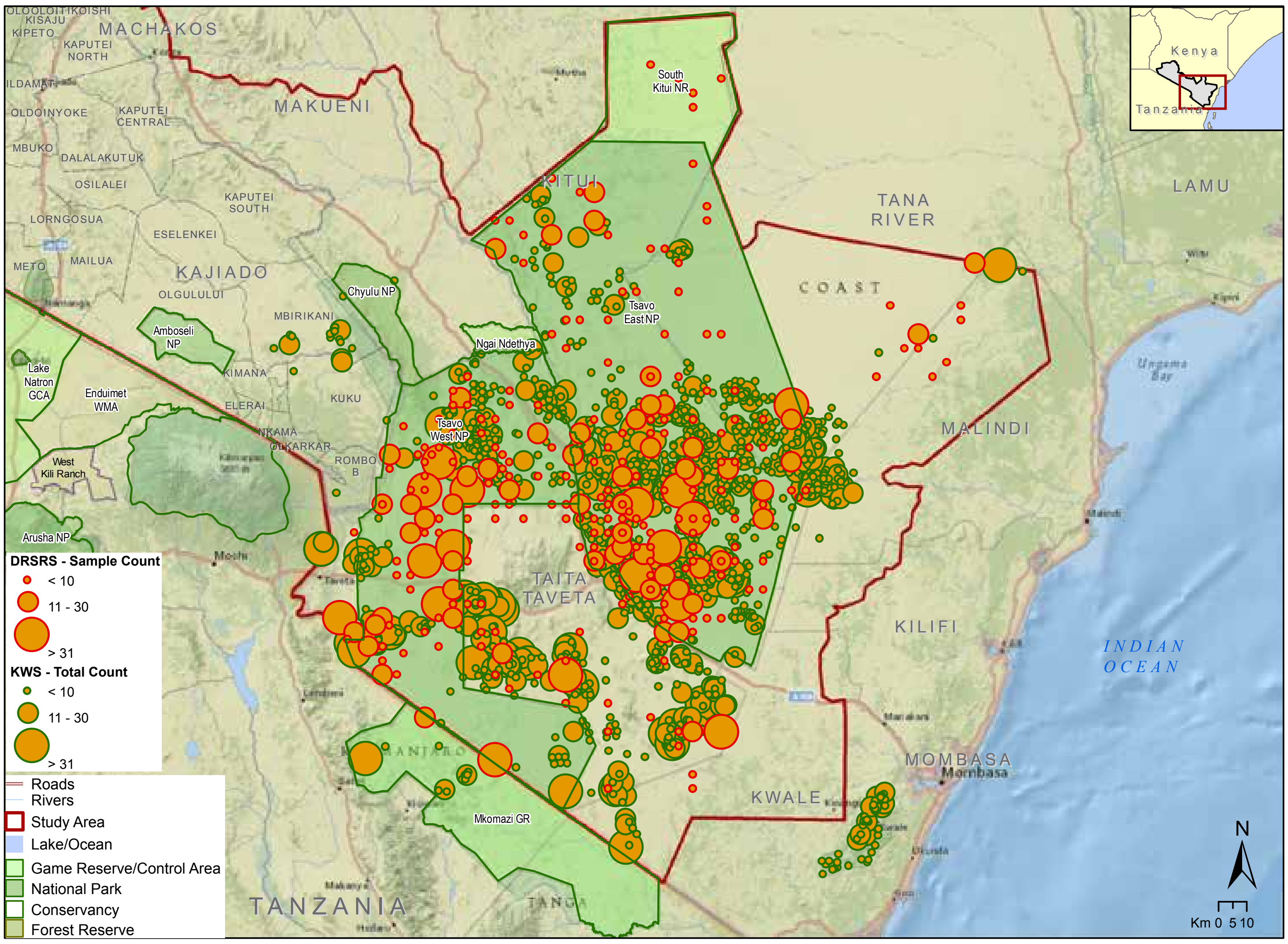
### 5.2.14. Population and distribution trends for Elephant in the Tsavo Ecosystem

The Tsavo ecosystem is the largest protected area in Kenya, covering 4 % of the country's total landmass, while also containing the country's largest elephant population (Blanc *et al.*, 2007). The Tsavo NPs and adjacent reserves are connected to the Mkomazi GR (Tanzania) and to community areas which form the contiguous Tsavo Conservation Area, spanning 60,000 km$^2$. The ecosystem's elephant population numbered more than 35,000 animals in 1974 (Cobb, 1976), and about 11,733 animals in 2008 (Omondi *et al.*, 2008). The drought of the early 1970s killed about 6,000 elephants, with mortality confined mainly to the eastern sector of Tsavo West NP (Cobb, 1976; Ottichilo, 1981). Heavy poaching further reduced the population to about 12,000 animals by 1980, and to 6,399 animals by 1988 (Douglas-Hamilton *et al.*, 1994; 1995). However, elephant numbers have recoved steadily since then (Table 5.3; Figure 5.9). Tsavo's elephants still face many challenges, including droughts, habitat degradation, and lack of enforcement of land-use policies and legislation. Long-term trends show a population that is slowly recovering due to improved anti-poaching efforts. In the dry season of 2011, 567 elephant carcasses were recorded in the Tsavo area, representing 4.3 % of the carcass ratio (Ngene *et al.*, 2011).

In the Tsavo-Mkomazi areas, there were 12,573 elephants in 2011, an increase of 2 % from the 2008 counts (Table 5.4). Most of these elephants (69 %) were inside the park. Large herds were found in the southern Tsavo East NP, near Galana River, with the Ndara Plains being the mean centre of distribution. Large herds also occur on the Taita ranches, and south of the Tsavo West NP (Njukini and Jipe area) (Map 5.25).

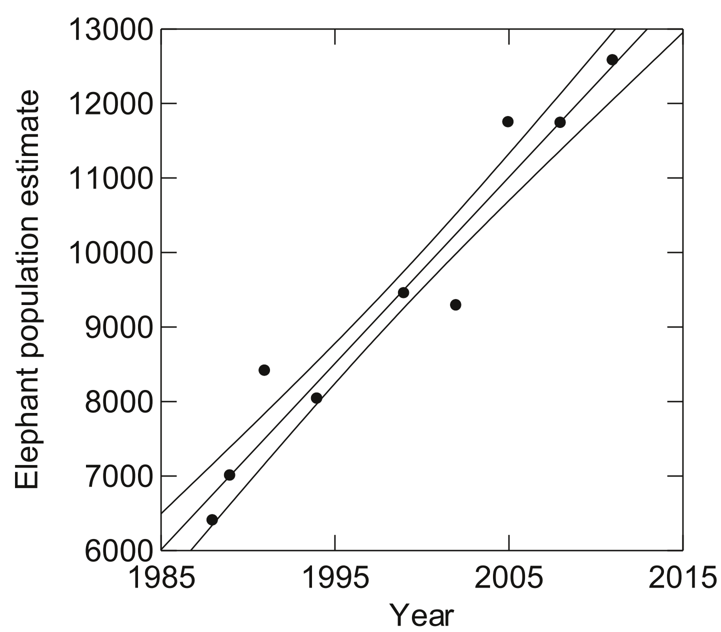
# DISTRIBUTION DENSITY AND TRENDS OF SPECIES IN THE TSAVO ECOSYSTEM

**Map 5.25:** Distribution of elephants in the Tsavo Ecosystem between 1978 and 2011.




Source: DRSRS/KWS

**Figure 5.9:** Population trends for elephants in the Tsavo Ecosystem show an increasing population between 1988 and 2011.




Source: DRSRS

**Table 5.4:** Total and sample aerial counts of elephants in the Tsavo Ecosystem between 1962 and 2011. Data was collected in June from 1962 to 1994, and in late January-early February (dry season) from 1999 to 2011.

| Census Area | 2011 | 2008 | 2005 | 2002 | 1999 | 1994 | 1991 | 1989 | 1988 | *1978 | 1973 | 1972 | *1970 | *1969 | *1965 | 1962 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (Tsavo East NP (North | 2,094 | 4,118 | 2,499 | 4,089 | 1,337 | 399 | 450 | 134 | 770 | 220 | 9,011 | 6,435 | 0 | 6,619 | 8,056 | 4,073 |
| (Tsavo East NP (South | 4,120 | 3,731 | 3,896 | 2,087 | 3,221 | 2,733 | 3,436 | 3,020 | 2,283 | 2,469 | 3,955 | 6,633 | 6,008 | 5,709 | 4,744 | 1,358 |
| Tsavo West NP | 2,142 | 2,161 | 2,626 | 2,168 | 2,119 | 3,132 | 1,233 | 2,106 | 1,274 | 1,938 | 9,208 | 4,328 | 6,592 | 8,134 | 2,238 | 1,394 |
| Chyulu NP | 135 | 131 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mkomazi NR | 256 | 8 | 41 | 63 | 77 | 302 | 131 | 11 | 93 | 667 | | 2067 | - | - | - | - |
| Galana | 398 | 308 | 11 | 14 | 27 | 46 | 50 | 74 | 90 | 1,076 | 500 | 4,379 | - | 2,964 | | 3,540 |
| Taita | 2,751 | 1,108 | 1,292 | 828 | 1,245 | 287 | 1,413 | 642 | 853 | 79 | | 1,235 | - | 500 | | |
| Rombo | 0 | 0 | 31 | 2 | 12 | 446 | | 193 | - | - | - | - | - | - | - | - |
| Other Blocks | 509 | 130 | 1 | 35 | 30 | 26 | 50 | 46 | - | - | - | 300 | 100 | - | - | - |
| Outside | 168 | 38 | 1,376 | | 1,391 | 1,107 | 1,644 | 966 | 1,036 | - | - | - | - | - | - | - |
| (Sub-Total (Parks | 8,614 | 1,0149 | 9,062 | 8,344 | 6,754 | 6,566 | 5,250 | 5,271 | 4,420 | 5,294 | 22,174 | 19,463 | 12,600 | 20,462 | 15,038 | 6,825 |
| (Sub-Total (Non-parks | 3,959 | 1,584 | 2,680 | 940 | 2,693 | 1,466 | 3,157 | 1,728 | 1,979 | 1,155 | 500 | 5,914 | 100 | 3,464 | | 3,540 |
| Total | 12,573 | 11,733 | 11,742 | 9,284 | 9,447 | 8,032 | 8,407 | 6,999 | 6,399 | 6,449 | 22,674 | 25,377 | 12,700 | 23,926 | 15,038 | 10,365 |

NB. Hyphen (-) no census took place and (*) represents data acquired using sample counts, the rest of data used the total count method.

*Source: KWS, 2011; Laws, 1969; Leuthold 1973; Otichillo 1983; Olindo et al. 1988; Douglas-Hamilton et al. 1994; Kahumbu et al. 1999; Omondi and Bitok 2008*

### 5.2.15. Population and distribution trends for Giraffe in the Tsavo Ecosystem

The Tsavo ecosystem's giraffe population in February 2011 was 2,055, up from from 1,148 in 1999 (Table 5.5). This represented an increase of 55 % over a period of 12 years. However, a decline of 19 % was recorded in the subsequent three years, as compared with populations in 2008 (Ngene *et al*., 2011). The Tsavo East and Chyulu NPs recorded the steepest declines, of 60 % and 45 % respectively. Four censuses, carried out between 1999 and 2011, found giraffe numbers to be highest in the Tsavo West NP, and lowest in the South Kitui NR. Large groups were observed in west Chyulu and south of the Tsavo West NP (Map 5.26).

**Plate 5.5:** Giraffe browsing on the leaves of Acacia tree while zebras graze on the undergrowth grasses and herbs in Chyulu NR. *Photo Courtesy: KWS/Joseph Mukeka*

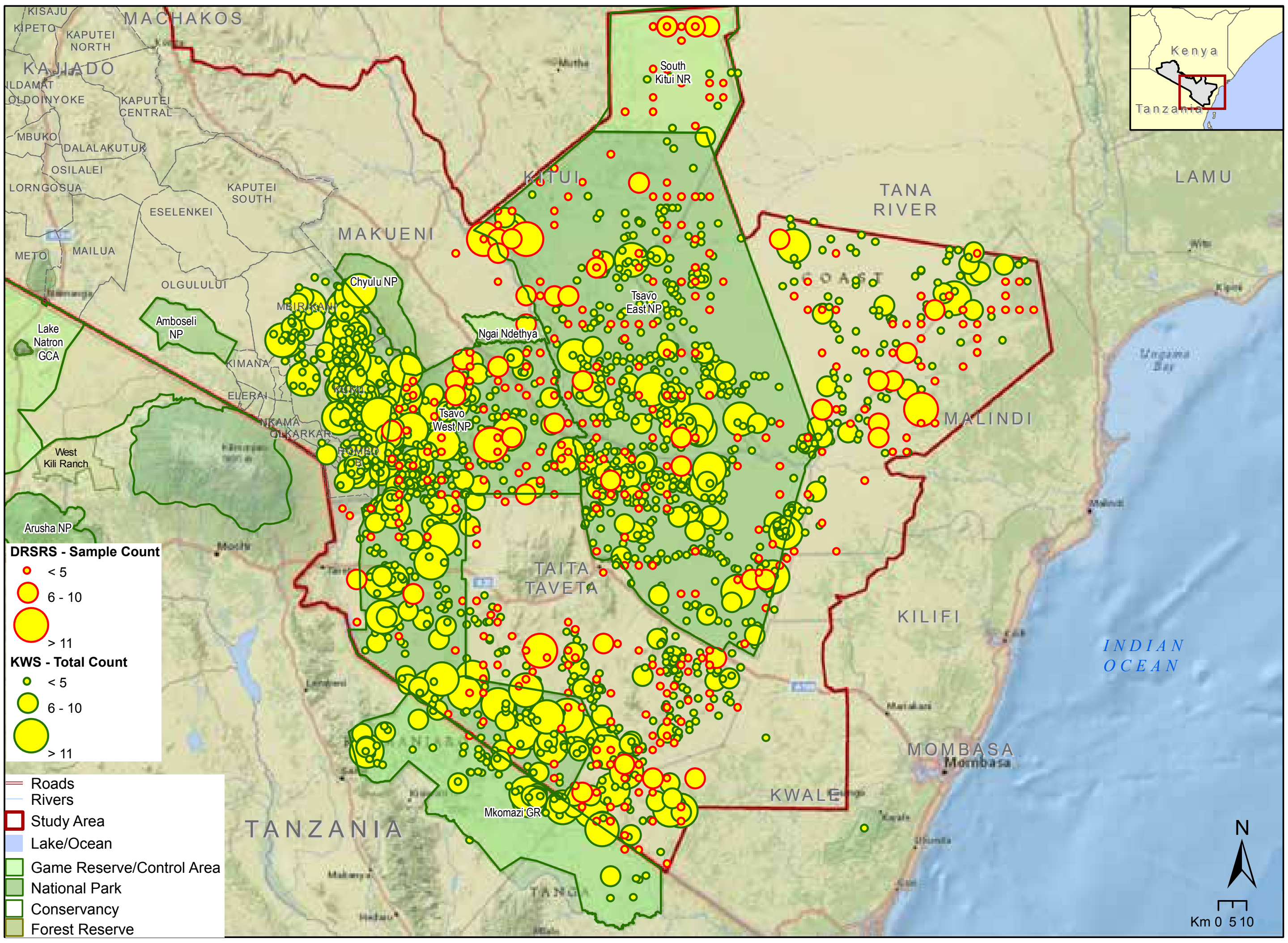
**Table 5.5:** Giraffe population in the Tsavo Ecosystem (1999 - 2011).

| Census Area | 2011 | 2008 | 2005 | 1999 |
|---|---|---|---|---|
| (Tsavo East National Park (north | 170 | 424 | 281 | 133 |
| (Tsavo East National Park (south | 222 | 257 | 261 | 222 |
| Tsavo West National Park | 691 | 678 | 568 | 272 |
| Chyulu National Park | 292 | 534 | - | - |
| Mkomazi National Reserve | 120 | 116 | 62 | 82 |
| South Kitui National Reserve | 6 | 3 | - | - |
| Galana Ranches | 93 | 95 | 153 | 171 |
| Taita Ranches | 282 | 193 | 148 | 147 |
| Other Blocks | 178 | 148 | 111 | 121 |
| Outside | 1 | 2 | - | - |
| (Sub-Total (Parks | 1,501 | 2,012 | 1,172 | 709 |
| (Sub-Total (Non-parks | 554 | 438 | 412 | 439 |
| Total | 2,055 | 2,450 | 1,584 | 1,148 |

*Source: KWS*

# DISTRIBUTION DENSITY AND TRENDS OF SPECIES IN THE TSAVO ECOSYSTEM

**Map 5.26:** Distribution of giraffes in the Tsavo Ecosystem between 1978 and 2011.




Source: DRSRS/KWS

## 5.3. Wildlife Dispersal Areas, Migratory Routes/ Corridors

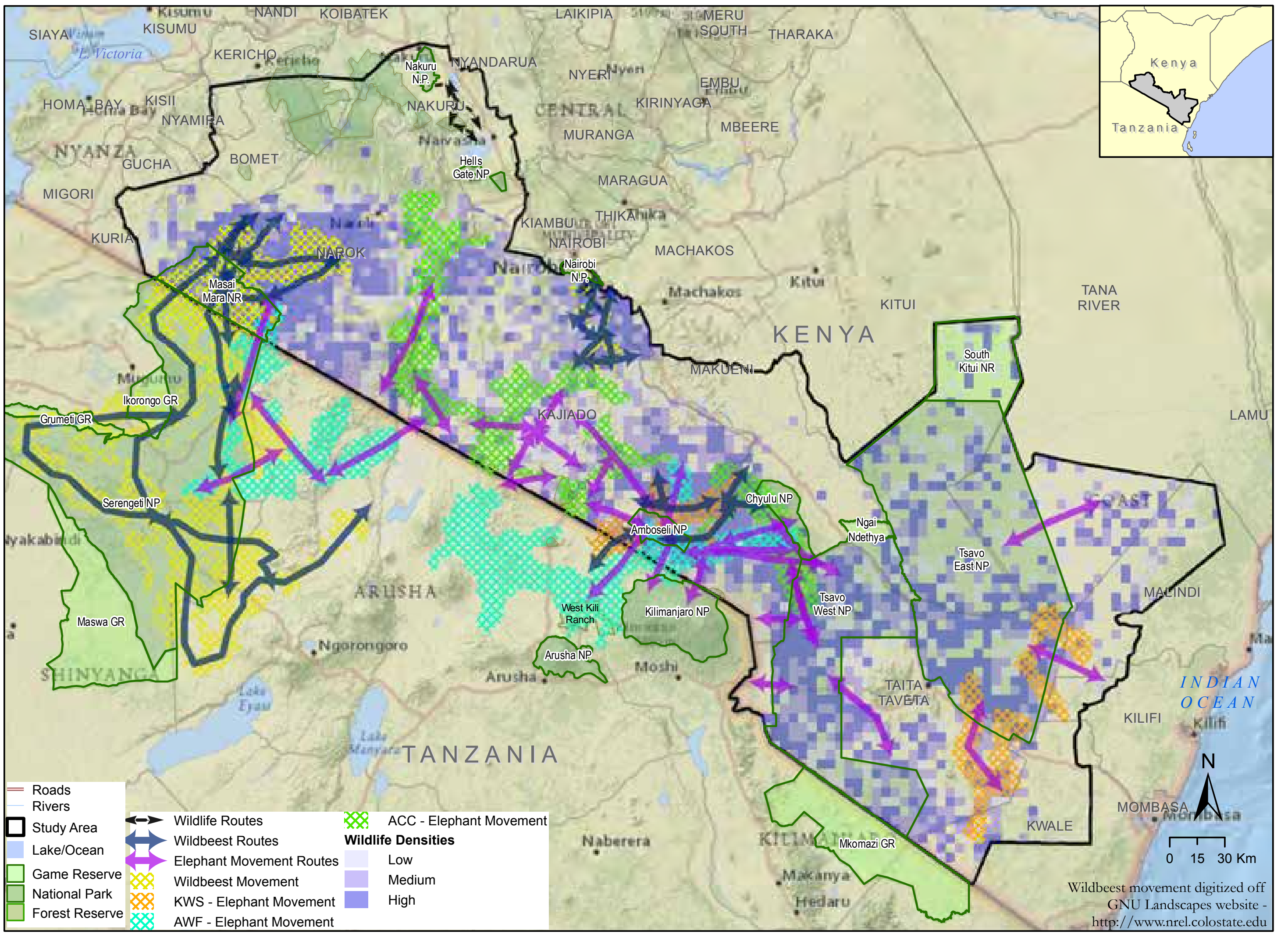
The insularization of protected areas, coupled with habitat loss or fragmentation, leads to the extinction of species, and directly affects biodiversity by reducing species abundance and variety. The isolation of habitats restricts the movement of species and causes competition for resources. Isolation may be caused by various factors, such as encroachment by agriculture or by high density settlements, roads that open up new ventures for the rural poor to sustain their livelihoods through charcoal burning, forest clearing for timber and construction materials, and the building of fences to demarcate subdivided lands, as well as conversion to land uses that are incompatible with wildlife conservation. Protected areas should have wide dispersal areas for wildlife, to enhance genetic drift and to avoid inbreeding. The absence of such dispersal areas may lead to population instability and local extinctions, through inability to adapt to fast-changing environmental conditions.

As protected areas become increasingly insularized by the rapid expansion of human activities such as crop cultivation, forest clearing, and high density settlements, the loss of biodiversity in adjacent areas threatens to eliminate wildlife populations from around the parks and reserves. In the southern Kenya rangelands, factors associated with rapid biodiversity loss include land-use and tenure changes, high rural poverty levels, and sedentarization. It is likely that protected areas will lose a significant proportion of their wildlife if they become completely isolated, as populations of the larger wild species depend, for year-round sustenance, on having access to vast areas outside the parks and reserves.

The intensity of human-wildlife conflicts around protected areas correlates with human population density and incompatible land use. A high human density is an indicator and predictor of the local extinction of large mammals in many areas. An increase in human population and the associated spread of human activities reduces wildlife space, increasing the likelihood of human-wildlife conflicts. Such conflicts create frustration and animosity towards wildlife, often resulting (for want of mitigation

# WILDLIFE DISPERSAL AREAS, CONNECTIVITY AND LINKAGES IN THE SOUTHERN KENYA RANGELAND ECOSYSTEMS

**Map 5.27:** Spatial overlay of species densities (DRSRS long-term counts on a 5x5 km grid) and wildlife telemetry, showing the general movement routes of elephants and wildebeest in the southern Kenya rangeland ecosystems.




Source: DRSRS/KWS

measures) in retaliatory wildlife killings. Practices that result in the blockage of wildlife migratory routes/ corridors include land sub-divisions, fences, the draining of wetlands, the clearing of natural vegetation for timber and construction materials, and high density human settlements.

## 5.4. Conservation Connectivity Threats in the Southern Kenya Rangeland Ecosystems

Exponential human population growth, and the fact that people and their activities are now overwhelmingly dominant in so many of the landscapes which they and their livestock historically shared with wildlife, is having a grave impact on biodiversity conservation. Manifestations of this impact include the fragmentation or outright destruction of habitats, the over-exploitation of natural resources, the over-harvesting of wild species, the spread of invasive alien species, pollution, and the lack of adequate policies and legislation to mitigate the impacts of these unsustainable practices.

1. *Land-use changes:* How a country makes use of its land, in having to accommodate a wide range of important social and economic activities, is the key to plotting a sustainable future. So, while room has to be found for agriculture and livestock production, and for human settlement, infrastructure, and urban development, biodiversity conservation too has to be prioritized as an activity of fundamental importance. This is because biodiversity plays a critical role in safeguarding the vital natural resources and ecosystem services on which the other forms of land use all depend. There have been sweeping land-use and tenure changes over recent years. Some of these changes are incompatible with biodiversity conservation, and have negatively affected wildlife dispersal areas

and migratory routes/corridors. These impacts are exacerbated by inadequate land-use policy guidelines for managing natural resources.

2. *Destruction of wildlife habitats*: Wildlife habitats provide the ecosystem goods and services on which the livelihoods of rural people depend. However, rapid human population increase and other socio-economic factors have put enormous pressure on limited productive land, forcing the rural poor to resort to poor land-use practices for subsistence. This has caused habitat loss and fragmentation in many areas.

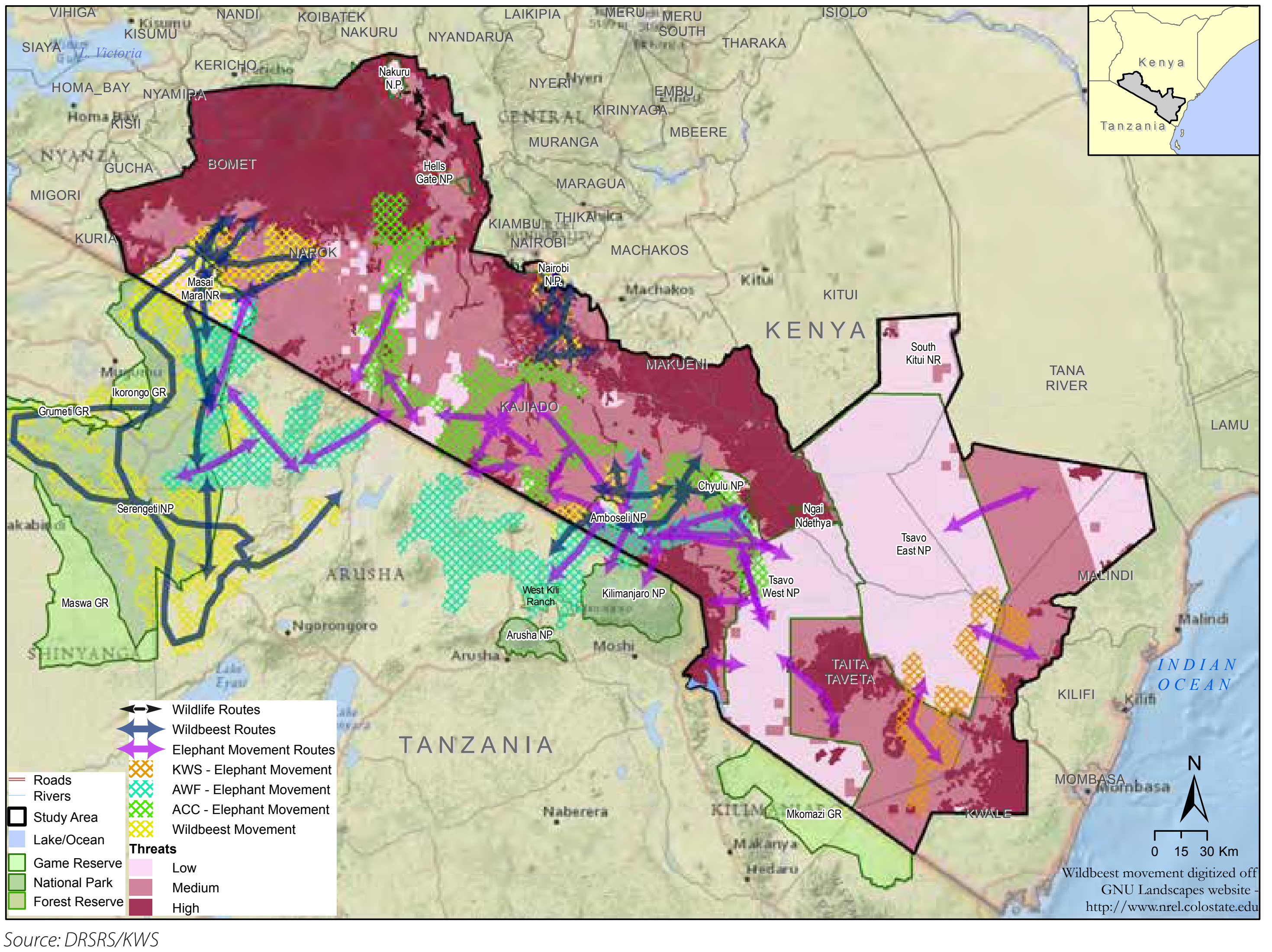
   Although people recognize that biodiversity can help support their endeavours, such as eco-tourism, agriculture, and medical research, and have made efforts to preserve small 'islands' of native habitat, such habitats are now increasingly being isolated amid oceans of human habitat. While noble in intent, this isolation of species has in many cases led to the destruction of biodiversity. Usually, the 'islands' are too small to sustain species, many of which, in being unable to migrate or to renew their fragmented gene pools, may become locally extinct.

   Outright habitat destruction, such as deforestation, drainage of wetlands, charcoal burning, and the conversion of biologically diverse woodlands and grasslands to vast agricultural monocultures are among the most destructive of human activities. Plants of thousands of species have been displaced by agricultural expansion, or removed for fuelwood, building/construction material, wood carving, and traditional medicine. While the destruction of a tract of forest may take only a few weeks, its regeneration, even if this were possible, might take decades.

3. *Insecurity:* Insecurity in some wildlife areas is a serious impediment to biodiversity conservation and management. Insecurity has negative implications for the protection of wildlife populations, and for local communities

## CONSERVATION CONNECTIVITY THREATS IN THE SOUTHERN KENYA RANGELAND ECOSYSTEMS

Map 5.28: Spatial model of conservation threats to wildlife corridors (from agriculture, human population density, encroachment on protected areas and water bodies, and infrastructure development).




Source: DRSRS/KWS

and visitors (tourists). This situation has been exacerbated by a proliferation of firearms from neighbouring war-torn states (Somalia and South Sudan) that fall into the hands of poachers, cattle rustlers, and bandits.

4. *Insecure land-tenure and illegal allocation*: In some wildlife areas, insecure tenure has contributed to general apathy among local communities towards wildlife conservation. Increased sub-division of large group ranches into individual parcels, and animosity between local communities and wildlife agencies, cannot be over-stressed. Some local authorities which hold huge parcels of land in trust for residents have abused their trusteeship through illegal allocations and through changes in land use. These changes may have negative impacts on the original intent, as new landowners have the right to practice any land use, including uses that are incompatible with wildlife conservation.

5. *Protected area management and partnerships:* Most protected areas were established without due regard for the importance of surrounding landscapes. Consequently, protected areas are becoming distinct from the wider landscapes, being separated by fences and other barriers that deter wildlife movements outside the protected areas. In terms of wildlife and habitat management, the rigid boundaries have compromised the integration and the effectiveness of many dispersal areas and migratory routes/corridors outside the protected areas. There is a need to create more protected space and broadly to re-define the protection status of the majority of wildlife populations outside the parks and reserves. This could be achieved through enhancing partnerships between the local communities adjacent to protected areas and the authorities managing the parks and reserves.

6. *Management effectiveness assessment and prioritization:* Biodiversity conservation management receives inadequate resources, given the enormous and compelling social challenges facing the country, with respect to poverty alleviation, health care, and education. Biodiversity, though, by underpinning the natural processes that are essential to the well-being and livelihoods of people, is one of the pillars of development. Effective conservation of wildlife resources calls for regular assessment of strategic actions that can be taken to address priority issues. Whereas protected areas are set aside for the purpose of wildlife conservation, it is equally important to recognize that land outside these small seclusions, whether communally or privately owned, is critical in providing wildlife dispersal areas and migratory routes/corridors in the wet and dry seasons. At present, there are few initiatives or programmes with adequate incentives to motivate local communities living in wildlife areas to support or practise land uses that are compatible with wildlife conservation.

7. *Inadequate scientific data:* Accurate scientific data on wildlife resources is critical in providing a basis for informed decision-making and policy formulation by wildlife managers and other stakeholders. Investment in long-term studies of wildlife ecosystems and in the maintenance of datasets has generally been poor. This has prejudiced understanding of ecosystem principles and ecological processes.

8. *Climate change:* A changing global climate is affecting wildlife species and communities in various ways, through altering movement patterns, opportunities for reproduction and recruitment, and interactions among species. While there have been periods of climate change and global warming throughout geological history, it is not the variability of precipitation or of absolute temperatures that are important, but rather the frequency and severity of dry spells. Historically, species have been able to respond to changing climatic conditions by moving or migrating to more suitable habitats. This has been a slow process, especially for plants, but for larger mammals the response has been a rapid one. Now, though, with the fragmentation and loss of dispersal habitats and the imposition of human barriers to movement, such a response is, in many areas, effectively blocked.

   Climate change may also produce conditions that are conducive to the establishment and spread of invasive alien species. A changing microclimate may alter the composition of native plant and animal communities. There is inadequate data on the impacts of climate change on biodiversity.

9. *Illegal and unsustainable off-take of wildlife and the bush meat trade:* Inadequate law enforcement, ineffective regulatory mechanisms, low penalties, lucrative illegal markets for bush meat and other wildlife products, and rising poverty indices have contributed to an escalation in the illegal off-take of wildlife. Since the 18th century, a combination of scientific, technical and industrial innovations has enabled humans to over-harvest wild species. Off-take has occurred at rates that are much faster than those at which wild species are able to replace themselves. This has been the cause of precipitous declines in the populations of most species, many of which face ultimate extinction.

10. *Pollution:* The technology that has enabled humans to control and eliminate other species has come at a price. That price takes the form of pollution. The burning of fossil fuels and the use of petrochemicals has led to an increase in greenhouse gases. The use of fertilisers and pesticides in agriculture has resulted in the contamination of water, the key to life on earth. Pollutants are the cause of drastic modifications in many wildlife habitats. The introduction of solid wastes, effluents and other pollutants into water and soil systems adversely affects habitats and disrupts ecological processes, which in turn may lead to the elimination of wildlife species.

11. *Invasive alien species:* Human mobility and global trade have resulted in the spread of invasive alien species. These are species which, on becoming established in new environments, outside their home ranges, out-compete and displace native species in the landscapes they colonise. The impacts of such species can be devastating, particularly on small islands, but also in arid and semi-arid areas and in aquatic ecosystems. Invasive alien species transform the structure and species' composition of ecosystems by repressing or excluding native species, or by altering nutrient cycles. The extent of the threat they pose to native biodiversity is second only to that of outright habitat destruction.

    Control of invasive species is a major management challenge. In addition to the direct economic costs of management, there are severe and very costly environmental consequences. In northern Kenya, for example, the introduction of Prosopis (P. juliflora) is a major threat to the conservation of natural habitats. Encroachment by agriculture has resulted in the spread into wildlife areas of many invasive weeds that are alien to the ecosystems.

12. *Human-wildlife conflict and compensation:* Human-wildlife conflict is a major problem in wildlife areas, where intensifying competition over scarce water resources and inadequate dry season pasture is severely affecting wildlife, livestock, and people. The expansion of human activities in wildlife areas, coupled with the effects of climate variability on water security and plant biomass production, has led to increased human-wildlife conflicts.

    Compensation for wildlife damage is paid by the government. The sums disbursed in compensation for human injury or death, crop damage, and livestock predation are very low and are not commensurate with the losses incurred by the communities in the wildlife areas. The bureaucratic process of compensation is also very slow for those affected, who are mainly poor rural people.

13. *Conservation of shared wildlife resources:* Availability of habitat is critical in enabling wildlife species to survive and reproduce. Most wildlife species have evolved in and adapted to large home ranges, which in some cases straddle two or more countries. This raises the need to promote a harmonized approach to the conservation and management of shared wildlife resources. The Serengeti-Mara Ecosystem, which sustains the annual wildebeest and zebra migration, is shared between Tanzania and Kenya, for example. Similarly, the Amboseli-West Kilimanjaro cross-border corridor is critical in sustaining the movements of elephants and other wildlife species. But, whereas Kenya has imposed a ban on hunting, Tanzania has created game control areas where hunting is permitted. This means that wildlife species crossing the border from Kenya into Tanzania may move into hunting areas.

14. *Size of Protected Areas:* The delineation of protected area boundaries did not take into account the full requirements of most wildlife species. Most of the protected areas are too small to encompass all the ecosystem processes on which wildlife populations depend. Increases in wildlife populations within the narrow confines of parks and reserves can result in pressures that degrade the integrity of ecosystems. Confining wildlife populations in protected areas of limited size is detrimental to the survival of species, especially at the edge of demarcations where fences separate wildlife from land uses that are incompatible with conservation.

    *Management plans:* The lack of comprehensive, integrated management plans and lethargy over implementing even what plans do exist are major challenges for wildlife conservation management, especially with regard to the wildlife that exists outside protected areas. This can be attributed to inadequate provision for community involvement and participation in the planning process, lack of preparedness for the implementation of plans owing to inadequate resources, and the absence of a monitoring and evaluation framework for gauging performance levels and outcomes.

## 5.5. Interventions and Opportunities

### 5.5.1 Community Conservancies

*Community Conservancies*: Post-privatization land re-consolidation to facilitate both wildlife and livestock mobility is taking place in conservancies around many protected areas in Kenya. Community-private partnerships are enabling local communities to benfit from the wildlife on their land. In Narok County, a total of sixteen conservancies (collectively spanning more than 92,248 ha), more than half (61 %) of these in areas contiguous with the Masai Mara NR (150,000 ha), have been established, and are offering bed-night-based rates and/or leases of U$ 36-43/ha. More conservancies are being created in the Mara region and elsewhere in other rangelands in the country, to expand the wildlife space outside protected areas, while benefiting the landowners through rents or lease of their land to tour operators.

### 5.5.2 Payments for Ecosystem Services:

*Payments for Ecosystem Services:* Biodiversity conservation among pastoral communities may hold the key to helping pastoralists deal with the challenges of unsustainable land use and climate change, through enabling them to diversify their incomes. Payments for ecosystem services, mostly around Kenya's protected areas, are proving effective as a way of providing pastoralists with a stable, reliable, predicable source of additional income, thereby reducing poverty while at the same time protecting wildlife. In many of the areas where payments for ecosystem services have been piloted, local-level institutions have played a significant part in allowing communities to develop self-governing structures that support flexible land uses and which respect traditional communal land ownership patterns.

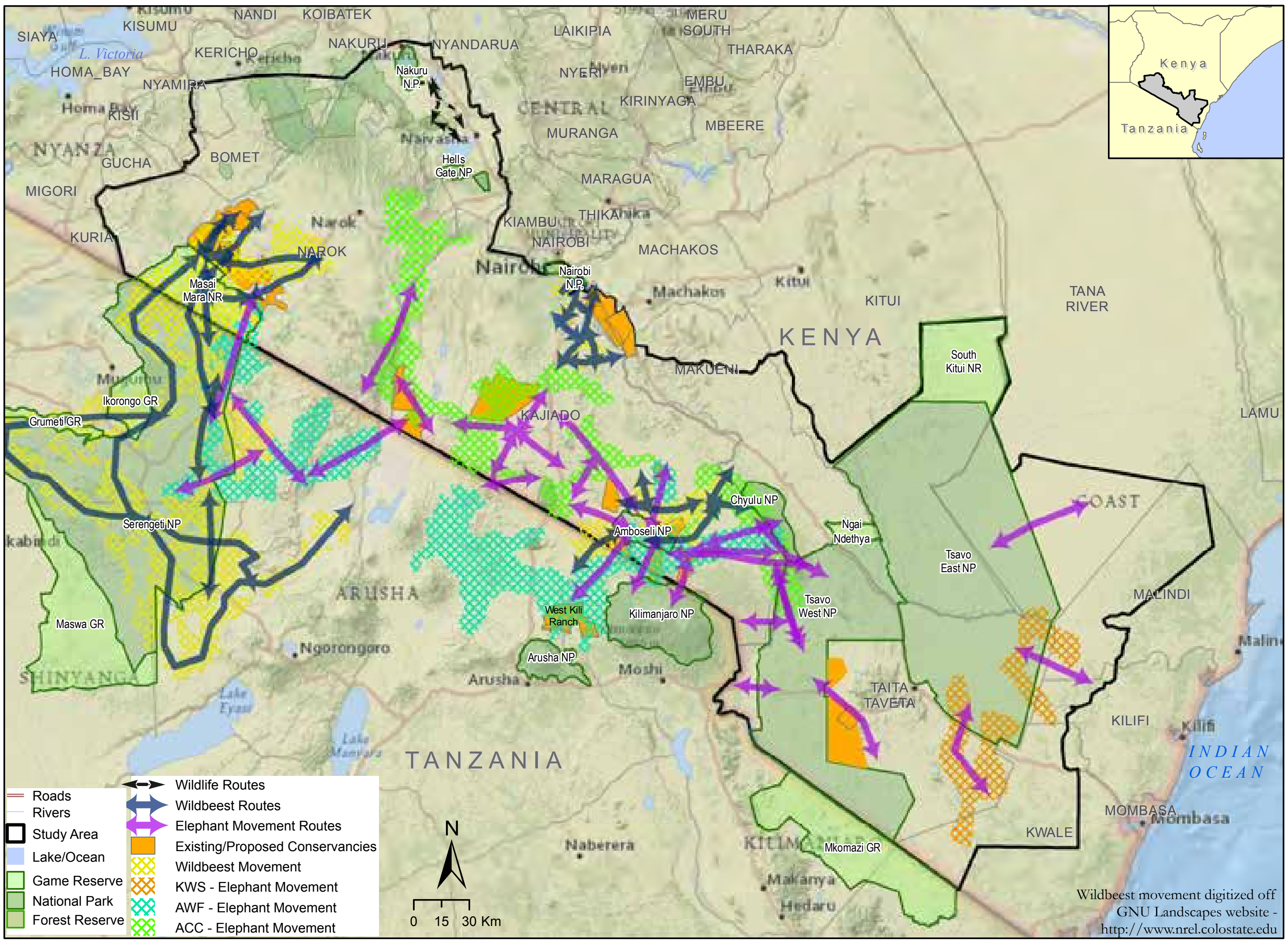
Payments to livestock herders for ecosystem services generated through responsible land use are being made in areas adjacent to the famous Masai Mara N and Amboseli NP, and in the Kitengela wildlife dispersal area, south of the Nairobi NP. In both areas, the Maasai people have formed 'eco-conservancies' to protect grazing areas for both their livestock and wildlife.

### 5.5.3 REDD programmes:

*REDD programmes:* The implementation of carbon projects under the Reduction of Emissions from Deforestation and Forest Degradation (REDD) programme is enabling many communities living in wildlife dispersal areas and migratory routes/corridors to benefit from payments for ecosystem services. For instance, the REDD project on communal and private ranches in Taita's Kasigau corridor will extend over an area of 330,000 ha. Phase One of this project is being implemented at the Rukinga Sanctuary, covering an area of 30,168.7 ha.

**Plate 5.6:** Maasai pastoralists signing up to the Naboisho Conservancy in the Mara area in 2010. Ecosystem conservation schemes are giving herders new sources of income *(Photo: courtesy ILRI/Bedelian).*

**Map 5.29:** Community conservancies in wildlife dispersal areas outside national parks and reserves are key to the protection of wildlife migratory routes/corridors.




Source: DRSRS/KWS/ACC

# MIGRATORY CORRIDORS FOR CONSERVATION IN NORTHERN RANGELAND AND COASTAL TERRESTRIAL ECOSYSTEM

# Chapter 6

# Migratory Corridors For Conservation In Northern Rangeland and Coastal Terrestrial Ecosystem

## 6.1. Regional Species Richness and Distribution Density

The northern Kenya rangelands and coastal terrestrial ecosystems support an extraordinarily rich biodiversity in a wide variety of landscapes and different habitats. Many of the species in this region are critically endangered, including elephant, Grevy's zebra, rhinoceros, Hunter's hartebeest (hirola), lion, cheetah, and wild dog. Protected areas in the region, along with private sanctuaries, large ranches, and community conservancies, support an abundance of large mammals of various species. Some of these areas are wildlife 'hot spots' in landscapes that otherwise are human-dominated. Wildlife species richness and distribution densities in the ecosystems are briefly described below.

### 6.1.1. The Turkana-Mt. Elgon Landscape

Wildlife distribution in the Turkana-Mt. Elgon landscape is generally patchy, with low densities and low diversity, except in the extreme northern strip bordering South Sudan and forming a linkage between the Kidepo NP in Uganda and the Lotikipi Plains (Maps 6.1 and 6.2). Pockets of species diversity occur in the Western Conservation Area (WCA) extending from the Nasolot and South Turkana NRs, southward to the Kerio Valley/Kamnarok NR and the Mau Forests Complex.

Scanty distribution and low wildlife densities in the Turkana-Mt. Elgon landscape can be attributed to harsh climatic conditions, aridity and frequent droughts, and competition with pastoralists' livestock for forage and water resources, as well as poaching and insecurity (wildlife harassment and killing by herders, banditry and rustling, and clan wars over grazing lands) in Turkana, West Pokot and Elgeyo-Marakwet Counties. Insecurity can be attributed to the region's remoteness, and to the large numbers of firearms that are illegally smuggled by herders across the porous borders from Uganda and South Sudan. Wildlife habitats have in recent years been diminishing due to bushland clearing, charcoal burning, and the expansion of irrigated arable agriculture along the river valleys.

### 6.1.2. The Greater Ewaso Ecosystem

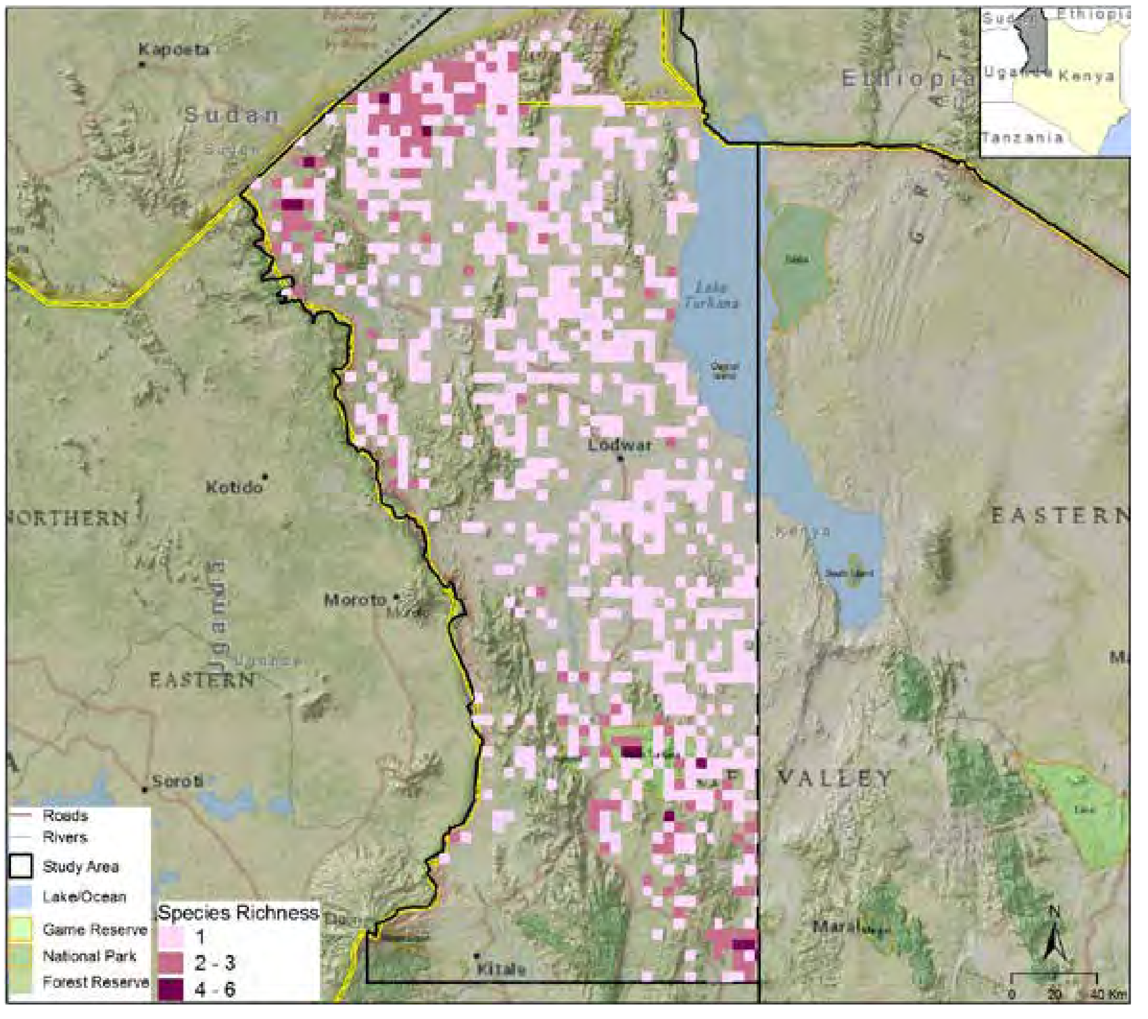
The greater Ewaso ecosystem contains large wildlife population of diverse species. The wildlife is concentrated largely within the Laikipia-Samburu-Isiolo-Meru landscapes, which support a diversity of 4-13 species per 25 $km^2$, but landscapes in the rest of the ecosystem hold low wildlife densities and species diversity, except in widely scattered habitats south of Marsabit and along the Mathews Range and the Sibiloi NP near Lake Turkana (Maps 6.3 and 6.4).

The Laikipia plateau is a human-dominated landscape that also supports abundant and diverse wildlife populations, including more than 70,000 large herbivores, of which almost half are Burchell's zebras. Several endangered mammals occur here, including more than 3,000 elephants, the largest population of rhinos in the country, the world's largest remaining Grevy's zebra population, Jackson's hartebeest, reticulated giraffe, buffalo, and various antelopes (impala, kudu, oryx, eland, kongoni, and Grant's and Thomson's gazelles). Carnivores include lion, leopard, hyena, and wild dogs.

### 6.1.3. The North-Eastern Rangeland and Coastal Terrestrial Ecosystems

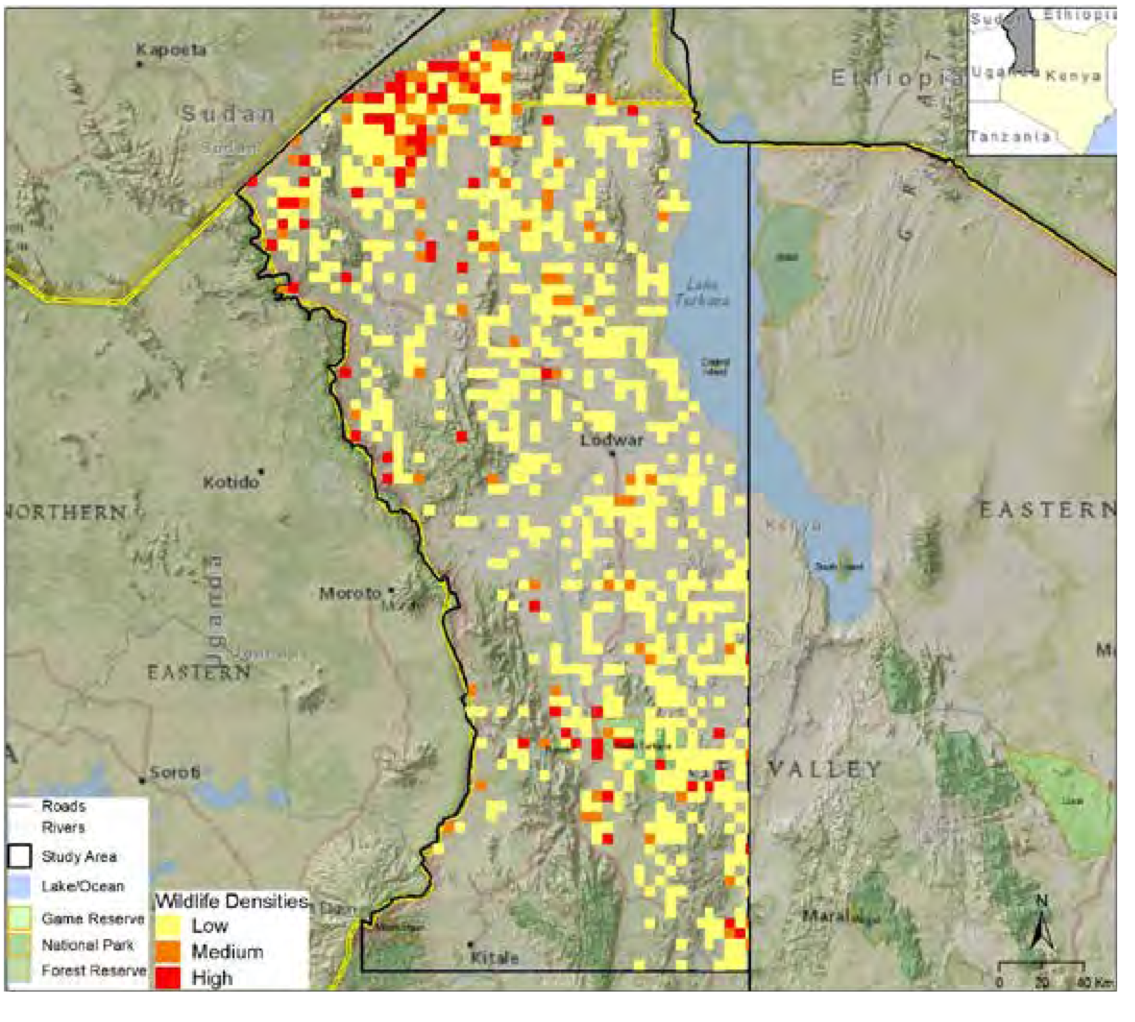
Wildlife densities and species richness are low in the Mandera, Garissa, Makueni counties, and in the upper part of Tana River County, but comparatively high in the coastal terrestrial ecosystem, especially in the Tana delta, and in Kilifi and Lamu Counties (Maps 6.5 and 6.6).

**Map 6.1:** Large wild ungulate species richness in the Turkana-Mt. Elgon landscape. Species diversity has been averaged on a 5x5 km grid based on DRSRS sample counts (1978–2011).



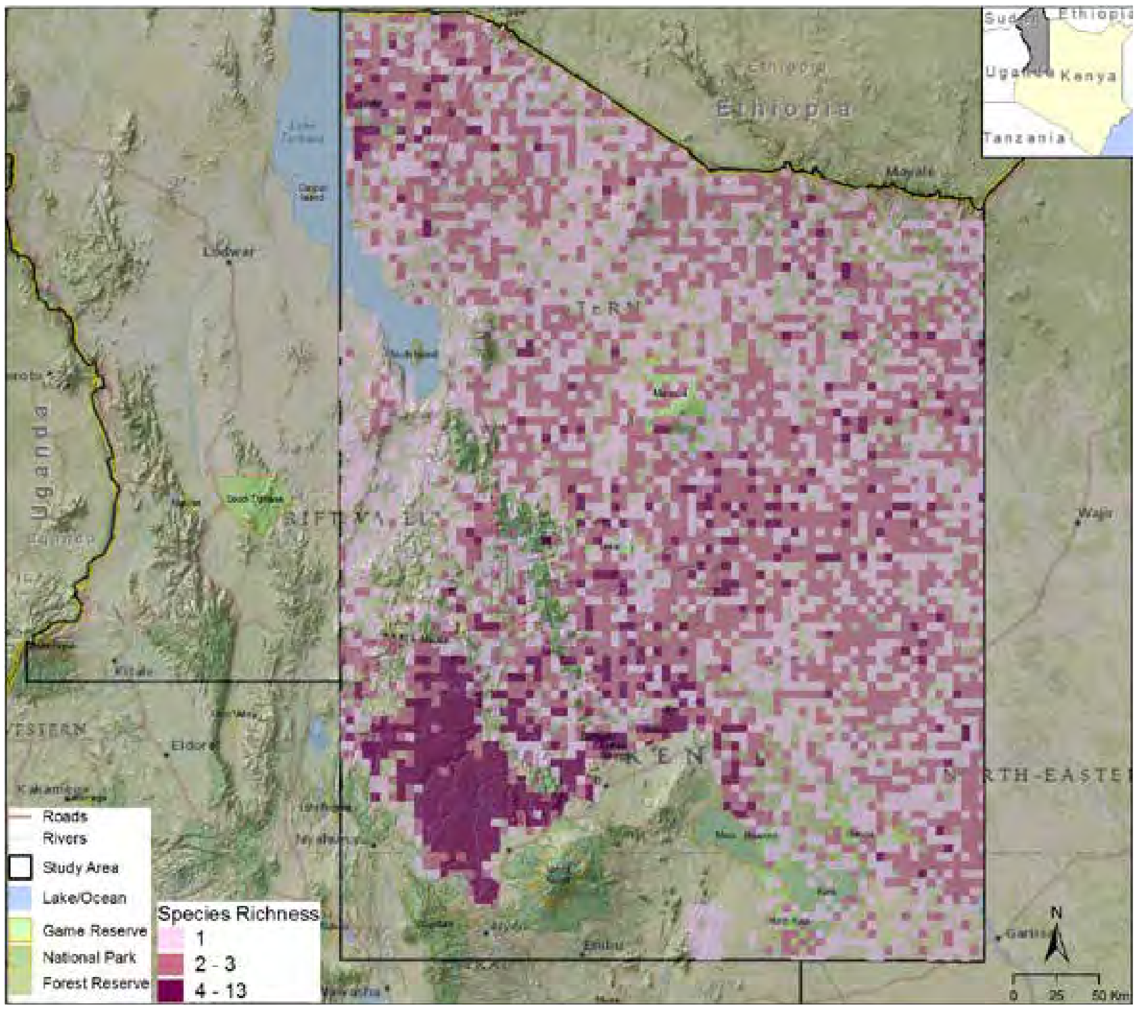

Source: DRSRS.

**Map 6.2:** Distribution density of large wild ungulate in the Turkana-Mt. Elgon landscape. Species density has been averaged on a 5x5 km grid based on DRSRS sample counts (1978–2011).



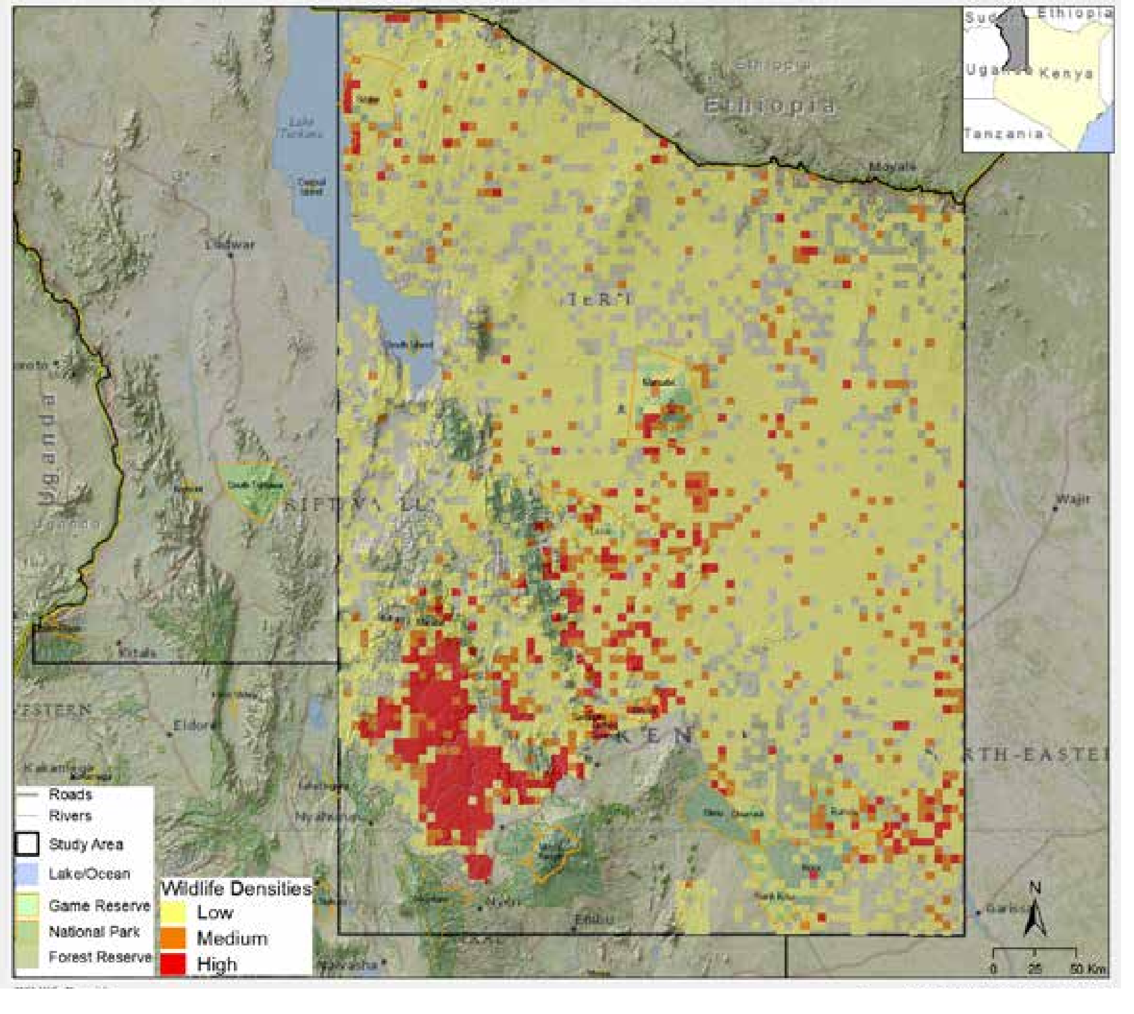

Source: DRSRS.

**Map 6.3:** Large wild ungulate species richness in the greater Ewaso ecosystem. Species diversity has been averaged on a 5x5 km grid based on DRSRS sample counts (1978–2011).



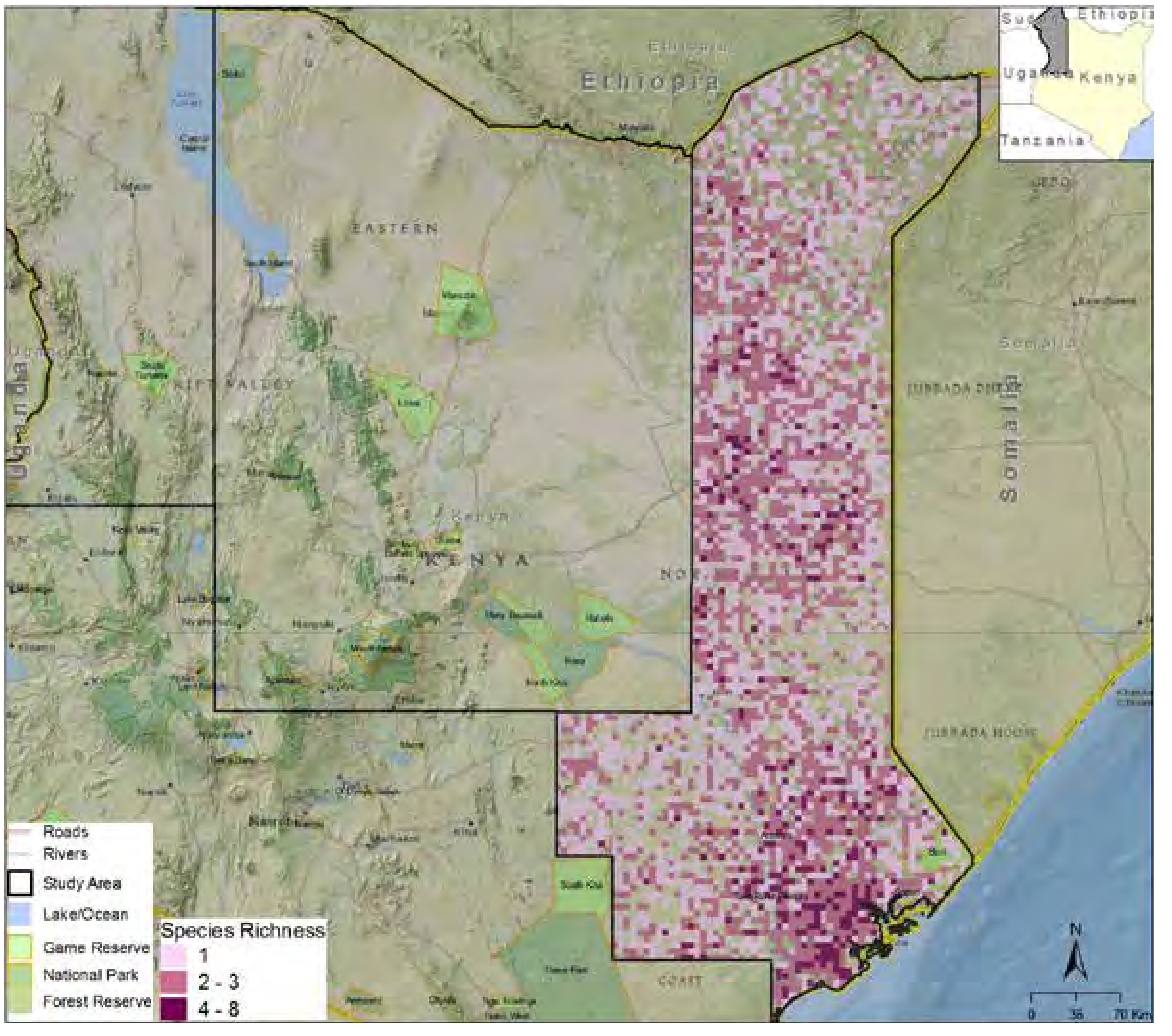

Source: DRSRS.

**Map 6.4:** Distribution density of large wild ungulates in the greater Ewaso ecosystem. Species density has been averaged on a 5x5 km grid based on DRSRS sample counts (1978–2011).



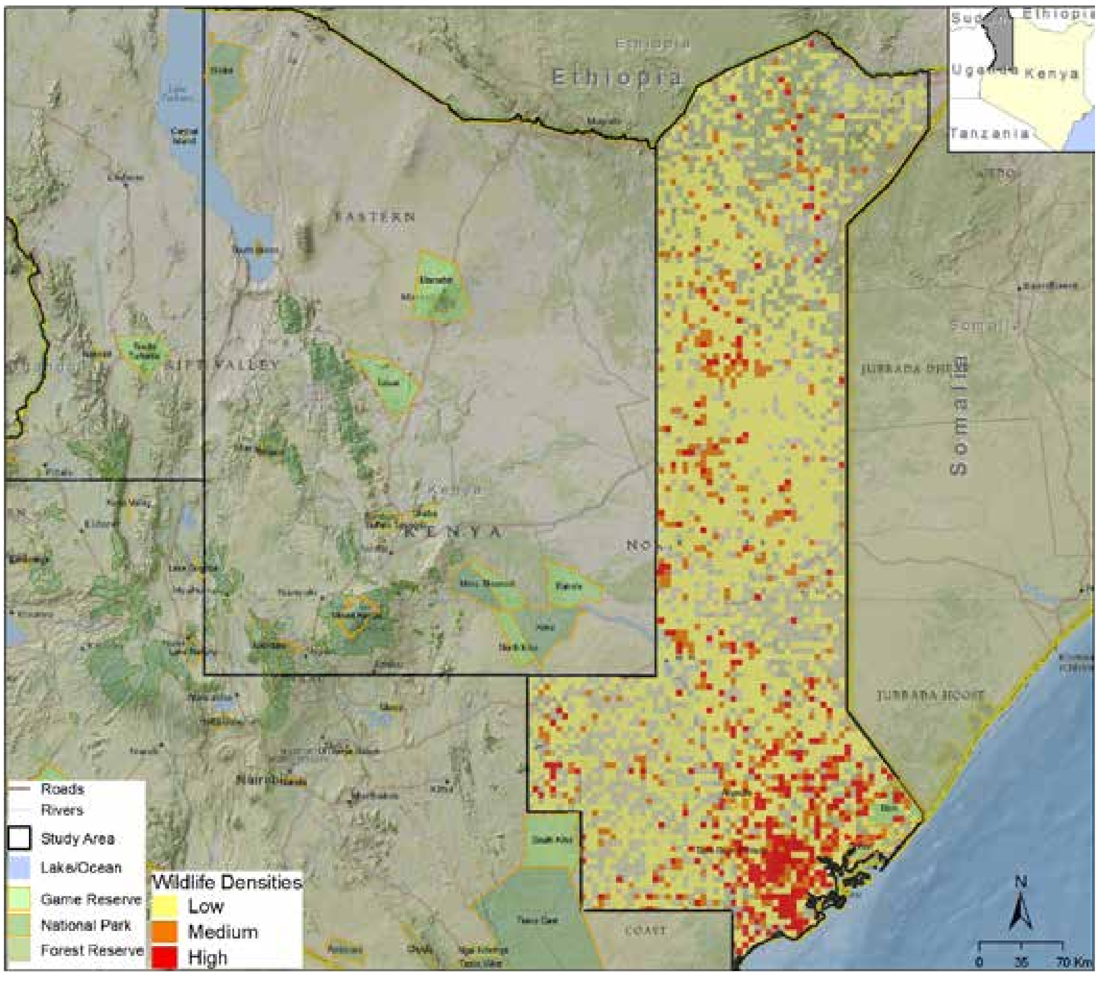

Source: DRSRS.

**Map 6.5:** Large wild ungulate species richness in the north-eastern rangeland and coastal terrestrial ecosystems. Species diversity has been averaged on a 5x5 km grid based on DRSRS sample counts (1978–2011).




Source: DRSRS.

**Map 6.6:** Distribution density of large wild ungulates in the north-eastern rangeland and coastal terrestrial ecosystems. Species density has been averaged on a 5x5 km grid based on DRSRS sample counts (1978–2011).




Source: DRSRS.

### 6.1.4. Regional Wildlife Population and Spatial Distribution Trends

Sweeping land use changes over recent decades have affected many ecosystems in Kenya, resulting in the fragmentation and/or loss of wildlife habitats and sharp declines in species populations. Climate variability, and the increased frequency of droughts especially, has resulted in steep declines in wildlife populations, including their extirpation from some areas. Poaching activity has also increased. Poaching of elephants and rhinos, both inside and outside the protected areas, is a serious concern. In early 2014, 18 rhinos and 51 elephants were lost to poachers, while 59 rhinos and 302 elephants were killed in 2013, compared with 30 rhinos and 384 elephants in 2012 (KWS, 2014). Many of the animals that are lost to poaching, either for subsistence needs (bush-meat) or for their products (skins and trophies), go unreported, however.

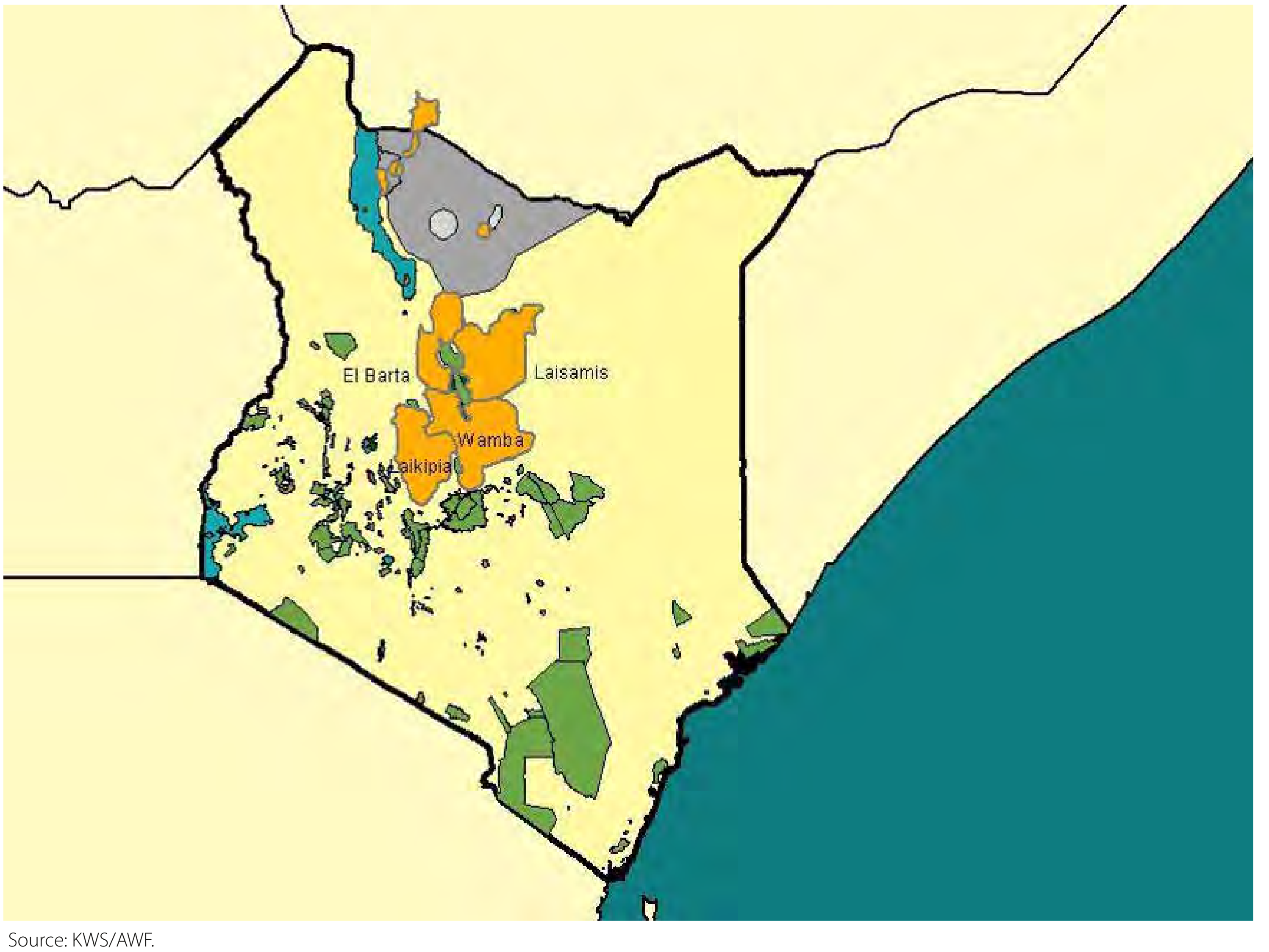
This section provides a regional synopsis and site-specific analyses of wildlife distribution densities and trends in various landscapes. Analysis of the six species (elephant, Burchell's zebra, Grevy's zebra, giraffe, topi, and oryx) shows considerable variation in occurrence and abundance in these landscapes. Most of these species are found outside the protected areas for much of the year. Populations have declined rapidly, however, and ranges have diminished, markedly in some cases.

#### 6.1.4(A). Population and Distribution Trends for Grevy's Zebra

Historically, the range of Grevy's zebra covered a large part of the greater Ewaso ecosystem and extended northward along the Great Rift Valley from Lake Turkana, through Ethiopia, to Djibouti, and eastward across south-western Somalia (Map 6.7). In the late 1970s, the estimated global population was about 15,000 animals (Klingel, 1980; Grunblatt *et al.,* 1989; Grunblatt *et al.,* 1996). This population has declined sharply over the past four decades, and today sub-populations are found only in northern Kenya, with a few small clusters in Ethiopia (Rowen & Ginsberg, 1992).

Grevy's zebra densities in far northern Kenya, and in Marsabit County primarily, are extremely low, and sub-populations are widely scattered (Parker & Davidson *et*

**Map 6.7:** Grevy's zebra dispersal is uneven across the species' potential range, being confined to a few narrow zones. Inset: historical (light green) and current (green) range in eastern Africa.




Source: KWS/AWF.

**Table 6.1:** Population estimates of Grevy's zebra in Kenya

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1977 | 1979 | 1982 | 1987 | 1992 | 1994 | 2000 | 2004 | 2008 | 2012 |
| Pop. Est | 12,989 | 8,500 | 6,393 | 4,211 | 5,267 | 4,164 | 2,571 | 1,976 | 2,462 | 2,774 |
| Source | DRSRS | | | | | | | | KWS | SWARA |

*al.,* in prep). The once abundant equids have been driven southward by worsening environmental conditions and by intensifying competition with human activities, and today they are confined largely to a few remaining strongholds in protected areas and community conservancies.

DRSRS rangeland monitoring surveys and the Grevy's Zebra Technical Committee (GZTC) have found evidence to suggest that dispersal of Grevy's zebra from the Marsabit area to Samburu and Laikipia has occurred within the past thirty years. The most recent aerial and ground surveys found scant evidence of the species' presence in the extreme northern parts of their range (Map 6.8).

An aerial survey in the northern rangelands found that 60 % of the Grevy's zebra population was on communal lands, which goes to show that pastoralist communities are critical to the survival of the species (Low *et al.*, 2009). On the Laikipia plateau, Grevy's zebras were found mainly on private ranches, with the Lewa and Ol Jogi wildlife conservancies being their important refuges (Low *et al.*, 2009). The Samburu, Buffalo Springs and Shaba NRs in Samburu and Isiolo Counties are particularly important in the dry season (Ginsberg, 1988; Williams, 1998). Other populations occur on adjacent communal lands.

Small, isolated sub-populations have been introduced to the Tsavo NP, to Oserian Wildlife Sanctuary in Naivasha, to Garissa, and to the Meru NP (National Stakeholders Review Workshop, April 2012). The protected areas managed directly by the KWS contain only negligible Grevy's zebra populations.

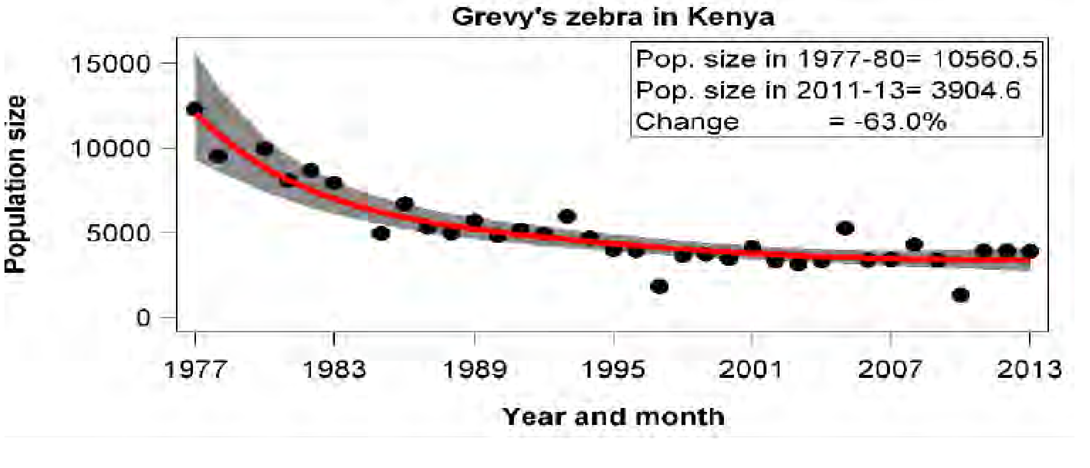
Population estimates for Grevy's zebra in Ethiopia suggest that numbers there have declined by at least 85 %, based on estimates of 1,900 animals in 1980 (Klingel, 1980), 577 in 1995 (Thouless, 1995), 110 in 2003 (Williams *et al.,* 2003), and 281 in 2012 (Fanuel Kabede, pers. comm., 2012). Rates of decline have been slower in Kenya, where the population is comparatively stable. Population estimates for Kenya were 13,718 animals in 1977 (Dirschl and Wetmore, 1978), 4,278 in 1988 (Grunblatt *et al.,* 1989), and 2,571 in 2000 (Nelson, 2003; Nelson and Williams, 2003). Systematic and coordinated aerial surveys in 2008 found 2,407 Grevy's zebras in the Laikipia- Samburu- Isiolo-Marsabit complex. The overall population, inclusive of the remnant herds in Ethiopia, is believed to number about 2,800 animals (NGZSW Proceedings, 2012; NCSGZ, 2013-17). If this population is added to the 491 individuals in captive breeding programmes in Europe (EEP, 2011), then current global numbers reflect a 78 % decline over the past four decades.

Over the past 10 years, there have been reboubled efforts in Kenya to save Grevy's zebra from extinction. As a result, the declining trend has been reversed, and numbers are slowly increasing. At the end of 2011, Kenya had about 2,546 Grevy's zebras, while Ethiopia had a total of 281 animals. Habitat degradation and loss continues to be the major threat facing Grevy's zebra conservation.

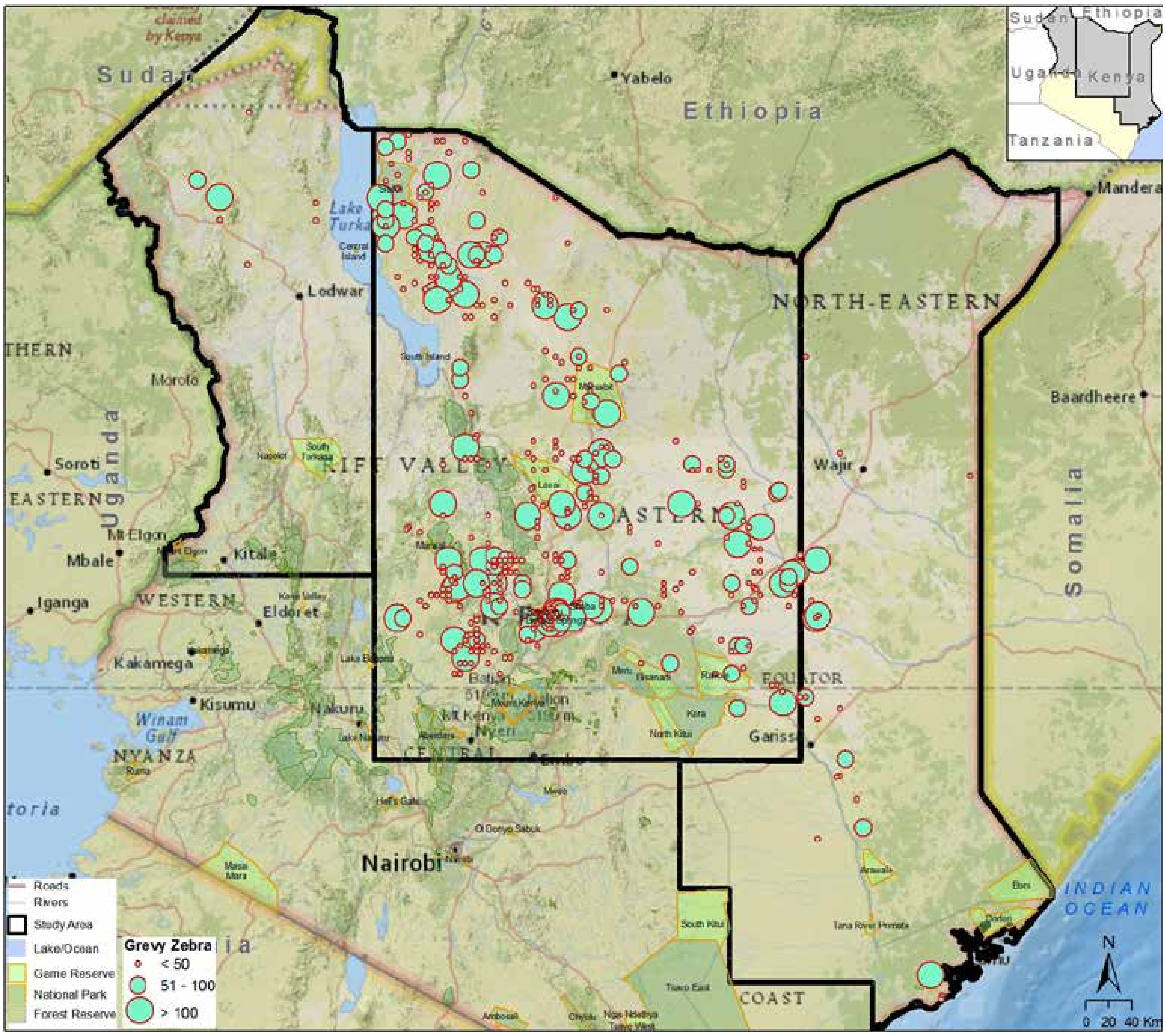
### 6.1.4 (B). Population and Distribution Trends for Elephant

Elephant distribution is strongly influenced by resource availability of forage and water, patterns of human land use, and competition and/or conflict with humans. Where there are 'hard edges' such as fences or abrupt changes in habitat or land use, it may be possible to define the limits of a population's range, often in relation to incidences of

**Figure: 6.1:** Population trends for Grevy's zebra in Kenya (DRSRS Data)



**Map 6.8:** Distribution of Grevy's zebra in the Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands and the north coast terrestrial ecosystems between 1978 and 2011.




Source: DRSRS.

conflict. In areas with low density elephant populations, range can be more difficult to define.

Spatial mapping of the elephant's range in Kenya in 2006, in the African Elephant Status Report (Blanc *et al.,* 2007), shows a considerable range outside protected areas, with contiguous habitats found mainly in: (i) the north coast terrestrial ecosystem; (ii) the Tsavo-Chyulu-Amboseli-West Kilimanjaro complex; (iii) the Aberdares-Mt. Kenya-Laikipia-Samburu complex; (iv) Nguruman-Mara-Serengeti, and (v) Nasolot-Romoi-Kerio Valley. In most cases, an elephant population's range extends beyond conservation area boundaries, while some populations also have cross-border ranges extending into neighboring countries, including Tanzania, Uganda, South Sudan, and Somalia.

Large, contiguous habitats linked by dispersal areas and corridors that provide a high degree of connectivity are critical in sustaining larger elephant populations, which need to be able to migrate between range patches that offer important ecological resources.

Observed rates of mortality among elephant in different parts of Kenya reflect differing levels of protection. Elephant populations in the southern rangelands (the Shimba Hills, Tsavo, Amboseli, Athi-Kaputiei, and Mara ecosystems) are well protected, relative to those in coastal areas (south of the Tana River and in Lamu, Kilifi and Kwale Counties), and those in the Mt. Elgon, Central Rift, Turkana, Laikipia-Samburu, Mt. Kenya, and Isiolo-Marsabit areas, which are relatively poorly protected. The major threat to elephant populations in northern Kenya and in the coastal areas is insecurity, which has been attributed to the large numbers of firearms that have illegally come into the hands of local communities, following the breakdown of law and order in neighbouring countries (South Sudan, Uganda, and Somalia).

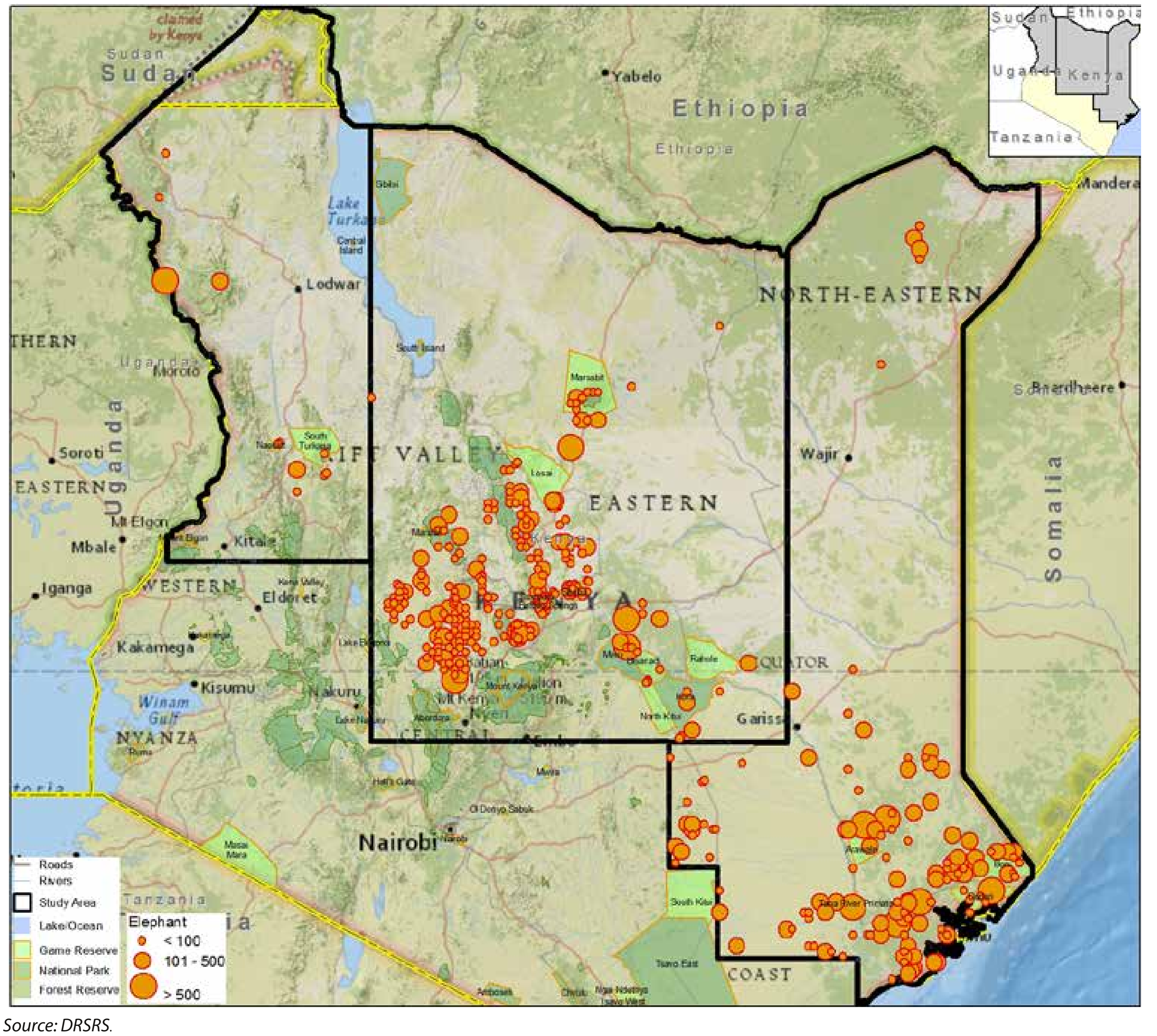
DRSRS rangeland monitoring (1978-2011) found elephant groups around the Loima Hills and in the South Turkana NR, the Nasolot and Romoi NR, the Kerio Valley corridor, the Mt. Marsabit NR, and the Laikipia-Samburu-Isiolo-Meru area, as well as in the south of Tana River County, and in Makueni, Garissa, and Lamu Counties. Elephants are also found in the Mt. Elgon NP, the Mt. Kenya NP, and the Aberdares NP, but these populations were not recorded (Map 6.9).

The overall population trend for elephants in Kenya (KWS total counts, 2006) shows increasing numbers in the coastal terrestrial ecosystem, and in the southern Kenya rangelands and the Central Rift. No clear trends were observed in the northern Kenya rangelands, or on the mountains, or in western areas, which collectively harbor about 45 % of the country's total elephant population.

**6.1.4(C). Population and Distribution Trends for Burchell's Zebra**

The landscapes of Laikipia-Samburu support Kenya's second largest population of Burchell's zebras (the largest population is found is in the southern rangelands, and within the Mara ecosystem especially). There is also a substantial population of Burchell's zebras on the coastal lowlands, in Lamu and Kilifi Counties and along the Tana River delta (Map 6.10).

**Map 6.9:** Distribution of elephant in the Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands and the north coast terrestrial ecosystems between 1978 and 2011

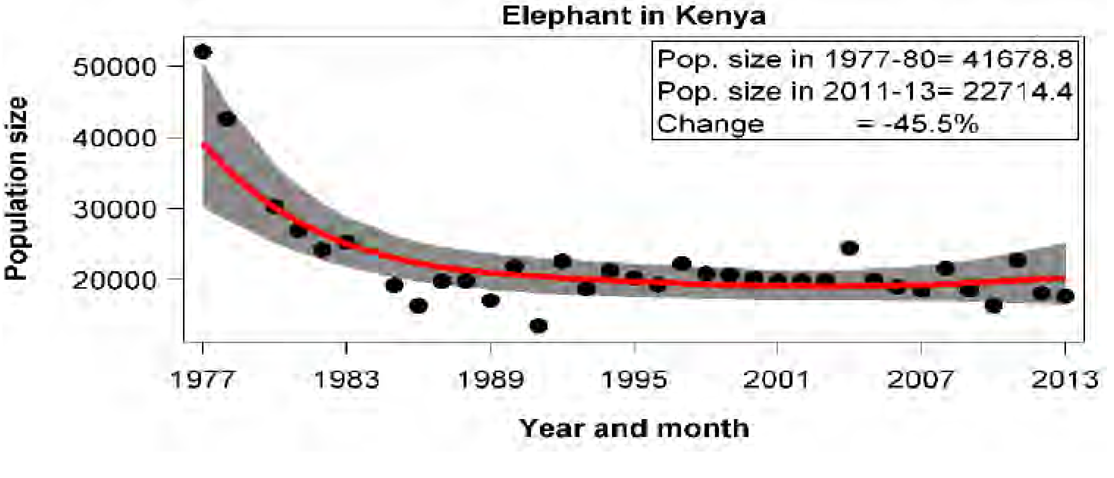



*Source: DRSRS.*

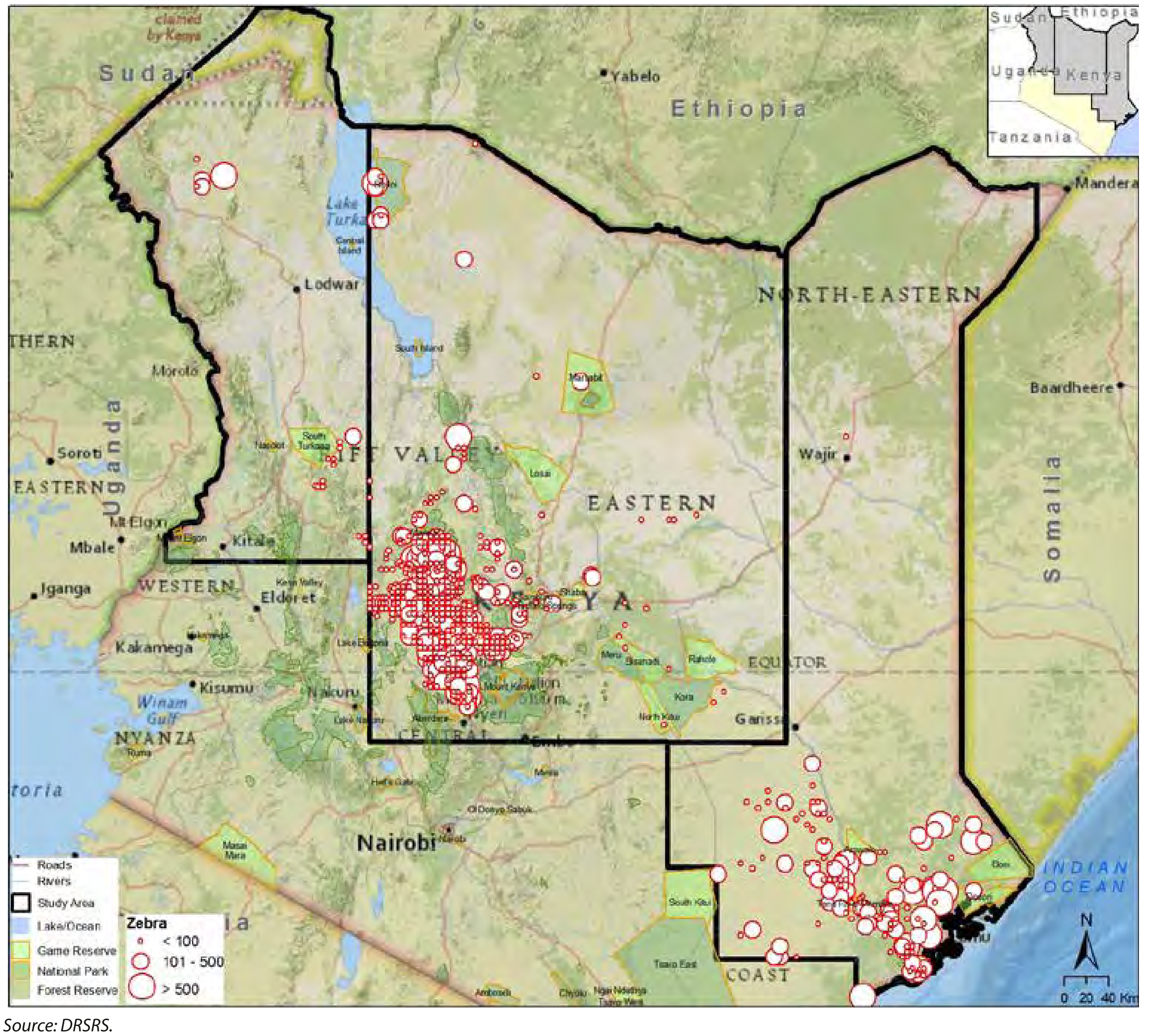
Table 6.2: Elephant population by conservation areas in Kenya (KWS).

| Conservation Area | Population Number | Year |
|---|---|---|
| Aberdares National Park | 1,920 | 2007 |
| (Aberdares (Outside | 1,780 | 2007 |
| Amboseli | 1420 | 2009 |
| Arabuko Sokoke Forests Reserve | 150 | 2009 |
| Bisanadi National Reserve | 30 | 2007 |
| Boni and Dodori National Reserve | 150 | 1996 |
| Kerio Valley Dispersal Area | 490 | 2002 |
| Kipipiri Forest Reserve | 56 | 2007 |
| Kora NP and Rahole National Reserve | 58 | 2007 |
| Lamu County | 100 | 2009 |
| Loroki Forest | 210 | 1997 |
| Masai Mara Game Reserve | 2,072 | 2007 |
| Narok/Mara Dispersal Area | 181 | 2006 |
| Mau Forest Complex | 1,003 | 1995 |
| Meru National Park | 268 | 2007 |
| Meru North Dispersal Area | 391 | 2007 |
| Mt. Elgon National Park & Reserve | 350 | 2009 |
| Mt. Kenya National Park & Reserve | 3,700 | 2009 |
| Mwea National Reserve | 55 | 1998 |
| Nguruman | 300 | 2009 |
| Shimba Hills National Reserve | 400 | 2007 |
| North Kitui National Reserve | - | 2008 |
| Samburu/Laikipia Ecosystem | 7,415 | 2008 |
| Marsabit Ecosystem | 319 | 2008 |
| South Kitui National Reserve | - | 2008 |
| Tana River Delta | 20 | 2002 |
| Tana River Primate National Reserve | 30 | 2005 |
| Transmara Forest | 600 | 2007 |
| Tsavo National Park | 10,346 | 2008 |
| (Tsavo (Outside | 1,387 | 2008 |
| **Total** | **35,201** | **2010** |

Figure 6.2: Population trend for elephants in Kenya (DRSRS Database).



**Map 6.10:** Distribution of Burchell's zebra in the Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands and the north coast terrestrial ecosystems between 1978 and 2011.




Source: DRSRS.

### 6.1.4(D). Population and Distribution Trends for Oryx

Kenya's largest remaining population of beisa oryx is found in the northern Kenya rangelands, with major herds in Wajir and Marsabit Counties, and in the Sibiloi NP. Significant, if scattered, populations also occur in the Samburu, Garissa, Mandera, Makwueni, and Tana River Counties. Oryx were formerly distributed widely in semi-arid and arid bushland and grassland habitats, but their population has declined markedly, especially at the margins of their range. They still persist in grazing areas where human and livestock densities are low (Map 6.11). Much of the oryx's range is in non-protected landscapes. The two subspecies of oryx, beisa and fringe-eared, are separated by the Tana River. The largest numbers of fringe-eared oryx are in the southern rangelands, particularly in Kajiado and Kilifi Counties, and in and around the Tsavo NPs, where numbers have declined substantially since the 1970s. Effective protection against threats such as poaching and competition from livestock for forage occurs in only a few parts of the subspecies' current range.

**Figure: 6.3:** Population trend for oryx in Kenya (*DRSRS Database*)

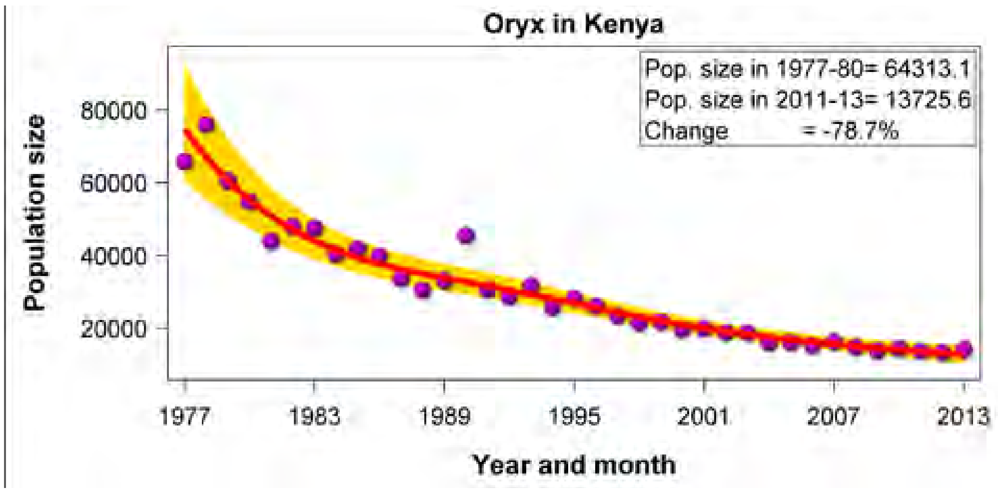
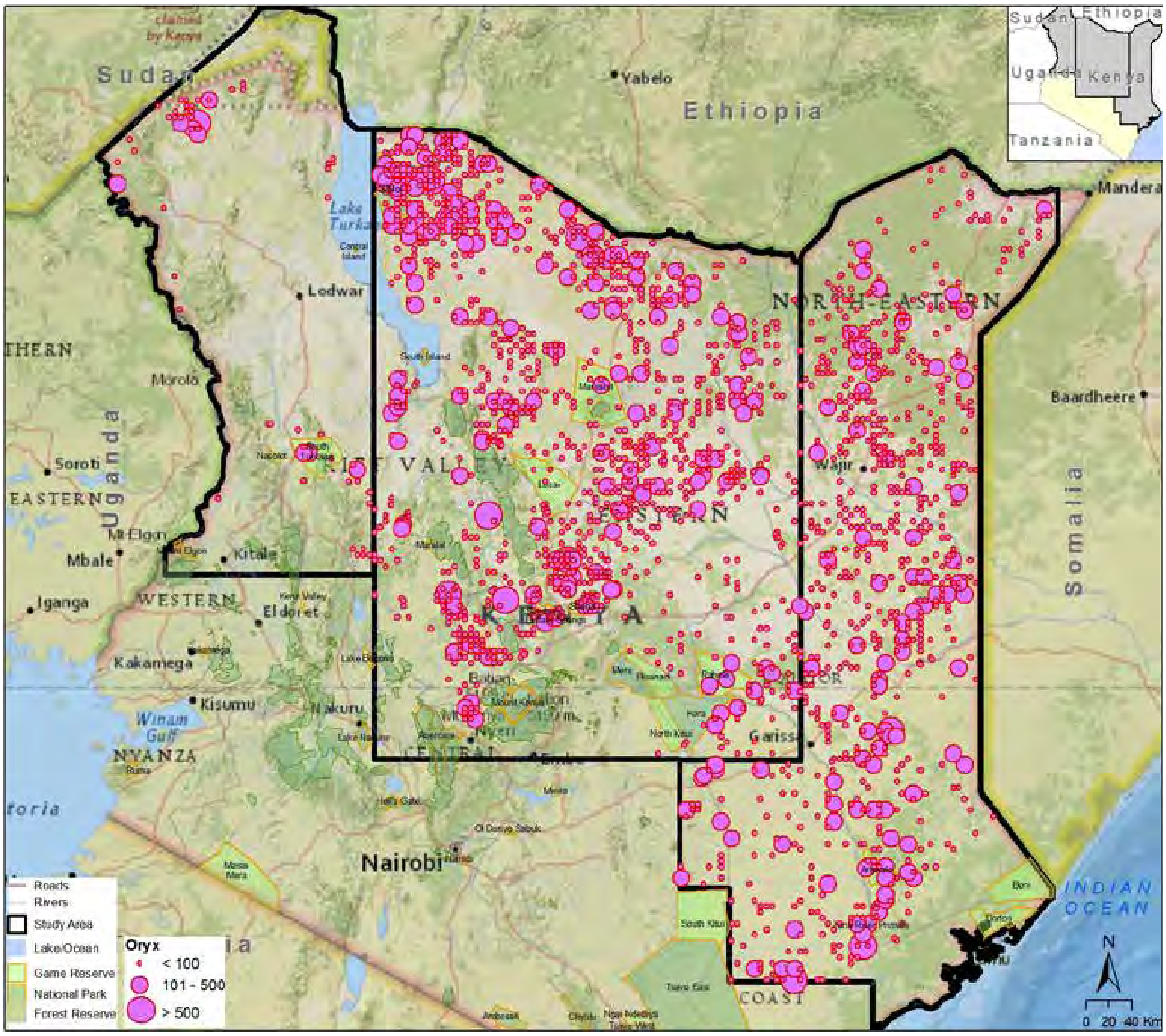



**Plate 6.1:** Maida Hut Springs, eastern Chalbi Desert (2010), showing lava flow encircling a spring to form a tiny seasonal oasis of pooled rain water. *Photo: courtesy Zeke Davidson*

**Map 6.11:** Distribution of oryx in the Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands, and the north coast terrestrial ecosystems between 1978 and 2011.




*Source: DRSRS.*

### 6.1.4(E). Trends in Giraffe population and Distribution

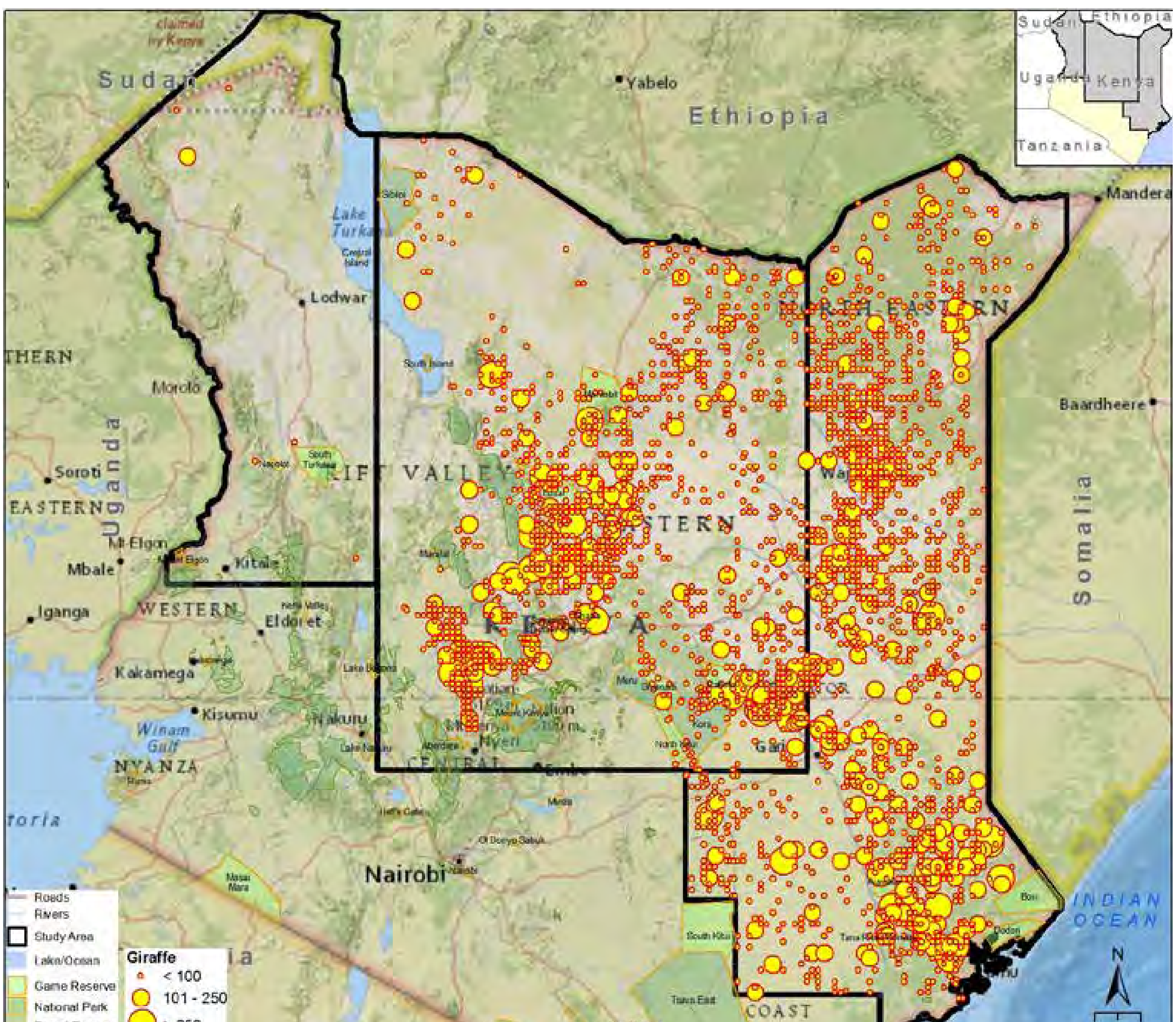
Conservation experts have raised the alarm over Africa's fast-declining giraffe populations, but calls for interventions that will counter threats to the animals' survival have been largely ignored. Human encroachment on giraffe habitats is one of the most pressing threats to the survival of the world's biggest ruminant. Giraffe numbers in Africa were estimated at in excess of 140,000 animals in 1998, but this number has dropped to fewer than 80,000 across all subspecies, according to an assessment in 2012 (Julian Fennessy, Giraffe Conservation Foundation chairman).

There are nine giraffe subspecies, but Kenya is the only African country with three subspecies, giving it the unique heritage and legacy of being the world's centre for giraffe diversity. The reticulated giraffe is found in northern Kenya; Rothschild's giraffe is found in the North Rift, and the Maasai giraffe is common in the southern Kenya rangelands.

Most of Kenya's giraffes occur outside protected areas, with fewer than 40 % found inside parks and reserves (Map 6.12). Human population growth, agriculture, settlements, poaching, and habitat destruction are some of the major factors that are reducing giraffe populations. Kenya has drafted a national giraffe conservation strategy designed to help the country mitigate these threats and boost giraffe numbers.

**Plate 6.2:** Reticulated giraffes on the Laikipia plateau. *Photo: courtesy Kes Smith.*

**Map 6.12:** Distribution of giraffes in the Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands and the north coast terrestrial ecosystems between 1978and 2011.




*Source: DRSRS.*

### 6.1.4(F). Trends in Topi Population and Distribution

Topi populations are confined to three geographically distinct regions in Kenya; namely, the north-eastern tip of Lake Turkana in Marsabit County; the south-western part of Narok County and near Lake Victoria in Homa Bay County; and parts of Lamu County and adjoining areas of Garissa and Tana River Counties (Map 6.13). Other small groups occur on the Lotikipi Plains of northern Turkana County. Topi are present at moderately high densities in four protected areas: the Sibiloi NP (tiang'), the Boni and Dodori NRs (coastal topi), and the Masai Mara NR and Ruma NP (western topi). Topi populations have declined over much of their range, especially in unprotected landscapes (Table 6.3). The declines have been attributed to habitat degradation and poaching.

The Narok topi population has been decreasing for unknown reasons, but the other two populations, near the coast and in northern Kenya, appear to be stable. Coastal Topi occur mainly outside protected areas, although they are present in the Boni and Dodori NRs (East, 1999). While the species is still numerous and widespread, it has been eliminated from large areas of its former range by hunting and habitat degradation associated with human encroachment and competition with livestock.

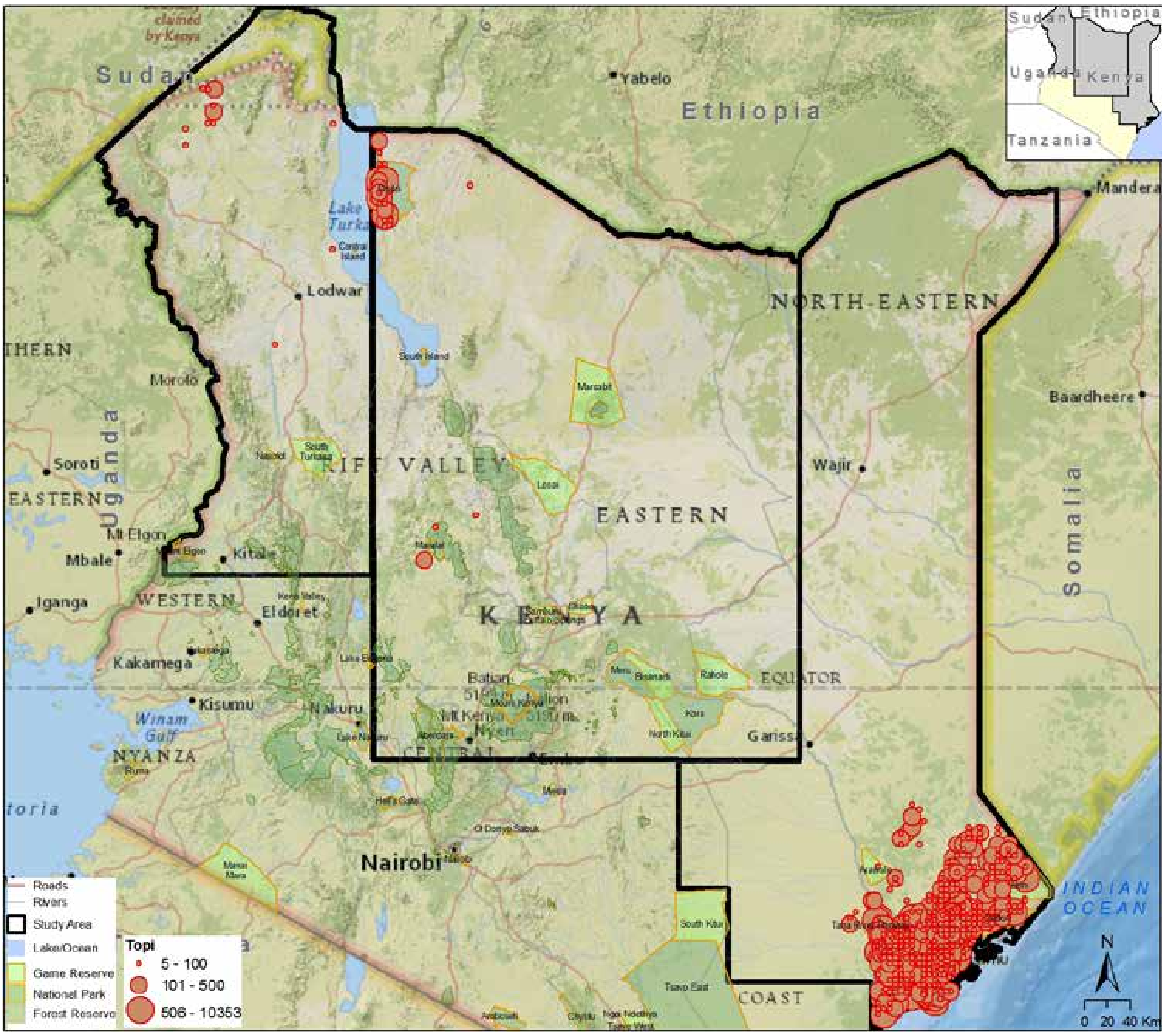
Table 6.3: Estimated population of topi, relative abundance, and trends in Kenya.

| Species | Protected Areas | | Other Areas | |
|---|---|---|---|---|
| | Population | Trend | Population | Trend |
| (Topi (Kenya | 5,440 | Decline | 5,680 | Decline |
| Tiang | 2,600 | Stable | | |
| Coastal Topi | | Unknown | 6,600 | Stable |

*Source: Antelope Specialist Group, 1998.*

**Plate 6.3:** Topi on the grassy shrubland. *Photo: AWF.*

**Map 6.13:** Distribution of topi in the Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands and the north coast terrestrial ecosystems between 1978 and 2011.




*Source: DRSRS.*

## 6.2. Threats to Conservation Connectivity in the Northern Kenya Rangeland and Coastal Terrestrial Ecosystems

Biodiversity conservation efforts in the northern Kenya rangeland and coastal terrestrial ecosystems are being undermined by a number of grave threats. Such threats stem mainly from land-use changes which have resulted in habitat fragmentation and/or loss through encroachment by agriculture, overgrazing, expansion of settlements, infrastructure development, water abstraction, and the proliferation of invasive species. Rampant poverty among rural communities and insecurity (especially through the proliferation of illegal firearms in remote areas) has aggravated wildlife harassment and poaching, while land-tenure issues and inadequate implementation of land-use policy and legislation have resulted in the mismanagement of natural resources. All these factors, coupled with aridity, the fragile nature of the ecosystems, the impacts of climate variability (resulting in prolonged periods of drought), and the spread of diseases, are contributing to the rapid decline in wildlife populations and the shrinking of wildlife habitats.

A. *Land-use changes:*

How a country makes use of its land, in having to accommodate a wide range of important social and economic activities, including the conservation of biodiversity, is the key to plotting a sustainable future. Over the years, sweeping land-use changes have taken place in the northern Kenya rangelands. Some of these changes are incompatible with conservation. The expansion of crop cultivation along rainfall gradients is one example. Pastoralists, meanwhile, are being forced to change their lifestyle from nomadism to sedentarism, which is leading to high livestock densities and over-grazing. The impacts of these changes are exacerbated by inadequate land-use policies. All these factors are hampering biodiversity conservation, and are threatening wildlife populations, dispersal areas and migratory routes/corridors.

B. *Destruction of wildlife habitats:*
The importance of biodiversity conservation in supporting the healthy function of ecosystems so they can continue to deliver essential goods and services (including water security) and opportunities (for eco-tourism, for example, and medical research) is widely recognized. Yet, while attempts have been made to preserve small pockets of native habitat, these pockets are increasingly being isolated. Areas of connectivity between such habitats are being degraded and blocked by human activities. The isolation of habitats has led to a collapse in the populations of many wildlife species. Often, these habitats are too small to meet all the needs of a species, or the species, in being unable to disperse in order to replenish its gene pool, may die out through inbreeding.

Increases in human population and in human socio-economic needs have put enormous pressure on resource use. Many communities in wildlife areas have resorted to unsustainable land-use practices due to rampant poverty. Habitat fragmentation or loss caused by deforestation, drainage of wetlands, and conversion to agriculture are among the greatest threats to biodiversity conservation. Many species of plants have been lost as the result of charcoal burning, the extraction of timber for use in construction or for woodcarving, and the gathering of traditional medicines, while the clearing of land for cultivation has also led to rampant soil erosion. The destruction of a pristine wildlife habitat may take only a few weeks, but its regeneration, even were this possible, might take decades.

C. *Insecurity relating to wildlife protection:*
Insecurity in relation to protecting wildlife populations is a serious challenge facing the conservation and management of biodiversity. The proliferation of firearms among communities in remote areas, of the northern rangelands for example, has resulted, not only in a scaling-up of internecine wars among pastoralist communities over pasture and water for their livestock, but also in an escalation in cattle rustling and banditry, and an increase in wildlife disturbance and poaching.

D. *Insecure land-tenure:*
Insecure tenure on communal lands has contributed to a growing apathy towards wildlife conservation among local communities. Over recent years, demand for individual land ownership and interventions by speculators have led increasingly to the sub-division of communal lands and of some large group ranches to smaller parcels. Huge tracts of land belonging to communities are held in trust by County governments, but this trusteeship has in some cases been abused through illegal land allocations and changes in land use, which have had negative implications for wildlife conservation.

E. *Protected area management and partnerships:*
Most protected areas were established without regard for the importance of surrounding landscapes in sustaining the ecology of the protected areas. The boundaries of protected areas are increasingly being separated from surrounding lands by fences and barriers that prevent the free movement of animals. Rigid boundaries compromise the effectiveness of conservation areas. Whereas protected areas are designated for wildlife conservation, adjacent habitats are of critical importance in providing dispersal areas for wildlife. Some of these adjacent habitats are under communal or private ownership. The need to secure more space for conservation outside the protected areas and to re-define the legal status of this form of land use is critical. This could be achieved through transparent collaboration, participation and partnership between communities, landowners, and the protected area management authorities.

F. *Assessment of management effectiveness:*
Biodiversity conservation safeguards natural processes that are vital to human well-being and socio-economic development, and yet it receives little resources. If natural resources are to be managed effectively, regular assessments are needed, and strategies put in place to address priority issues.

At present, there are few initiatives in place to support local communities living around protected areas in the northern Kenya rangelands, save for the Northern Rangeland Trust (NRT), the Lewa Conservancy, and the Il-Ngwesi Community Conservancy. Incentives to encourage conservation-compatible land uses outside the parks and reserves are wholly inadequate. Exceptions are the large pro-wildlife properties on the Laikipia plateau, where landowners have embraced wildlife management strategies to benefit, through non-consumptive activities, from the abundance and diversity of wild species found on their properties. Conservancies such as Ol Jogi and Solio have engaged in similar conservation ventures.

G. *Inadequate scientific data:*
Accurate scientific data are critical for informed and rational decision-making. A combination of remoteness and insecurity has hampered research

efforts over much of the northern rangelands and along the Kenya-Somalia border. Lack of adequate data has prejudiced the understanding of ecosystem processes and wildlife dynamics, which require long-term studies and investment. The Directorate of Resource Surveys and Remote Sensing (DRSRS), STE, and KWS are the only institutions with a significant long-term ecological monitoring presence in the northern rangelands, yet to date only a tiny fraction of the required data has been gathered.

H. *Climate change:*
Periods of global warming and climate change have occurred throughout geological history. Today, it is the increasing frequency and severity of dry spells that is impacting most heavily on wildlife species and communities on the rangelands. In particular, changes in abiotic factors and in reproductive and recruitment opportunities are affecting species and interactions among species. Historically, species have responded to changing climatic conditions by moving or migrating to more suitable habitats. This has been a slow process, especially for plants, but for the larger, more mobile mammals, such as elephants, zebras and wildebeest, the response has been rapid. The fragmentation and loss of dispersal habitats and the imposition of human barriers to movement, means that today such a response is, in many areas, effectively blocked. Climate change may also create conditions that are conducive to the establishment and/or spread of invasive species, which may impoverish the ecology of rangelands.

I. *Illegal off-take of wildlife and bush meat trade:*
The escalating illegal off-take of wildlife, both for the international trade in wildlife products and as bushmeat for subsistence, can be attributed to inadequate law enforcement, ineffective regulatory mechanisms, and low penalties, as well as rising poverty levels among local communities. The result is that wildlife species are being killed at rates that far exceed their capacities to replace themselves.

J. *Pollution:*
The burning of fossil fuels and the use of petrochemicals has led to an increase in greenhouse gas emissions. The use of fertilisers and pesticides in agriculture has resulted in the contamination of water systems. The introduction of solid wastes, effluents and other pollutants into water and soil systems adversely affects habitats and disrupts ecological processes, which in turn may lead to the elimination of wildlife species.

K. *Invasive alien species:*
Human mobility and global trade have resulted in the spread of numerous invasive alien species. These are species which, upon becoming established in new environments, outside their home ranges, out-compete and displace native species in the landscapes they colonise. The impacts of such species can be devastating, particularly on small islands, but also in fragile arid and semi-arid lands (ASALs) and in aquatic ecosystems. Invasive species transform the structure and species' composition of ecosystems by repressing or excluding native species, or by altering nutrient cycles. The extent of the threat they pose to native biodiversity is second only to that of outright habitat destruction. Control of invasive species is a major management challenge. In addition to the direct costs of management, there are severe and costly environmental and economic consequences. The spread of Prosopis (P. juliflora) in northern Kenya is now a major threat to natural habitats. Encroachment by agriculture has resulted in the spread into wildlife areas of many invasive weeds that are alien to the rangeland ecosystems.

L. *Human-wildlife conflicts:*
Acute water shortages and inadequate dry season pasture force wildlife species into competing with humans and their livestock for the scarce resources. Human-wildlife conflicts are very often the result. The government pays compensation for wildlife damage relating to human injury or death, livestock predation, and crop destruction, but current payments are too low. The compensation guidelines in the Wildlife Management and Conservation Act, 2013, are still not commensurate with the losses incurred by communities living in areas adjacent to parks and reserves. The stringent bureaucratic procedures for seeking compensation further disadvantage most claimants, who are among the rural poor.

M. *Conservation of shared resources:*
Most wildlife species have evolved in and adapted to large home ranges, which in some cases straddle two or more countries. This raises the need for a harmonized approach to the conservation and management of shared wildlife resources. The Mt. Elgon ecosystem, for example, which is important for forest elephants, is shared between Kenya and Uganda. Similarly, Kenya and Tanzania share the annual migration of wildebeest and zebras in the Serengeti-Mara Ecosystem. The Amboseli-West Kilimanjaro ecosystem, which is critical in sustaining the movements of elephants, is also shared between Kenya and Tanzania. But, whereas Kenya has imposed

a ban on hunting, Tanzania has created game control areas (GCAs) where hunting is permitted. This means that wildlife species crossing the border from Kenya into Tanzania may move into hunting areas.

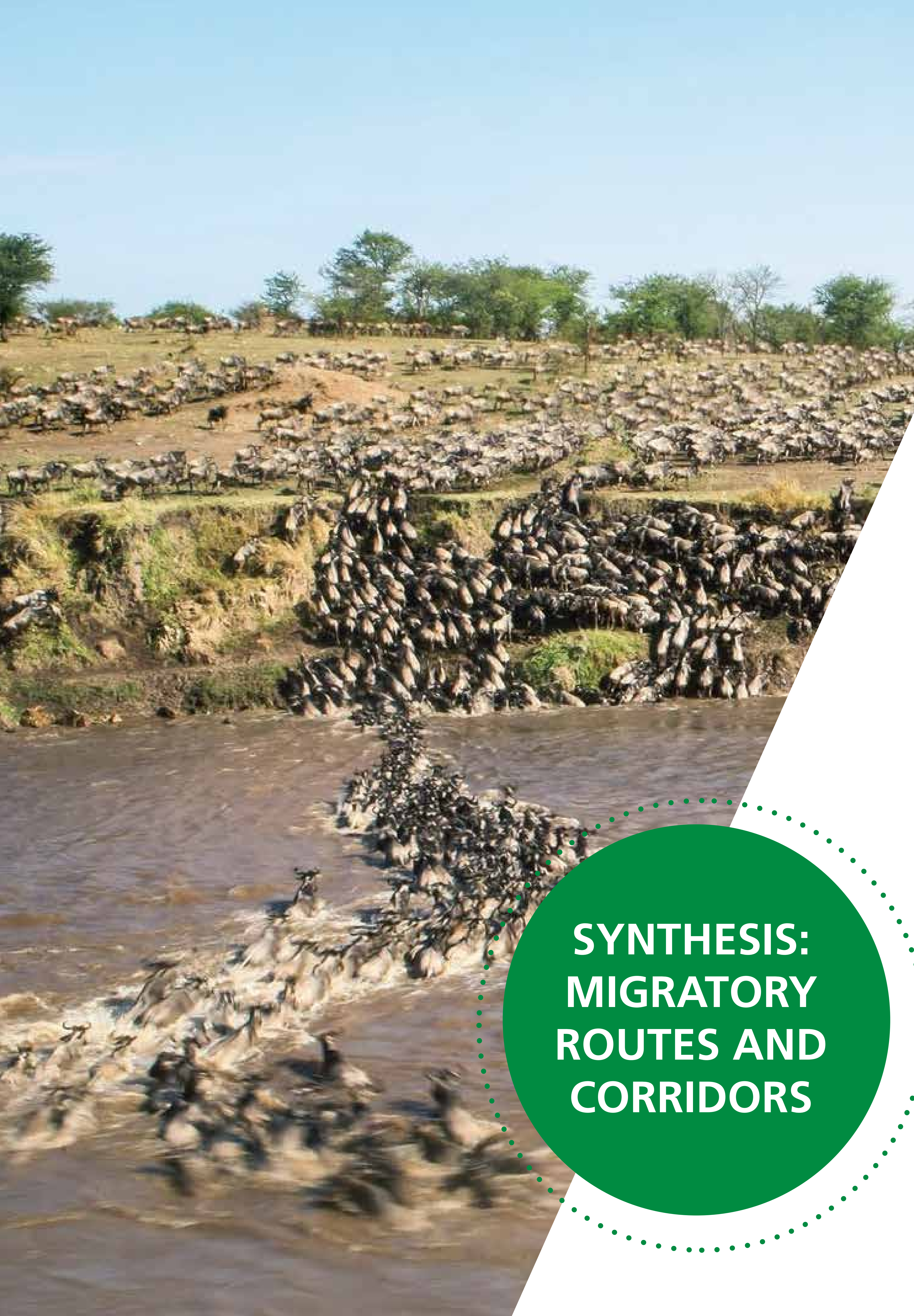
N. *Size of protected areas:*
The delineation of protected area boundaries did not take into account the full requirements of many wildlife species. Most protected areas are too small to encompass all the ecosystem processes on which wildlife populations depend. Confining large wildlife populations within the narrow boundaries of parks and reserves can degrade ecosystem integrity, to the detriment of all the species in such protected areas. Pressure on the survival of species is especially acute in enclosed habitats where fences separate wildlife from land uses that are incompatible with conservation.

O. *Management plans:*
The lack of comprehensive, integrated management plans, coupled with lethargy over implementing even what plans do exist, are major challenges for wildlife conservation management, especially with respect to wildlife outside protected areas. Inadequate provision for community involvement and participation in the planning process may result in a lack of preparedness for the implementation of plans. Inadequate management resources and the absence of effective monitoring and evaluation frameworks for gauging performance levels and outcomes are other contributing factors.

## 6.3. Interventions and Opportunities

A. *Establishment of Community-based Conservancies:*
Post-privatization land re-consolidation for wildlife use and livestock mobility is taking place in many areas through public-private-partnerships (PPPs). Several conservancies and wildlife sanctuaries have emerged around protected areas in recent years. Their aim is to protect wildlife, and to enable local communities to benefit from wildlife conservation through receiving payments for ecosystem services. Income diversification among pastoralist communities could hold the key to biodiversity conservation. Payments for Ecosystem Services (PES), now disbursed around most protected areas in Kenya, provide communities living alongside protected areas with stable, reliable, and predicable sources of additional income. Where PES have been piloted, local level institutions have played a significant role in allowing communities to develop self-governing structures that support flexible land uses and which respect traditional land ownership patterns. This has had the doubly beneficial effect of reducing poverty, while at the same time protecting wildlife and ecosystems. Pastoralist communities on the borders of the Samburu and Buffalo Springs NRs fared much better over the two most recent droughts than they had done before, due to partnerships with KWS. The NRT has also partnered with communities in the north to develop various conservancies.

B. *Implementation of REDD Programmes:*
Some communities in wildlife dispersal areas and along migratory routes/corridors are implementing carbon projects under the Reduction of Emissions from Deforestation and Forest Degradation (REDD) programme, and are benefiting from payments for ecosystem services (PES). Such projects include both the restoration of indigenous forests and plantation forestry.



# SYNTHESIS: MIGRATORY ROUTES AND CORRIDORS

# Chapter 7

# Synthesis: Migratory Routes and Corridors

**Plate 7.1:** Wildebeest on the vast grassland plains during a migration from the Serengeti to the Mara ecosystem.

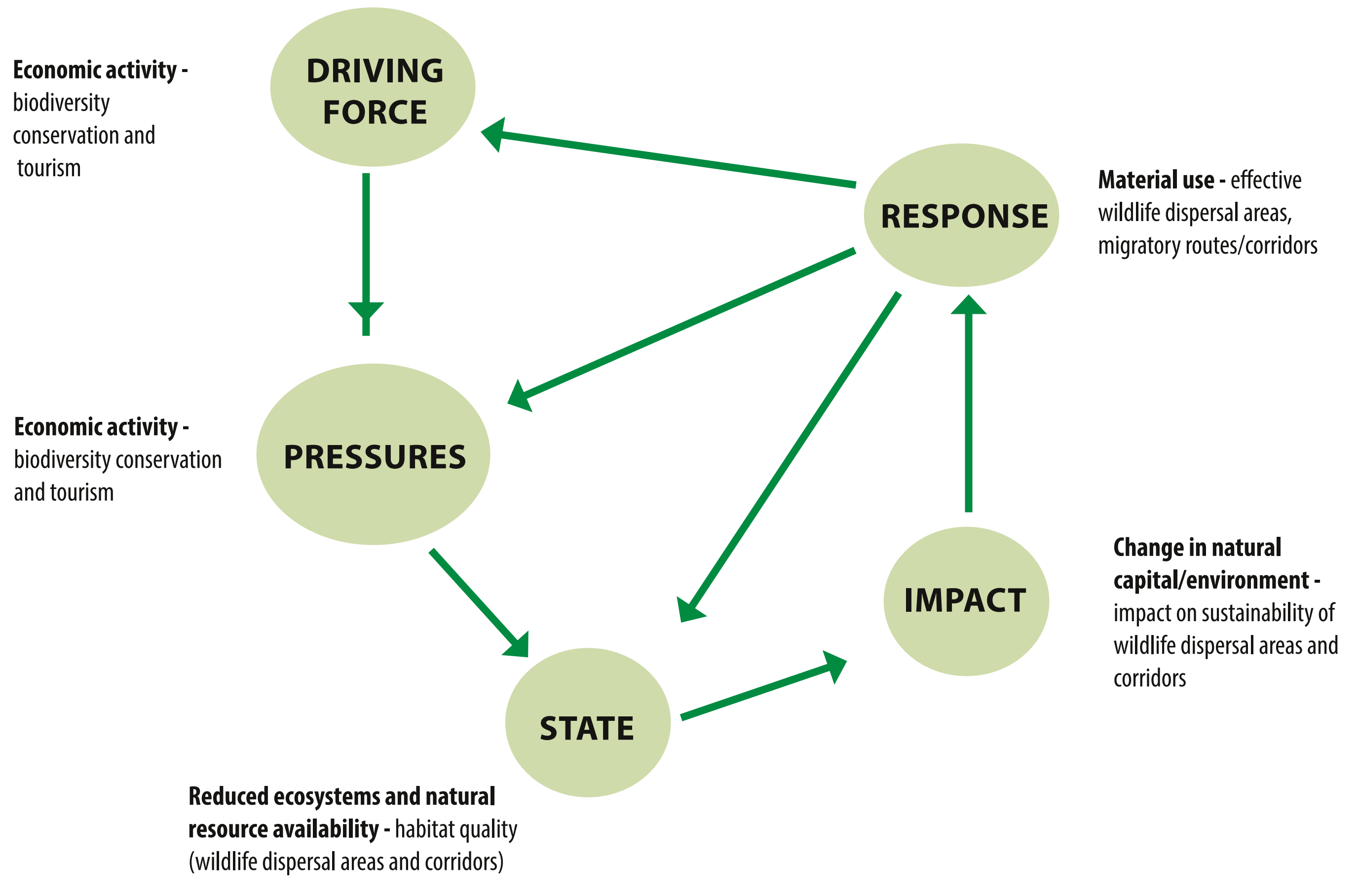
## 7.1. DPSIR Framework Model

The DPSIR (Drivers, Pressure, State, Impact and Response) model, which defines environmental problems in a logical way, showing relationships between various sectors of human activity and the environment as a causal chain of links (UNEP, 1997), was adopted to investigate and prioritize wildlife dispersal areas and migratory routes/corridors identified in the mapping process. The DPSIR model (Fig. 6.1) was originally developed for environmental reporting, and is based on an understanding of the basic principles of system dynamics in planning and decision-making.

Over recent decades, most of Kenya's wildlife populations have declined and their distribution ranges have diminished, mainly as the result of changes in land-use and tenure, drought, and poaching. Rapid human population growth and a soaring demand for natural resources, especially land for agriculture and settlements, has led to uncontrolled conversion of wildlife habitats and dry season refuges. The loss or fragmentation of habitats (core areas, dispersal, and connectivity) has impacted negatively on wildlife populations.

As protected areas become increasingly engulfed by incompatible land uses, competition between wildlife and the communities living in adjacent areas intensifies, and human-wildlife conflicts escalate. In the dry seasons, many wildlife species roam widely in search of the food and water resources they need in order to survive. Besides having to compete with humans and their livestock for these resources, wild animals outside the protected areas become easy targets for poaching. The biological significance of animal movements and the importance of habitat connectivity has been discussed in Chapter 3.

**Figure 7.1:** Diagrammatic presentation of the DPSIR model approach as it relates to conservation and decision-making processes.




In this study, the historical and current states of wildlife dispersal areas and migratory routes/corridors, and of the driving forces, pressures, impacts, and responses, were investigated through a review of the literature (studies and reports in journals), expert opinion, fieldwork, personal communication, and feedback from the local communities.

Based on DPSIR analysis, a set of recommendations and actions, including economic, legal, and policy instruments, can be explored for each of the wildlife dispersal areas and migratory routes/corridors. This process is helpful in guiding the various government institutions and ministries responsible for implementing the proposed conservation connectivity framework. Further research on the viability and sustainability of those migratory routes/corridors which have been interfered with by human activities is then critical, as is consultative engagement with all the stakeholders and local communities whose lands are perceived as wildlife areas.

## 7.2. Masai Mara Ecosystem

### Introduction

Kenya has long been of the world's foremost tourist destinations. The country's appeal to tourists stems in large part from its stunning natural landscapes and their magnificent wildlife. This unique natural endowment has turned Kenya's tourism industry into a leading economic sector, generating revenues of about KSh 49 billion (US$ 700 million) in 2005. Kenya's Vision 2030 development blueprint identifies tourism as one of the country's major economic pillars and encourages further development and diversification within the sector. This can be achieved only through astute management of wildlife resources and careful forward planning. Setbacks, in the shape of declining wildlife populations, loss of wildlife habitats, and illegal wildlife harvesting, will have to be reversed.

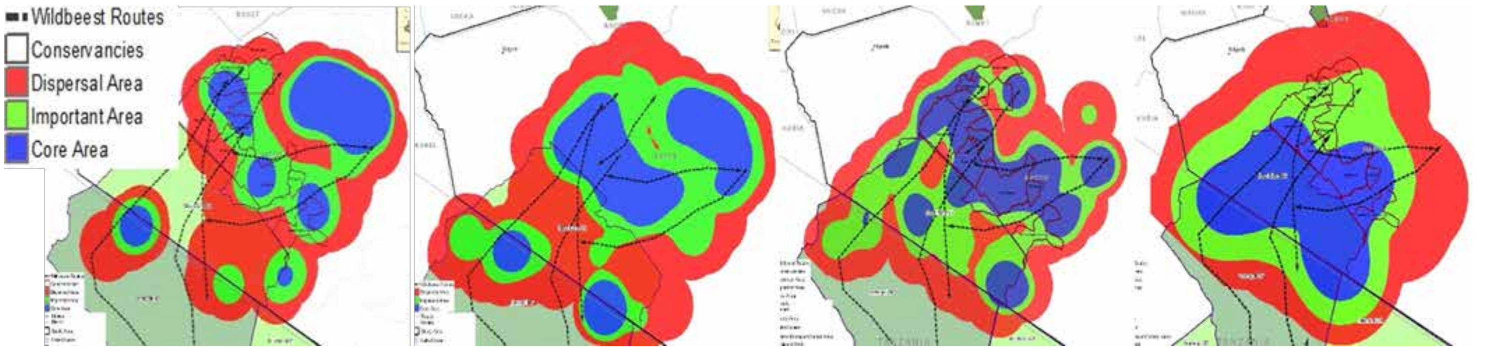
The Masai Mara National Reserve (MMNR) is one of the country's most visited parks, attracting more than 0.3 million tourists every year. The Masai Mara Ecosystem (MME) is renowned for its large and diverse assemblages of wild ungulates and carnivores, and for the annual migration of wildebeest and zebras that it shares with the northern portion of the Serengeti National Park in Tanzania. In being part of the wider Serengeti-Mara Ecosystem (SME), the MME supports the highest wildlife densities and the greatest species richness in the country.

Kernel densities identify core habitats, important habitats, and dispersal areas used by wildlife species in the Mara ecosystem (Map 7.1). The core area for wildebeest is largely outside the Masai Mara NR, on the Ngorengore Plains; the pattern for Burchell's zebra is similar, but zebras are more widespread outside the reserve; giraffes are widespread, but are concentrated largely on nearby

**Plate 7.2:** Wildebeest and zebra after crossing the Mara River during the migration. *Photo courtesy: AWF*

**Plate 7.3:** Large-scale mechanized wheat farming in the Ngorengore area is a major impediment to dry season dispersal of wildlife in Narok County. *Photo: courtesy Gordon Ojwang'*

**Map 7.1:** Kernel densities for wildebeest (left), Burchell's zebra (center left), giraffe (center right) and elephant (right) in the greater MME, showing core habitat, important habitat, and dispersal areas.




*Source: DRSRS/KWS.*

conservancies; and elephants are confined largely to the reserve and to the area around Talek, although they have extensive ranges beyond the conservancies.

### The State of Conservation Connectivity

**A. Drivers**

1. *Human population:* According to the 2009 population census, Narok County had 850,920 people, with a density of 47 persons/km$^2$ and a growth rate of 3.3 % (against the national rate of 2.2 %). This has increased the pressure on land-use and resources outside the protected areas, in habitats which also serve as dry season refuges for wildlife.

2. *Land-tenure:* Insecurity over tenure has led many Maasai pastoralists to subdivide, under individual titles, land that was formerly on group ranches (Map 7.2). This privatization has led to land-use transition, with the emergence of large-scale mechanized cultivation (wheat, barley, and maize) and intensification of agriculture and livestock production, in the Lemek and Ngorengore areas for example (Map 7.4).

3. *Climate change:* Annual rainfall has been deceasing slightly, and droughts are becoming more frequent, often at the expense of the long rains. Maximum temperatures have increased by about 0.5$^oC$, and minimum temperatures by about 1$^oC$. Rainfall has become unreliable, resulting in long periods of water scarcity and poor biomass production. This has had negative impacts on crop cultivation, on livestock production, and on wildlife populations.

**B. Pressures**

1. Human numbers in the Mara ecosystem have increased significantly. Since the 1940s, settlements around the Masai Mara NR have increased five-fold, and there are many more homesteads in the landscape.

2. The change in land tenure from communal to private ownership has resulted in the sub-division, into small parcels under individual title, of most of the former group ranches.

3. Over the past 39 years, rapid land-use changes have occurred in the Mara ecosystem, where more than 400 km$^2$ of wet season grazing pasture have been converted to agriculture.

4. Between 1977 and 2007, the Mara ecosystem's resident wildebeest population declined from 150,000 to fewer than 40,000 animals. Overall cattle numbers remained stable, with only small fluctuations caused by changes in yearly rainfall patterns. The numbers of small stock (sheep and goats) increased significantly.

5. The uncontrolled proliferation of tourist facilities within and outside the Mara NR will have severe repercussions for wildlife and habitats, interfering with wildlife movements and degrading habitats through the discharge of sewerage and waste into water sources, and other disturbances.

**C. State**

1. Wildlife movements outside the reserve are threatened by the increasing number of settlements, by competition with higher densities of livestock, and by crop cultivation.

2. The movement of wildebeest to the Loita Plains is dthe movement of elephants into Trans-mara and the Mau uplands is hindered by agricultural fields and expanding settlements (Map 7.3 and 7.4).

**D. Impacts mpacts**

1. The long-term trend shows a decline of more than 65 % in total wildlife density over the past 30 years. As

the human population continues to grow, and as land use intensifies (through agriculture and land-tenure change), the pressure on what wildlife remains will be even greater.

2. The wet season wildebeest grazing and calving areas in Loita and Ngorengore have been lost. The Lolgorian Forest, as a refuge for elephants, has also been lost.

3. Zebra numbers in the Mara ecosystem have declined, although not as steeply as the numbers of resident wildebeest. Worryingly, there has been a steep decline (85 %) in giraffe numbers since 1977. The elephant is one of the few species in the Mara to record a population increase.

4. Deforestation in the Mau Forests Complex and extraction of water from the headstreams there of the Mara River will reduce water flows to the Mara, with direct impacts on wildlife and livestock.

5. Increasing numbers of tourists and tourism facilities are putting more pressure on wildlife habitats.

**E. Response**

1. A proposed new management plan for the Masai Mara NR seeks to moderate the impacts of tourism development through enhanced infrastructure and through zoning. The development of conservancies is to be coordinated under this plan, so that management can be more efficient.

2. Individual landowners have re-consolidated their parcels and, together with private entrepreneurs, they have formed conservancies. These conservancies include Mara North, Enonkishu, Isaten, Lemek, Motorogi, Naboisho, Nashulai, Ol Kinyei, Olare Orok, Olchorro Oiroua, Olderkesi, Oloisukut, and Pardamat. Others, including Olarro North, Olarro South and Siana, have also been proposed (Maps 7.2 and 7.3).

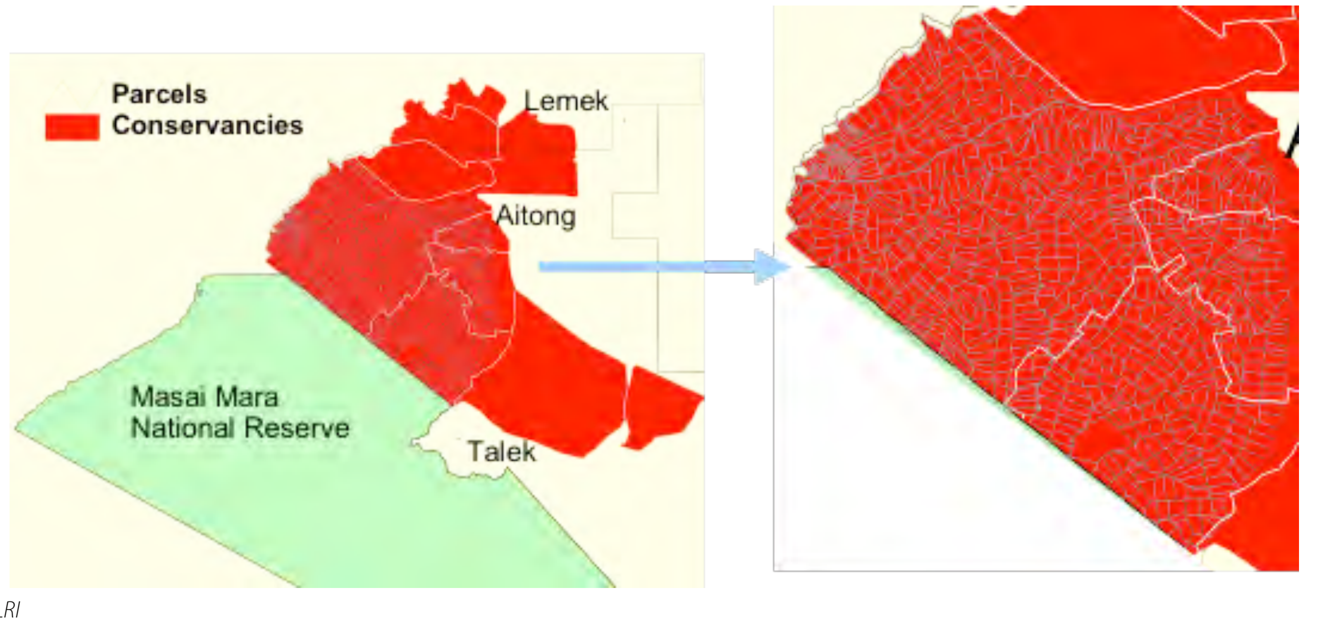
3. The owners of the conservancies lease the land to tour operators who develop and run the tourism facilities. The contiguity of conservancies helps to ensure connectivity, and increases the range over which large animals such as wildebeest, zebra, giraffe, and elephant can move. Already, there are 16 conservancies, collectively covering more than 100,000 ha. Most of these were created between 2004 and 2006 in partnerships involving the pastoralist landowners and tour oprators, however additional ones have been created to expand the area in the recent periods. On average, a family owns between 60 and 100 ha of land, which is then leased at the rate of between US$ 25 and US$ 40 per hectare.

**F. Threats to Conservation Connectivity**

1. Sub-division and fragmentation of land as the result of insecure land tenure and through land-use changes are major threats to conservation connectivity. Fences and other barriers to wildlife movement are another major constraint, along with increases in poaching and human-wildlife conflict. Uncoordinated management partnerships and actions in wildlife areas may also be a setback, along with weak implementation of policies and legislation.

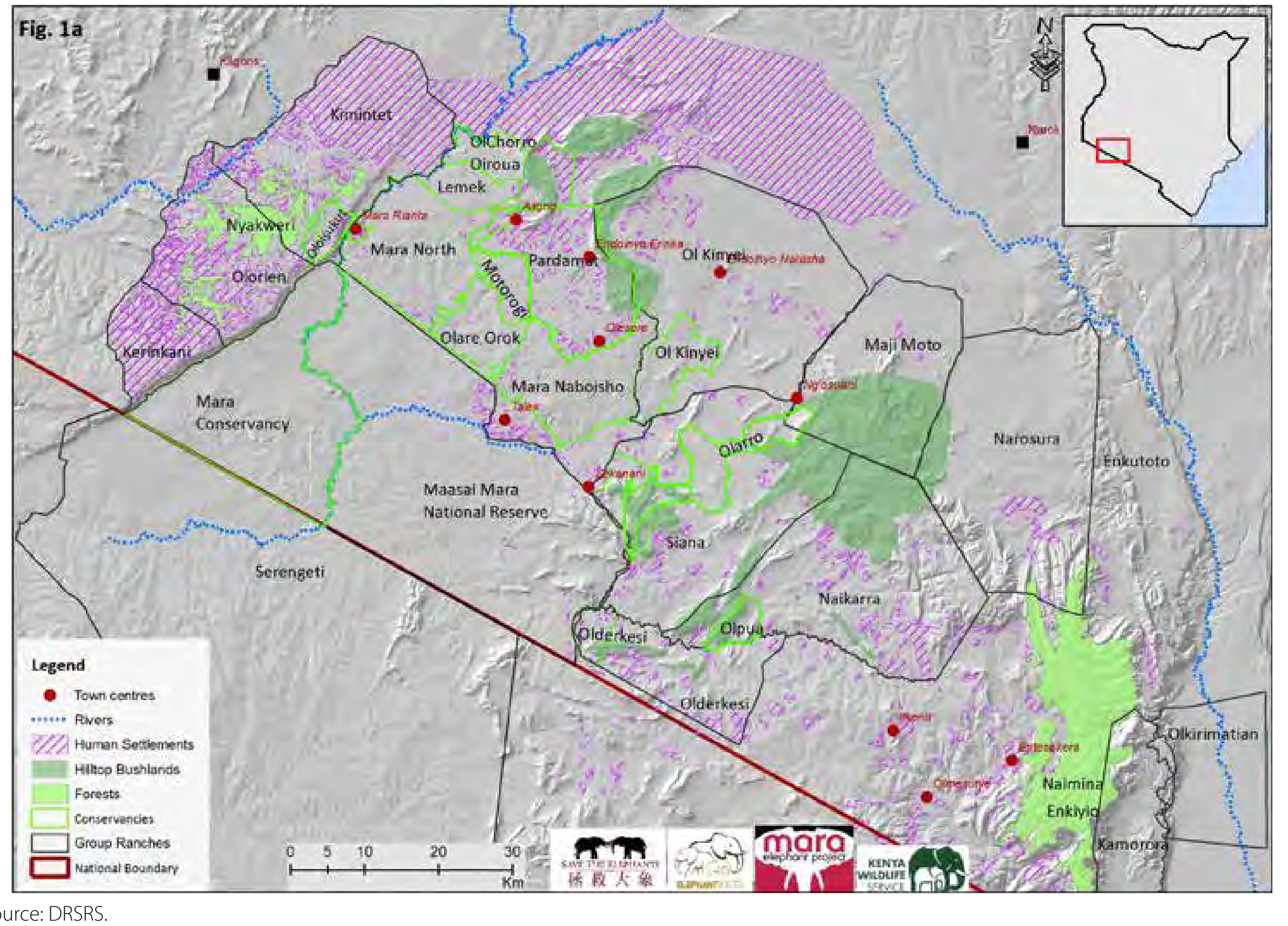
2. Forest clearing, charcoal burning, high density settlements, high livestock densities, and intensive agriculture are all obstacles to conservation connectivity in the Mara ecosystem.

**Map 7.2:** Privatization and subdivision of Koyaki group ranch to individual small land parcels.




*Source: ILRI*

**Map 7.3:** The expansion of agriculture and settlements and land sub-division are some of the major threats to habitat connectivity in wildlife dispersal areas and migratory routes/corridors in the Masai Mara ecosystem. Re-consolidation of subdivided land to create community conservancies (green boundary) in areas adjacent to the reserve has helped to increase wildlife space.

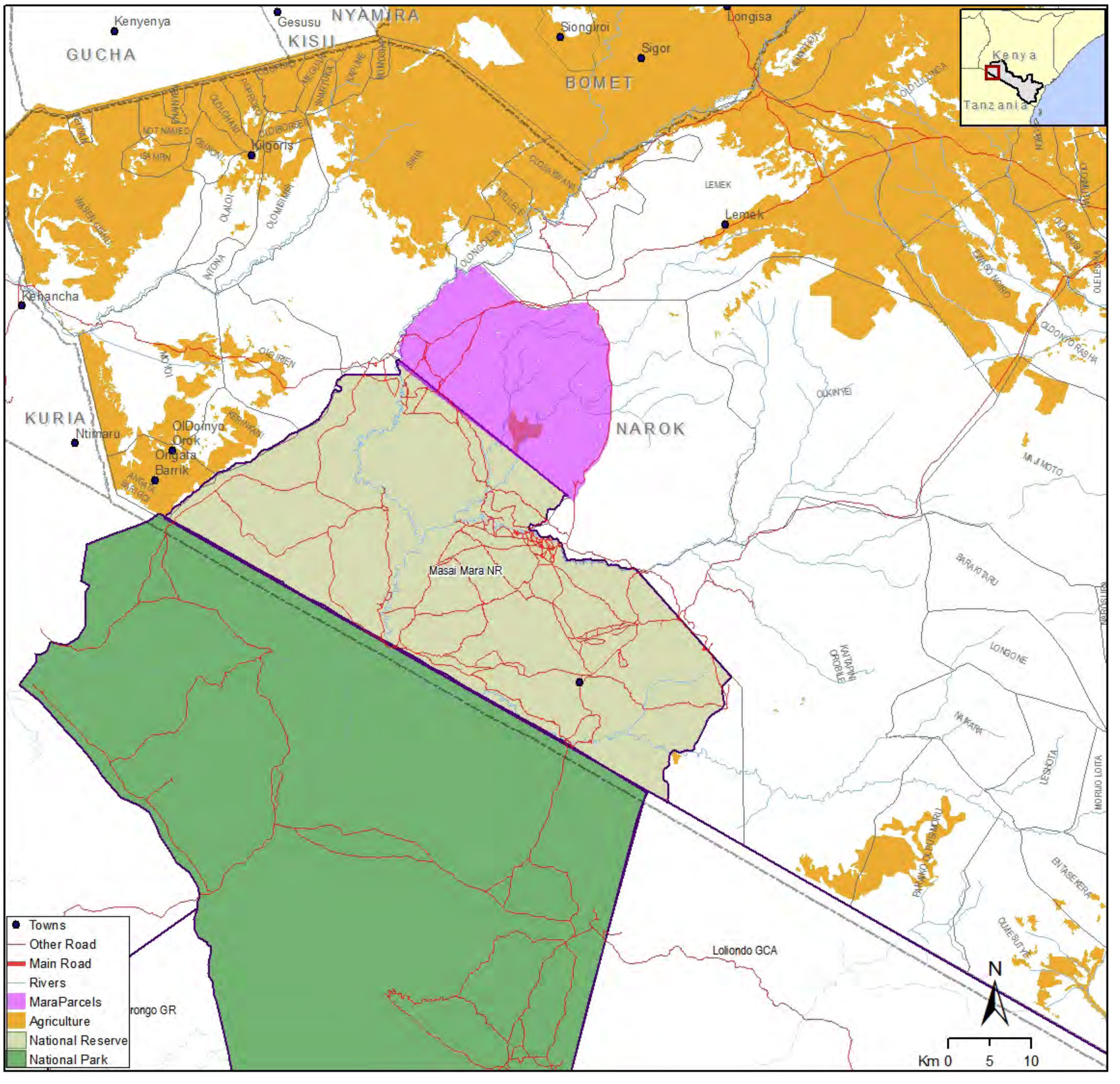



Source: DRSRS.

G. **Opportunities for Conservation Connectivity**

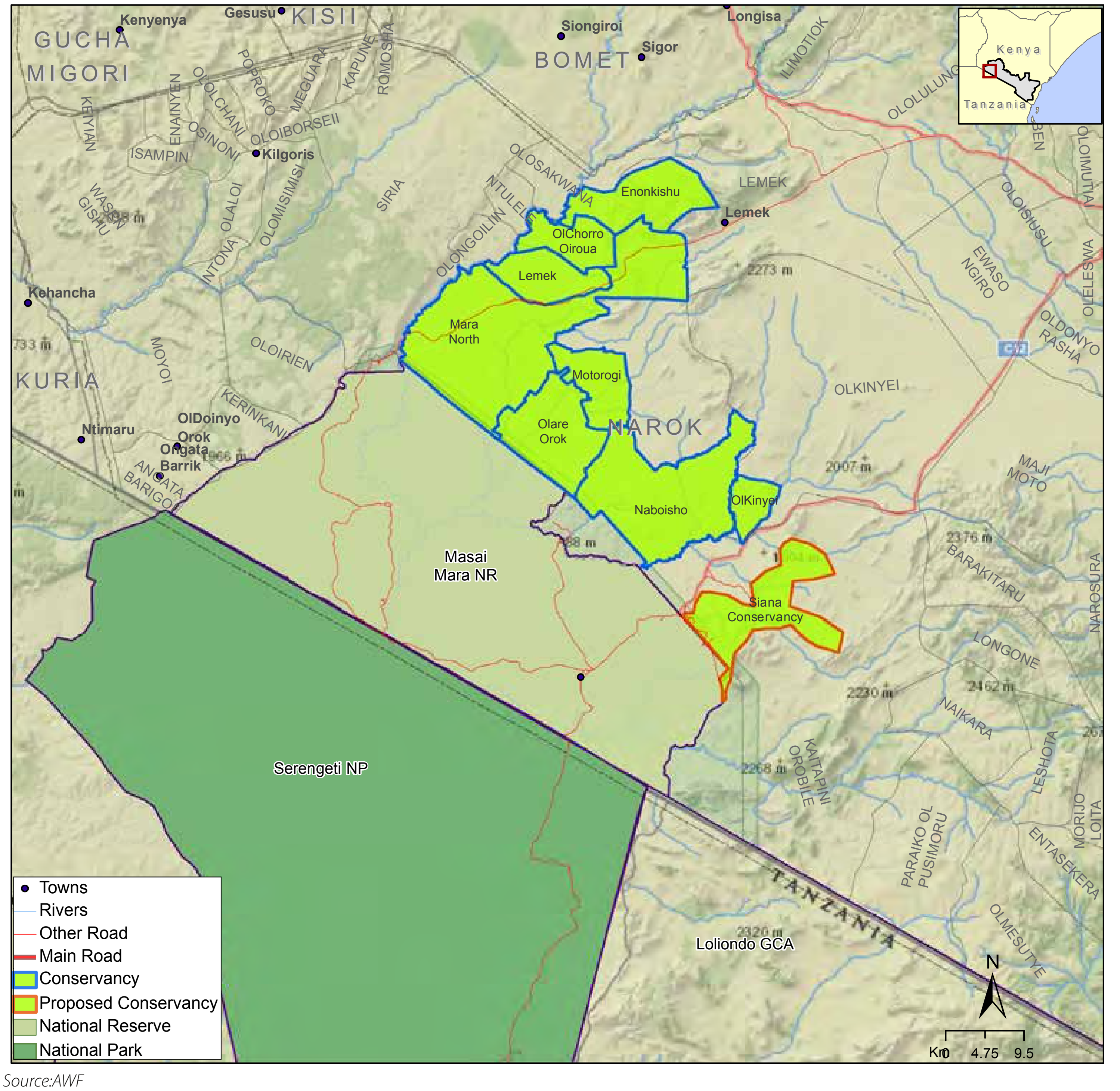
1. The area is currently experiencing an increase in eco-tourism-related enterprise development under various pro-wildlife conservation initiatives. Many families are re-consolidating their subdivided parcels of land to form community conservancies. For the MMNR, conservancies are a crucial buffer in helping to minimize conservation threats. Communities engaged in wildlife conservation receive livelihood sustenance in the form of payments for ecosystem services.
2. Eco-tourism and conservation partnerships with tour operators who lease the land are important components in helping to off-set the costs of improved livestock production and better access to markets, on which the region's economic future depends.

**Map 7.4:** Threats to wildlife migratory routes/corridors in the Masai Mara ecosystem – agriculture, land sub-division, settlements, and infrastructure developments (tourism facilities and roads).




Source: DRSRS./ILRI

**Map 7.5:** Some of the existing and proposed community conservancies around the Masai Mara National Reserve. To date, there are more conservancies created around the protected area (KWCA).

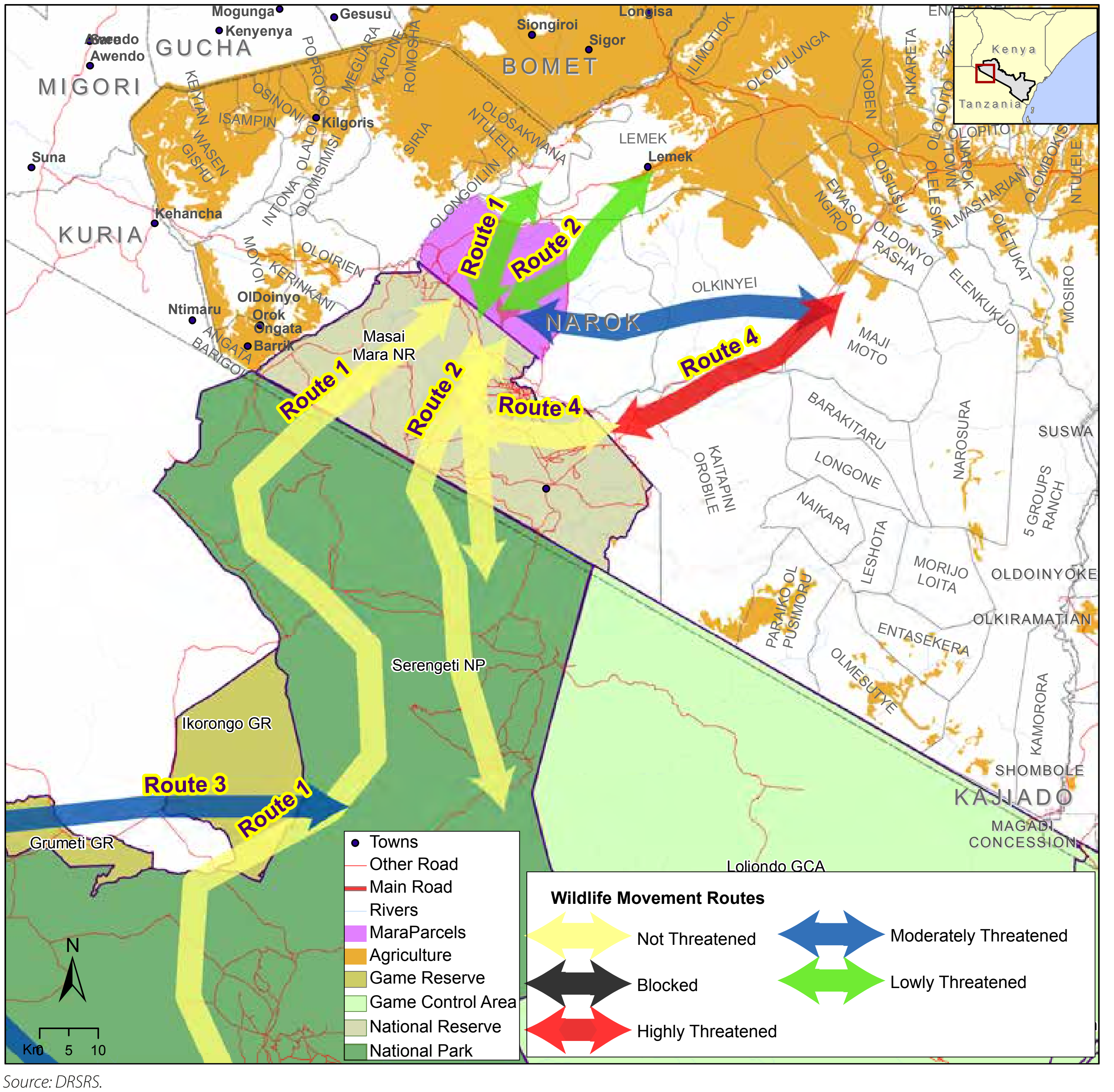



Source:AWF

## H. Wildlife Routes and Corridors

The general wildlife migratory routes identified in the northern part of the Serengeti NP and the Mara ecosystem were assigned threat levels based on wildebeest movements (Table 7.1 and Map 7.6). The Mara ecosystem connectivity report (2016) presents detailed maps based on current understanding of the salient routes used by elephants in the greater Mara ecosystem, for use in spatial planning and conservation in Narok County (Table 7.2 and Map 7.7).

**Map 7.6:** General wildlife dispersal areas and migratory routes/corridors in the Masai Mara ecosystem and surrounding areas, showing relative threat levels (read together with Table 7.1)




*Source: DRSRS.*

**Table 7.1:** Connections and linkages, threat levels and actions need in the Maasai Mara ecosystem

| Ecosystem | Routes | Threats | State | Action |
|---|---|---|---|---|
| Mara Ecosystem | 1 & 2 | | Low threats depending on the existence of conservancies | Immediate - need policy to support |
| | 3 & 4 | | Need compatible land use - low settlement and livestock numbers | Immediate - develop compatible land uses |
| | 5,6,7,8 | | No threats inside the park | Need s habitat monitoring and vegetation dynamics |
| Serengeti Ecosystem | 6,7,8 | | No threats inside the park | Low |
| | | | Intense poaching in Game Controlled Areas | High |

Legend: Non, Low, Moderate, High, Blocked

**Table 7.2:** Current land status and salient routes used by elephant and threats to their future: Corridors connecting MMNR/Mara Conservancy and the other conservancies. This table to be read alongside Map 7.7, as the route numbers are marked on the map.

| **Route Location**<br>*(Land status)* | **Current understanding of salient routes used by elephants and threats to their future** |
|---|---|
| **Route 1**<br><br>**Mara North Conservancy**<br>*(Individual titles)*<br><br>**AND**<br><br>**MMNR and Mara Conservancy**<br>(Protected National Reserve) | The southern part of Mara North Conservancy is heavily used by livestock and there is increasing settlement along its boundary with the MMNR, despite current lease agreements with Mara North. The MMNR boundary area is particularly attractive to those who wish to access the Reserve for illegal night grazing. As this area is very open habitat, its use by people and livestock during day as well as at night creates a particular barrier to elephant movement. The town of Mara Rianta also presents a formidable impediment. Elephants mainly use the following routes to move between Mara North and the MMNR:<br>a. The vegetated luggas that flow from the central part of the Conservancy and enter the MMNR near to Musiara Swamp.<br>b. The river course that marks the boundary between MNC and OOC.<br>c. Avoiding Mara Rianta by crossing into Trans-Mara between Royal Mara and Olololo.<br><br>Each of these routes requires elephants to move through human settlement and could become flash points for conflict unless some specific corridors are set aside for them to use. Ideally there should be no settlement between Mara North and the MMNR for the benefit of both wildlife and tourism. |
| **Route 2**<br><br>**Mara Naboisho Conservancy**<br>*(Individual titles)*<br><br>**AND**<br><br>**MMNR**<br>*(Protected National Reserve)* | Elephants use a number of different routes between Mara Naboisho Conservancy and MMNR, each taking them through areas of settlement. As settlement is increasing, the setting aside of a protected elephant corridor(s) is a way to prevent escalating HEC.<br>a. South-east corner of Mara Naboisho crossing the Talek River onto private land and into the reserve. Protecting the Talek River and land on either side will secure this passage.<br>b. South-east corner of Mara Naboisho following the Talek River course into MMNR by Mara Simba. This route passes through several hundred meters of unprotected land along the river course. If protected it could provide long-term passage through the current gap in settlement, as long as Mara Simba is not a major barrier to elephants.<br>c. Following the river courses and luggas in the Baar valley and then via a number of routes passing through heavy settlement around Talek. This route goes through 3-5 km of unprotected and heavily settled land and is likely to be unsustainable at the current rate of growth in Talek.<br>d. Crossing the south-western boundary of Mara Naboisho into a narrow part of Olare Orok Conservancy before descending into MMNR. There is considerable settlement in this area, and the route passes a part of Mara Naboisho that is occupied by land-owners who do not wish to be part of the Conservancy. Without intervention, this route may be unsustainable. |

*Adapted with permission from the Mara ecosystem connectivity report: Information on elephant population status and movements for spatial planning and conservation in Narok County (2016).*

**Table 7.2 (Continuation):** Current land status and salient routes used by elephant and threats to their future: Routes to connect the conservancies. This table to be read alongside Map 7.7 as the route numbers are marked on the map.

| | |
|---|---|
| **Route 3**<br><br>**Olare Orok Motorogi Conservancy**<br>*(Individual titles)*<br><br>**AND**<br><br>**Naboisho Conservancy**<br>*(Individual titles)* | The boundaries of Mara Naboisho, Olare Orok and Motorogi Conservancies abut in the north-western corner of Mara Naboisho. Elephants use this thickly vegetated area to move between the three conservancies, as it offers safety and forage. As long as the conservancies persist, this movement is likely to be secured, although there are quite a number of families that do not wish to be part of Mara Naboisho and have settled on the western plains.<br>To the north-east of this area, satellite tracking and signs of elephants indicate a couple of separate routes between Mara Naboisho and Motorogi that pass through open plains and settlement and which are used at night. These routes represent a significant potential for human-elephant conflict unless the Pardamat Conservation Area is secured and people leave a designated route open for elephants to pass. |
| **Route 4**<br>**Mara Naboisho/Ol Kinyei Conservancies**<br>*(Individual titles)*<br><br>**AND**<br><br>**Olarro Conservancy**<br>*(Individual titles)* | A main elephant route used at night between Mara Naboisho/Ol Kinyei Conservancies and Olarro Conservancy follows the Talek and Ropili Rivers. The route requires elephants to cross the main Narok-Sekenani road, which (based on individually known elephants) appears to be a barrier to the movement of elephant families, though less so for males. This critical route requires elephants to move through private land that is being fenced right down to the river's edge. *This is a vital corridor in need of urgent protection as it links the western conservancies to Siana, Olarro and the Loita Hills and is being rapidly settled.* The vehicle track that once linked these conservancies is now closed by fencing. |
| **Route 5**<br>**Mara Naboisho Conservancy**<br>*Individual titles*<br><br>**AND**<br><br>**Siana Conservancy**<br>*(Individual titles)* | This route crosses the Talek River from the south-eastern side of Mara Naboisho and follows several different luggas across private land and the Olmeroi River crossing the Narok-Sekenani road in the vicinity of Sekenani. The use of this route can be seen via satellite tracking, though most tracks stop before the main road. Signs of elephant along the road, however, indicate that elephant do cross into Siana. The main road is already a partial barrier to movement of elephant families and the route is at risk, depending upon how settlement is controlled in the vicinity of Sekenani and the AA Camp. If movement is to be sustained, the AA Camp could be approached to support the protection of a corridor for elephant movement. |
| **Route 6**<br><br>**Ol Kinyei Conservancy**<br>*(Individual titles)*<br><br>**AND**<br><br>**Olarro Conservancy**<br>*(Individual titles)* | Between Ol Kinyei and Olarro Conservancies elephants follow several primary routes.<br>a. Follow the Ropili River (see Corridor 4 above) into Olarro and then the Losoitik, Parakitabu, Lentiangasir Rivers into Loita Hills.<br>b. Leave Ol Kinyei Conservancy south of the Olare Lemuny salt licks, following the Shangalera River east and then go north of Endoinyo Namankewon and into Olarro Conservancy by a variety of paths, some south, others north of Ngosuani centre.<br>c. From Olare Lemuny to Ormuntorobi Hill south of Ngosuani centre. In this area land is being rapidly settled. All of these routes must cross the main Narok-Sekenani road, which is already a partial barrier to elephant family groups and is due to be paved. |
| **Route 7**<br>**Siana Conservancy**<br>*(Individual titles)*<br>**AND**<br>**Olarro Conservancy**<br>*(Individual titles)* | The recent extension of Olarro Conservancy forms a critical link to securing the passage of elephants between the core Mara population and the Loita Hills. However, until Siana Conservancy is formalised, and corridors (Routes 2, 4, 5 and 6) connecting the conservancies west of the Narok Sekenani road, secured, the movement of elephants will be in jeopardy. |

*Adapted with permission from the Mara ecosystem connectivity report: Information on elephant population status and movements for spatial planning and conservation in Narok County (2016).*

**Table 7.2 (Continuation):** Current land status and salient routes used by elephant and threats to their future: Routes to connect the conservancies and critical uproteced habitats. This table to be read alongside Map 7.7, as the route numbers are marked on the map.

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| **Route 8**<br>**Mara Naboisho/Ol Kinyei Conservancies**<br>*(Individual titles)*<br><br>**AND**<br><br>**Pardamat Hills**<br>*(Individual titles)* | Elephant movement between Mara Naboisho/Ol Kinyei Conservancies and the Pardamat Hills has been documented by satellite tracking as well as by observations of elephants, their signs, and interviews with people. The movement follows two routes that need to be protected:<br>a. The eastern route follows Osepukie River (boundary between Mara Naboisho and Ol Kinyei Conservancies), with movement through settlement occurring at night.<br>b. The western route is used at night and follows the lugga that forms the boundary between Mara Naboisho and the Olesere community.<br>The long neck of Mara Naboisho stretching northward to the Pardamat Hills is key to the sustained movement of elephants, but settlement is rapidly developing at the base of the hills and to the north and west of Mara Naboisho, including many fences. High levels of poaching in this area also need addressing. The creation of the Pardamat Conservation Area should help to secure this movement, although its success will depend upon the level of fencing and settlement, while the narrow passage at the northern end of Mara Naboisho will need special attention. |
| **Route 9**<br>**Motorogi Conservancy**<br>*(Individual titles)*<br><br>**AND**<br><br>**Endonyo Erinka, Pardamat Hills**<br>*(Individual titles)* | The movement between Motorogi and the Pardamat Hills can be clearly seen on the tracking map (Figure 1b). Elephants follow the main drainages that flow westward from Endoinyo Erinka and the Pardamat Hills across the plains and the Aitong-Talek road and into the eastern side of Motorogi. These drainages cross open and settled plains and elephant movement across this area typically occurs at night. This part of the ecosystem is changing rapidly with increasing livestock, settlement and fencing.<br>To ensure the connectivity of these habitats and to avoid human-elephant conflict, provision of a corridor for elephants and other wildlife to move through is critical. The creation of the Pardamat Conservation Area may help, but to avoid escalating conflict a dedicated route should be set aside free of settlement. |
| **Route 10**<br>**Mara North Conservancy**<br>*(Individual titles)*<br>**AND**<br>**Lemek Hills**<br>*(Individual titles)* | Elephants move between the northern Mara North Conservancy and the Lemek Hills following the watercourse that flows from the Lemek Hills past Aitong and into Mara North Conservancy as can be seen on Figure 1b. In recent years, settlement around Aitong has increased dramatically. Fencing is now taking place right up to the banks of the watercourse. The result is that elephants must pass through dense human settlement, causing frequent conflict. Further study of this area is recommended to determine how best to solve the problem, if it is not already too late. |
| **Route 11**<br>**Ol Kinyei Conservancy**<br>*(Individual titles)*<br>**AND**<br>**Maji Moto Salt Licks**<br>*(Individual titles)* | Elephants move between Ol Kinyei Conservancy near the Olare Lemuny salt lick following the lugga north towards Oldoinyo Narasha. Little data is available on this route (from signs and a couple of satellite tracked individuals - see Figure 1b.), but elephants seem follow watercourses where there is forage and cover and travel at night. The Maji Moto salt licks and the Loita Hills are an important destination for elephants. More information about this movement is required to know how best to protect elephants and to contain and reduce conflict. |
| **Route 12**<br>**Siana/Olarro Conservancies**<br><br>**AND**<br>**Maji Moto/Narosura**<br>*(In process of subdivision)* | Very little data exist in this area, but satellite tracked individuals, elephant signs and conversations with people indicate that they travel over the Loita Hills following river valleys and luggas toward the Maji Moto and Narosura salt licks. Collared elephants using this area go to a particular spot north east of Narosura, where there are salt licks. More research is required to understand the value of this area to elephants. If more elephants in the east were collared, significantly more movement along this route might be noticed. The risk of losing movement/increased human-elephant conflict depends on the rate of settlement on the slopes and tops of the Loita Hills. |

*Adapted with permission from the Mara ecosystem connectivity report: Information on elephant population status and movements for spatial planning and conservation in Narok County (2016).*

**Table 7.2 (Continuation):** Current land status and salient routes used by elephant and threats to their future: Routes to connect critical unprotected forests with the Greater Mara Ecosystem and populations further east. This table to be read alongside Map 7.7, as the route numbers are marked on the map.

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| ***Route 13***<br><br>***Mara Conservancy*** *(Protected National Reserve)* ***/Mara North Conservancy*** *(Individual titles)*<br><br>***AND***<br><br>***Nyakweri Forest, Forest Fragments and greater escarpment*** *(In the process of sub-division to individual titles)* | Elephants use 20+ defined pathways to move up and down the Siria Escarpment to the Nyakweri Forest and forest fragments beyond, as well as to raid crops. These pathways have been mapped and their use by elephants monitored by Lydia Tiller. Elephants travel up the escarpment to access browse and other important resources such as salt licks. The pathways themselves contain forest habitat and provide important areas of browse for elephants, particularly as Mara Conservancy is primarily grassland. Movement tracked via satellite collars is illustrated in Figure 1b. As can be seen from these data, elephant movement is focused on the remaining forest patches, and they move only relatively rarely beyond the escarpment pathways in Kerinkani (closest to the Tanzanian border) that lead to farms.<br><br>Land in Transmara is heavily settled and habitat is undergoing intense transformation through charcoal burning, agriculture and settlement. The Nyakweri, Mugor and Laila forests have been steadily cleared and settled, and the remaining forest is highly fragmented. Forest patches are surrounded by farms, which tempt elephants to raid crops, leading to human-elephant conflict. Sub-division of the Nyakweri Forest was recently halted, and it has been proposed as a conservancy. Charcoal burning, however, is continuing unabated and urgent measures are required to protect this forest as a water tower and for biodiversity. We recommend that a management plan be developed for this area to highlight forest conservation and human-elephant conflict mitigation strategies. |
| ***Route 14***<br><br>***Maasai Mara National Reserve*** *(Protected National Reserve)*<br><br>***AND***<br><br>***Naimina Enkiyio Forest*** *(Community forest)* | Elephants use several routes between the MMNR/Olderikesi Conservancy and the Naimina Enkiyio Forest. Each passes through Olpua, which has recently been proposed as a conservancy. Since the sub-division process some 100 plots encompassing 2,500-3,000 ha have been set aside as a core area for this conservancy, with additional plots expected to be incorporated in due course.<br><br>a. The northern route follows the Sand River valley and flanking hills to the east, curving north-east after Olpua, past the salt licks at the base of Olopilukunya and the dam at Ilkerin, and then heading south, passing to the north of Baata village and joining the southern route north of Olmesutye.<br>b. The southern route branches away from the Sand River after Olpua and heads south-east across the Ilkerin plains, passing south of Baata village and then following either the Olosirami or Olmesutye Rivers (north or south of Olmesutye) to the Olkeju Arus River and salt licks. Here the route angles sharply north-east up a narrow spit of forest following the Enkare Nanyukie River into the Naimina Enkiyio Forest. This migration path is an ancient route used by elephants covering a distance of 70 km (as the crow flies) of unprotected land, most of which is in the process of sub-division and rapid settlement. This route is absolutely critical to sustain connectivity between the Mara elephants and elephant populations to the east.<br>c. A third branch of this migration route (b) follows the Olosirami and Olaragai Rivers into the forest near to Entesekera.<br>d. A fourth route branches off the Olosirami and follows the Olaragai and then Kiloni Rivers.<br><br>Use of these routes has been curtailed in recent years by severe poaching activity and increasing settlement. With poaching in decline and the development of Olpua as a conservancy, it is expected that the migration of elephants will be restored. Naikarra and Olderikesi Group Ranches are in the process of subdivision. Naikarra distributed title deeds in May 2015 and has subdivided the entire group ranch to 30-acre plots running from the bottom to the top of hills. Only 30 meters on either side of rivers is secured. They are to be commended, however, for setting aside Olpua Conservancy, as this is a critical habitat for elephants and will provide a key link for this route. Olderikesi intends to follow the same sub-division plan. Loita has not yet begun the adjudication process, but individuals are laying claim to plots by cutting down forest in anticipation of sub-division. A number of these plots cut across the routes used by elephants. Both Olmesutye and Tiamenangen villages are discussing how to protect the corridor to permit the passage of elephants and their use of the salt licks, but local disagreements and political wrangling threaten to derail any conservation initiative. |

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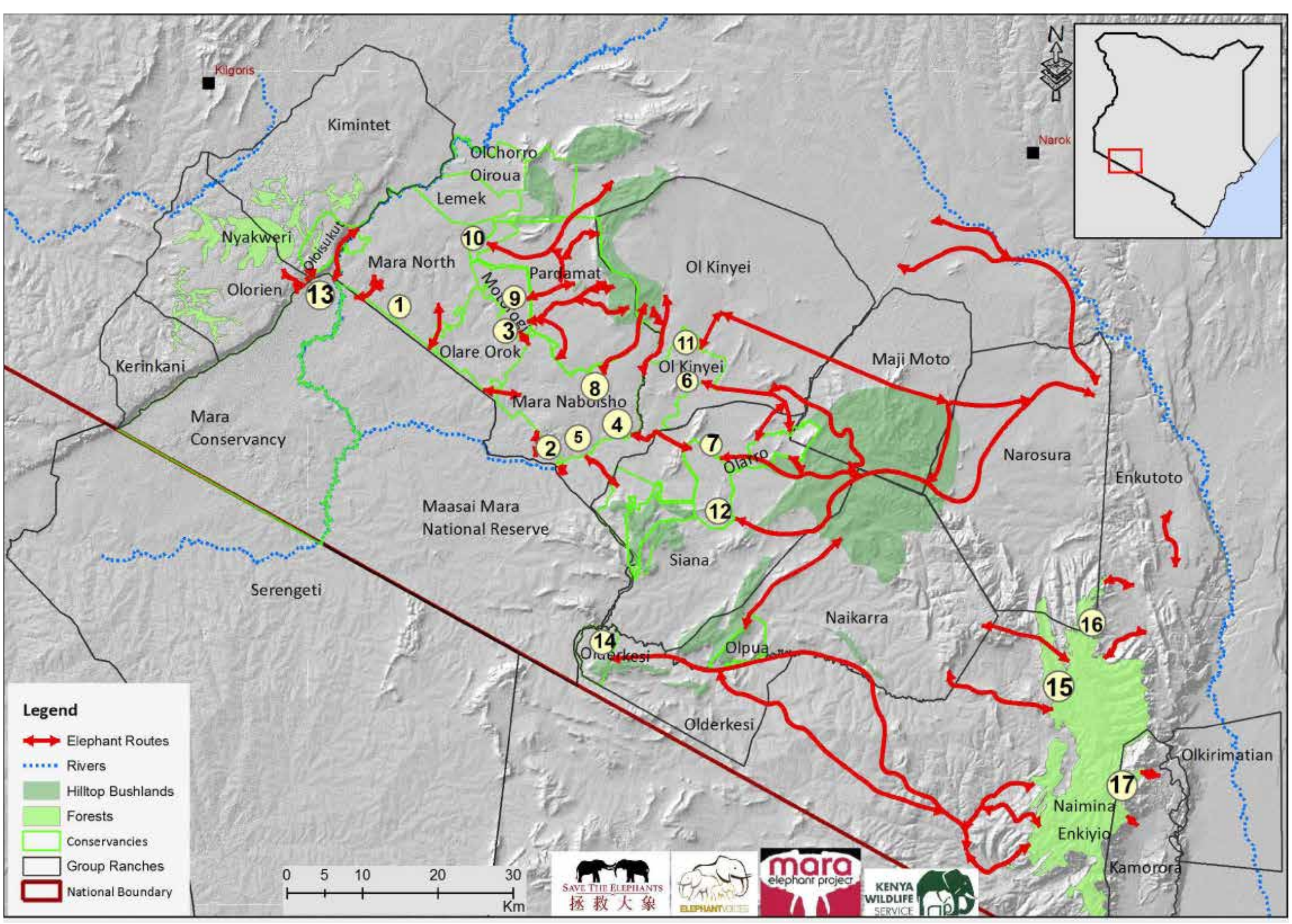
| **Route 15**<br><br>**Naimina Enkiyio Oln'garua**<br>*(Under consideration)*<br><br>**AND**<br><br>**Loita Hills**<br>(*In the process of sub-division)* | A route once used by elephants joins the Naimina Enkiyio Forest and the Loita Hills around Oln'garua. In 2014, people interviewed in Leshuta stated that they had not seen elephants for some years, yet in April 2015 a group of 50 elephants was sighted near Oloitokito, Oln'garua, and residents claimed they had come from the Mara via Emorogi Hill. It may be that this route was temporarily abandoned due to the high levels of poaching and may now be in use again. Elders note that elephants once also moved north-west from Inkonyiek Ekanunka across the escarpment to Olemegili Hill. More research is needed to understand the routes that are used to cross the Loita Hills and across to Olarro, and how these routes may be linked with the presence of elephants around Naikarra town, where human-elephant conflicts occurs; or whether elephants are following the Sand River north-east and crossing to Naimina Enkiyio via Emorogi Hill. |
| **Route 16**<br><br>**Naimina Enkiyio**<br>(*Community forest)*<br><br>**AND**<br><br>**Elangata Enderit** | Signs of elephants and interviews with people indicate that elephants move across the Naimina Enkiyio Forest through Enkutoto to Elangata Enderit. The northern part of the forest is the best conserved area, with the highest presence of elephants and the least occurence of human activities. This is an area that requires further study, especially as to the health of the elephant population following the extreme levels of poaching here in recent times, and the connectivity of this route to the Mara via the Loita Hills and/or Maji Moto. There is ongoing resource assessment of this section of the forest by the Olkonyil Association. |
| **Route 17**<br>**Naimina Enkiyio**<br>(*Community forest)*<br><br>**AND**<br>**Kamorora/ Olkirama-en/Shompole** | Based on earlier satellite tracking by the African Conservation Centre (ACC; see Figure 1b), and based on recorded elephant signs and discussions with local people, elephants are known to use two main routes to move up and down the Nguruman escarpment from the Naimina Enkiyio Forest to the Kamorora/Olkiramatien Group Ranch/Shompole Conservancy in Kajiado County. Elephants took refuge in Kamorora during the heavy poaching of recent years in the Naimina Enkiyio Forest. In the last year, however, there has been a great influx of livestock to Kamorora, and elephants have apparently moved back into the Forest and across to Shompole Conservancy. |

*Adapted with permission from the Mara ecosystem connectivity report: Information on elephant population status and movements for spatial planning and conservation in Narok County (2016).*

**Map 7.7:** Salient routes used by elephants in the Mara ecosystem and the Naimina Enkiyio Forest. Courtesy: ElephantVoices (Joyce Poole & Petter Granli); Save The Elephants (Benson Okita-Ouma, David Kimanzi, & Iain Douglas-Hamilton); Mara Elephant Project (Marc Goss); DICE, University of Kent (Lydia Tiller); and Kenya Wildlife Service (Sospeter Kiambi).



## I. Priority Actions and Recommendations

Most of the large mammals, and elephants especially, are highly intelligent social animals, which are acutely aware of and sensitive to anthropogenic activities. They respond to changes in human activities by making adjustments in their movements (speed, time of day or night, location), and their habitat use and/or grouping patterns, as well as behaviour (becoming more or less aggressive towards people).

The Mara ecosystem connectivity report (2016) proposes five priority actions and several additional recommendations, given the uncertain plight of elephants and of wildlife in general in the Mara region. How wildlife responds to changing human activities may have long-term knock-on effects, which may be either beneficial or detrimental to habitats and/or human livelihoods. The importance of elephants and of other wild species, the critical role they play in sustaining biodiversity, their value both culturally and economically, their vulnerability, and their effects on people and livelihoods have contributed to the identification of the following priority actions.

i. The halting of development activity within all critical conservation and migratory routes, and the establishment of protected corridors (as identified in Map 7.7, and described in Table 7.2), designed to sustain biodiversity and to minimize human-wildlife conflict. Legal and economic instruments should be used, in consultation with the local communities and landowners.

ii. Suspension of further sub-division of land and issuance of title deeds until the ongoing spatial planning process is completed and approved.

iii. Encouragement of watershed management, and rehabilitation of the Mau catchments, through carbon credit payment mechanisms. It is crucial that the Mau Forests Complex is secured and restored, if wildlife is to be able to continue to flourish in the Mara-Serengeti ecosystem (both areas depend on the Mau catchments for the survival of the Mara River). Destructive activities in the Mau forests, such as logging, charcoal burning, and settlement, should be halted, as well as in the forests of Naimina Enkiyio, Nyakweri, Mugor, and Laila, in order to protect critical water towers, biodiversity, and dry season grazing areas, while minimizing human-wildlife conflict.

iv. Sustainable management of livestock grazing in the MMNR and in the community conservancies, so that wildlife is not negatively impacted.

v. Equitable and transparent sharing of benefits from the MMNR, so as to improve livelihoods and mitigate human-wildlife conflict among the communities hosting wildlife in the Mara region.

## J. Additional Policy Recommendations: Sustaining Conservancies

The survival of the MMNR and the entire Mara ecosystem is dependent on the success of recently created community conservancies. Narok County should therefore contribute financially to the long-term sustainability of conservancies in the ecosystem, acknowledging that downturns in tourism can threaten their existence. Establishing a collaborative, predictable and transparent relationship between the government of Narok County, the MMNR and the conservancies will inspire governments, NGOs and other potential development donors to contribute towards ecosystem sustainability, the purchase or lease of wildlife habitat, and the development of local Mara communities and amenities.

i. Encourage communities to form conservancies through public-private partnerships as an alternative land-use where appropriate (areas perceived as corridors and which ensure contiguity of wildlife habitats) and economically viable. While policy governing the creation of community conservancies is still lacking, amendments to the Wildlife Bill (2013) are expected to address this and will encourage the management of wildlife outside protected areas.

ii. Improve wildlife conservation and management, so the rapid declines in wildlife numbers and wildlife habitats in Narok County can be stopped.

iii. Establish a Mara Wildlife Task Force to address existing and potential future threats to wildlife. Such a task force would consist of representatives from the County, the KWS, the MMWCA and other conservation NGOs working in the Mara region.

iv. Ensure that wildlife monitoring, research and data sharing is coordinated, in a fully collaborative process involving KWS, the County administration, the MMWCA, and NGOs/researchers.

v. Ensure that wildlife crime law is enforced through proactive collaboration involving KWS, the County administration, the MMWCA, NGOs, the police, the judiciary, and the local communities.

vi. Improve cross-border collaboration with Tanzania over the management of the Mara-Serengeti elephant, wildebeest, and zebra populations.

**K. Spatial Planning for Ecosystem Connectivity and Human-Wildlife Conflict Mitigation**

Encroachment by humans is one of the primary drivers of wildlife conflict. Levels of human-wildlife conflict in Narok County are among the highest in Kenya (KWS, 2010). Where wildlife is properly conserved and managed, however, it can be of benefit to human livelihoods.

i. *Management planning*: Revisions to Narok County's overall spatial plan are urgently needed. In particular, the plan needs to define the areas that are to be used as community conservancies, protected as forests or as other natural habitats, or set aside for livestock grazing or as other multiple-use zones that wildlife can also inhabit.

ii. *Establish zones that keep people and wildlife as separate as possible*: Zoning is important in ensuring that competition and conflict between people and wildlife can be minimized. Villages and towns (with amenities such as running water, schools, health facilities, and woodlots) and settlements and agricultural areas should, as far as possible, be set apart from wildlife habitats; with more open zones reserved for other land uses (such as livestock production and wildlife conservation).

iii. *Prioritize mapped wildlife routes between core habitats*: Connectivity between protected areas and conservancies, forests, and other key wildlife habitats should be sustained through the establishment of clearly defined corridors for elephants and other wildlife species, particularly along rivers, seasonal watercourses, and luggas.

iv. *Encourage and pursue ways of securing land for wildlife*: Ways of avoiding settlement, fences and farms along, or in the vicinity of, wildlife corridors should be actively explored. Mechanisms might include the Compulsory Acquisitions Act; the purchase or lease of land for conservation; the negotiation of easements; the setting of caveats on title deeds; the offer of incentives (such as payments for ecosystem services and for carbon sequestration, and of opportunity costs for not engaging in alternative land-uses), or disincentives (such as ineligibility for compensation), as well as endowment funds, and tax rebates.

v. *Protection of critical waterways*: Strict legislation should be introduced, prohibiting settlement, fencing and farming within 30 meters of springs and rivers, seasonal watercourses, and luggas, as these courseways hold key natural resources and are also vital for the movement of wildlife.

vi. *Alleviate current human-wildlife conflict hotspots*: Pathways should be established for elephants and other wildlife species in areas where they can persist. But, in areas where wildlife has no future, denser but better-planned human settlements should be encouraged.

vii. *Lands critical for the long-term survival of species*: Options for securing migration routes and and dispersal areas that are critical to the long-term survival of elephants and other wildlife species should be vigorously pursued.

## 7.3. Greater Lakes Nakuru, Elementaita, Naivasha and Eburu Forest Ecosystem

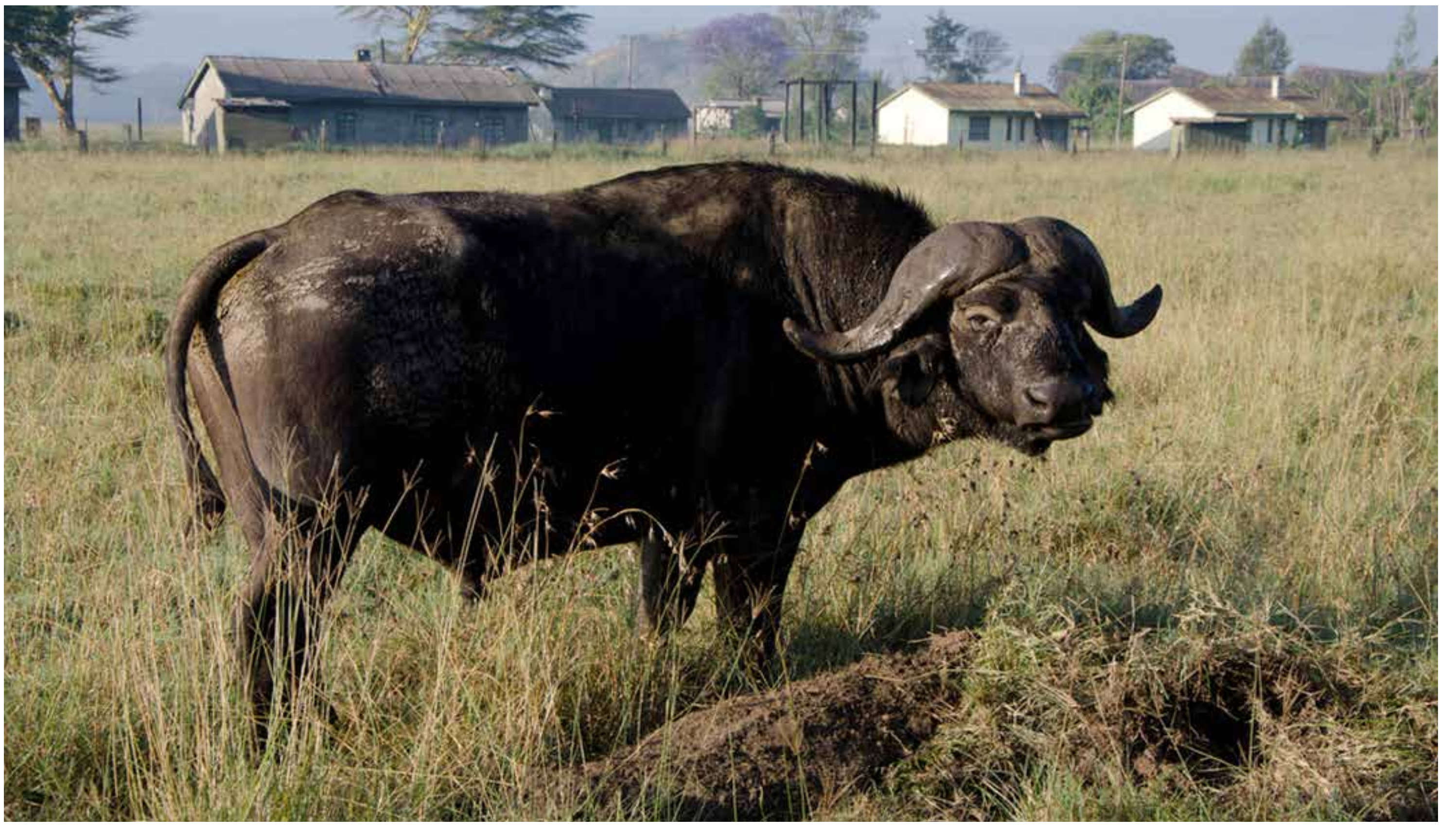
### Introduction

The greater ecosystem and conservation area refers to land occupied by the Lake Nakuru NP, the alkaline Lake Elementaita, and the riparian lands between these lake systems and their fringing *Acacia* woodlands, and the shallow freshwater Lake Naivasha and its fringing *Acacia* woodland. In the north, this area encompasses public land, forests, private wildlife sanctuaries, and ranches, all with a substantial wildlife presence. Wildlife-rich areas include Marula, KARI, Loldia, the Eburu Forest Reserve, Kekopey, Ututu, and the Soysambu Conservancy. West of the Eburu Forest is the large Mau Forests Complex, an area of immense conservation value, being one of the country's vital water towers. The southern portion of the ecosystem includes the Mt Longonot NP, Kedong ranch, the Hell's Gate NP, Oserian, Crater Lake, Hippo Point, and Mundui.

The rest of the area is occupied by mixed-community smallholdings under varying uses. Historically, livestock ranching was the dominant land use, but recently much of the land has been subdivided and converted to mixed-ranching (livestock/wildlife) and/or agriculture. The owners of many of the smallholdings in the Kekopey area are absentees, mainly because the harsh environment cannot support viable livestock production and/or sustain agriculture.

Lake Naivasha is a major source of water for an increasing human population and for proliferating agribusiness ventures and other industries. A variety of critical wildlife habitats are found in the region. Lakes Nakuru and Elementaita are important breeding sites for flamingos and pelicans. The Eburu Forest harbours numerous wildlife species, including one of only a few remaining wild populations of the critically endangered eastern, or mountain, bongo antelope. The area is a prime destination for tourists, and boasts a growing number of tourism-

**Plate 7.4:** African buffalo near a landowner's staff quarters in Kenya. *Photo: courtesy AWF*



related enterprises. Uncontrolled and uncoordinated infrastructure growth, though, is a threat to sustainable development in the area.

## The State of Conservation Connectivity

### A Drivers

1. The 2009 population census found there to be 1,187,039 people living in Nakuru County, with a growth rate of 3.4 % (against a national rate of 2.2 %). This has created a soaring demand for agricultural land and for space on which to build settlements and residential houses.

2. Insecurity of land tenure has led the owners of some large tracts to subdivide and sell small parcels of land to individual title holders. Sub-division of land in some places, and the expansion of agriculture (the horticulture industry especially) and soda ash mining in others, has led to the fragmentation of habitats and to increased fencing.

3. Improved infrastructure and establishment of new industries have resulted in the rapid growth of towns and settlements along this stretch of the main Nairobi-Nakuru highway.

4. Climate change is expected to cause a slight decrease in annual rainfall (-100mm), to increase the frequency and severity of droughts (often at the expense of the long rains), and to increase maximum temperatures by about 1.1oC and minimum temperatures by about 0.5oC. Rainfall will become unpredictable, which may affect water resources, with potentially severe impacts on agricultural activities in the region.

### B Pressures

1. An increasing human population, urbanization, industrialization (thermal energy generation and salt mining), rain-fed crop cultivation, irrigated horticulture, and fences.

2. Over the past two decades, rapid land-use changes have resulted in agricultural encroachment on natural habitats, deforestation, over-grazing, logging, and the burning of charcoal.

### C State

1. Environmental factors, including limited access to fresh water (except in Lake Naivasha), are such that the scope for large-scale agriculture across much of the region is limited. Potential economic developments include livestock production, eco-tourism, and conservation off-sets through land leases, game ranching, and payments for ecosystem services (PES).

2. Local communities are heavily reliant on the Eburu Forest Reserve for dry season livestock grazing, as well as for the collection of medicinal plants, firewood extraction, charcoal burning, the supply of thatching materials, and honey gathering. Accidental fires, often caused by honey gatherers, are common, and are one of the major threats to the forest.

**D. Impacts**

1. Wildlife populations have declined throughout the ecosystem, due to land degradation, bush-meat poaching, and overgrazing.

2. Forests and woodlands are being eliminated by increasing logging for timber and extraction of construction materials, and through charcoal burning.

3. Illegal water abstraction for horticulture irrigation and flower farming has adversely affected the hydrological functions of the lake system.

4. The lake system and the Eburu Forest Reserve are increasingly being isolated and surrounded by agricultural activities and settlements.

**E. Response**

1. The area is experiencing increasing development of eco-tourism enterprises, but traditional livestock ranching and facets of agriculture still predominate.

2. The construction of the fence around the Eburu Forest Reserve is one part of the conservation effort. Other components include initiatives to raise conservation awareness among local communities with a view to improving livelihoods and reducing dependence on forest products and resources.

3. Landowners and private enterprises are engaged in operating conservancies (e.g. Soysambu, Kigio, Kongoni, and Marula) and game sanctuaries (Ututu, Soysambu), or in participatory land-use planning through the development of co-management strategies (ADC Dabibi, Eburu Forest Reserve).

4. A draft land-use plan for Reducing Emissions from Deforestation and Forest Degradation (REDD) has already been developed for the Eburu Forest Reserve.

5. Communities have increased the use of mechanisms through which they can benefit from the presence of wildlife on their properties through Payments for Environmental Services (PES).

**F. Threats to Conservation Connectivity**

1. The sub-division and fragmentation of land as the result of insecure land tenure and through land-use changes are major threats to conservation connectivity. Fences and other barriers to wildlife movement are another major constraint, along with increases in poaching activity, illegal off-take for the bush-meat trade, and human-wildlife conflict. Inadequate incentives for conservation and uncoordinated management partnerships and actions in wildlife areas may also be a setback, along with weak implementation of policies and legislation.

2. In the 1990s, uncontrolled charcoal burning destroyed the original vegetation around the edges of the Eburu Forest, leading to secondary invasions by weeds from the surrounding farmlands. Charcoal burning has also resulted in the loss of native *Juniperus* (pencil cedar) trees from the Ututu area.

3. The continuing expansion of agriculture threatens many wildlife corridors, particularly through the Kedong ranch between the Mt. Longonot and Hell's Gate NPs.

**G. Opportunities to Conservation Connectivity**

1. The area is currently experiencing an increase in eco-tourism-related enterprise development under a variety of wildlife conservation initiatives.

2. Sustainable eco-tourism and conservation off-sets through land leases for game ranching and payments for ecosystem services are helping, in tandem with improved livestock production and better access to markets, to facilitate economic growth in the area.

**H. Wildlife Routes and Corridors**

1. Land uses within the Greater Lake Naivasha, Elementaita, Nakuru and Eburu Forest Ecosystem were mapped, and wildlife routes and corridors were identified, based on recorded animal movements and on consultation with experts and conservation stakeholders (Map 7.8; KWS, 2013). The Soysambu Conservancy plays a critical connecting role in allowing animals to move between the Lake Nakuru NP, Lake Elementaita, the Eburu Forest, and Lake Naivasha. The Kedong dispersal area in the south is critical in sustaining wildlife movements between the Hell's Gate and Mt. Longonot NPs.

**I. Recommendations**

**1. High Priority Action**

a. Develop and implement land-use master plans for specific areas. Tracts of land that are unsuitable for crop production can be utilized for wildlife conservation and other compatible land uses.

b. Secure the corridor linking the Hell's Gate NP, via Oserian, to Lake Naivasha through easement or purchase of the land.

c. Gazettement of Lake Naivasha as a national reserve, and of the Gorge in Hell's Gate as a national monument, might enhance tourism.

**Map 7.8:** Land use and existing/proposed wildlife routes and corridors in the wider Lakes Naivasha, Elementaita, Nakuru and Eburu Forest Ecosystem. To be read together with Table 7.3.

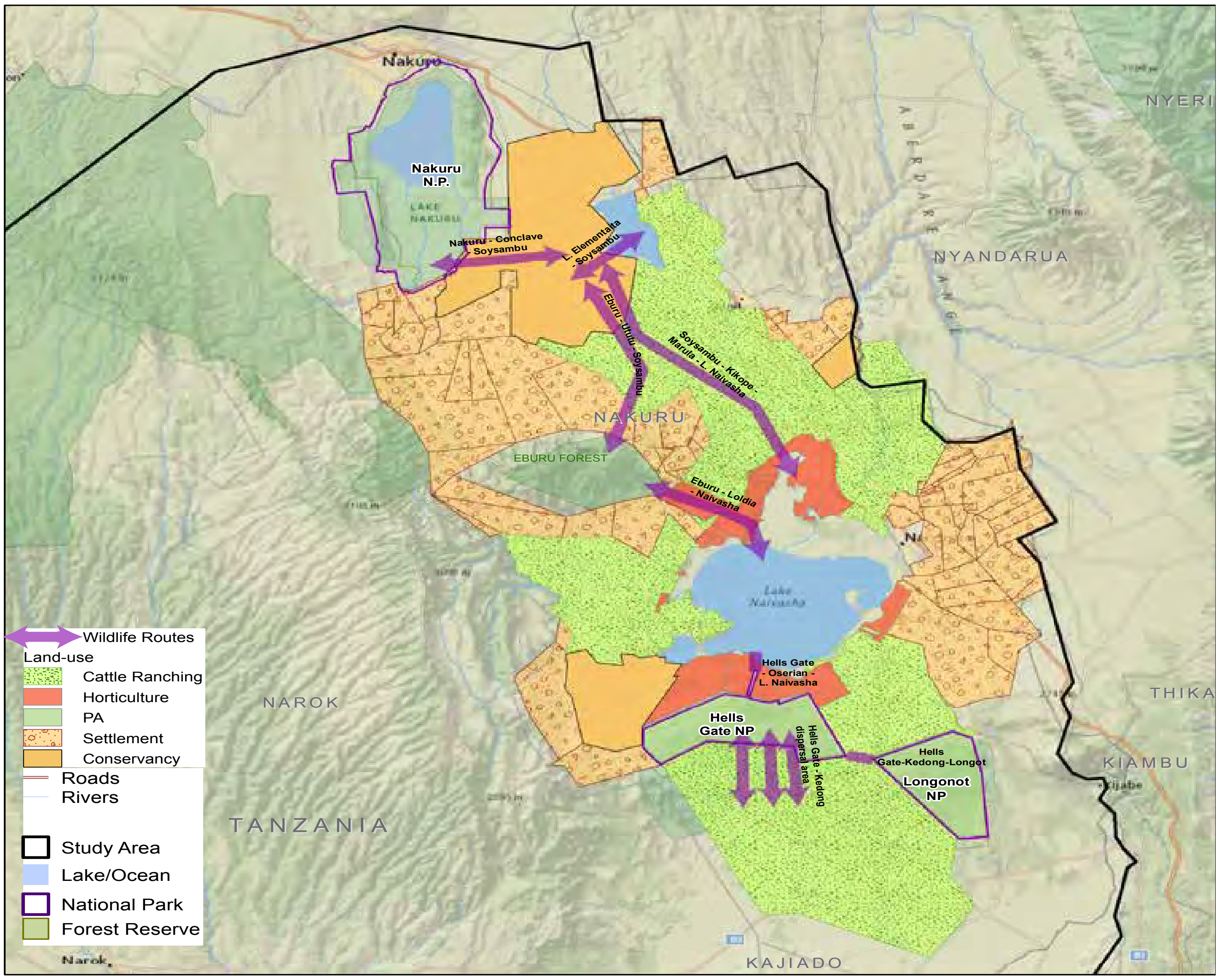



**Table 7.3:** Existing and proposed wildlife movement corridors. To be read together with Map 7.8

| | |
|---|---|
| 1.Route | Corridor linking Lake Nakuru NP, via Conclave, with Soysambu |
| 2.Route | Corridor between Lake Elementaita and Soysambu |
| 3.Route | (Movement between Eburu Forest and Soysambu (via Ututu |
| 4.Route | Dispersal area linking Soysambu, via Kekopey and Marula, to Lake Naivasha |
| 5.Route | Corridor linking Eburu Forest, via Loldia, to Lake Naivasha |
| 6.Route | Corridor linking Hell's Gate NP, via Oserian, to Lake Naivasha |
| 7.Route | Movement between Hell's Gate NP and the Kedong dispersal area |
| 8.Route | Corridor linking Hell's Gate NP, via Kedong, to Longonot NP |

d. Secure the Hell's Gate-Kedong- Longonot NP corridor through an easement with the Kedong ranch.

e. Encourage conservation co-management arrangements in the Lake Nakuru NP and the Soysambu Wildlife Conservancy.

f. Purchase private land for the extension of conservation areas (explore pilot areas in Kekopey).

2. **Medium Priority Action**
   a. Develop and gazette participatory land-use plans for the following focal areas: Eburu Conservation Area; the greater Elementaita conservation area (including Lake Elementaita Wildlife Sanctuary, the Ututu conservation area, and the Soysambu Conservancy); the Lake Naivasha riparian area; the Hell's Gate-Longonot conservation area; the Lake Nakuru NP, and Soysambu ranch.

b. Implement the REDD project that has been drawn up for the Eburu Forest Reserve.

c. Introduce incentives (including provision for consumptive uses and cropping of wildlife) in line with the Wildlife Act (2013). This will require regular, close monitoring.

d. Create wildlife trust funds for specific conservation areas and programmes.

## 7.4. The South Rift Region: Lake Natron - Magadi Area

### Introduction

The South Rift region encompasses the Lake Natron-Namanga and Lake Magadi-Nguruman escarpment areas and includes the conservation areas of the Lake Natron GCA, Magadi Concession, Shompole, and the Meto, Torosei, Mbuko, Elangata Wuas, Ol-kiramatian, and Lorngosua ranches. Lake Magadi is the southernmost lake in the Kenyan Rift Valley, lying in a catchment of faulted volcanic rocks, north of Tanzania's Lake Natron. The southern Ewaso Ng'iro (Brown River) plays an important role in shaping the ecology of the Lake Natron-Magadi-Nguruman escarpment area. Land-use changes along the river's headwaters or in the marshes upstream of Lake Natron could have serious impacts on both livestock and wildlife species.

The southern Ewaso Ng'iro River rises on the Mau escarpment and drains the southern part of the Mau Forest, which http://en.wikipedia.org/wiki/Southern_Ewaso_Ng%27iro - cite_note-MauICS-1 plays an important role in regulating and filtering its flow. The river, which is perennial, flows south through the Rift Valley to the east of Nguruman escarpment, before crossing into Tanzania and emptying into Lake Natron. Parts of the Mau Forest, though, are under threat from logging and land clearance for agriculture. Destruction of the forest would increase sediment loads in the river, and could cause enormous seasonal variations in water flow; so much so that, during the dry seasons, flows might conceivably stop altogether, turning the southern Ewaso Ng'iro into a seasonal river. http://en.wikipedia.org/wiki/Southern_Ewaso_Ng%27iro - cite_note-3

At the foot of the Shompole volcano, a horst has dammed the southern Ewaso Ng'iro River, causing its waters to spread out into the Engare Ng'iro swamp, where the river deposits its sediments. The sediment-free river water then seeps into the brine of Lake Natron.http://en.wikipedia.org/wiki/Southern_Ewaso_Ng%27iro - cite_note-4 This permanent swamp covers about 4,000 ha, and south of it there is a seasonal floodplain of about double the size, extending to Lake Natron and along its eastern shore. The Engare Ng'iro swamp in Shompole is contiguous with the Ol Kiramatian conservation area, and is a critical dispersal area for wildebeest, zebra, elephant, giraffe and a host of other wildlife species.

Elephants are known to move back and forth between the Kawuet-Lake Kapong area and the Engatreli Forest via Noongumot, Lositeti, and Donyo Seleken. Although the Nguruman escarpment is a physical barrier to elephant movements across to the Loita Hills, they are able to negotiate the escarpment at Ol Kiramatian and to cross to the Naimina Enkiyio Forest and to Kisinante.

Kernel densities identify core habitats, important habitats, and dispersal areas used by wildlife species in the Lake Natron - Magadi area (Map 7.6). The core area for wildebeest is largely around the Magadi concession - Shompole area, and the plains adjacent to Nguruman escarpment; the pattern for elephants is shifted slightly to the west of Lake Magadi, while the giraffe is more widespread in the south Rift region.

### The State of Conservation Connectivity

**A. Drivers**

1. The human population of the South Rift Region is growing and becoming increasingly sedentarized, which is putting pressure on natural resources in the region.

2. Privatization in response to insecure land tenure is resulting, increasingly, in the sub-division of group ranches, and in land sales to speculators, leading to land-use changes, including agricultural expansion and declining livestock mobility.

3. Unregulated water resource projects and unregulated tourism development is impacting negatively on wildlife around the Shompole concession area.

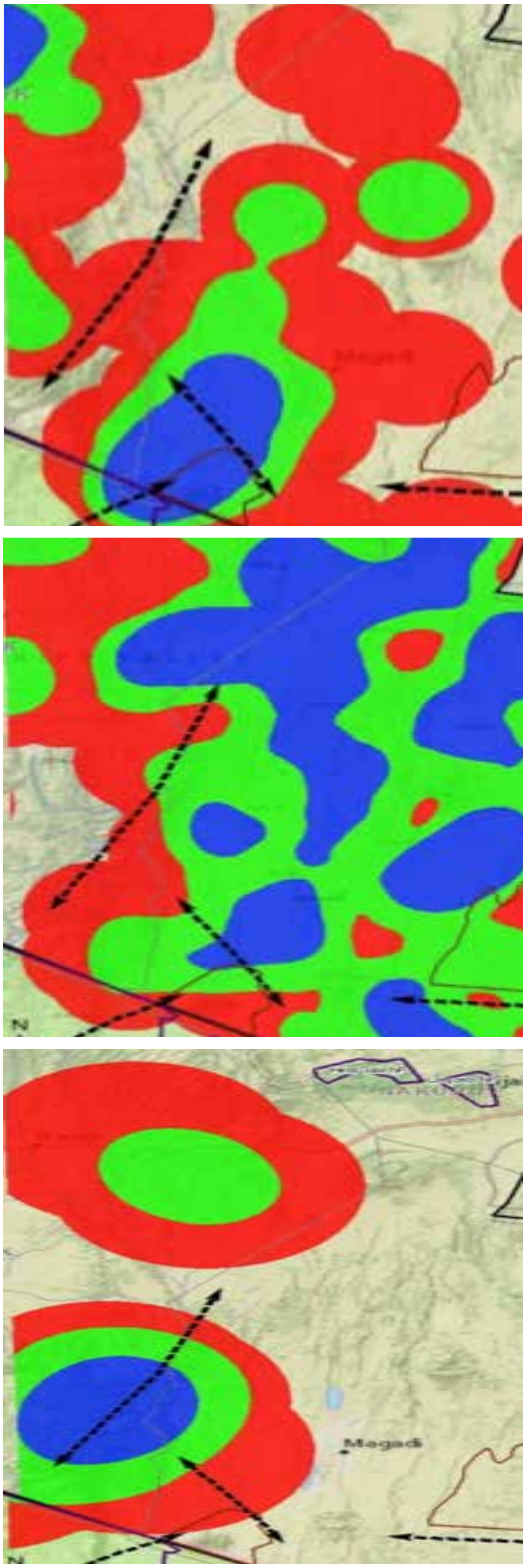
4. Climate change and variability is increasing the frequency of droughts.

5. A lack of clear policies and cross-sectoral and cross-border coordination mechanisms is hampering conservation connectivity in the region.

**B. Pressures**

1. Increasing levels of sedentarization among the region's growing human population is undermining the viability of wildlife dispersal areas through intensifying competition over key natural resources.

**Map 7.6:** Kernel densities and migratory routes/corridors (black arrows) for wildebeest, giraffe and elephant in the South Rift Region, showing core habitats, important habitats, and dispersal areas.




*Source: DRSRS datasets*

2. Lifesyle changes among pastoralists, from nomadism to sedentarism, have led to an increase in the numbers and local densities of livestock. Land-tenure changes have caused massive sub-divisions on group ranches, with individual parcels increasingly being used to accommodate settlements and agricultural expansion, especially around water sources. The increase in water extraction is having a grave impact on hydrological functions, while the rampant burning of charcoal, along with other activities such as sand harvesting, is further contributing to environmental degradation.

3. Climate change and variability is the cause of severe stress in wildlife areas. The high losses of both wildlife and livestock during the 2009 drought demonstrates this phenomenon, while the increase in human-wildlife conflicts highlights the vulnerability of the South Rift region.

**C. State**

1. Core Areas
    a. *Land and habitat*: Threats to core habitats are being exacerbated by reduced habitat resilience in the face of environmental degradation and loss of productivity;

    b. *Biodiversity losses associated with habitat loss*: Effective protection of certain flagship species, such as elephant, is essential, if biodiversity losses are to be averted;

    c. *Wildlife populations*: Sharp declines in the numbers of certain wildlife species during the 2009 drought have highlighted the need for closer monitoring of the population dynamics of larger herbivores, such as elephants, wildebeest, and zebras.

2. Dispersal Areas
    a. *Land and habitat*: Loss of key habitats and reduced habitat resilience is increasing as the result of degradation and declining productivity in important dry season grazing areas.

    b. *Land-use change*: High poverty levels, sedentarization, and the expansion of settlements have resulted in conflicting land-use practices, which in the Shompole and Nguruman area have led to increased land degradation and habitat loss, fragmentation, and homogenization, as well as to an increase in human-wildlife conflicts;

    c. *Agricultural expansion and intensification*: This has led to a decline in rangeland productivity, and has also reduced the grazing and forage ranges available to wildlife and livestock alike, creating major conflicts of interest.

**Plate 7.5:** The Nguruman Escarpment, with the Loita Hills in the background. Photo: courtesy AWF

**D. Impacts**

1. Core Areas
   a. *Land and habitat*: Increasing soil erosion; reduced land resilience; declining productivity, and wildlife declines;

2. Dispersal Areas
   a. *Habitat fragmentation*: loss of dry season grazing areas; deforestation; drainage of wetlands; increased soil erosion; encroachment by undesirable species, and human-wildlife conflicts;

   b. *Biodiversity*: declining biodiversity, and falling wildlife numbers.

3. Connections and Linkages
   a. Parts of the South Rift region, such as the southern Ewaso Ng'iro River and the Engare Ng'iro swamp in Shompole, which are critical for wildlife and livestock, are under increasing pressure from human settlements, land sub-division, agriculture, and water extraction. All these factors are threatening wildlife habitats and hampering the development of sanctuaries and tourism.

**E. Responses**

1. Core Areas, Dispersal Areas, Connections and Linkages

a. Participatory land-use planning mechanisms are being used to engage communities on group ranches in conservation activities, including the setting up of conservancies, re-afforestation initiatives, and eco-tourism ventures, with a view to opening up the South Rift tourist circuit;

b. The South Rift Landowners' Association has brought together 14 group ranches in a bid to steer developments in the region towards conservation practices that will benefit local communities;

c. Legal and economic instruments (leases, easements, and agreements) are being encouraged on subdivided group ranches and un-subdivided sections, to expand wildlife areas and to promote the development of viable conservation ventures;

d. Enabling policies, contained in the Land Policy, the Draft Wildlife Bill, and the Trans-boundary Ecosystem Management Bill, are being pursued to guide land-use plans.

e. Efforts are being made to encourage projects of the Reducing Emissions from Deforestation and Forest Degradation (REDD) on the Nguruman escarpment.

**F. Threats to Conservation Connectivity**

The South Rift is a region of contrasting elevation gradients, spanning all but one of Kenya's seven ecological zones. It links two of Kenya most important national parks, the Masai Mara NP and the Amboseli NP (Map 7.9). Unlike the parks, the South Rift is beset with many of the problems that arise where pastoralist communities and wildlife share open rangelands.

The growing conflict between people and wildlife over diminishing land and resources in the South Rift is typical of the rangelands. More and more pastoralists have been forced into a cash economy, and now transact businesses. When their herd numbers are decreasing and livestock prices are poor, they resort to unsustainable exploitation of rangeland resources, through activities such as subsistence farming, woodland clearing for charcoal and timber, poaching, and sand extraction from dry river beds, or even selling parts of their land to speculators.

Other threats to conservation connectivity in the South Rift include insecure land tenure, the lack of comprehensive management plans, weak implementation of legislation, inadequate scientific data, the effects of adverse climatic conditions, inadequate incentives for conservation, sedentarization and the proliferation of unplanned settlements, excessive water extraction and the fouling of water sources, over-grazing and environmental degradation, and human-wildlife conflict.

1. *Suswa-Mosiro-Olorgeseile route*: The recent increase in elephant poaching in the Mosiro area is cause for serious alarm. Large-scale wheat farming is taking over much of this area, and there is speculation that the geothermal power station could have further negative consequences for wildlife. Land-use planning should be undertaken, to prevent agricultural fields from spilling over into wildlife areas. In addition, inter-sectoral consultations should consider the incorporation of a conservation component within the framework of the geothermal development plans.

2. *Nguruman-Loita elephants*: The main water catchments for the Shompole/Ol Kiramatian areas are being converted to crop cultivation, amid increasing acrimony over land sub-divisions and access to resources. This situation calls for urgent monitoring and evaluation of the water catchments, and of water extraction, logging, and other activities on the Nguruman escarpment.

3. *Namanga/Amboseli wildlife (lions and elephants, as well as other species)*: Namanga town is being developed as a major cross-border clearing house for trade. Land speculation and fences put up by wealthy developers have changed the landscape in many areas, and are a major threat to wildlife movements. Land-use planning for this ongoing urbanization process should incorporate provisions for compatibility with the conservation of the Amboseli ecosystem.

4. *Magadi/Ol Donyorok area*: This is currently a migratory corridor for wildlife, but the ongoing sub-division of group ranches in central Kajiado will lead to an influx of settlements, resulting in the fragmentation of habitat, and curtailing wildlife movements. Increased awareness creation is needed to avoid sub-divisions that will further degrade wildlife refuges and pastoralist grazing lands. Policy and legal frameworks should be used to define compatible land-use options, to ensure that wildlife dispersal areas and migratory routes/corridors are secure.

5. *Natron/Lengai (wildebeest)*: This area spans two countries with different wildlife policies, under which game hunting, for example, is permitted in Tanzania, but banned in Kenya. Land-use planning for the management of shared resources straddling international frontiers should as far as possible be coordinated, so that cross-border policy conflicts can be avoided.

### G. Opportunities for Conservation Connectivity

Community-based conservation initiatives in the South Rift began in 2002 with the establishment of conservation areas and eco-tourism lodges on the Shompole and Ol Kiramatian group ranches, along with the capacity and the institutions needed to manage tourism enterprises and wildlife. More than 15 group ranches under the South Rift Association of Landowners (SORALO) and more than 8,000 km$^2$ of land linking the Amboseli and Masai Mara NPs are involved. The African Conservation Centre (ACC) has been drawing in new partners to help SORALO develop and market the South Rift as a premier tourism destination. The programme aims to maximize sustainable benefits from natural resources, while ensuring that natural resilience to stress from both traditional and new land uses can be enhanced, through the creation of drought refuges and drought insurance schemes that will improve and safeguard productivity.

### H. Wildlife Routes and Corridors

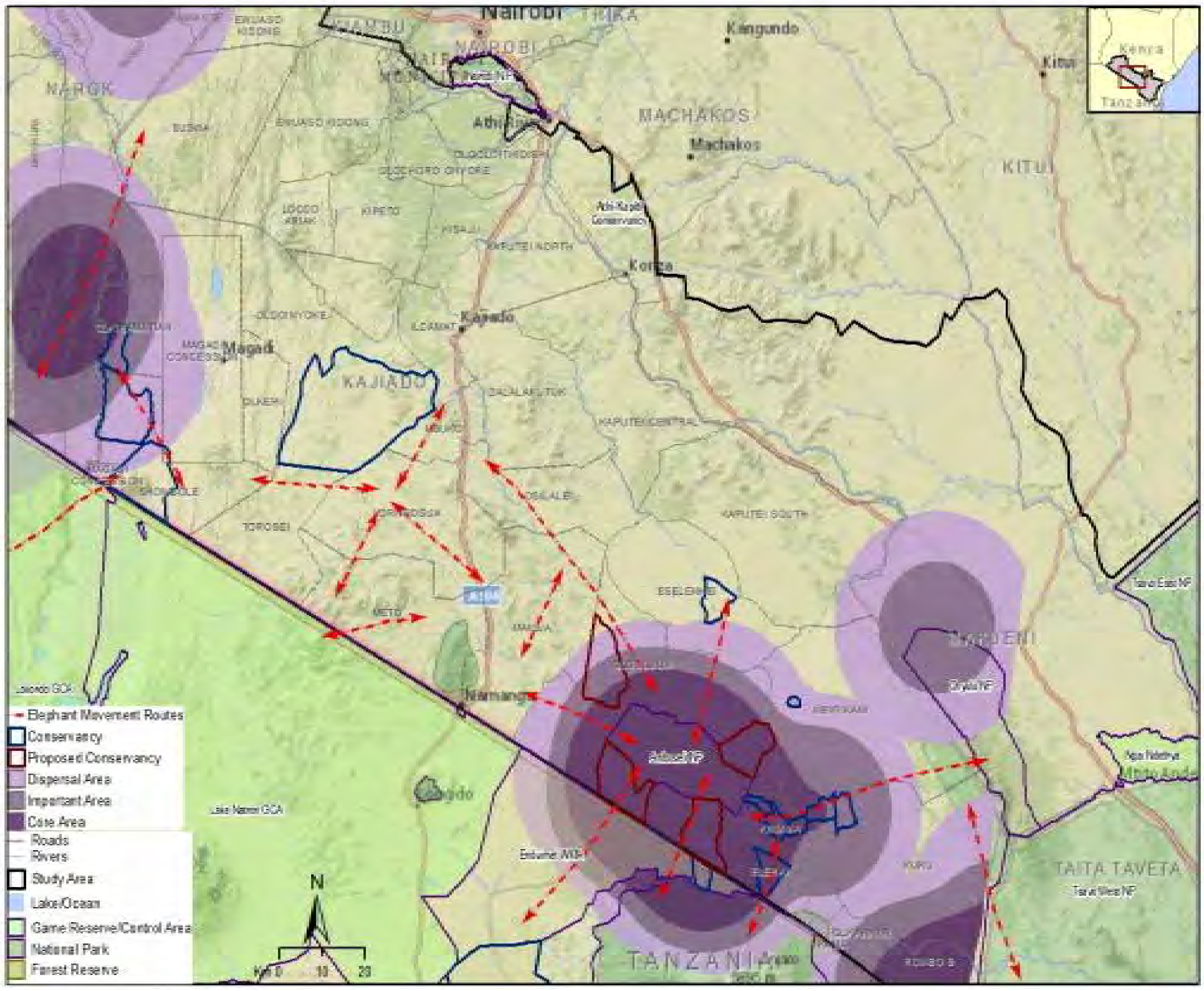
The existing and proposed conservancies and wildlife migratory routes/corridors in the South Rift were identified and assigned threat levels based on DPSIR analysis and on consultations with professionals and conservation stakeholders (Maps 7.9 and 7.11). Actions were then prioritized, together with some recommendations and responsibilities for each of the actions identified.

### I. Recommendations

#### 1. High Priority Actions

a. Establish community conservancies in the most important wildlife dispersal areas and migratory routes/corridors. The Longosua area, as a critical convergence zone for many wildlife species, is a priority area suitable for the establishment of a conservancy. This conservancy would be contiguous with the existing Bangata Wuas Conservancy. The Nguruman-Loita Hills is another critical area for elephants, and it too requires the establishment of a conservancy.

**Map 7.9:** Core habitats, important habitats, and dispersal areas for keystone species, showing elephant routes (red arrows) in South Rift, Amboseli NP, and the Chyulu NR.




b. The cross-border corridors, especially those of the Namanga-Longido-Lake Natron GCA and the Shompole-Loliondo CGA should be secured.

2. **Medium Priority Actions**

a. The government should recognize conservancies as legitimate protected areas with legal status.

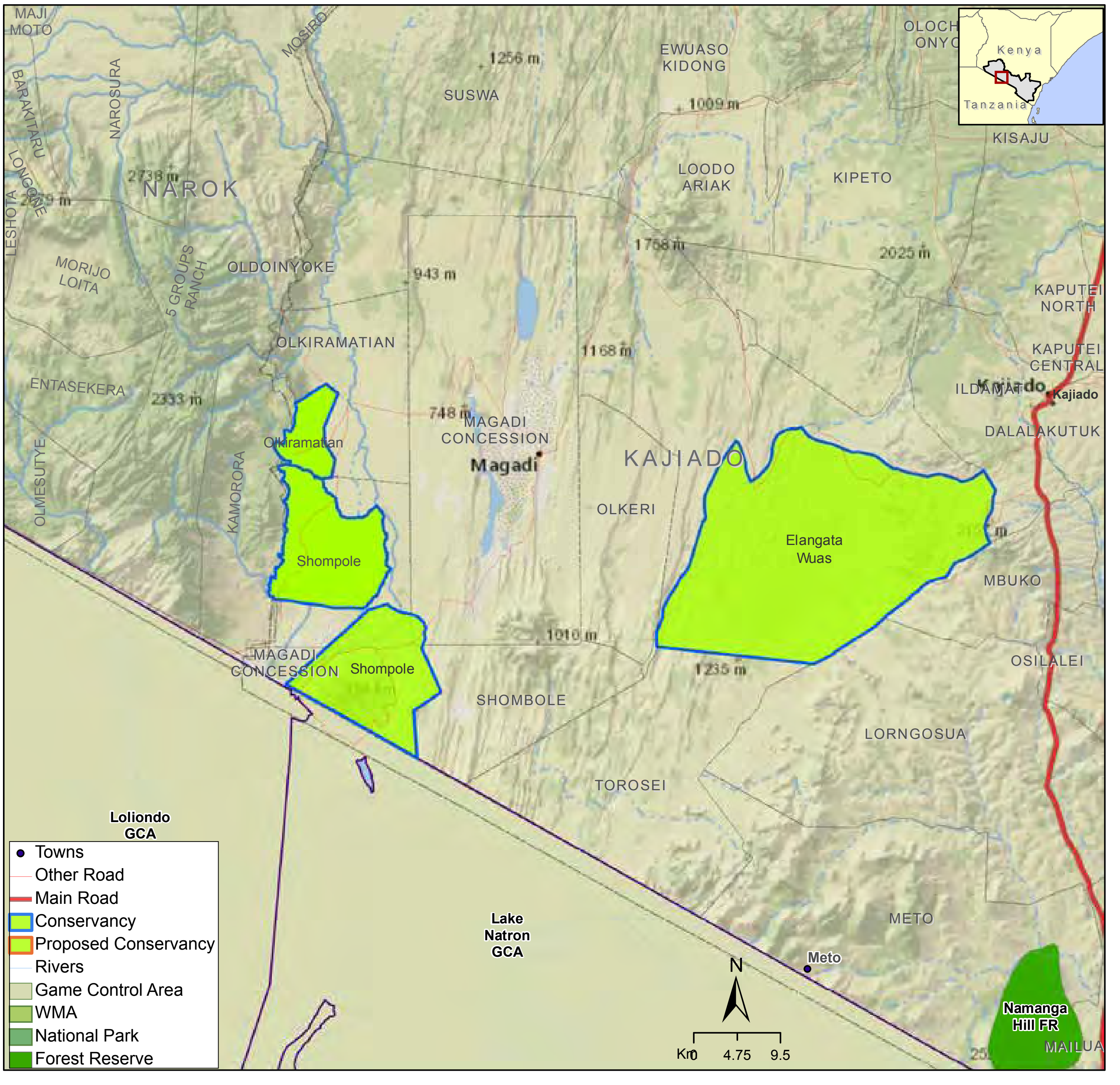
b. Concerted efforts should be made, through public/private-sector partnerships, to invest in the development of tourism infrastructures needed to open up the South Rift as a tourism circuit.

c. The economic potential of rangelands (for conservation and livestock production) should be identified and promoted for sustainable environmental management / community livelihoods.

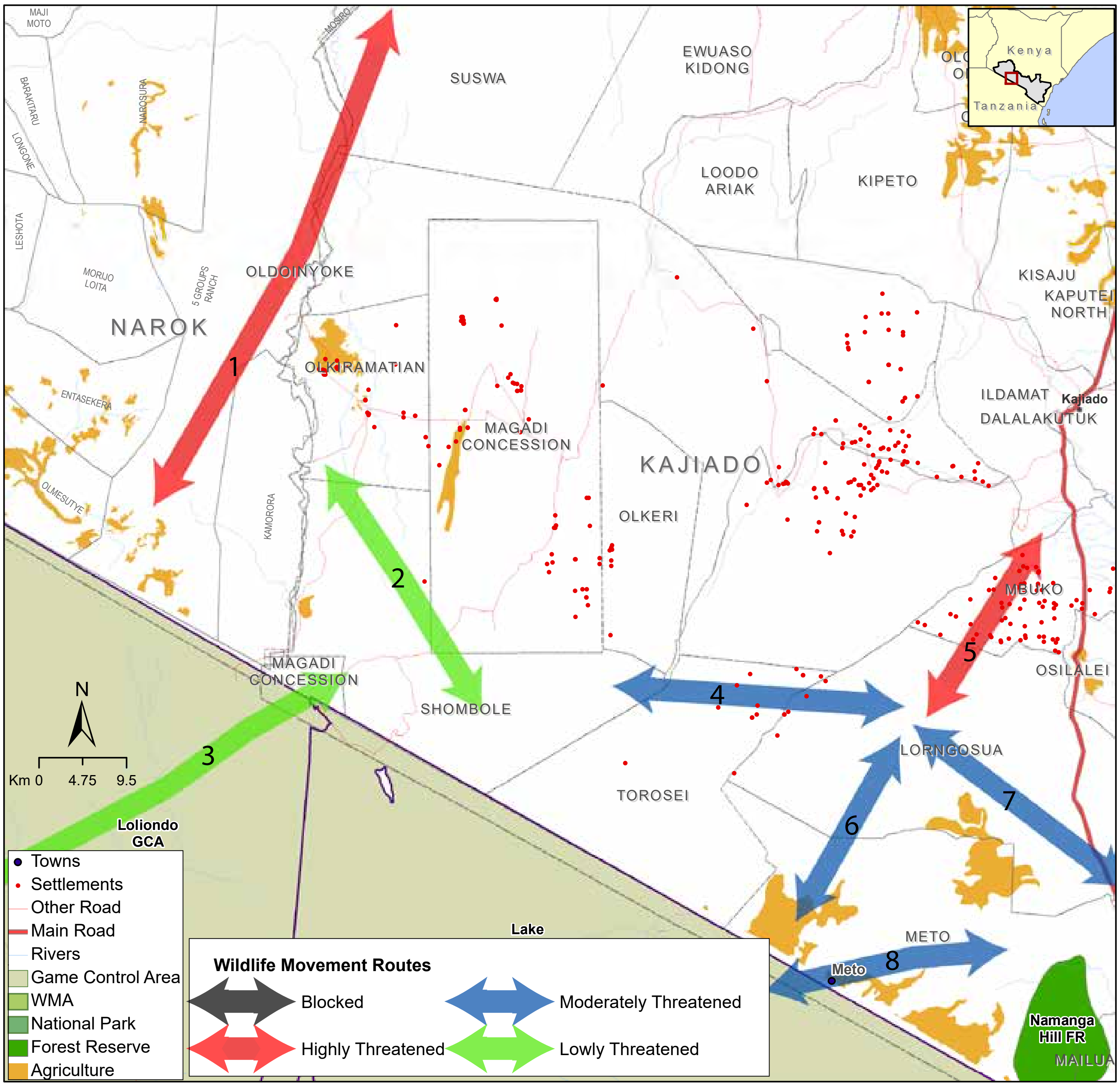
d. The participation of SORALO in wildlife conservation should be encouraged, by engaging host communities in land-use planning and decision-making processes.

e. Local communities should be encouraged to initiate a REDD+ programme in forested and woodland areas, such as the Nguruman escarpment.

**Map 7.10:** Existing and proposed conservancies in the South Rift (Shompole, Ol Kiramatian and Bangata Wuas).



**Map 7.11:** Wildlife migratory routes/corridors in the South Rift.




*Source: DRSRS database.*

**Table 7.4:** Habitat connectivity, conservation threats and actions needed in the South Rift. To be read together with Map 7.11

| Routes | Threats | State | Action |
|---|---|---|---|
| 1 | High | Suswa-Nguruman-Loita: The main water catchments for Shompole-Olkiramatian being converted to agriculture; increased subdivision and land disputes | Immediate - monitor water catchments and logging in Nguruman; Land use plan to stem agricultural fields from spilling into wildlife corridors |
| 2 | Low | Shompole-Magadi-Olkiramatian | |
| 3 | Low | Loliondo GCA-Shompole | |
| 4 | Moderate | Lorngosua-Shompole: sedentarization associated with high density settlements | |
| 5 | High | Lorngosua-Mbuko: high density settlements, subdivisions, and cultivation | |
| 6 | Moderate | Lorngosua-Meto-Lake Natron GCA: Settlements and agriculture | |
| 7 | Moderate | Lorngosua-Namanga -Amboseli: increased sedentarization, on-going subdivision and influx of settlements | Awareness creation to avoid subdivision; Policy and legal framework to define the compatible land use options |
| 8 | Moderate | Namanga Hills-M eto-Lake Natron GCA: high density settlements and agriculture | Immediate - land use plans and compatible cross-border policies |

None | Low | Moderate | High | Blocked

**Plate 7.7:** Wildebeest with calves on the 'Sheep and Goat Land' on the outskirts of Nairobi City, with urban settlement in the background. Photo: courtesy Shem Kifugo

## 7.5. The Nairobi National Park and Athi-Kaputiei Ecosystem

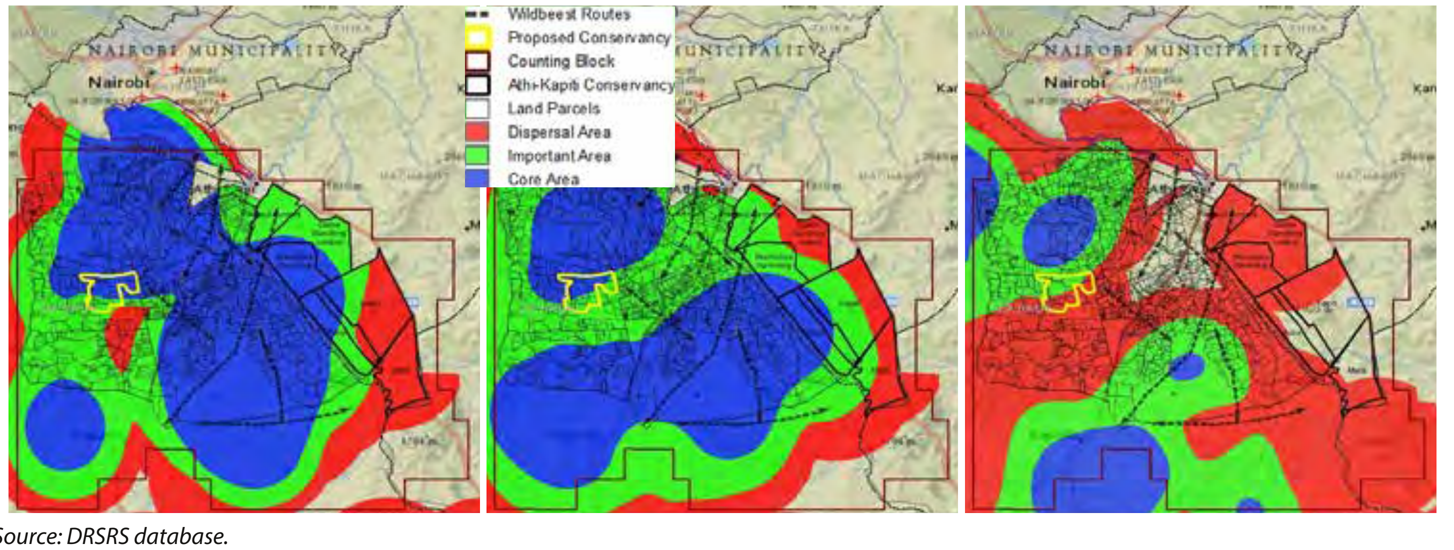
### Introduction

The Nairobi NP and Athi-Kaputiei ecosystem is adjacent to Nairobi City, an urban area with a population of more than 4 million people. Even so, the area supports a large wildlife population (more than 20 species, including the migratory wildebeest and zebras). The semi-arid plains to the south of the Nairobi NP are home to the Kaputiei Maasai community, which depends for its livelihood on livestock keeping. In also hosting a rich wildlife population, these plains are critical to the health of the Nairobi NP, in that 70-80 % of the park's larger mammals roam outside its boundaries at one time or another (Ogutu *et al*., 2013).

### Connections and Linkages

The kernel densities for key species (wildebeest, zebra and giraffe) in the Athi-Kaputiei area and Nairobi NP were mapped to identify core wildlife habitats, important habitats, and dispersal areas (Map 7.12). The core area for wildebeest was around Olooloitikoishi, Kaputiei North, the Machakos ranches, and the Nairobi NP. The pattern was similar for zebra, except for in the park, which they utilize as a dispersal area. Giraffes were widely dispersed, with core areas around Olooloitikoishi and towards the south.

**Map 7.12:** Kernel densities for wildebeest (left), zebra (middle) and giraffe (right) in the Nairobi NP and Athi-Kaputiei ecosystem.




*Source: DRSRS database.*

### The State of Conservation Connectivity

**A Drivers**

1. *Human Population*: The 2009 census found that Kajiado County had 687,312 people, with a density of 31.4 people/km$^2$ and a growth rate of 4.51 % (against the national rate of 2.2 %). The increasing population of Nairobi and environs has put intense pressure on the Athi-Kaputiei ecosystem, especially in the quest for space on which to build residential houses.

2. *Land-tenure*: Insecurity of land tenure may lead many of the members of Maasai group ranches to subdivide the land under individual titles. Already, privatization in Athi-Kaputiei has led to severe land fragmentation, fencing, and developments in agriculture, mining, and flower farming.

3. *Infrastructure and Industrial Development*: The Athi-Kaputiei ecosystem is becoming increasingly fragmented by developments associated with the establishment and growth of urban centres around Nairobi city. These include Machakos, Kitengela, and Kajiado, as well as the proposed Konza ICT city. The ecosystem is criss-crossed by highways, including the Nairobi-Mombasa and Kitengela-Namanga road networks, the proposed southern bypass (Mlolongo-Mbagathi), as well as the standard gauge railway (SGR). Major industrial activities include cement factories, horticulture processing, steel mills, and an Export Processing Zone (EPZ).

4. *Climate Change*: A slight decrease in annual rainfall is expected, punctuated by more frequent droughts. Maximum temperatures are likely to rise by about 0.5°C, and minimum temperatures by 1°C. This has resulted to unpredictable rainfall, with negative impacts on water flows in rivers and on the water table (accessed through boreholes).

**B. Pressures**

1. Rapid land-use changes have occurred over the past two decades. Most of the wetter parts of the ecosystem are now under crop cultivation. Residential housing and real estate developments have mushroomed along the Nairobi-Namanga highway, along with nuclear shopping malls and markets. Urbanization, industrialization (including gypsum mining and quarrying), and infrastructure development (the southern bypass and other road networks), have resulted in an escalating human population, and in a proliferation of fences and other barriers, which preclude the movement of livestock and of wildlife.

2. The new Standard Gauge Railway (SGR), now under contruction, may have further disruptive effects on wildlife and wildlife habitats. The first phase of the new railway, from the port of Mombasa to Nairobi, was originally designed to run parallel to the existing narrow-gauge railway that skirts the northern periphery of the Nairobi NP. However, it has been realigned to pass through the park, as it would, in following the original path, have had to displace high-value properties incurring billions of shillings in compensation costs. Some, including FoNNaP (the Friends of Nairobi NP), have argued that, in cutting through the park, the high-speed train track will interfere with prime wildlife habitat and wildlife behaviour.

**C. State**

1. More than 20 % of the former Kitengela Conservation Area is already fenced, and there are plans to develop more residential estates and shopping centres, more gypsum mining and quarrying areas, and more agricultural enterprises, all of which will further curtail wildlife movements and block some of the remaining migratory routes/corridors and dispersal areas (Map 7.13).

**D. Impacts**

1. *Infrastructure and urban development*: Residential housing and major highways (Nairobi-Mombasa, Kitengela-Namanga, and the proposed Mlolongo-Mbagathi southern bypass) are physical barriers to wildlife movements, and are considerably reducing the ranges of wildlife species.

2. *Increasing isolation of the Nairobi National Park*: Wildlife movements into the Nairobi NP have been restricted, now that access from the Machakos ranches is blocked for many animals, including sizeable wildebeest and zebra populations. Already, the wildebeest migration into Nairobi National Park and the Athi-Kaputiei ecosystem has collapsed (Plate 7.8 c).

3. *Diminishing wildlife dispersal areas and pastoralist grazing areas*: Most wildlife rangelands have been blocked, and pastoralists have moved away from the ecosystem with their livestock due to land-tenure changes (private properties associated with high density fencing), land degradation, and inaccessibility to watering points in dry season grazing areas.

4. *Declining wildlife populations*: Wildebeest numbers in the Athi-Kaputiei ecosystem declined from 40,000 animals in the late 1970s to fewer than 5,000 in 2011.

5. *Increasing livestock numbers:* Livestock densities around the Nairobi NP have increased, and herds are spilling over into parts of Nairobi city during periods of drought, as pastoralists search for water and pasture.

**E. Responses**

1. *Underpass corridors*: Pressure from conservationists who argued that shifting the course of the SGR to run through the Nairobi NP would cut off acres of prime rhino habitat led the Kenya Railways to agree to increase the number of bridges from one to three, so the underpasses can be used by wildlife during their migration and movement (*Nation n*ewspaper*,* 15 March 2016).

2. *Land-lease and easement programmes*: Communities are engaging in partnerships with private entrepreneurs to develop community conservancies and wildlife resource management ventures that will enhance community livelihoods. Examples are the Olerai Conservancy in Kekonyokie, Kaputiei plains (Map 7.13), and Swara Game Ranching (KWS, 2014).

3. *Master land-use plan*: Community and conservation stakeholders have come up with plans for the sustainable management of resources within the Athi-Kaputiei Ecosystem based on zoning (Map 7.14).

4. *Research and capacity building*: Many development institutions are engaged in research and local capacity building to improve the livelihoods of pastoralists, through rainwater harvesting, improved market access for livestock sales, milk production, and diversification into farming.

**F. Threats to Conservation Connectivity**

The intensity of fenced small plots in the Kitengela area indicate that almost all the wildlife corridors are under threat (Map 7.13). Major threats to wildlife conservation in the Athi-Kaputiei Ecosystem include land sub-division, urban development, and the spread of residential housing (Plate 7.8a and b), expansion of agricultural activities (small-scale farming and horticulture), industrial developments (gypsum mining, quarrying, and sand harvesting) and pollution of rivers by industrial effluents. For instance, expansion of activities in the Tuala-Oloosirikon, Empakasi, and National Pipeline Cooperation (NPC) areas, and the growth of Olooloitikoshi town will, through an increase in associated land sub-division and fencing, lead to the further blockage of route 1 (Map 7.15).

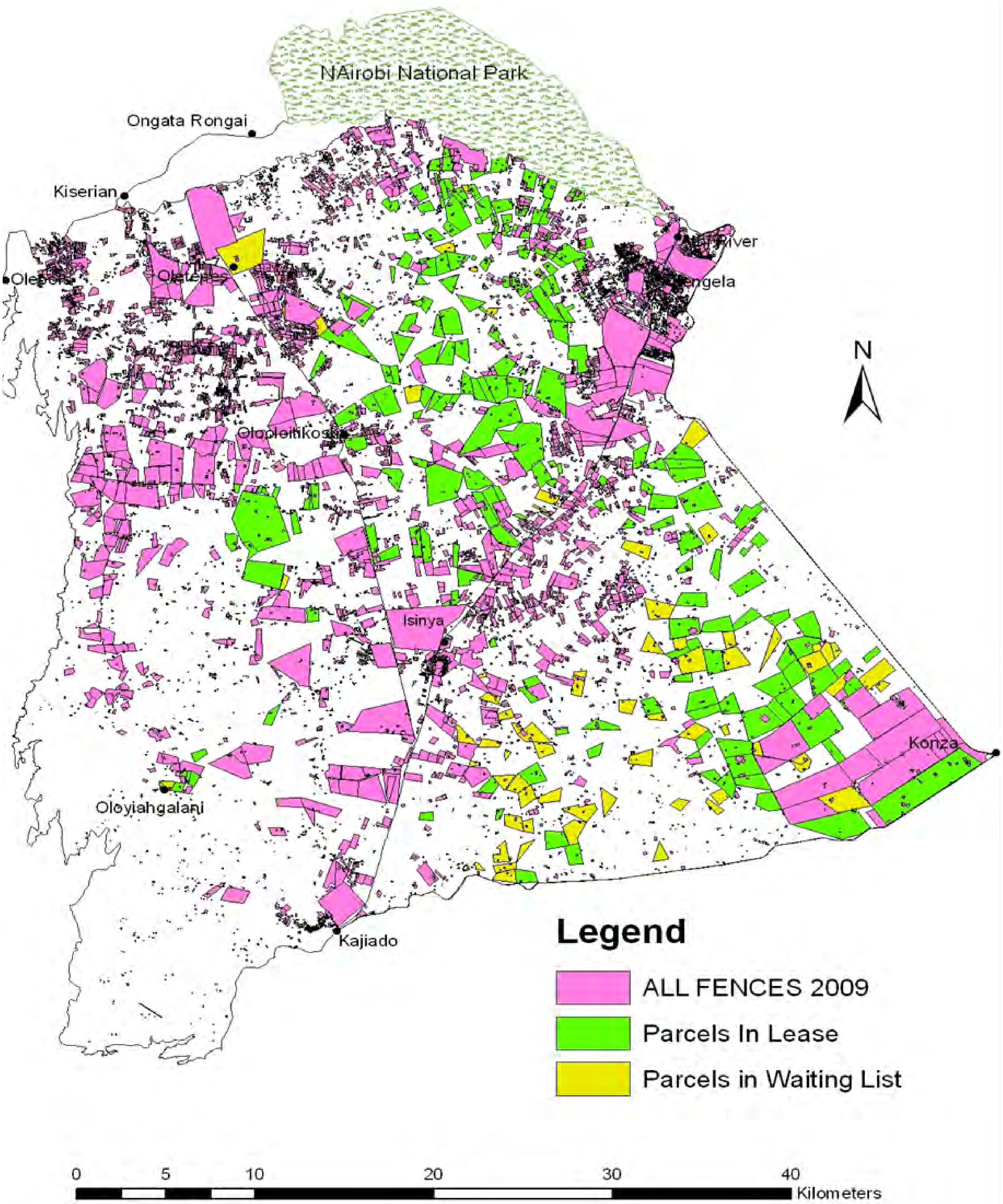
The Sheep and Goat Land is one of the critical passages for wildebeest and zebras into the Nairobi NP. However, the two routes passing through this area are now threatened by private land ownership, urban development, and increasing land sub-division into plots, as well as by the high density settlements in Embakasi, and the erection of fences around the expanding towns of Mlolongo, Athi-River, and Kitengela. Routes further south have been blocked by the expansion of Kisaju and Isinya towns.

High density settlements and agricultural activities in the Olturoto area, coupled with gypsum mining in Enkirigirri, are threatening route 3. Although routes 4 and 5 face few threats, the increasing land sub-division between Ilasit and Olturoto, and gypsum mining in the Ilopolasat and Enkirigirri areas are causing land degradation and habitat fragmentation. Routes 6 and 7 are completely blocked by property developments along the Kitengela-Namanga highway (Map 7.15).

**G. Wildlife Migratory Routes and Corridors**

The wildlife migratory routes/corridors in the Athi-Kaputiei Ecosystem were identified and assigned threat levels based on the DPSIR analysis and in consultation with experts, the local community and conservation stakeholders (Map 7.15).

**Map 7.13**: Current status of fences and land leases in the Kitengela area.



**Map 7.14:** Proposed Isinya zoning plan (2006-2026).

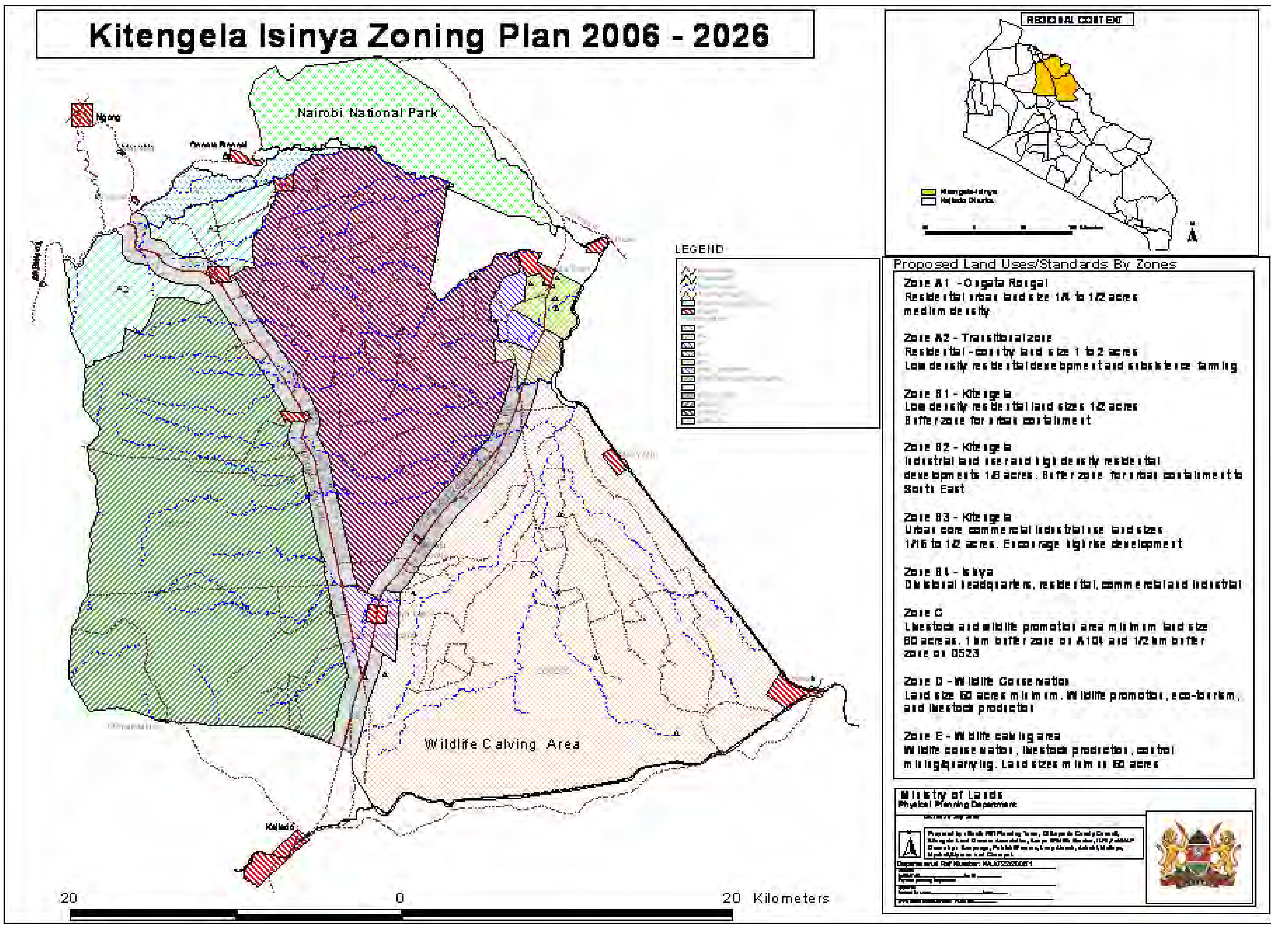
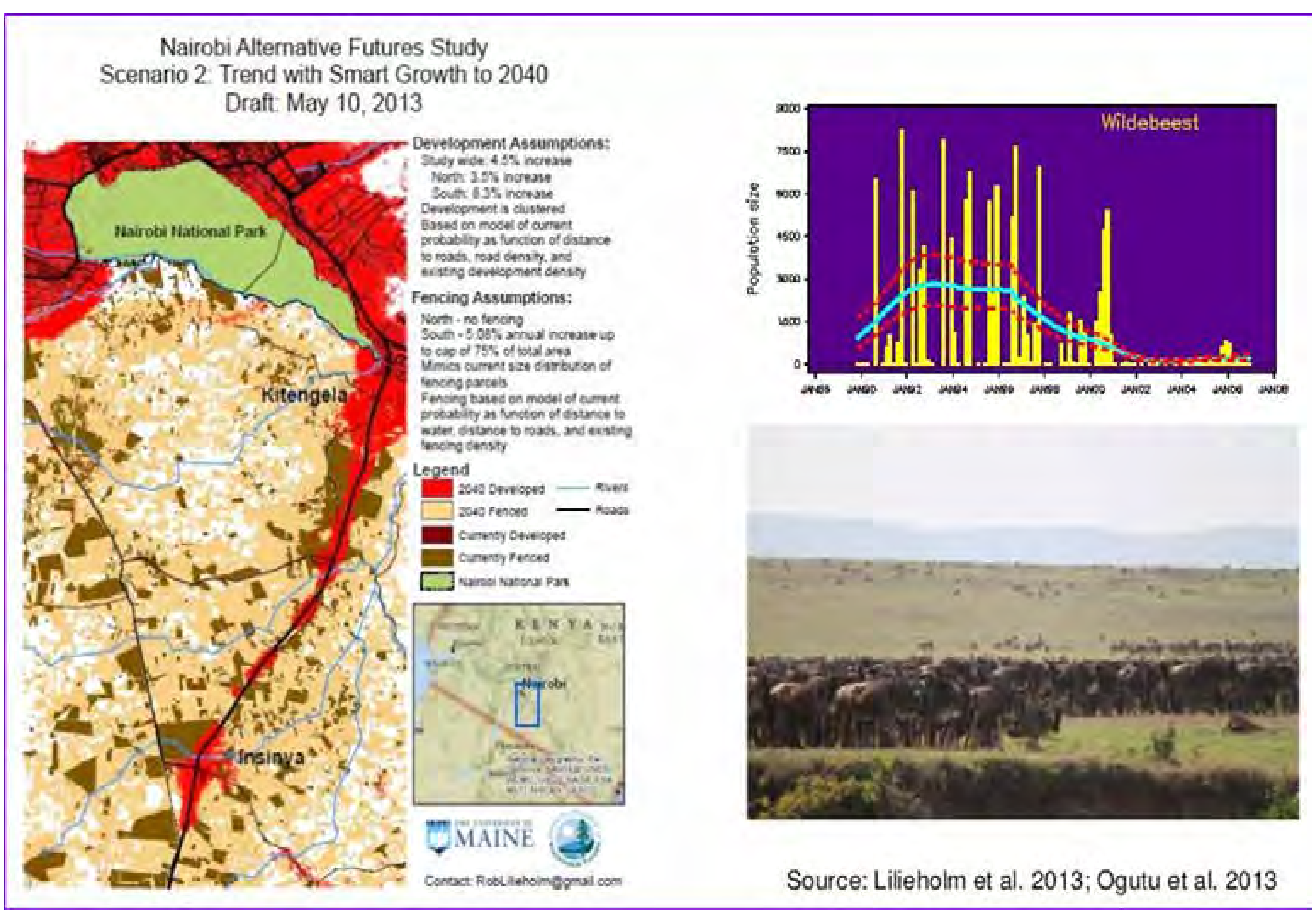



**Plate 7.8 (a):** Satellite image of the Kitengela area in 2003, showing sparse urbanization.

**Plate 7.8 (b):** Satellite image of the Kitengela area in 2013, showing the expansion of industrial activities and residential housing.

**Plate 7.8 (c):** Collapse of the wildebeest migration into the Nairobi National Park and the Athi-Kaputiei ecosystem.




*Source: Lilieholm et al. 2013; Ogutu et al. 2013*

**Table 7.5:** Connections and linkages, conservation threats and action needs in the Athi-Kaputiei Ecosystem.

| Route | Threat | Description | State | Action |
|---|---|---|---|---|
| 1 | Moderate | Runs to and from Nairobi NP through upper eastern part of Sheep and Goat open land, and towards Oloolotikosh-Kipeto open lands. | Privately owned but critical passage to the park. Also imminent blockade by the proposed Mlolongo - Mbagathi bypass. | Immediate - Negotiate for land lease; plan to construct animal subway bypasses across the highway. |
| 2 | High | Exits the park at Sheep and Goat open land and crosses Kitengela and Oloolitikishi Rivers to Enkasiti and Kisaju | The sheep and goat open land is a critical link to Nairobi National Park | Immediate - GoK land - reclaim |
| 3 | Moderate | Runs from the upper Machakos ranches to east of Kitengela town, and crosses Ilasit and Olturoto in the south, and then to wildebeest calving zone in Enkirigirri (Kaputiei North). | Housing developments (shopping centres, residential estates) along the Kitengela-Namanga highway | Immediate - Need land use policy to support |
| 4 & 5 | Low | 4 - Runs to and from Ilasit in the east of Olturoto and crosses Olturoto River to Emarti in Kaputiei Central.<br><br>5 - Cross Emarti and connect calving zone in Enkirigirri to Machakos ranches | Land subdivisions between Ilasit and Olturoto, and gypsum mining at Ilopolasat and Enkirigirri | Immediate - Implement land use master plan; put restriction to the minimum size of land parcel. |
| 6 & 7 | Blocked | 2nd triangle to ensure 1st and Connects the wildebeest and zebra movements to Nairobi NP | Blocked | Immediate - Secure the corridors; Develop compatible land use. |

Legend: None, Low, Moderate, High, Blocked

## H. Recommendations

### 1. High Priority Actions

a. *Expansion of wildlife space*: The open Sheep and Goat Land to the south of the Nairobi NP is government property, and should be reclaimed to safeguard wildlife movements to and from the Nairobi NP. This will ensure accessibility for wildebeest from the 1st triangle to the 2nd triangle, and the Machakos Ranches.

b. *Land-lease or outright purchase*: Government should negotiate with landowners (of about 10,000 acres which have been identified as offering the only remaining passage south of the Nairobi NP), so that that park can be linked with core wildlife areas on the Oloolotikoishi plains.

c. *Establishment of conservancies*: Communities and private enterprises should be encouraged to engage in partnerships that can exploit opportunities for establishing more conservancies in areas perceived to be wildlife migratory routes/corridors or core species areas (such as Oloolotikoishi and the wildebeest calving grounds in Kaputiei North).

d. *Formation of conservation areas*: Owners of non-viable agricultural land within core wildlife areas, dispersal areas, and calving grounds which has already been subdivided should be encouraged to re-consolidate the land and to form conservation associations. Already, some private properties with abundant wildlife, including Portland Cement, Machakos Ranching, Game Ranching (Hopcraft), Astra, Lisa Farm, Kaputiei, and Malili, are pro-wildlife conservation.

e. *Wildlife Act (2013)*: Policies and legislation governing the creation of conservancies and encouraging the practice of sustainable wildlife management outside protected areas should be implemented to the full.

f. Government should implement and enforcement the Land-use Master Plan. This will discourage uncontrolled land sub-division and promote conservation and other compatible land uses.

### 2. Medium Priority Actions:

g. Payments for Ecosystem Services (PES):

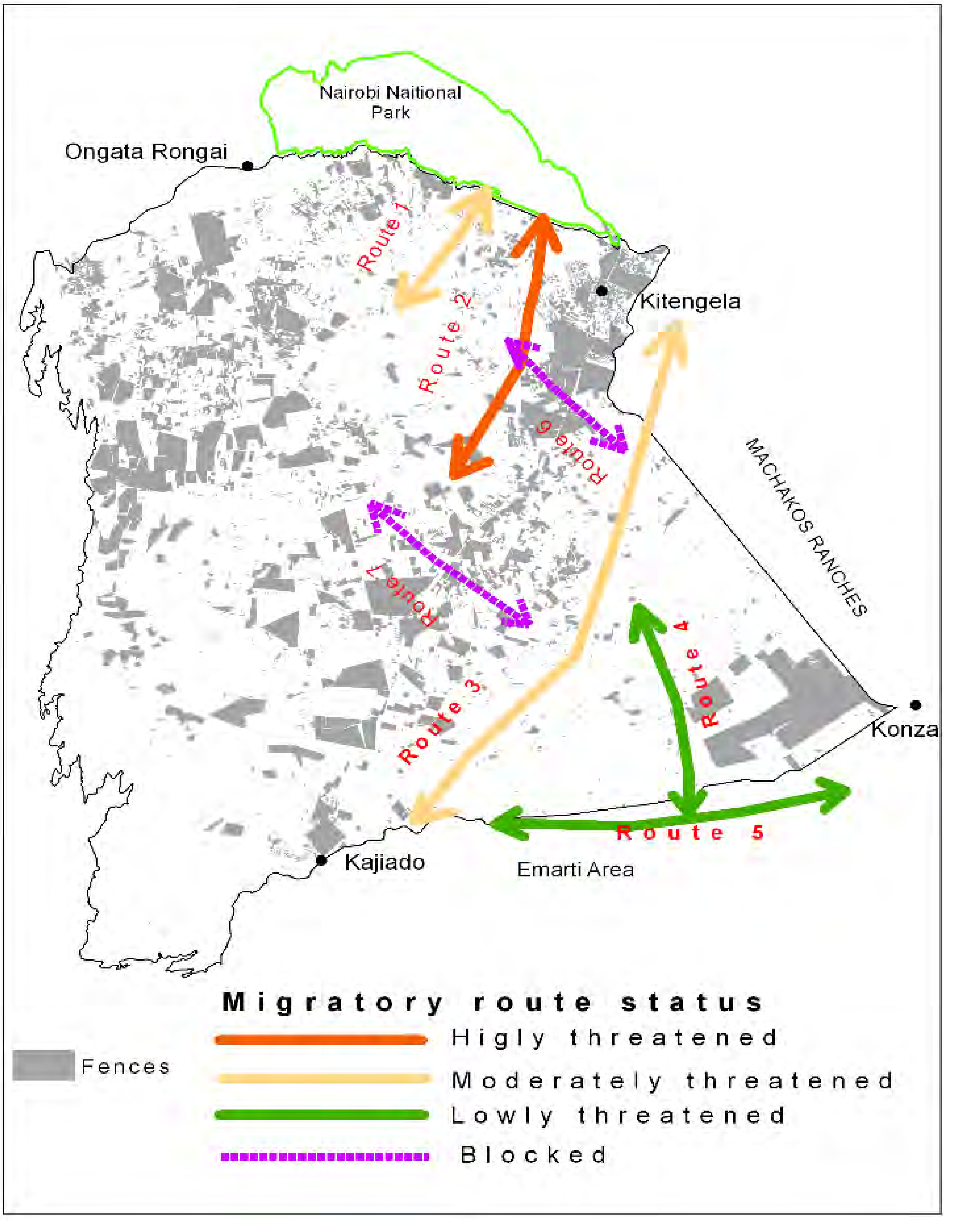
i. Land-lease programmes should be expanded to include areas formerly used by wildlife for migration and dispersal, especially during the dry seasons.

ii. Easement mechanisms should be encouraged and pursued in order to secure wildlife areas. Legislation should be developed to legalize the formation of a special fund to address the issue of easement programmes. Land-lease programmes should also be expanded to include all areas used as corridors by wildlife. *Responsible*: Conservation Trust, local landowners, and private entrepreneurs.

h. Watershed Management:

i. Carbon projects (REDD and REDD+ mechanisms) should be encouraged to rehabilitate the Ngong Hills, which supply water to the Athi-Kaputiei Ecosystem, through carbon payments. Restoration of the Ngong

**Map 7.15:** Migratory routes/corridors and threats in the Athi-Kaputiei Ecosystem (Nairobi NP-Kitengela Area). This map should be read together with Table 7.5 describing the routes.




Forest is crucial, if wildlife is to flourish in the Nairobi NP and on the Kitengela Plains. *Responsible*: Ministry of Environment, Water and Natural Resources.

ii. Payments for Ecosystem Services (PES) to up-stream water resource user associations (WRUAs) that use water responsibly and sparingly in highland areas should be encouraged, as a way of safeguarding the water security of downstream communities and people in urban centres. *Responsible*: Ministry of Environment, Water and Natural Resources; Ministry of Livestock Development; Ministry of Agriculture, and County government.

I. Management Plans need to to be revised to incorporate provision for new programmes, such as the development of conservancies. Responsible: Ministry of Tourism; County government; the Athi River Development Authority.

**Plate 7.9:** A herd of elephants in the Amboseli NP, with the ice-capped summit of Kilimanjaro in the background.

## 7.6. The Amboseli Ecosystem

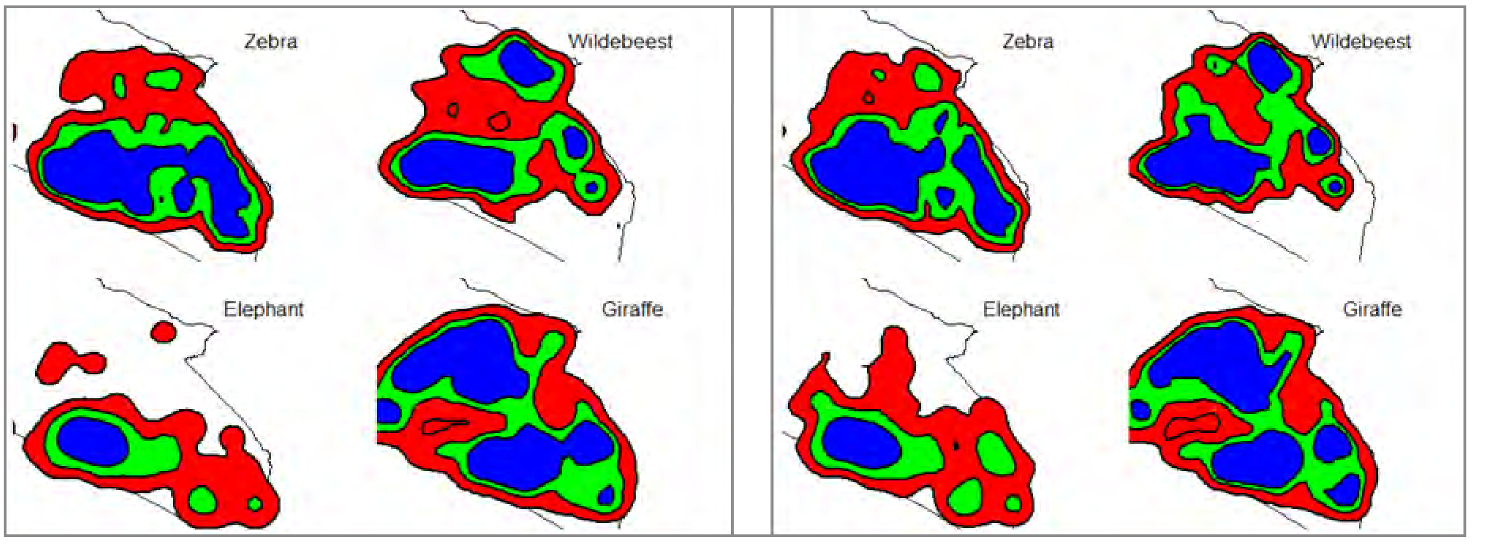
### Introduction

The Greater Amboseli Ecosystem is one of Kenya's leading tourist destinations. High concentrations of wildlife in the Amboseli basin at the foot of Mt. Kilimanjaro during the dry season is one of the quintessential images of conservation and tourism in Africa. Yet, this rich wildlife area is increasingly being threatened by the loss of critical habitats, especially along migratory routes and corridors. The area's increasing human population (in higher settlement densities) and associated activities (including agricultural expansion and growing livestock numbers) are putting ever greater pressure on dwindling natural resources. Development activities around the edges of the park, resulting from changes in land tenure and sub-division, as well as from expanding tourism infrastructure, have fragmented wildlife habitats and encroached on dispersal areas, disrupting the free movement of animals by blocking their migratory routes/corridors.

The Greater Amboseli Ecosystem consists of the Amboseli NP (392 km$^2$) and the six surrounding group ranches, of Kimana/Tikondo, Olgulului/Lolarashi, Selengei, Mbirikani, Kuku, and Rombo in Loitokitok District, which collectively cover 5,063.3 km$^2$. The ecosystem also includes 48 former individual ranches on the foothills of Mt. Kilimanjaro that are now under rain-fed agriculture. The community-owned group ranches around the Amboseli NP lie within the wet season dispersal areas for wildlife, and include several key habitats. The park itself, as the heart (core habitat) of the ecosystem, is utilized by the majority of the area's wildlife for both dry and wet season grazing. Swamps in the park are the lifeline for large populations of migratory species, but it is the interaction of these productive wetlands with the high-quality grasslands in the community-owned dispersal areas, and the essential linkages with neighbouring ecosystems, that underpin the resilience of this unique landscape.

The Greater Amboseli Ecosystem faces multiple challenges which are threatening the dispersal and movement of wild herbivores, and undermining the long-term resilience of the ecosystem. One of the biggest challenges is habitat loss and degradation. The vast community-run group ranches adjacent to the park are undergoing privatization and sub-division. This, combined with the general increase in the human population and in sedentarization, is disrupting wildlife habitats and key resource areas such as riverine forests, swamps, and wetlands. In more general terms, changes in land tenure have led to increased sales of land, and to the expansion of land uses incompatible with wildlife conservation, such as rain-fed and irrigated agriculture, quarrying, and unregulated tourist facilities.

**Map 7.16:** Kernel densities for zebra, wildebeest, elephant, and giraffe in the Amboseli ecosystem in the wet season (left) and the dry season (right). The Amboseli swamp remains the critical (core) habitat for all species year-round, except for the giraffe.




*Source: ACC.*

**Connections and Linkages**

Kernel densities for key species in the Greater Amboseli Ecosystem (zebra, wildebeest, elephant, and giraffe) were mapped to identify their core habitats, important habitats, and dispersal areas during the wet and dry seasons (Map 7.16). The maps show core components and individual connections and routes. The essential wildlife areas and connections include the Amboseli NP, the Chyulu NP, the Tsavo West NP, and trans-boundary areas (Mt. Kilimanjaro and Ngaserai) in Tanzania (see also Map 7.19).

Important dispersal areas (mainly essential as dry season refuges) are the Ol Kejuado flood plains and the Olgulului rangelands, while important linking corridors include the Olngosua, Kitendeni, the Isinya extension, and Rombo areas.

**The State of Conservation Connectivity**

**A. Drivers**

1. *Human population*: Increasing numbers, sedentarization, and associated activities.

2. *Land-use and land-tenure*: Insecure tenure, privatization, and increasing land sub-division; the sale of land; agricultural expansion, especially in key wildlife areas, and declining livestock mobility.

3. *Infrastructure and tourism*: Increasing pressure on water resources through development and peri-urbanization; unregulated tourism development around the Amboseli NP.

4. *Climate Change and variability*: Proneness to more frequent droughts.

5. *Policy*: Lack of clear policy, inadequate coordination mechanisms, and poor implementation across sectors and international boundaries.

**B. Pressure**

1. *Human population*: Increasing human numbers and their concentration around support structures and amenities such as markets, schools, medical facilities, and water services has led to an increase in sedentarization. This is especially true of the key resource areas and on the periphery of the Amboseli NP.

2. *Land-use and land-tenure*: Maasai pastoralists are turning increasingly to sedentarism, as opposed to a nomadic lifestyle. This has led to increases in livestock densities. Changes in land tenure have resulted in the sub-division of group ranches and the sale of individual parcels, which in turn has led to an increase in human settlements; agricultural expansion, especially around water sources; the fencing of swamps, and huge increases in water extraction. This is having a grave impact on the hydrological cycle, while the rampant burning of charcoal is resulting in environmental degradation.

3. *Infrastructure and tourism*: Completion of the Emali-Loitokitok tarmac road marks the beginning of a new era in the transformation of the Amboseli ecosystem. The upgraded road not only bisects the key migration route used by herbivores moving to essential wet season resources in neighbouring ecosystems, but it also increases the pressure on the land from sub-division and sales, while also facilitating the extraction of natural resources (such as charcoal and harvested sand). Although the road has enhanced tourism

through improving access to the Amboseli NP and to the conservancies, the gains associated with increased exposure and visitation are negated by the proliferation of badly planned and unregulated tourist facilities around the protected area.

4. *Climate change*: Climate change and variability are having a major impact on the protected areas. The steep declines in wildlife and livestock populations during the 2009 drought is evidence of this. Continuing habitat fragmentation is amplifying the effects of recurrent droughts in the ecosystem, and is heightening the isolation of the park. The near-collapse of the park's wildebeest population, the decline in buffalo numbers, and the increase in human-carnivore conflicts all underline the vulnerability of the Amboseli ecosystem. The park's gradual recovery after the 2009 drought is a testament to the relatively compatible land uses then practised by pastoralists in the surrounding areas, and to the absolutely critical role of wildlife corridors in providing lifelines to neighbouring ecosystems, which enable wildlife populations to recover even after such catastrophic die-offs.

**C. State**

1. Core Areas

a. *Land and habitat*: Intact, but compromised by the loss of some key habitats, declining habitat resilience, and edge effects caused by degradation and productivity losses in the key dry season grazing areas;

b. *Biodiversity losses associated with habitat loss*: Effective protection of certain flagship species, such as elephant, is essential, if biodiversity losses are to be averted;

c. *Wildlife populations*: Connectivity with neighbouring ecosystems, such as those of Chyulu, Tsavo and West Kilimanjaro proved critical in preventing the total collapse of Amboseli's wildebeest and buffalo populations during the 2009 drought. Further monitoring of herbivore population dynamics in the region is essential.

2. Dispersal Areas:

a. *Land-use changes*: Sedentarization and the expansion of pastoralist settlements has resulted in increasing land degradation and in the spread of conflicting land-use practices, which in turn have led to habitat loss, fragmentation, and homogenization, and to increased human-wildlife conflicts in the Amboseli-Olgulului North-Selengei vicinity and neighbouring areas;

b. *Agricultural expansion and intensification*: Irrigated farming in the Amboseli-Kitenden-Mt. Kilimanjaro area, and in the Amboseli-Olgulului North and Mbirikani areas, is causing declines in rangeland productivity and in grazing and forage ranges, leading to conflicts of interest;

c. *Fences:* Fence lines in the Amboseli-Kimana-Kuku-Chyulu-Tsavo West NP dispersal area are blocking wildlife movements.

**D. Impacts**

1. *Core Areas*: Reduced land resilience; restricted wildlife movements; declining productivity, and falling wildlife numbers.

2. Dispersal Areas:

a. *Habitat fragmentation*: Loss of dry season grazing pasture; damage to forests and wetlands; soil erosion; encroachments by undesirable species, and human-wildlife conflicts;

b. *Biodiversity losses*: An inevitable consequence of habitat fragmentation and loss, and declining wildlife numbers.

3. Connections and Linkages

a. The connection between the Tsavo West NP and the Amboseli ecosystem through the Kuku and Mbirikani group ranches has been curtailed, as has access to the Chyulu Hills;

b. The last remaining links in the ecological gradient extending down the northern face of Mt. Kilimanjaro to the Amboseli NP, are being severed, along with the corridor linking the montane forest with the lowlands;

c. Swamps such as Kimana and Lenker, which are critical to wildlife and livestock on the Kimana, Kuku, and Mbirikani group ranches, are being eliminated, which threatens the development of sanctuaries and tourism.

**E. Response**

1. Core Areas:

a. The Amboseli Ecosystem Plan is already in place and will soon to be gazetted. The Land Policy, Draft Wildlife Bill, and Trans-boundary Ecosystem Management Bill should be fast-tracked.

b. The management of protected areas is being strengthened through the inclusion of wildlife habitat extensions and the diversification of incentives.

2. Dispersal Areas:
   a. Participatory land-use planning mechanisms are being used to engage communities on all the Amboseli group ranches in projects that address conservation issues and which encourage the establishment of conservancies;

   b. Legal and economic instruments (leases, easements, and agreements) are being encouraged on the subdivided group ranches and on the as yet un-subdivided sections, in order to expand wildlife areas and promote the development of viable conservation ventures;

   c. Efforts to initiate Reducing Emissions from Deforestation and Forest Degradation (REDD) projects in the Chyulu and Mbirikani areas are being encouraged.

3. Connections and Linkages:
   a. Implementation of trans-boundary conservation initiatives is critical, especially along the Amboseli-Kitenden-Kilimanjaro wildlife corridor.

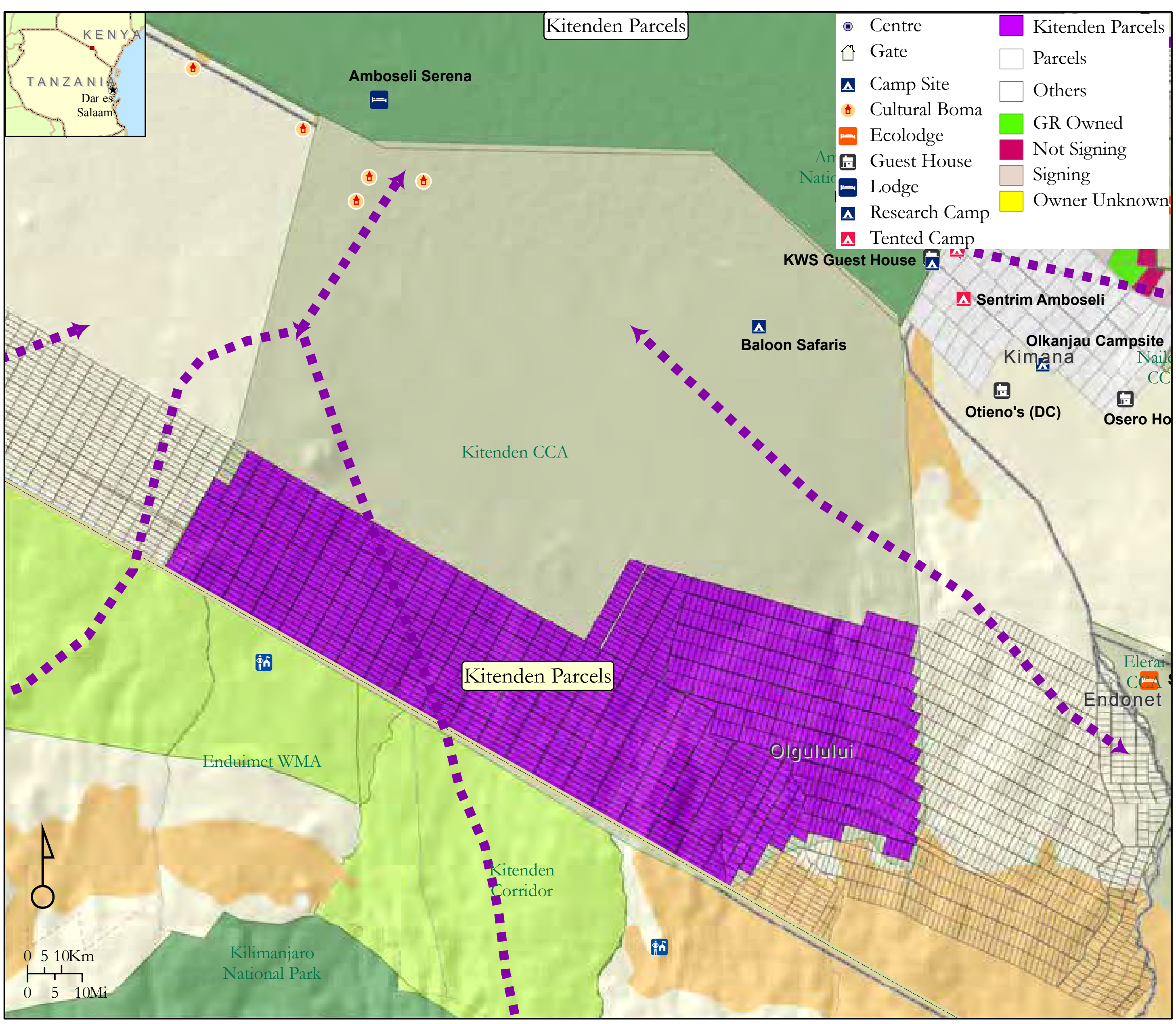
### F. Threats to Conservation Connectivity

The main threats to conservation connectivity in the Amboseli ecosystem are: increasing human population, agricultural expansion, land sub-division, overgrazing and degradation, sedentarization and settlements, fences, the destruction of wetlands and forests, unsustainable levels of water extraction, charcoal burning, poaching, bush-meat consumption, and human-wildlife conflicts.

A report submitted to the task force for the development of the Amboseli Ecosystem Plan (Western, D., 2007) identified the following threats to migratory routes and corridors in the Amboseli ecosystem (see also Maps 7.17a and b).

a. Farming, settlement, and sub-division, which threaten dispersal areas south of the park and wildlife routes to and from the Kilimanjaro forest.

**Map 7.17 (a):** Land sub-division, farming, and settlements threaten wildlife dispersal areas south of the Amboseli NP, on the Kitenden-Kilimanjaro and Kimana-Tsavo routes.



b. Settlements along the Loitokitok Pipeline, which threaten to sever migration corridors between Amboseli and the Mbirikani dispersal areas, as well as access to the Chyulu Hills.

c. Sub-division, shambas and fences around Namelok and Kimana, which threaten continued wildlife movements (especially of elephants) to and from Amboseli.

d. Farming using irrigation from the Kimana and Lenker Swamps threatens to sever access to the critical drought refuges on the Kimana, Kuku, and Mbirikani Group Ranches. Tourism facilities on these ranches are also threatened by loss of the swamps.

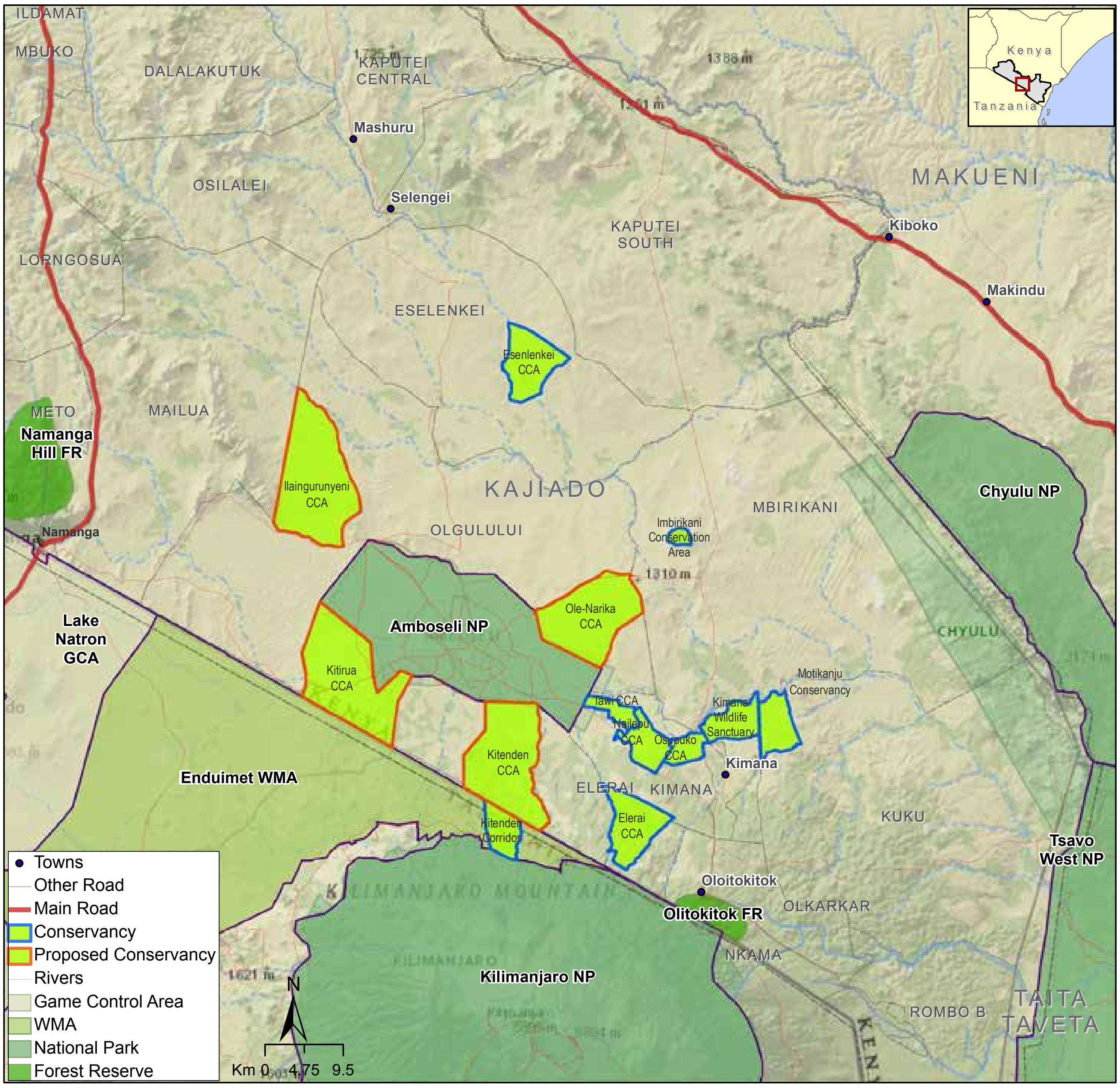
e. Farming along and water extraction from the Loleterish River threaten to dry up the riverine habitat and the Soit Pus Swamp, an important drought refuge connecting the Tsavo, Kuku, and Mbirikani wildlife populations.

f. Land sub-division and settlement on Selengei threatens to sever the link between the Amboseli and Eastern Kaputiei populations of migratory herbivores.

### G. Opportunities to Conservation Connectivity

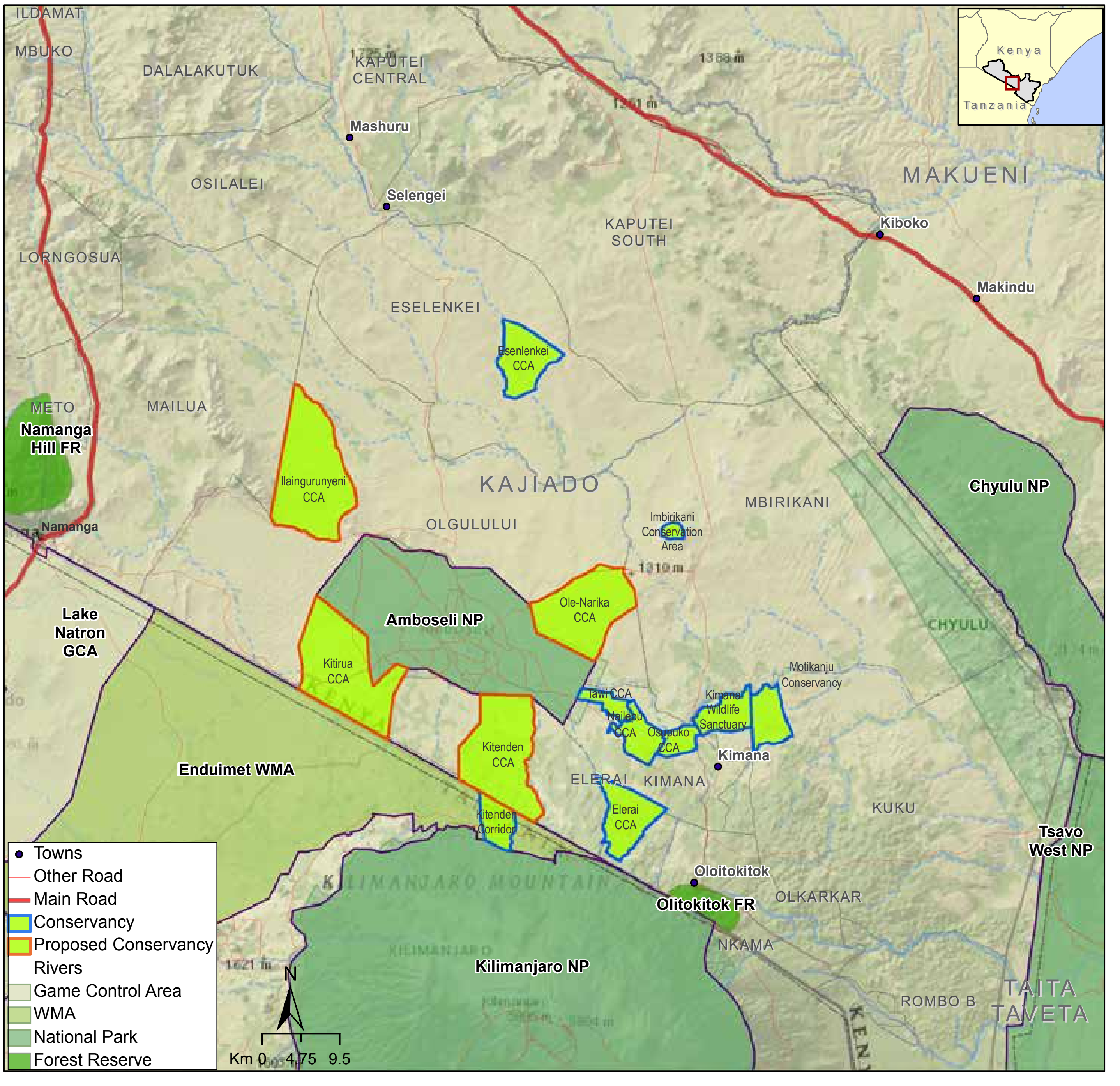
As more and more Maasai pastoralists have turned away from the nomadic life and towards a lifestyle of sedentarism, there has been an increase in livestock production as a means of sustaining livelihoods. At the same time, changes in land tenure have resulted in the sub-division of many of the once large group ranches into small, individually owned parcels. On finding that such small parcels are not viable on the rangelands, and that a combination of pastoralism and wildlife conservation is a better option, many of the pastoralists have reverted to the amalgamation of land parcels to form conservancies.

**Map 7.17 (b):** Land sub-division, farming, and settlements threaten wildlife dispersal areas south of the Amboseli NP, on the Kitenden-Kilimanjaro and Kimana-Tsavo routes.




Conservancies

**Map 7.18:** Community conservation areas form important wildlife dispersal areas and migratory routes/corridors outside the Amboseli National Park.




Conservancies

**Table 7.6:** Proposed conservancies in the Amboseli Ecosystem

| Conservancy | Location |
|---|---|
| Ileng'arunyani | Partly in Olgulului/Olorarashi GR and Mailua GR |
| Selengei-Kinyei | Selengei conservation area and proposed Kinyei conservation area |
| Losikutok | Establishment of a Rhino Sanctuary in Mbirikani GR. |
| Chyulu West | Western footslope of Chyulu hills traversing both Mbirikani and Kuku group ranches. |
| Motikanju | Kimana extension at the north-western tip of Kuku GR. |
| Kilotome | In subdivided Kimana GR, borders Amboseli NP and Olgulului/Olorarashi GR |
| Osupuko | Subdivided Kimana GR borders Mbirikani ranch and Oloitokitok-Emali road |
| Elerai | Footslopes of Mt. Kilimanjaro in Entonet. |
| Rombo Emampuli | In Rombo GR along the Rombo-Tsavo West boundary. |
| Kitirua-Kitenden | Kitirua concession and Kitenden elephant corridor in Olgulului/Olorarashi GR. |

*Source: KWS, 2008. The Amboseli Ecosystem Management Plan (2008-2018)*

Ownership and control of land is a significant issue in the establishment of community conservancies. Land not only offers empowerment in decision-making on resource management, but also confers on a community the pride of ownership and long-term security. Historically, pastoralists co-existing with wildlife outside protected areas have practised an open-access approach to land use, but traditional systems are struggling to keep pace with rapidly changing socio-economic conditions, and long-term security over land tenure is increasingly becoming a priority as pastoralists become more sedentary.

The establishment of conservancies reflects this need, in tandem with a growing recognition of the value of wildlife in providing an alternative livelihood strategy and as a contributor to the well-being of whole communities. On many of the group ranches where conservancies have been established, core areas, designated as livestock-free, have been demarcated for wildlife and tourism development. These conservancies form important conservation buffer zones for the Amboseli NP, while preserving the migratory routes and corridors that connect the park to neighbouring ecosystems.

### H. Wildlife Migratory Routes and Corridors

The migratory routes/corridors in the Amboseli Ecosystem were identified and assigned threat levels based on DPSIR analysis and on consultations with professionals and conservation stakeholders (Map 7.19). Some recommendations and responsibilities for each of the actions have also been identified.

**Table 7.7:** Connections and linkages, conservation threats, and action needs in the Amboseli ecosystem

| Routes | Threats | State | Action |
|---|---|---|---|
| 1 | High | Kitenden-Kilimanjaro - impinged by subdivision and irrigated agriculture | Immediate - needs legal and economic instruments to maintain connection |
| 2 | Moderate | Kitirua-West Kilimanjaro - challenged by sedentarization and fragmentation | Needs policy coordination across international boundaries |
| 3 | Moderate | Amboseli-Mailua-Namanga - challenged by sedentarization and degradation | |
| 4 | Moderate | Amboseli-Magadi-Shompole - challenged by sedentarization, fragmentation and degradation | |
| 5 | Low | Amboseli-Eselenkei-Imbirikani - open, threatened by agriculture and the impacts of new Emali-Oloitokitok tarmac road | Protect the remaining key habitats "stepping-stones" - e.g. swamps and riverine areas |
| 6 | High | Amboseli-Chyulu-Tsavo - invaded by subdivision, agriculture and settlements | - Immediate |
| 7 | High | Amboseli-Kimana-Tsavo - encroached by subdivision, agriculture and settlements | - Immediate |
| 8 | High | Kimana-Elerai-Kilimanjaro - impinged by subdivision, agriculture and settlements | - Immediate |

None Low Moderate High Blocked

**Recommendations**

**1. Immediate Action**

a. Gazette and implement the Amboseli Ecosystem Management Plan (2008-2018).

b. Establish conservancies on the Kimana and Kuku Ranches to link the Amboseli-Chyulu route.

c. Establish conservancies in Olgulului North and Mbirikani to link the Amboseli-Olgulului North-Mbirikani-Chyulu-Tsavo route, and encourage community conservation on the Olgulului and Olorarashi ranches.

d. Establish a conservancy in Olgulului South to connect the Amboseli-Olgulului-Loliondo-Longido route.

e. Establish a conservancy in Rombo to connect Chyulu-Rombo with Tsavo, and enhance security.

f. Secure the Amboseli-Kitenden-Kilimanjaro corridor, and keep areas south of the Amboseli NP open (unfenced) along the Kilimanjaro corridor by establishing grazing associations and grass-banks that will ensure continued wildlife and livestock mobility.

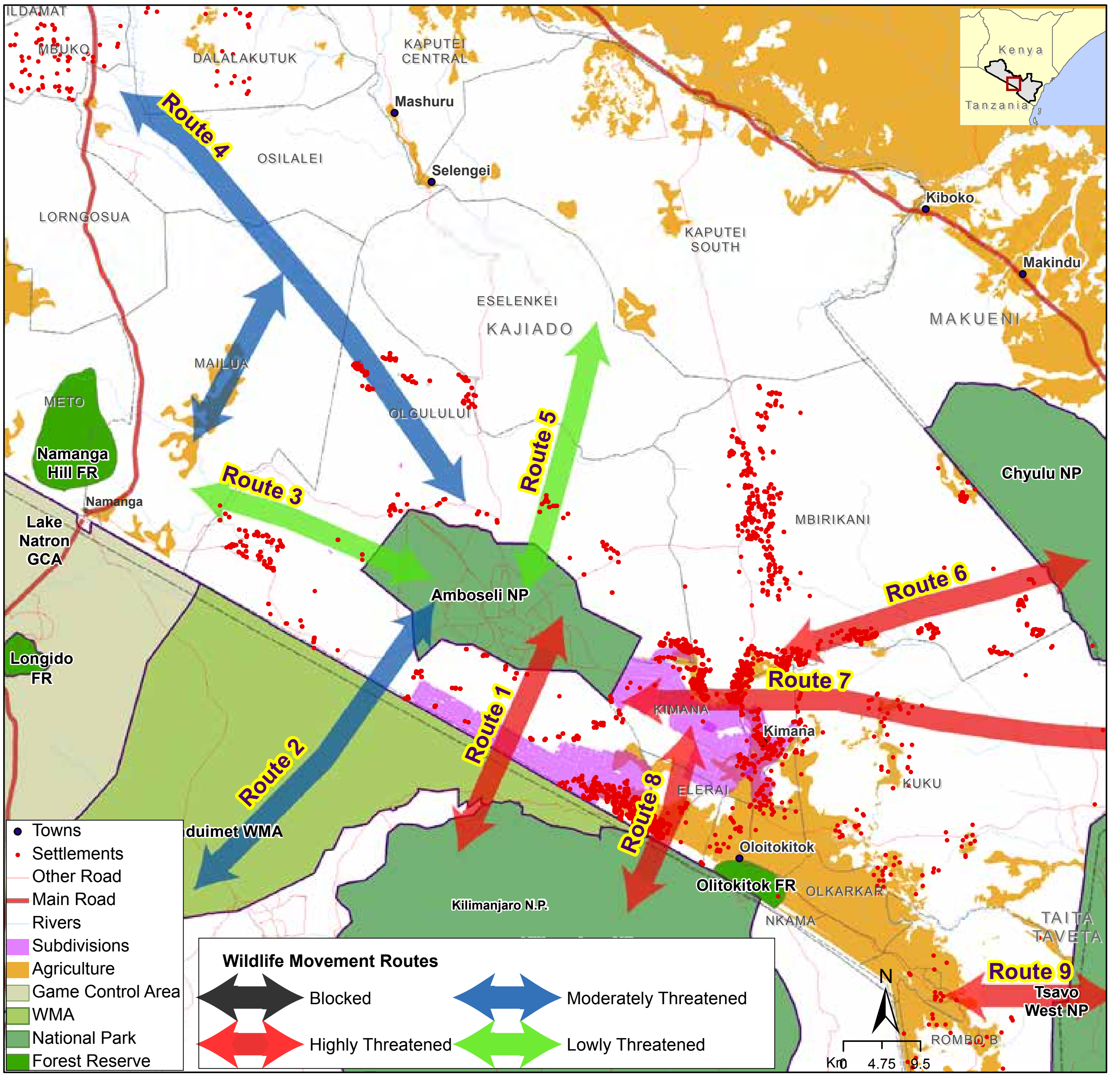
g. Maintain the Kimana-Namelog-Amboseli corridor delineated by elephant movements.

h. Draw up cross- border agreements in line with the EAC Ecosystem Bill.

**2. Medium -Long Term**

i. Establish mechanisms for ecological monitoring of the greater Amboseli ecosystem in collaboration with the Amboseli Conservation Programme (ACP), local communities, and other stakeholders.

**Map 7.19:** Wildlife migratory routes/corridors and threats in the Amboseli Ecosystem. To be read together with Table 7.7.




j. Establish water associations of downstream users aimed at legally safeguarding river flows and enforcing wetland regulations to establish grass-banks and drought refuges for livestock and wildlife.

k. Monitor wildlife populations and curb poaching through engaging community scouts on both sides of the border, linked to the wildlife authoriies and to the Amboseli-Tsavo Community Scouts Association.

l. Link up the South Rift Landowners' Association and the Amboseli-Tsavo Association, to explore prospects for a connecting tourist route between Magadi and Amboseli, establishing 'stepping-stone' grass-banks and wildlife refuges, while coordinating the activities of community scouts.

m. Develop plans aimed at protecting and restoring threatened species and habitats, and reducing poaching and human-wildlife conflict. Species plans should be based on individual threats and integrated into the overall ecosystem management plan.

n. Re-establish elephant migrations and explore ways of keeping open space within the Amboseli ecosystem for seasonal and drought movements of livestock using the landowner and grazing associations.

**Plate 7.10:** Baboons roost on a rocky outcrop in the Tsavo East NP. Photo: courtesy Philip Muruthi

## 7.7. Tsavo Ecosystem (Tsavo Conservation Area)

### Introduction

The Tsavo Ecosystem is the largest protected area complex in Kenya and comprises three contiguous national parks (Tsavo East NP, Tsavo West NP, and Chyulu NP), three adjoining national reserves (South Kitui NR, Tsavo Roads and Railways NR, and Ngai Ndeithya NR), and extends across the international border into Tanzania to Mkomazi Game Reserve. It also includes adjacent community lands and private ranches. Almost 45 % of the Tsavo Conservation Area (TCA) is protected. Non-protected areas (55 % of the TCA) include extensive cattle ranches (nearly 40 % of the whole) and small-scale crop cultivation, while 2 % of the area is under large-scale sisal plantations.

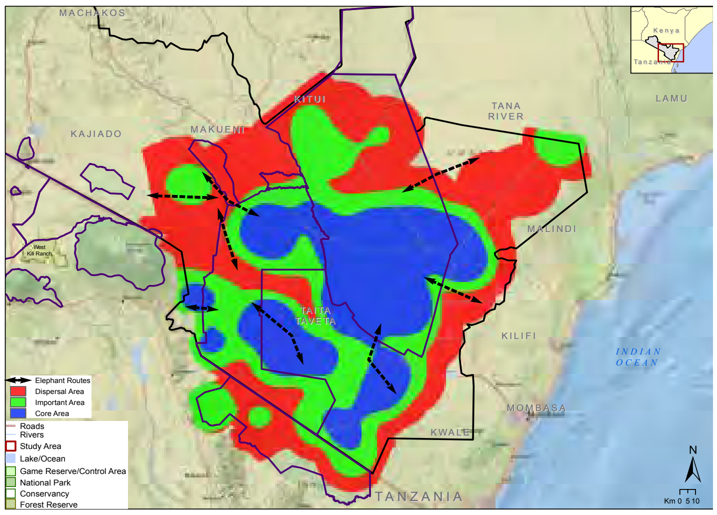
The Tsavo ecosystem is particularly important for its migratory wildlife species, especially the elephants that are known to migrate from the Tsavo West NP to Mkomazi Game Reserve in Tanzania. The Tsavo ecosystem contains a high number of endangered species, partly by virtue of its large size (44,000 km$^2$). It has the largest population of elephants in the country, and hosts populations of black rhinos, African wild dogs, Hirola (Hunter's hartebeest), and Grevy's zebras, all of which are classified as threatened. The latter two species (Hirola and Grevy's zebra) were translocated to the conservation area to give them increased protection.

The ecosystem is also a vital water catchment for much of the coastal lowlands in Kenya, and for some large towns. The Tsavo River (the only perennial water source in the area) and the Mzima Springs that lie within the ecosystem supply several large towns, including the port of Mombasa, with water for domestic and industrial use. A substantial portion of the Athi/Galana River (Kenya's second largest river system) flows through the Tsavo East NP.

### Connections and Linkages

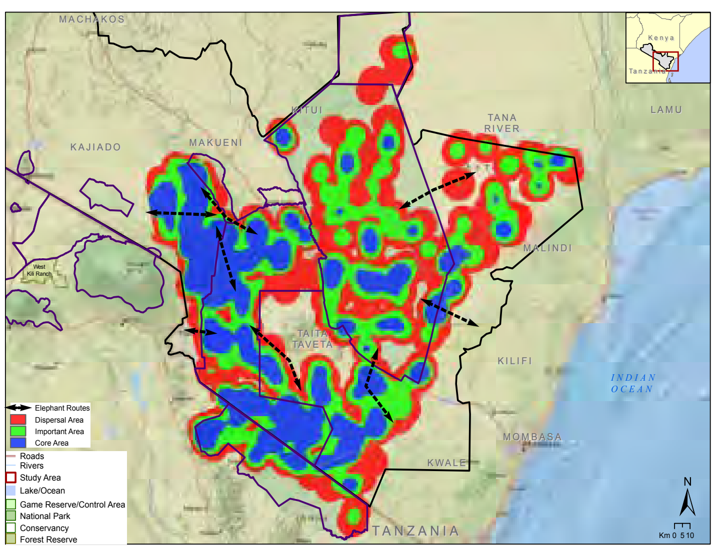
Kernel densities for key species (elephant, giraffe, and Burchell's zebra) in the Tsavo Ecosystem were mapped to identify core habitats, important habitats, and dispersal areas (Map 7.20; a, b, c). The maps show the main routes between the core components. Essential wildlife areas and connections include the Tsavo West NP, the Chyulu NP, the Tsavo East NP, the Galana Ranches, and dispersal areas in Taita-Taveta County, as well as trans-boundary areas (the Mkomazi GR in Tanzania).

**Map 7.20 (a):** Kernel densities for elephant in the Tsavo Ecosystem.



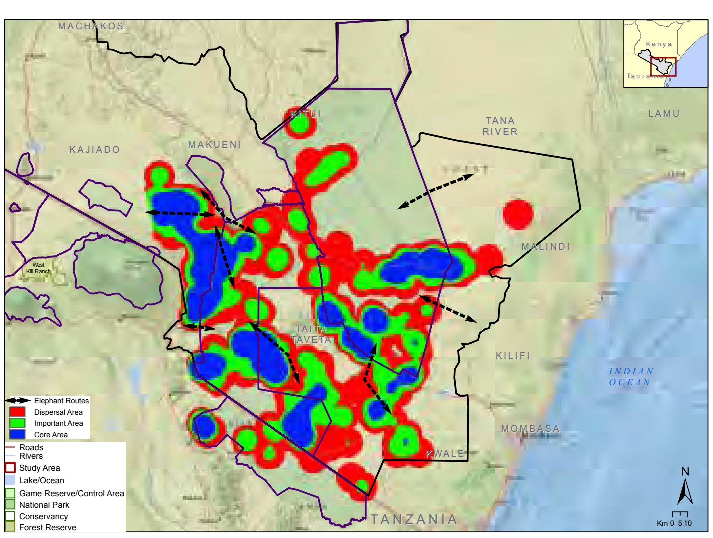

*Source: DRSRS/KWS datasets*

**Map 7.20 (b):** Kernel densities for giraffe in the Tsavo Ecosystem




*Source: DRSRS/KWS datasets*

**Map 7.20 (c):** Kernel densities for Burchell's zebra in the Tsavo Ecosystem.




*Source: DRSRS/KWS datasets*

The core area for elephants lies mainly within the southern half of the Tsavo East NP, but includes an expansive range outside the parks, to the south-west of the Taita Hills and along corridors linking the Tsavo West NP with Amboseli. Dispersal areas extend widely throughout the Tsavo ecosystem, taking in important areas on the Galana Ranches and in the Mkomazi GR in Tanzania. Core habitats for giraffe are spread widely across the ecosystem, but with concentrations in the Tsavo West NP, and in areas of overlap with the Amboseli Ecosystem outside the Chyulu NR, as well as in trans-boundary areas south of the Tsavo West NP in the Mkomazi GR. Core areas for Burchell's zebra are spead widely across the Tsavo West NP, extending west into areas outside the Chyulu NR which overlap with the Greater Amboseli Ecosystem, while also extending north into the southern part of the Tsavo East NP, and south into Mkomazi.

### The State of Conservation Connectivity

**A. Drivers**

1. *Human population*: Increasing numbers, sedentarization, and associated activities.

2. *Land-use and land-tenure*: Insecure tenure; privatization; increasing sub-division and sale of land in small parcels; expansion of agriculture (small-scale cultivation and sisal plantations) and livestock ranching, especially in key wildlife areas.

3. *Infrastructure and tourism*: Unsustainable use of water resources, and peri-urbanization.

4. *Climate change and variability*: Water scarcity as the result of more frequent droughts.

5. *Policy*: Lack of clear policy, inadequate coordination mechanisms, and poor implementation across sectors and international boundaries; inadequate incentives to encourage wildlife conservation and the development of conservancies.

**B. Pressures**

1. *Human population growth*: This has led to the increasing use of key resource areas outside the parks and reserves for agriculture (both small-scale crop cultivation and sisal plantations), and for livestock (under grazing leases). Fences, too, are proliferating. These trends are evident around the periphery of the protected areas, and especially south-east of the Taita Hills, which is a critical wildlife dispersal area linking the Tsavo West and Tsavo East NPs. Here, human-wildlife conflicts (crop damage, livestock predation, injury and/or death to humans) are rampant.

2. *Land-use and land-tenure*: The sub-division of ranches into small, individual parcels of land has led to a rapid increase in human settlements and to rapid agricultural expansion, especially around water sources, which are being cut off by fences. Unsustainable off-take of water is disrupting hydrological functions, while the impacts of rampant charcoal burning, forest destruction, bush-meat poaching, honey gathering (often the cause of wild fires), and gemstone mining are all contributing to environmental degradation.

3. *Infrastructure and tourism*: The Nairobi-Mombasa highway bisects key migration routes used by herbivores moving between essential wet and dry season resources, while facilitating the extraction of natural resources (through poaching, charcoal burning, sand harvesting, etc.). The highway has enhanced conservation through improving access to the national parks, but the gains associated with increased exposure and visitation are negated by the unregulated development of tourism facilities around the protected areas, and by the mowing down of animals by speeding vehicles.

4. *Climate change and variability*: The pattern of more frequent droughts is having a devastating impact on both wildlife and livestock populations (as borne out by the catastrophic losses suffered during the 2009 drought). At such times, competition over scarce resources results in a dramatic increase in human-wildlife conflicts, highlighting the vulnerability of the Tsavo ecosystem.

**C State**

1. Core Areas

a. *Land and habitat*: Intact, but compromised in some areas by degradation and by productivity losses which have reduced habitat resilience, especially in dry season grazing areas;

b. *Biodiversity losses associated with habitat loss*: Effective protection of certain flagship species, such as elephant and African wild dog, is essential, if biodiversity losses are to be averted;

c. *Wildlife populations*: Populations may crash again (as they did in 2009); so close monitoring of the vegetation and of the population dynamics of the large herbivores is essential.

2. Dispersal Areas

a. *Land-use changes*: Expanding settlements, environmental degradation, and conflicting land-use practices have led to the fragmentation, homogenization, and loss of habitats, and to increased human-wildlife conflicts;

b. *Agricultural expansion and intensification*: The spread of small-scale crop cultivation and sisal plantations has reduced the size and productivity of rangeland habitats;

c. *Fences*: These are blocking wildlife movements on routes linking the Amboseli-Kimana-Kuku-Chyulu-Tsavo West NP.

**D Impacts**

1. Core Areas

a. Reduced habitat resilience; declining productivity; diminishing rangelands, and falling wildlife numbers (of African wild dogs, for example).

2. Dispersal Areas

a. *Habitat fragmentation*: Loss of dry season grazing areas; destruction of woodlands; increased soil erosion; encroachment by undesirable species, and increased human-wildlife conflicts;

b. *Biodiversity losses*: The inevitable consequence of habitat loss and falling wildlife numbers.

3. Connections and Linkages

a. Links between the Tsavo East NP, Rukinga, and the Taita Hills are threatened by high-density settlements, fences, and small-scale farming;

b. Links between Maktau and Kasigau are threatened by high-density settlements, fences, and small-scale farming;

c. The route from Kamboyo to Chyulu is threatened by encroachments (of small-scale farming and settlements);

d. Links between Chyulu and Amboseli are threatened by land sub-division, the spread of irrigated and rain-fed agriculture, fences, and unregulated tourism developments;

e. High-density settlements and agriculture are threats in the Tsavo West-Lake Jipe area;

f. Corridor habitats linking the Tsavo East NP with Galana and with Kulalu have been degraded by livestock over-grazing.

**E. Responses**

1. Core Areas:

a. The Land Policy, the Draft Wildlife Bill, and the Trans-boundary Ecosystem Management Bill should all be fast-tracked;

b. Management of wildlife areas is being strengthened through the inclusion of wildlife extensions to protected areas, and through a diversification of conservation incentives;

2. Dispersal Areas:
a. Participatory land-use planning mechanisms and incentives are being used to engage local communities in conservation efforts, and to encourage the establishment of wildife sanctuaries and conservancies;

b. Legal and economic instruments (leases, easements, and agreements) are being used to encourage landowners on subdivided ranches and on as yet un-subdivided sections to create additional space for wildlife, and to promote the development of viable conservation ventures;

c. Efforts are being made to enhance conservation on the Chyulu Hills and in the Rukinga sanctuary through encouraging community involvement in the Reducing Emissions from Deforestation and Forest Degradation (REDD) programme.

3. Connections and Linkages:
a. Implementation of trans-boundary conservation initiatives is critical, especially with regard to the Tsavo West NP and the Mkomazi GR.

**F. Threats to Conservation Connectivity**

Increasing human populations and activities in areas adjacent to the protected area system are a major challenge for biodiversity conservation and for the maintenance of essential ecological processes. The main threats to conservation connectivity in the Tsavo-Mkomazi ecosystem are the increasing human population, settlements, agricultural expansion, land sub-division, livestock overgrazing/degradation, the destruction of wetlands and woodlands, fences, water extraction, charcoal burning, poaching and bush-meat consumption, and human-wildlife conflicts.

High-density settlements and the spread of small-scale farming around the Tsavo West and the Chyulu NPs are threatening to block migratory routes to and from the two parks. The same is true of areas around the Taita and Rukinga Hills, where human settlements and activities, along with fences, have blocked the direct connection between the Tsavo East and Tsavo West NPs, curtailing the movement of elephants (Map 7.23). Loss of forest cover on the upper Chyulu Hills, and farming and settlements on the lower slopes, are threatening to sever vital ecological links between the Tsavo West NP and the Amboseli ecosystem. Off-take of water draining from the Chyulu Hills is threatening habitat diversity in historically important drought refuges.

In an effort to mitigate human-wildlife conflicts in the Tsavo-Mkomazi ecosystem, the Kenya Wildlife Service (KWS) has overseen the construction of a number of electric fence lines at conflict hotspots along the Tsavo NP boundary (Maps 7.21). Such fences have in many cases proved effective in minimizing conflicts (crop damage, livestock predation, and injury or even death to humans) through containing 'problem' wildlife populations within protected areas. In most cases, however, delineation of the protected area boundaries did not take into account the full ecological needs of wildlife species, i.e. the extended dispersal areas and migration routes outside the narrow confines of the protected areas that most of the larger animals need in order to sustain their populations (Lusigi, 1981). At times of severe stress, mainly during periods of drought, fences may lead to the death of many animals, through denying them access to water and forage in the dispersal areas, while forcing them into degrading the habitats of the protected areas in which they are confined. Some animals, notably elephants, will break the fences, in their desperate quest to find water and forage.

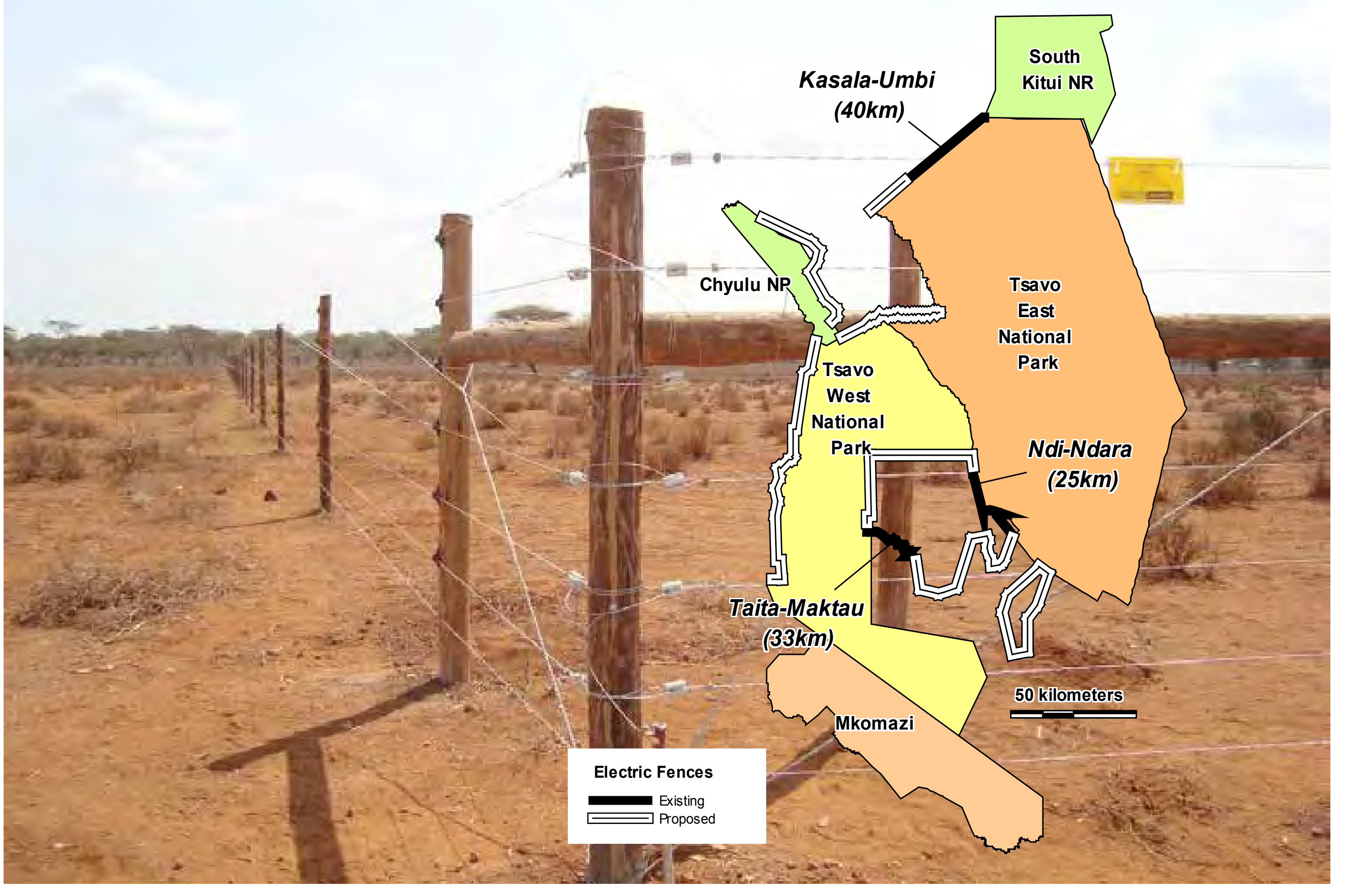
**G. Opportunities to Conservation Connectivity**

Among protected areas in Kenya, the Tsavo East and Tsavo West NPs are second only to the Masai Mara National Reserve (MMNR) in terms of the numbers of visitors they receive. The two parks attract more than 200,000 visitors per annum. Most of these visitors come on package tours from the coastal resort towns of Mombasa, Kilifi, and Malindi, or from the south coast. Most are attracted by the high concentrations of wildlife that can be found gathered around the few water points, where the animals are easily visible. The new Standard Gauge Railway (SGR), once completed, will offer panoramic views over the long underpasses (See also impacts of the SGR on wildlife, above). If the recent increase in the Tsavo ecosystem's elephant population is to continue, then connectivity between core habitats will be essential in enabling the animals to migrate to dispersal areas, especially during the dry seasons. It is critical that traditional migration routes remain open and accessible, if conflicts between wildlife and people are to be mimimized.

**H. Impact of High-Speed Railway Passage on Wildlife in the Tsavo Ecosystem**

Data on elephant movements, recorded with advanced satellite radio-tracking collars, can be crucial to the informed planning of infrastructure projects. With such data, the securing of wildlife space, as part of an

**Map 7.21:** Existing and proposed fences at 'hotspots' along Tsavo NP boundary.




*Source: KWS*

integrated approach to sustainable land use, can be planned with precise spatial definition. In March 2016, KWS and Save The Elephants (STE) collared 10 elephants from both sides of the new Standard Gauge Railway (SGR) across the Tsavo NP to monitor the effects of this major infrastructural development on elephant movements and behaviour. This will be a precursor for the planning, in wildlife-rich areas, of future developments (such as the LaPSSET corridor in northern Kenya). Using data from the radio collars, detailed maps can be generated, showing wildlife crossings and their intensity of use, while enhancing the understanding of connectivity within an ecosystem. This information can be used to improve infrastructural planning (Map 7.22 and plate 7.11).

Sections of the SGR track traversing the Tsavo ecosystem are elevated on bridges, so as to allow wildlife migration and movement. Where the trains will run 'above' the park, wildlife – in being able to move back and forth under the bridges – will have unhindered access to habitat on both sides of the railway line. Some of the bridges, of almost one kilometre in length, have underpasses that are over 20 metres high (and which are nowhere under 6 metres in height). Other, normal sections of the track are raised slightly, above the level of the flanking terrain, and are fenced in from either side, so there is no danger of the high-speed trains' colliding with wildlife. Even so, some lobbyists have argued that the railway may split Kenya's largest national park, and home to most of the country's elephants, into two sections, making wildlife mobility on pre-existing corridor crossings difficult (Okita-Ouma *et al*., 2016, a and b).

### I. Wildlife Migratory Routes and Corridors

Most of the larger mammals and carnivores in the Tsavo ecosystem come under intense human pressure in the dispersal areas on which they depend for their requirements. The Taita ranches (Map 7.23) create a wide gap between parts of the Tsavo East and Tsavo West NPs. This critical pathway for elephants is now covered with a patchwork of settlements and agricultural activities, criss-crossed by fences, curtailing elephant movements and causing human-elephant conflicts. Additional support for existing community conservancies and the establishment of new conservancies will help to create contiguous habitats for wildlife outside the protected areas, while at the same time helping to improve community livelihoods through incentives that will enable people to benefit from payments for ecosystem services and from wildlife conservation, eco-tourism, and related enterprises). Existing elephant routes (Map 7.24) have been identified as follows (Table 7.8).

**Map 7.22:** Movements of 10 collared elephants in the Tsavo ecosystem, showing crossings of the new Standard Gauge Railway, and of the Mombasa-Nairobi and Voi-Taveta highways in March-September 2016.

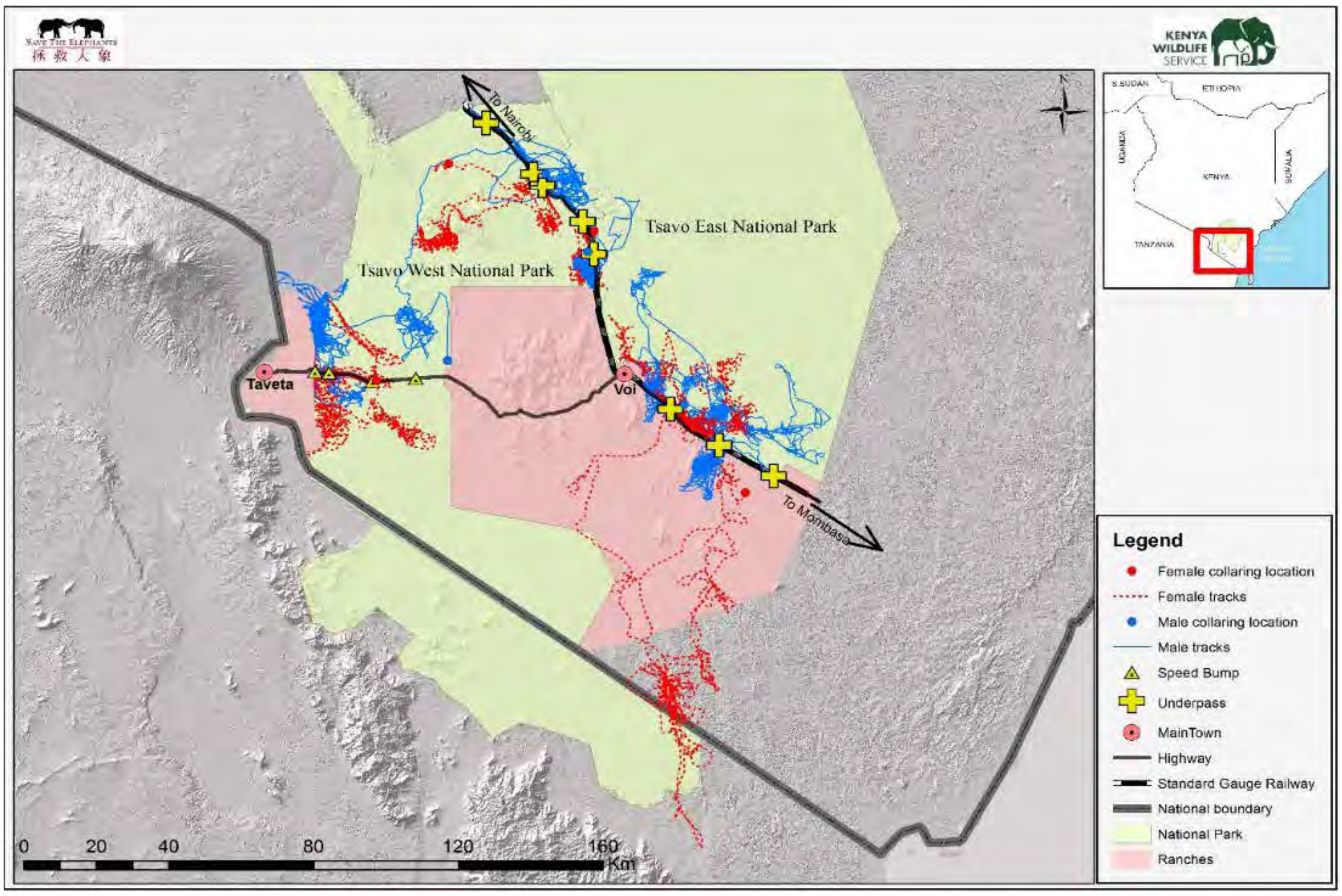



**Plate 7.11:** Aerial view of the SGR Tsavo River super-bridge, with underpass for use by wildlife. Next to it is the Mombasa-Nairobi highway. An overpass allowing animals to cross the highway needs to be urgently considered. Photo: courtesy Richard Moller/Tsavo Trust.

**Recommendations**

1. **High Priority Actions**

a. Secure contiguous habitats for wildlife through establishing new wildlife conservancies around the Tsavo-Mkomazi ecosystem, and in the following areas especially: Taita Discovery Centre, Yatta II, Galana, Kulalu, Saghasika, Kishushe-Mburia, Rombo, and Kasigau. *Agencies*: Kenya Wildlife Service (KWS), local communities and stakeholders.

2. **Medium Priority Actions**

a. Develop and gazette participatory land-use plans for the conservancies in Galana, Kulalu, Saghasika, Kishushe-Mburia, Rombo, and Kasigau.

b. Develop co-management arrangements between KWS and the ADC Galana ranch to ensure optimal range use for both livestock and wildlife, to prevent over-grazing/degradation.

c. Strengthen trans-boundary wildlife conservation and management collaboration between KWS and the Tanzania National Parks Authority (TANAPA).

d. Implement REDD+ programmes that have been proposed for the Chyulu Hills, the Rukinga Sanctuary, and the Taita ranches.

**Map 7.23:** Land-use on the Taita ranches, some of which straddle critical elephant routes/corridors.

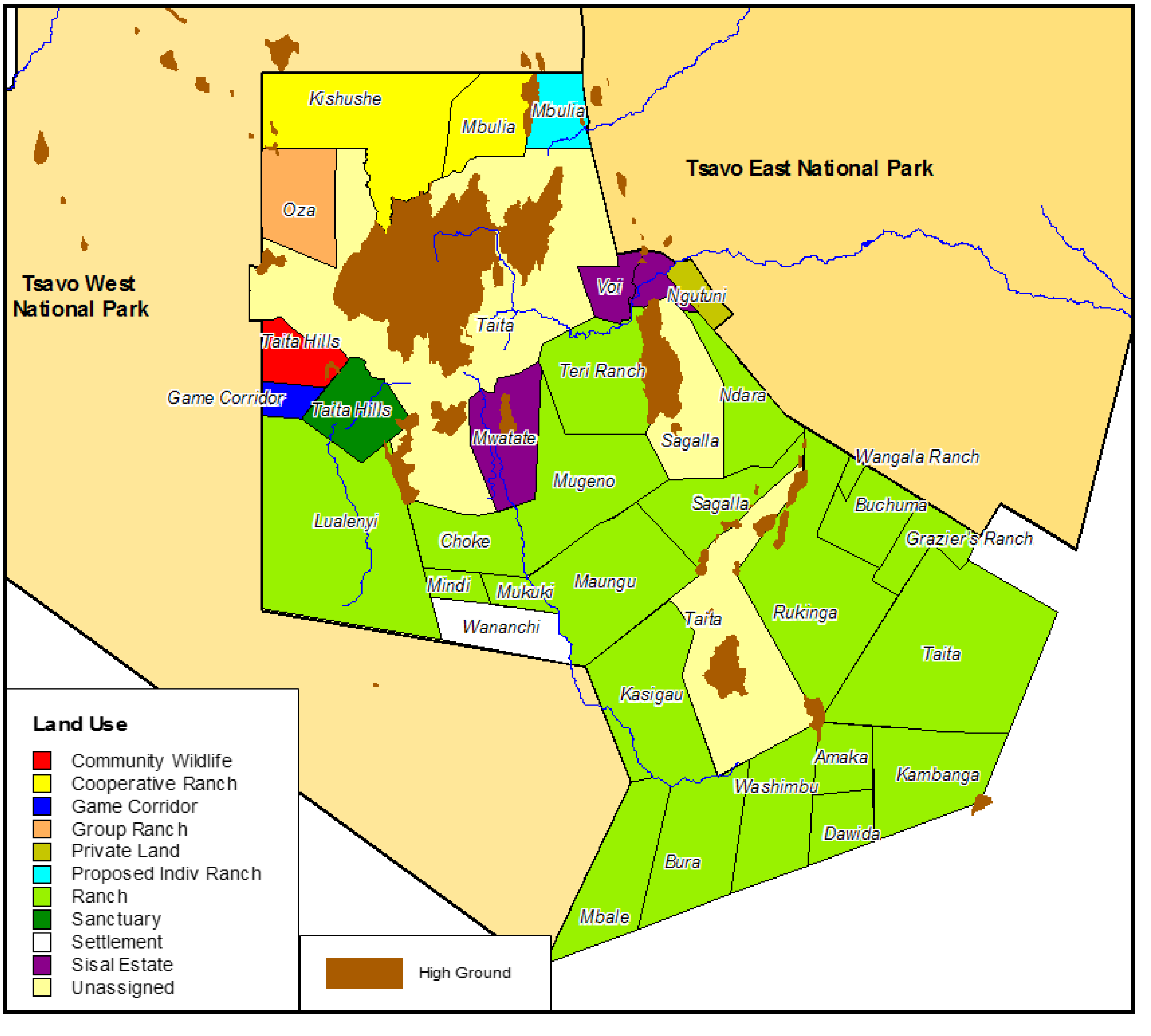
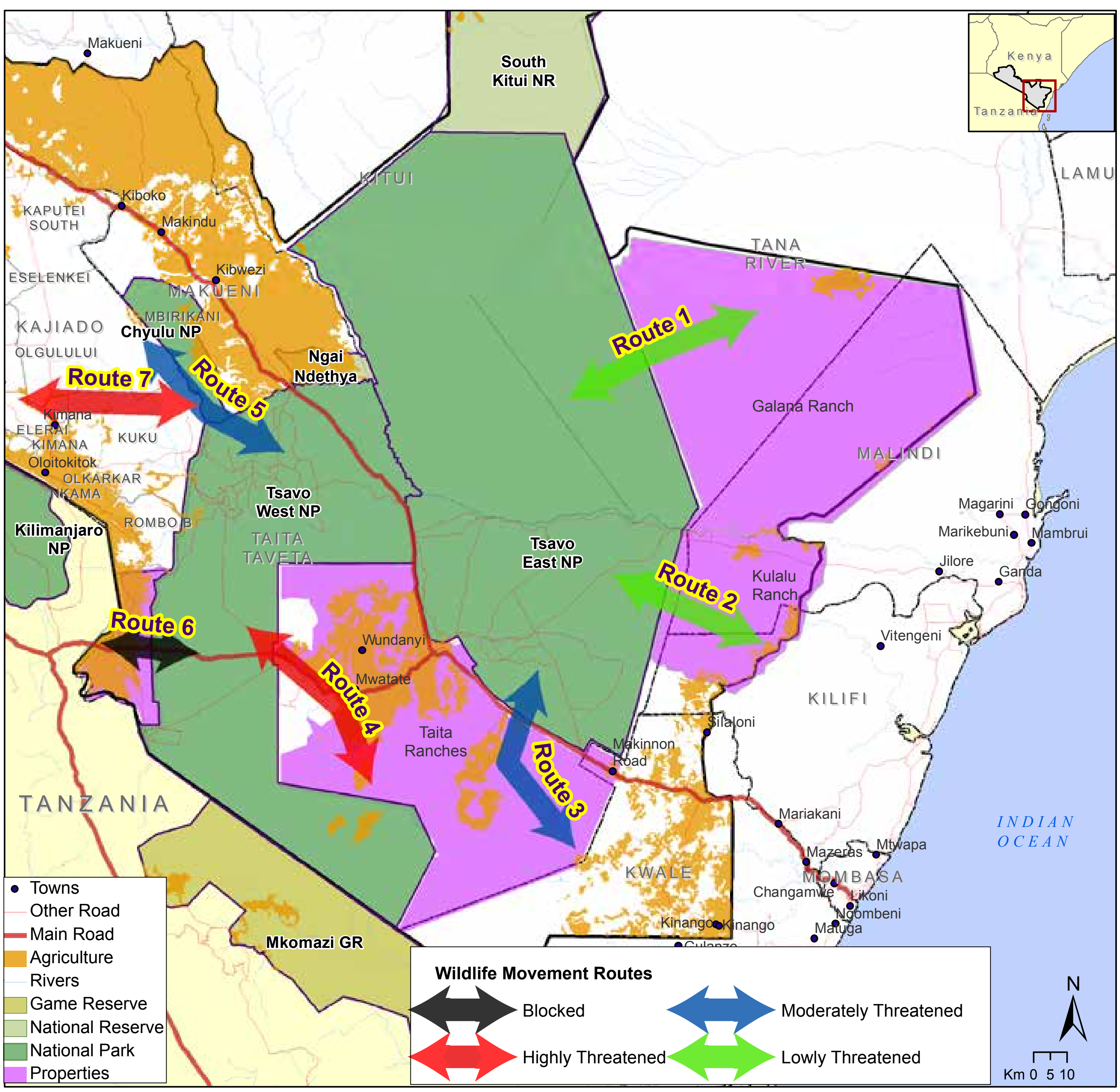


**Table 7.8:** Connections and linkages, threat levels, and actions needed in the Tsavo Ecosystem. To be read together with Map 7.24.

| Routes | Threats | State | Action |
|---|---|---|---|
| A, B, C | | Tiva River crossing, Gaps in Yatta and Ngulia to Yatta - critical elephant corridors inside the park | Monitor the vegetation dynamics, and effects of Standard Gauge Railway (SGR) on elephant movements and behaviour |
| 2&1 | | Tsavo East to Galana and Kulalu Ranches - degraded through overgrazing by livestock | Immediate - landowners to adapt proper range management |
| 3 | | Southern part of Tsavo East NP to Rukinga and Taita hills - fences ;and small-scale farming | Immediate - establish conservancies in the ranches |
| 4 | | Maktau to Kasigau - settlements, small-scale farming and fences blocking wildlife movement | Immediate - establish conservancies and fences |
| 5 | | Kamboyo to Chyulu - heavily encroached by small-scale farming and settlements | Immediate - construct and maintain fences to separate farms and settlements from wildlife areas |
| 6 | | Tsavo West NP to Lake Jipe - blocked by settlements, small-scale farming and fences | |
| 7 | | Chyulu to Amboseli - subdivision, irrigated agriculture, fences and tourism developments | Immediate - establish conservancies, restore wetlands |

None Low Moderate High Blocked

**Map 7.24:** Wildlife migratory routes/corridors in the Tsavo-Mkomazi ecosystem (see Table 7.8).



## 7.8. Range Contraction in the Northern Rangeland and Coastal Terrestrial Ecosystems

### 7.8.1. Elephant Range

Kernel densities were used to identify core habitats, important habitats, and dispersal areas for elephants in the Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands, and the coastal terrestrial ecosystem (Maps 7.25 a, b, c, d). In the 1970s, elephants were widely distributed, with concentrations on the north coast (the Boni and Dodori NRs) and south of Garissa, and with pockets in the greater Ewaso ecosystem and in the trans-boundary ecosystem of north-western Kenya and eastern Uganda (to the Kidepo NR). Now, the core area for elephants is in the Laikipia-Samburu-Isiolo landscape, much of which lies outside protected areas.

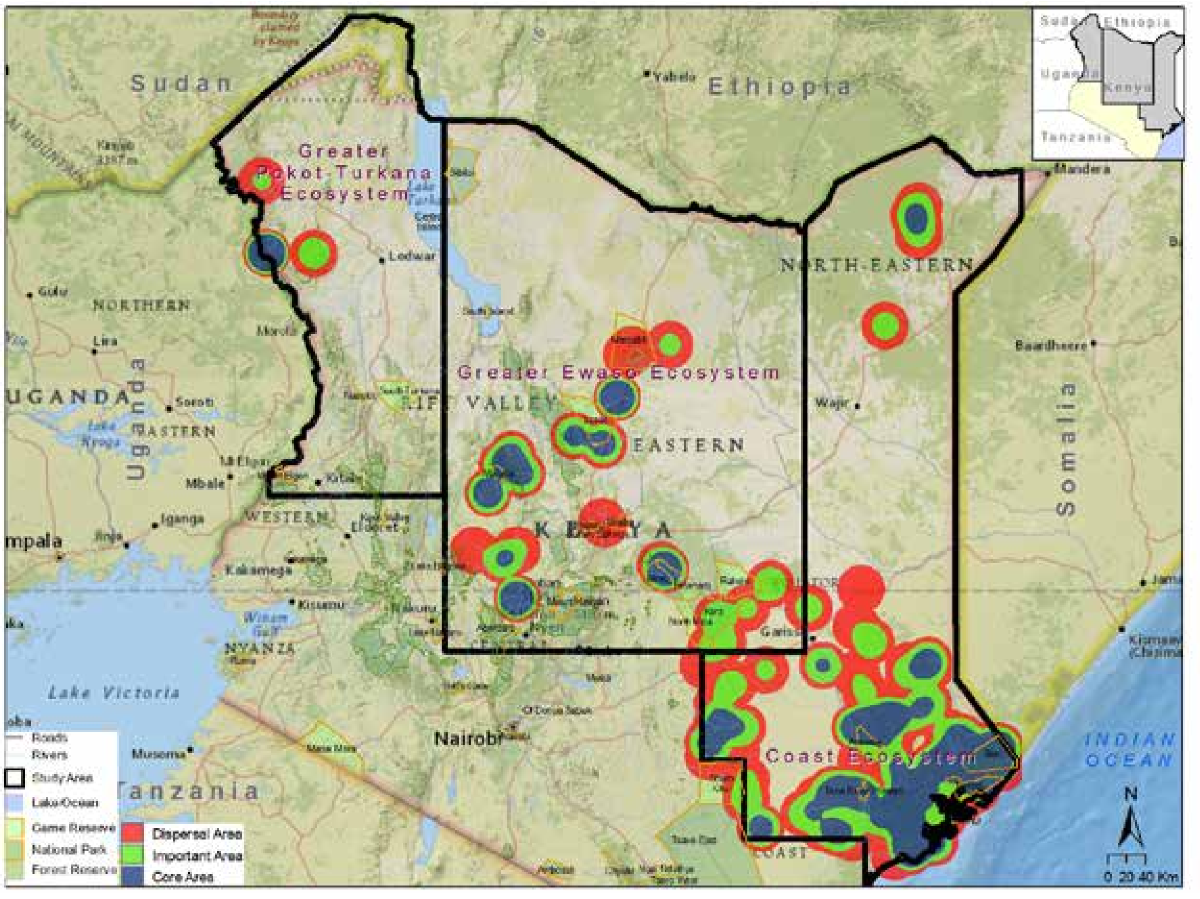
The greater Ewaso ecosystem has a limited network of protected areas, but in 2012 it was found to host an estimated 6,454 elephants, down from 7,514 four years ealier (2008 census). This is the second largest elephant population in the country (after that which occurs in the southern Kenya rangeland ecosystems of Tsavo-Mkomazi, Amboseli, and the Mara).

Elephant movements within the greater Ewaso ecosystem (spanning Laikipia, Samburu, Isiolo and Marsabit Counties), and in the wetter Mt. Kenya region were monitored between 1998 and 2012. Over this period, more than 100 collared elephants (in a male: female ratio of roughly 50:50) were tracked, some animals for up to six years (Save The Elephants).

### 7.8.2. Grevy's Zebra Range

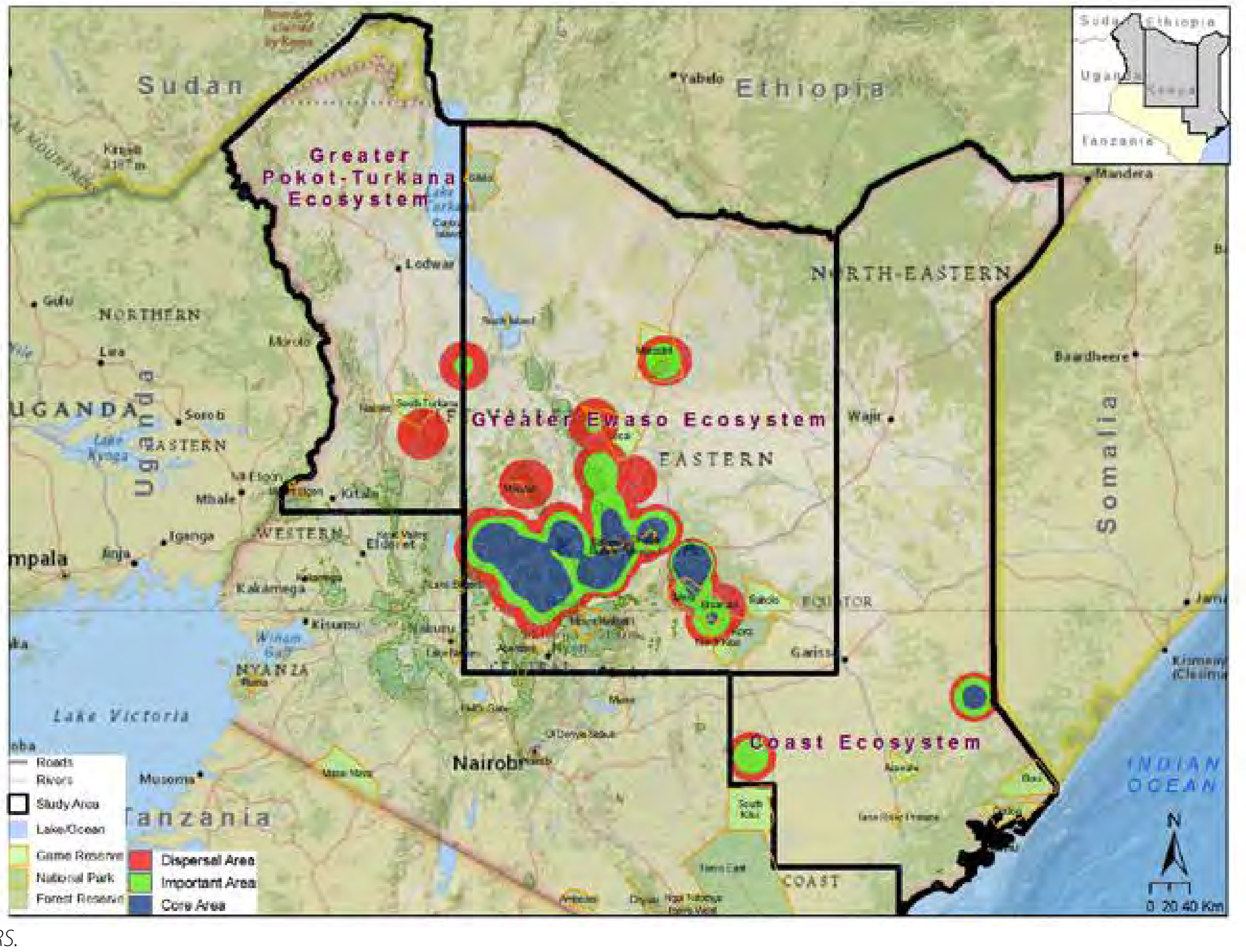
Grevy's zebra has undergone one of the most substantial reductions in range, of any species, since wildlife distribution records began (DRSRS database, 1978-2011; Kingdon, 1997). Historically, the species was distributed widely across the Horn of Africa, in several countries, including Djibouti, Eritrea, Somalia, and Ethiopia, as well as Kenya, and with reported sightings in Sudan. Today, Grevy's zebras persist only in northern Kenya, with a few animals in Ethiopia

**Map 7.25 (a):** Kernel density and range for elephants in the 1970s in Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands and the north coast terrestrial ecosystem showing core areas (blue), important areas (green) and dispersal areas (red).



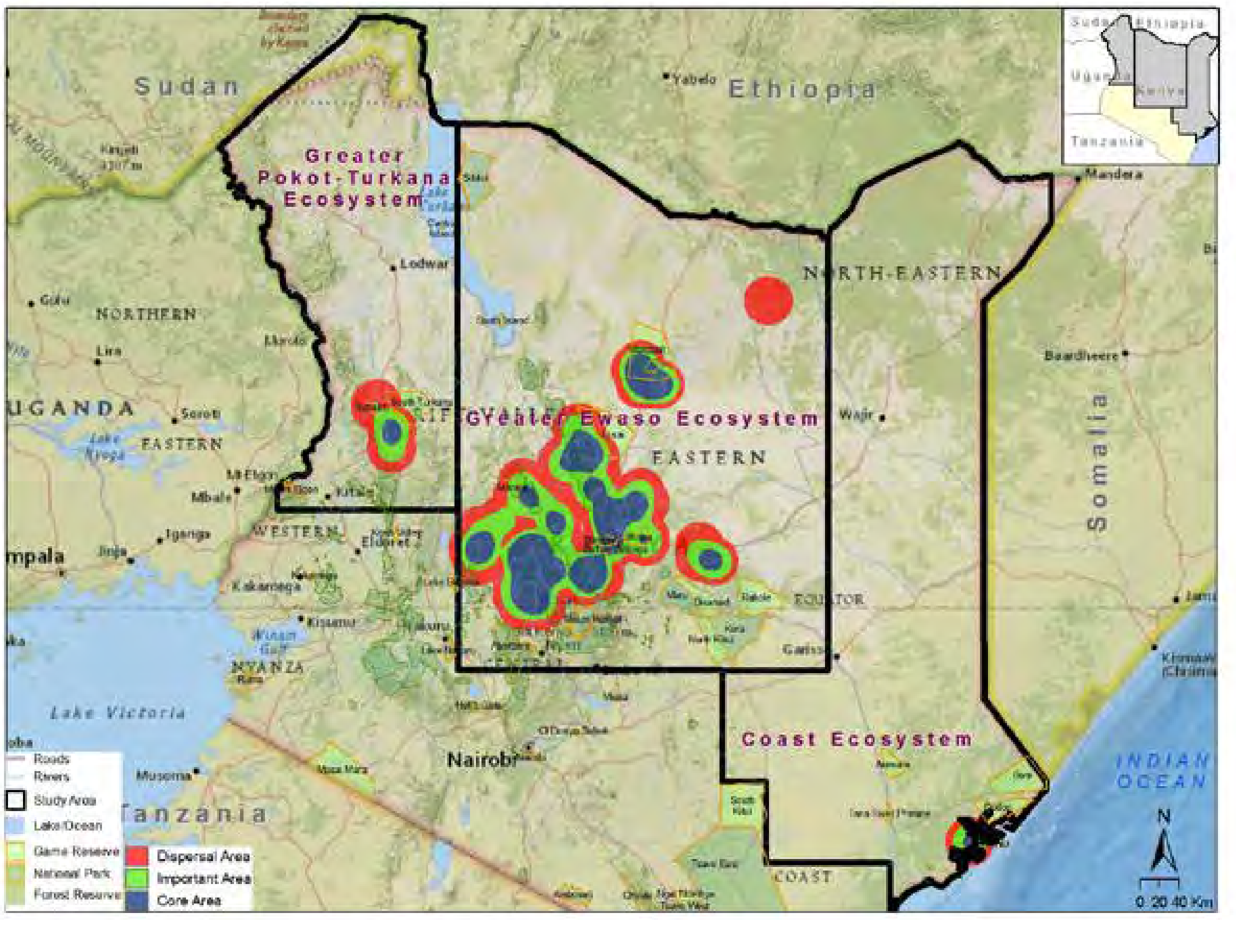

*Source: DRSRS.*

**Map 7.25 (b):** Kernel density and range for elephants in the 1980s in Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands and the north coast terrestrial ecosystem showing core areas (blue), important areas (green) and dispersal areas (red).



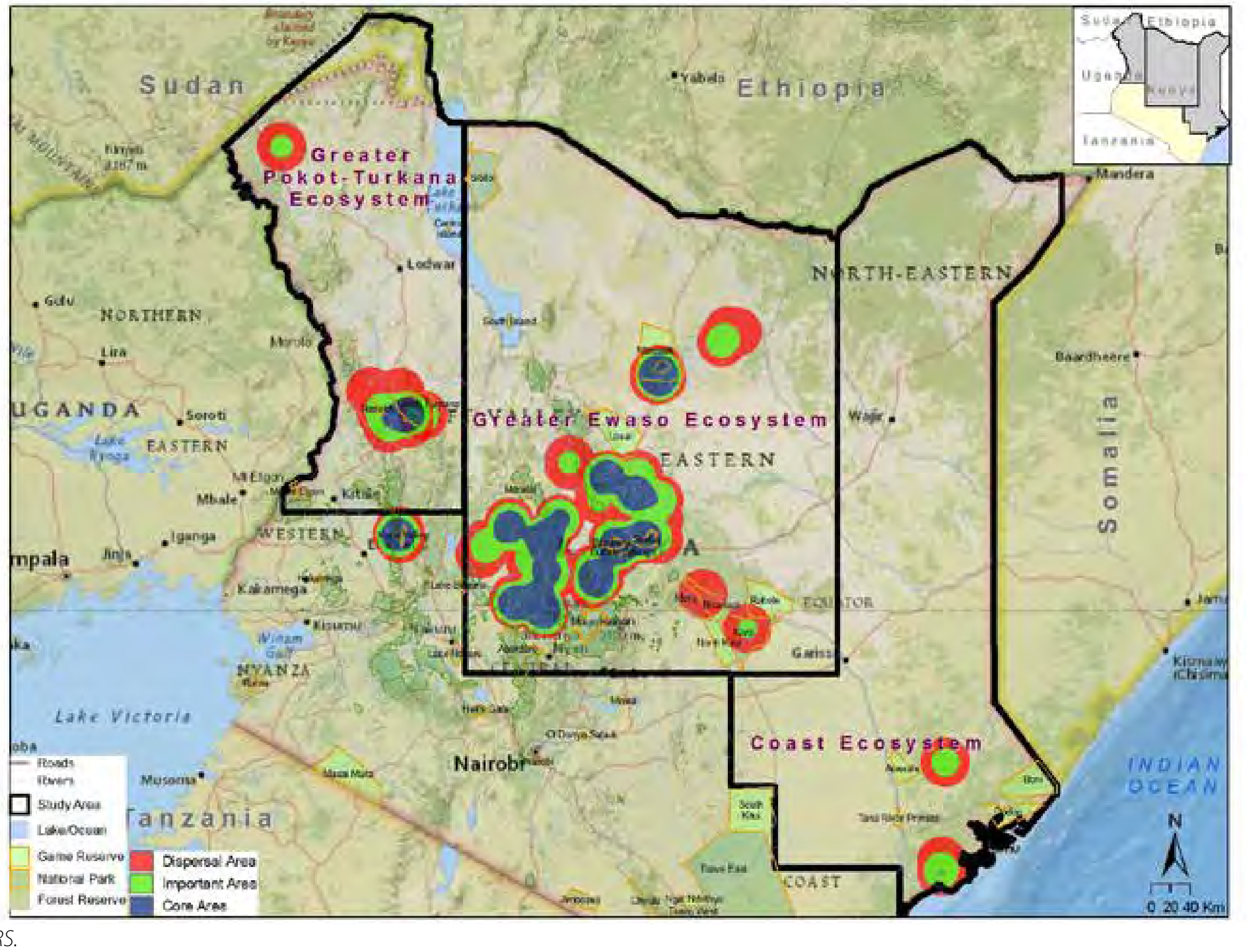

*Source: DRSRS.*

**Map 7.25 (c):** Kernel density and range for elephants in the 1990s in the Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands and the north coast terrestrial ecosystem showing core areas (blue), important areas (green) and dispersal areas (red).



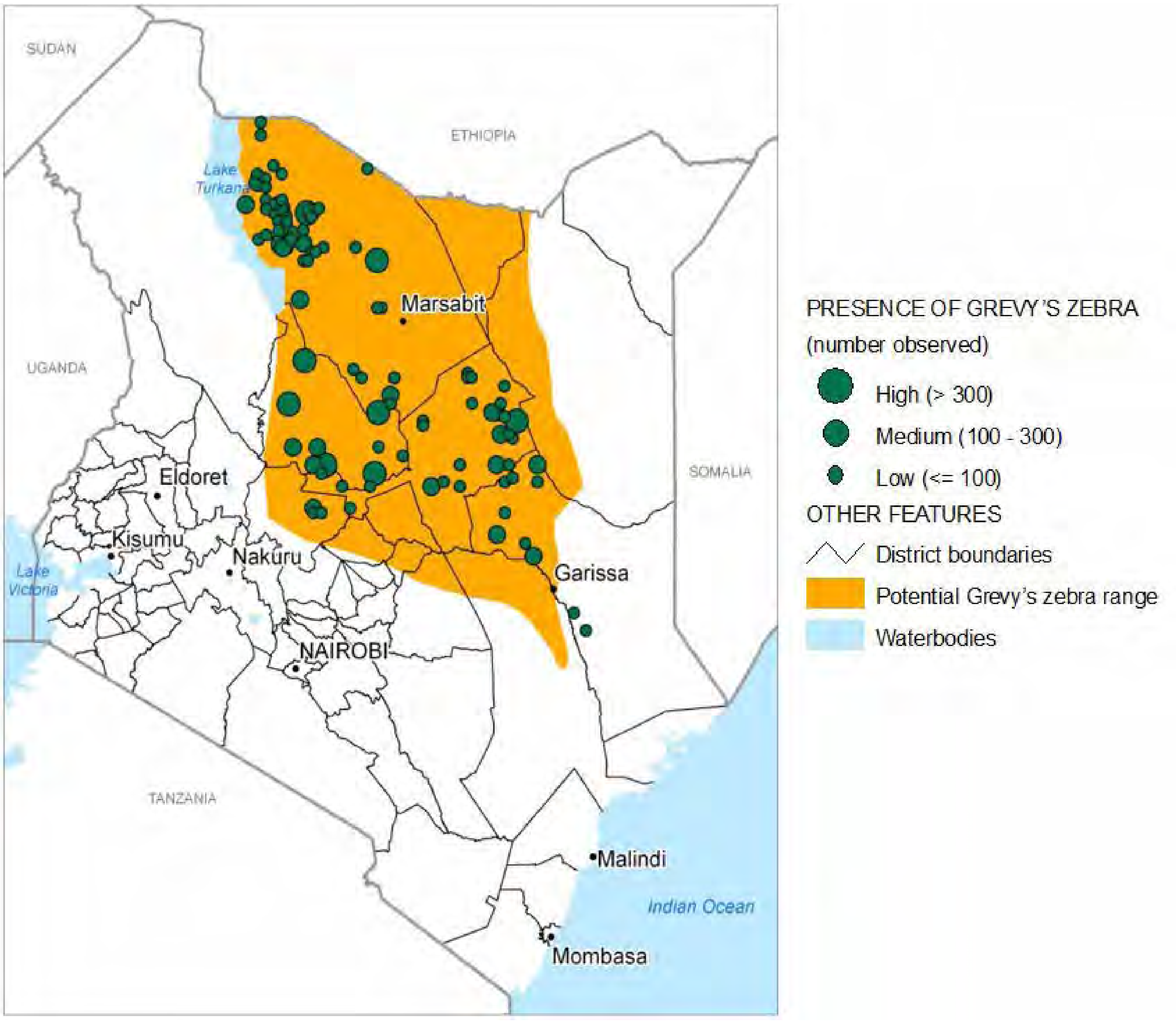

Source: DRSRS.

**Map 7.25 (d)**: Kernel density and range for elephants in 2000s in the Turkana-Mt. Elgon landscape, the greater Ewaso ecosystem, the north-eastern rangelands and the north coast terrestrial ecosystem showing core areas (blue), important areas (green) and dispersal areas (red).




Source: DRSRS.

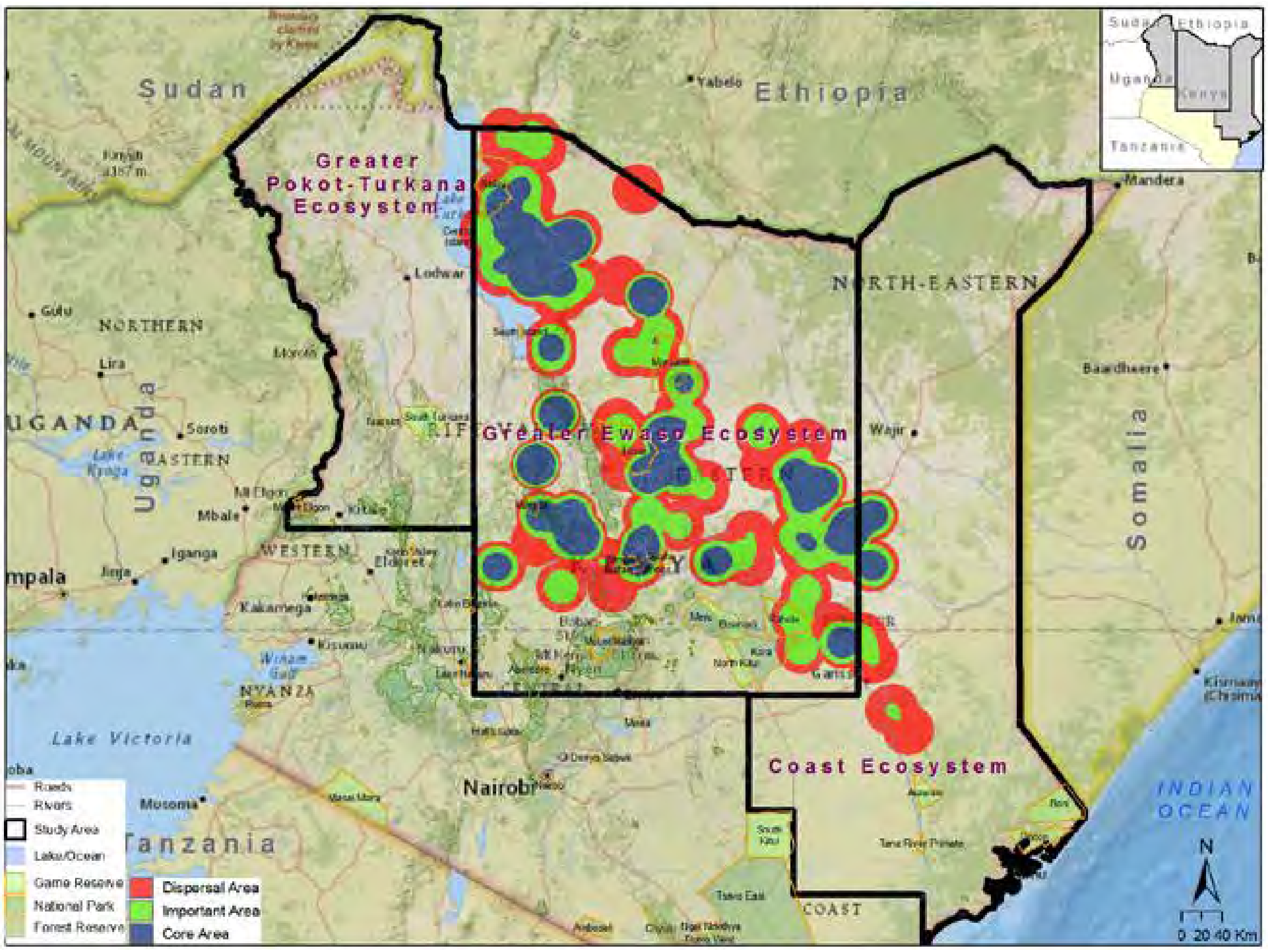
**Map 7.26 (a):** Grevy's zebra range in Kenya



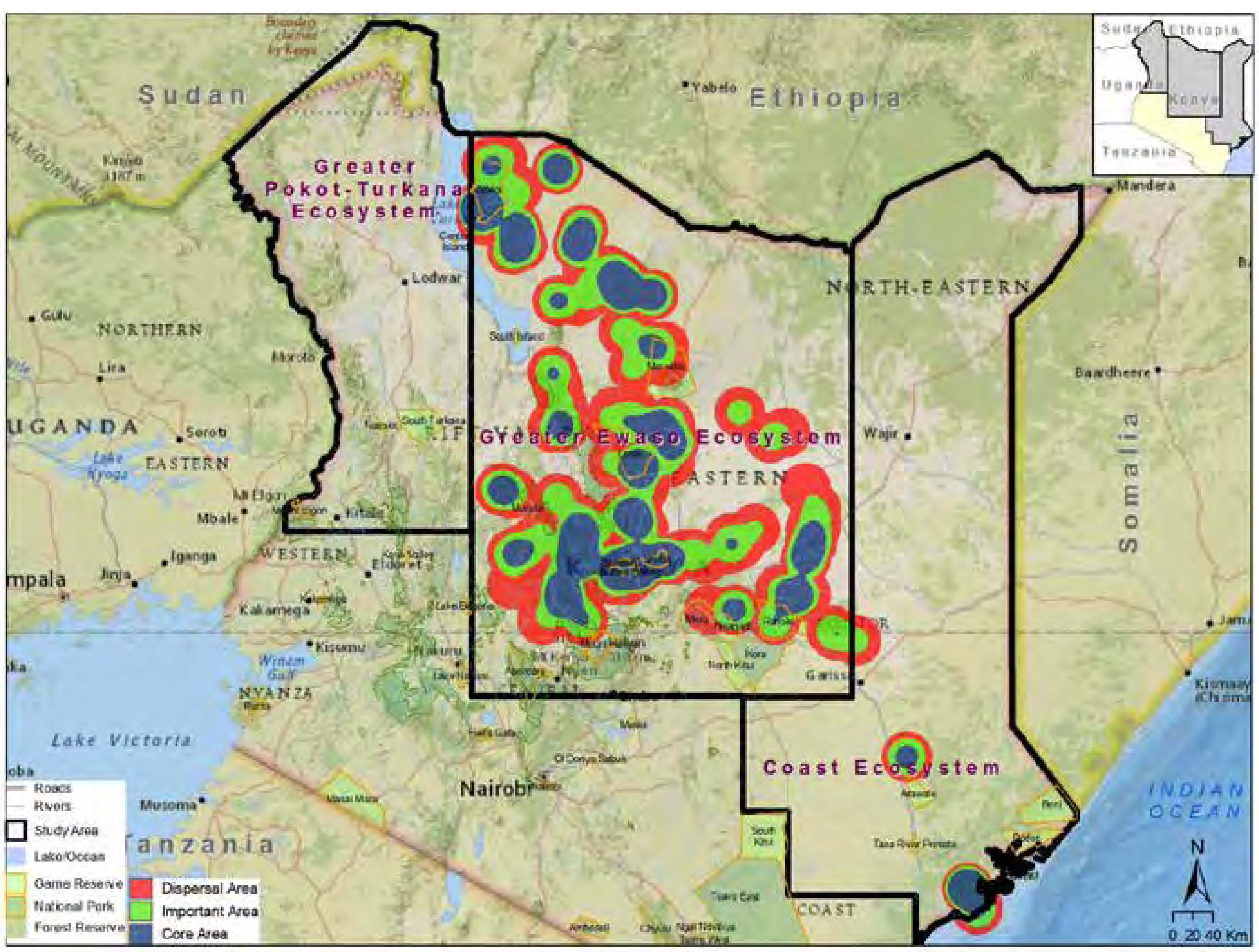

In Kenya, the range of Grevy's zebras in the 1970s was extensive, stretching north from the Tana River and from western parts of Garissa and Wajir Counties to Marsabit, Isiolo, and Meru Counties, and across the Laikipia-Samburu landscape. Core areas, important habitats, and dispersal areas are spead across the greater Ewaso ecosystem, with large groups to the east of Lake Turkana (in the Sibiloi NP-Loiyangalani-North Horr triangle); in the Lake Baringo-Laikipia plateau-Archer's Post area; in the Marsabit-Laisamis area, and in the Garissa-Mado Gashi-Habaswein and other areas adjacent to the Ewaso Ng'iro River (Maps 7.26 a, b, c, d & e).

There have been significant declines in Grevy's zebra numbers in Kenya, and a marked reduction in their range, which is now confined primarily to the landscapes of the Laikipia-Samburu-Isiolo-Marsabit complex. In the 1980s, Kenya's Grevy's zebra population was confined largely to the greater Ewaso ecosystem, with a small group observed near Garissa town and another south of Lamu on the north coast. During the 1990s, the range of the species within the Ewaso ecosystem began to shrink. Small groups appeared on the Lotikipi Plains of northern Turkana, while the group at the coast disappeared. In the 2000s, there were significant further declines in numbers and distribution, with populations confined to a few areas in the southern part of the Ewaso ecosystem.

**Map 7.26 (b):** Kernel density and range for Grevy's zebra in the 1970s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green) and dispersal areas (red).

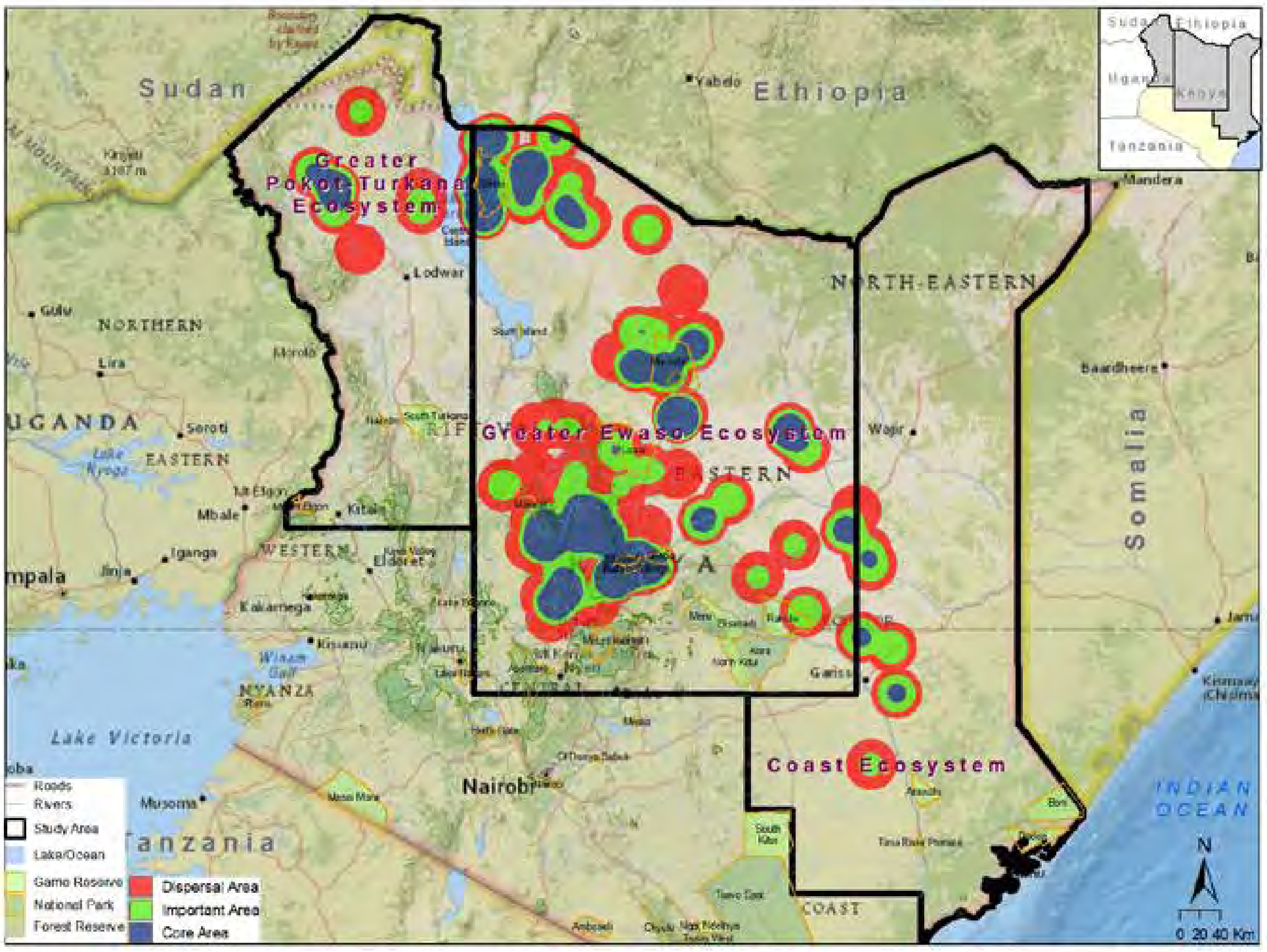



Source: DRSRS.



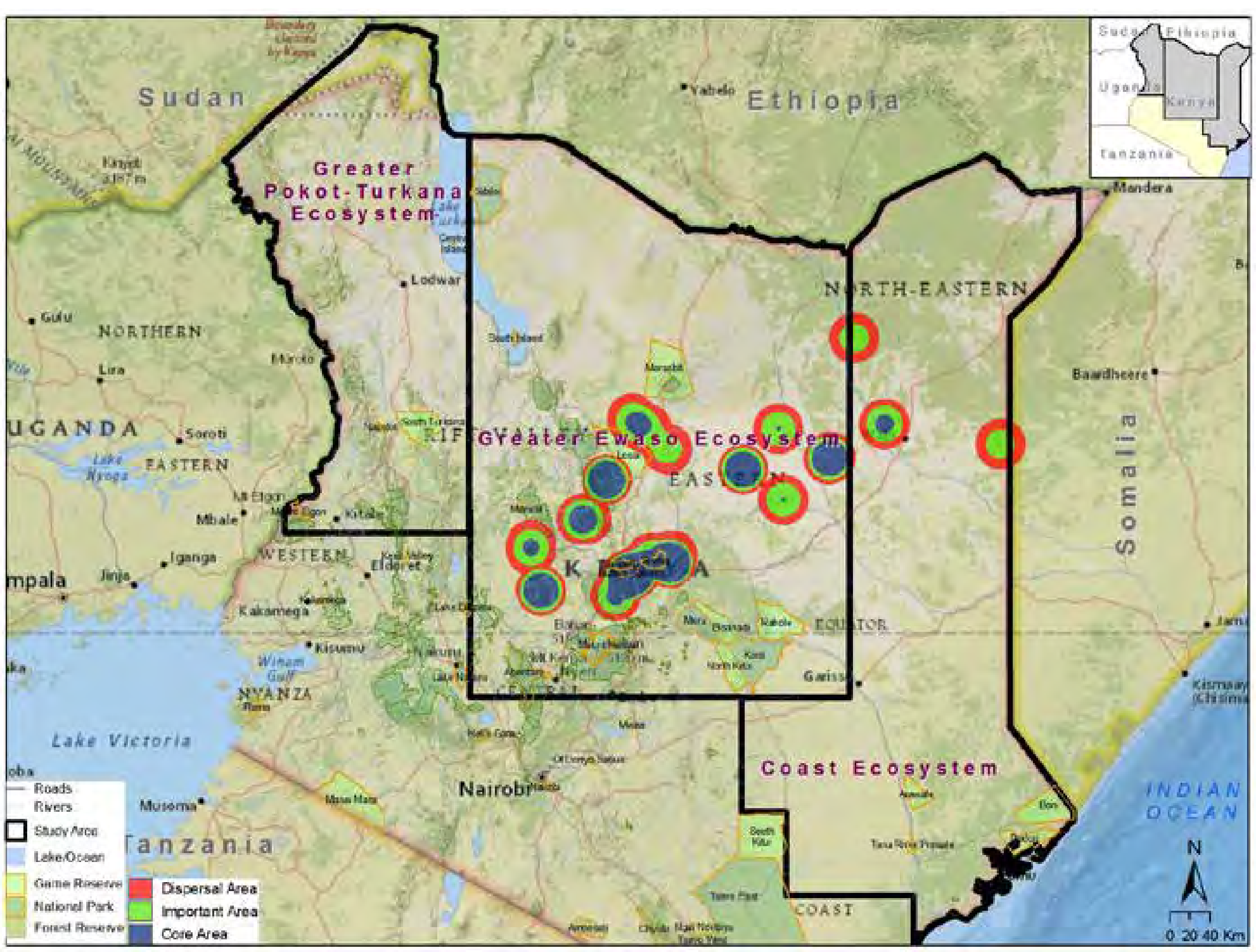

Source: DRSRS.

**Map 7.26 (d):** Kernel density and range for Grevy's zebra in the 1990s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green) and dispersal areas (red).




*Source: DRSRS.*

**Map 7.26 (e):** Kernel density and range for Grevy's zebra in the 2000s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green) and dispersal areas (red).

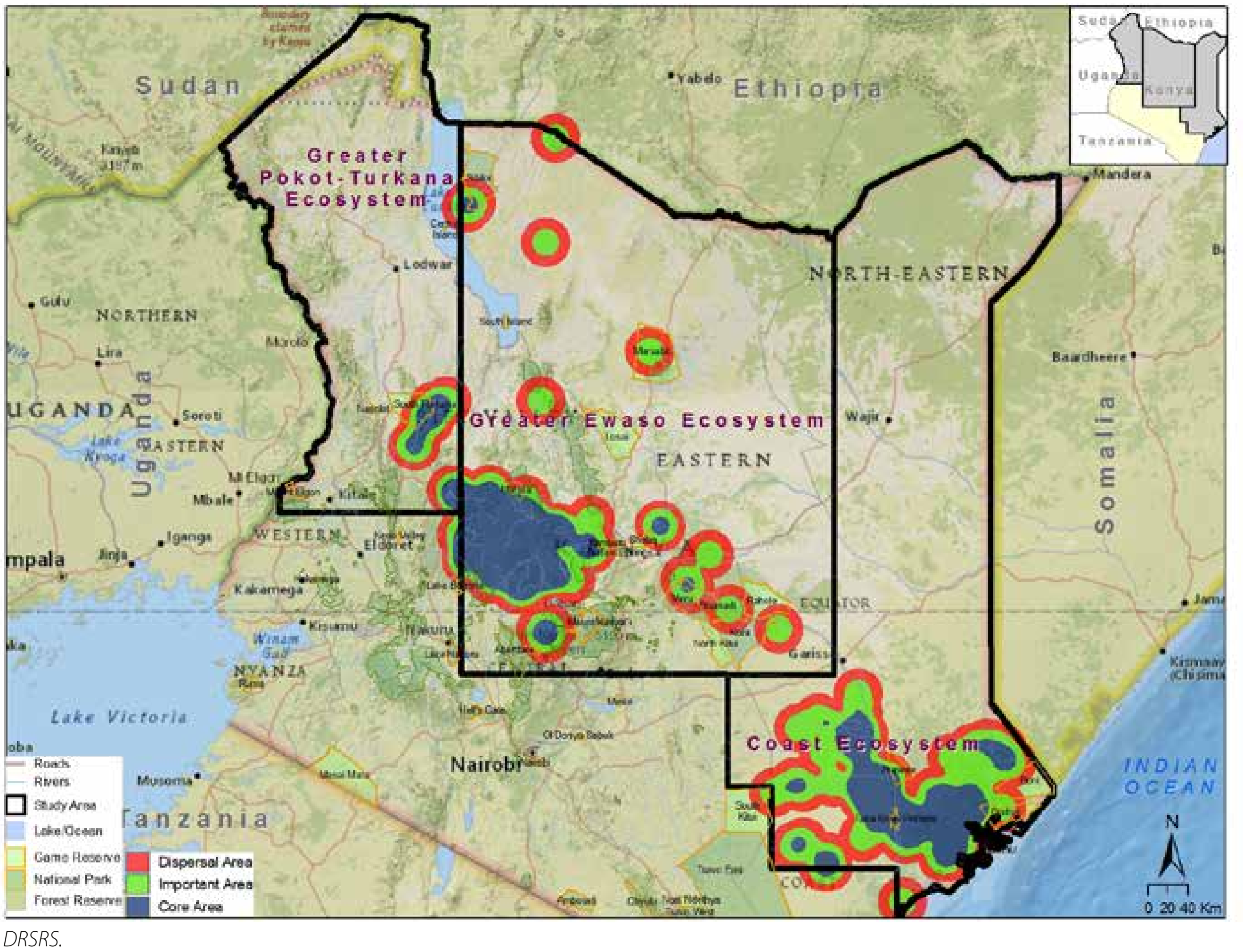



*Source: DRSRS.*

### 7.8.3. Burchell's Zebra Range

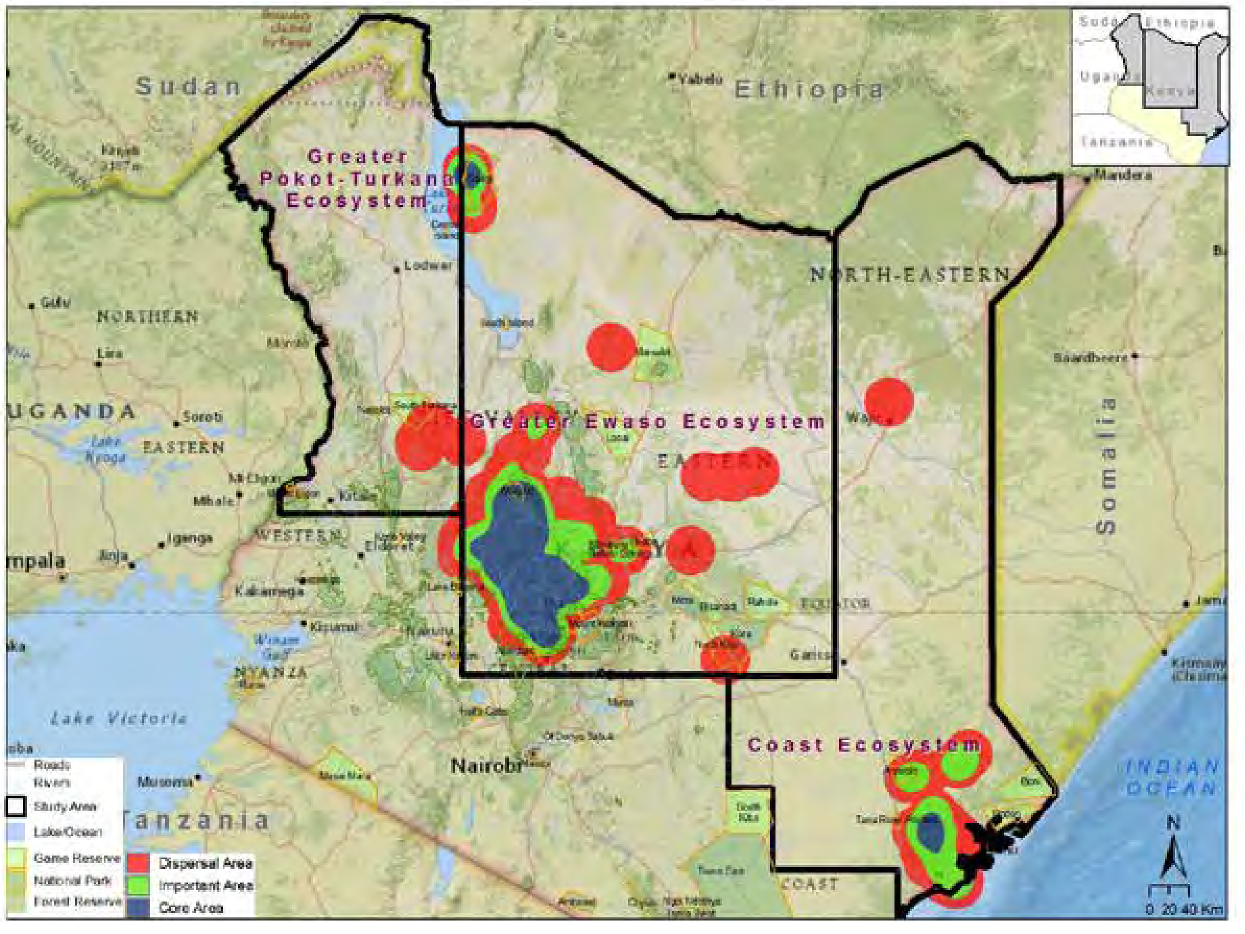
The greater Ewaso ecosystem holds Kenya's second largest population of Burchell's zebras (the largest is in the southern rangelands, and the Mara ecosystem in particular). In the 1970s, Burchell's zebras were distributed widely across the greater Ewaso ecosystem, with concentrations found in the Tana River delta area, in areas south of Garissa, and in the landscapes of Laikipia-Samburu, and with pockets elsewhere in the region. Now, the core area for Burchell's zebra in the greater Ewaso ecosystem is in the Laikipia-Samburu-Isiolo vicinity, mostly outside protected areas (Maps 7.27 a, b, c, d).

**Map 7.27 (a):** Kernel densities and contracting range for Burchell's zebra in 1970s in the northern rangeland and north coast terrestrial ecosystem, showing the species' core areas (blue), important areas (green), and dispersal areas (red).



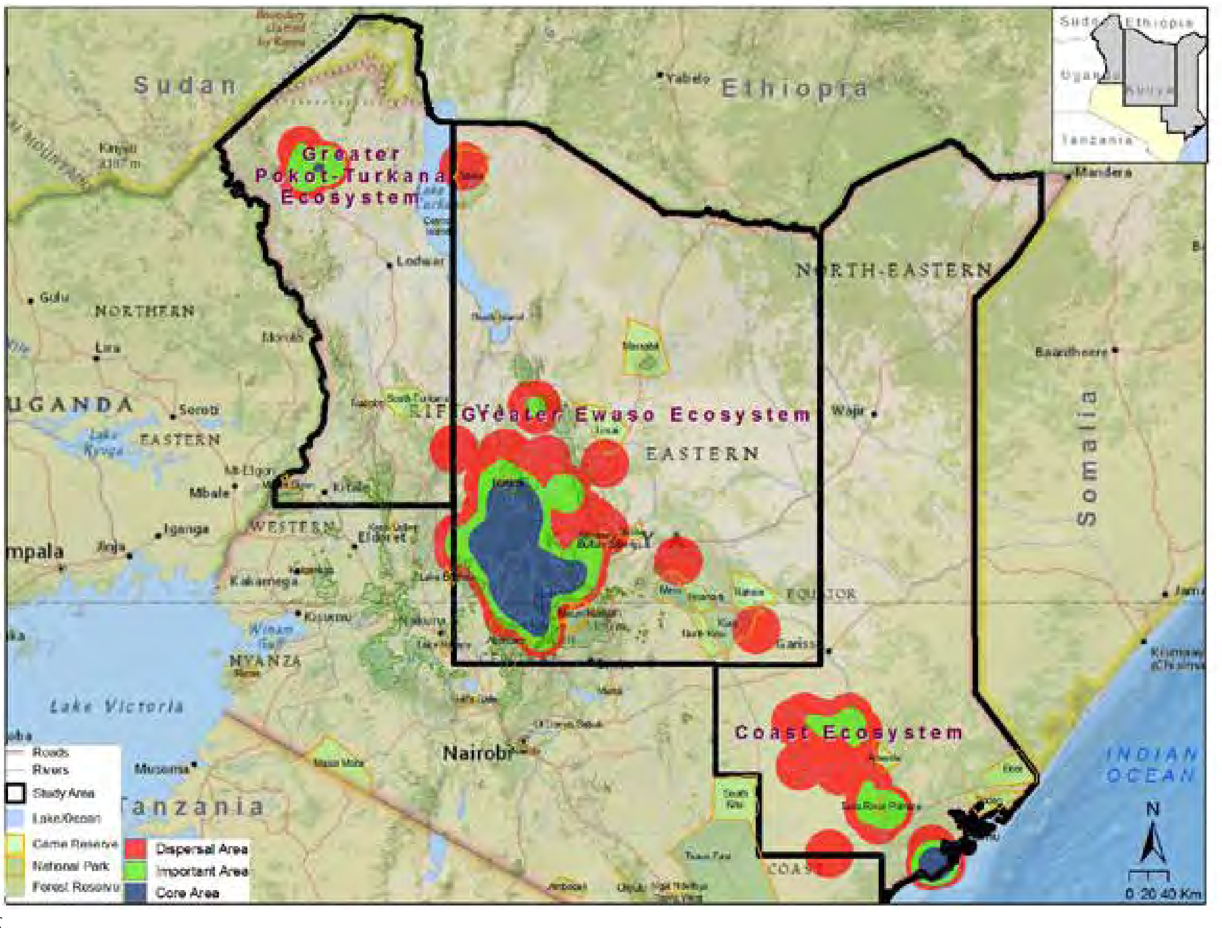

Source: DRSRS.

**Map 7.27 (b):** Kernel densities and contracting range for Burchell's zebra in 1980s in the northern rangeland and north coast terrestrial ecosystem, showing the species' core areas (blue), important areas (green), and dispersal areas (red).



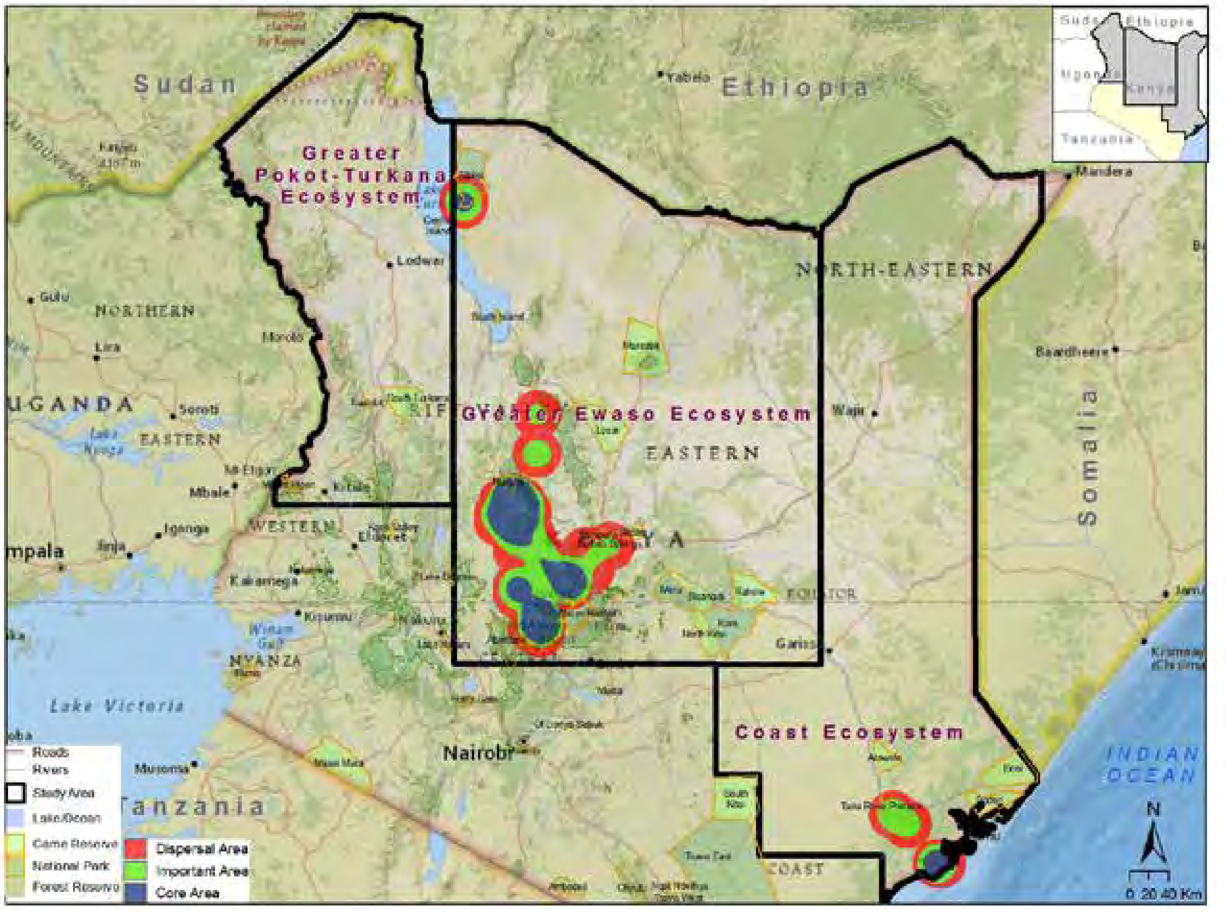

*Source: DRSRS.*

**Map 7.27 (c)**: Kernel densities and contracting range for Burchell's zebra in 1990s in the northern rangeland and north coast terrestrial ecosystem, showing the species' core areas (blue), important areas (green), and dispersal areas (red).




*Source: DRSRS.*

**Map 7.27 (d):** Kernel densities and contracting range for Burchell's zebra in 2000s in the northern rangeland and north coast terrestrial ecosystem, showing the species' core areas (blue), important areas (green), and dispersal areas (red).

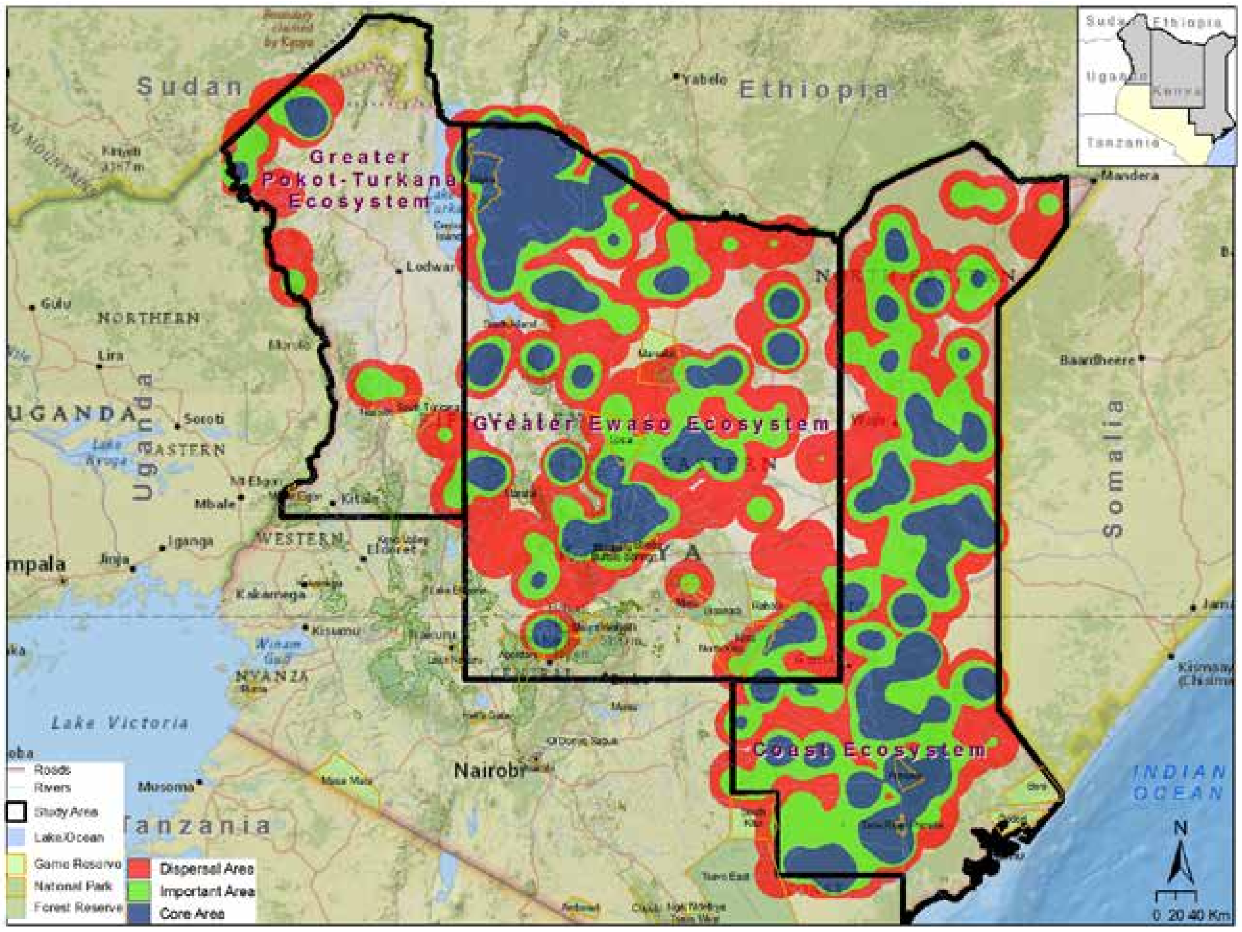



*Source: DRSRS.*

### 7.8.4. Oryx Range

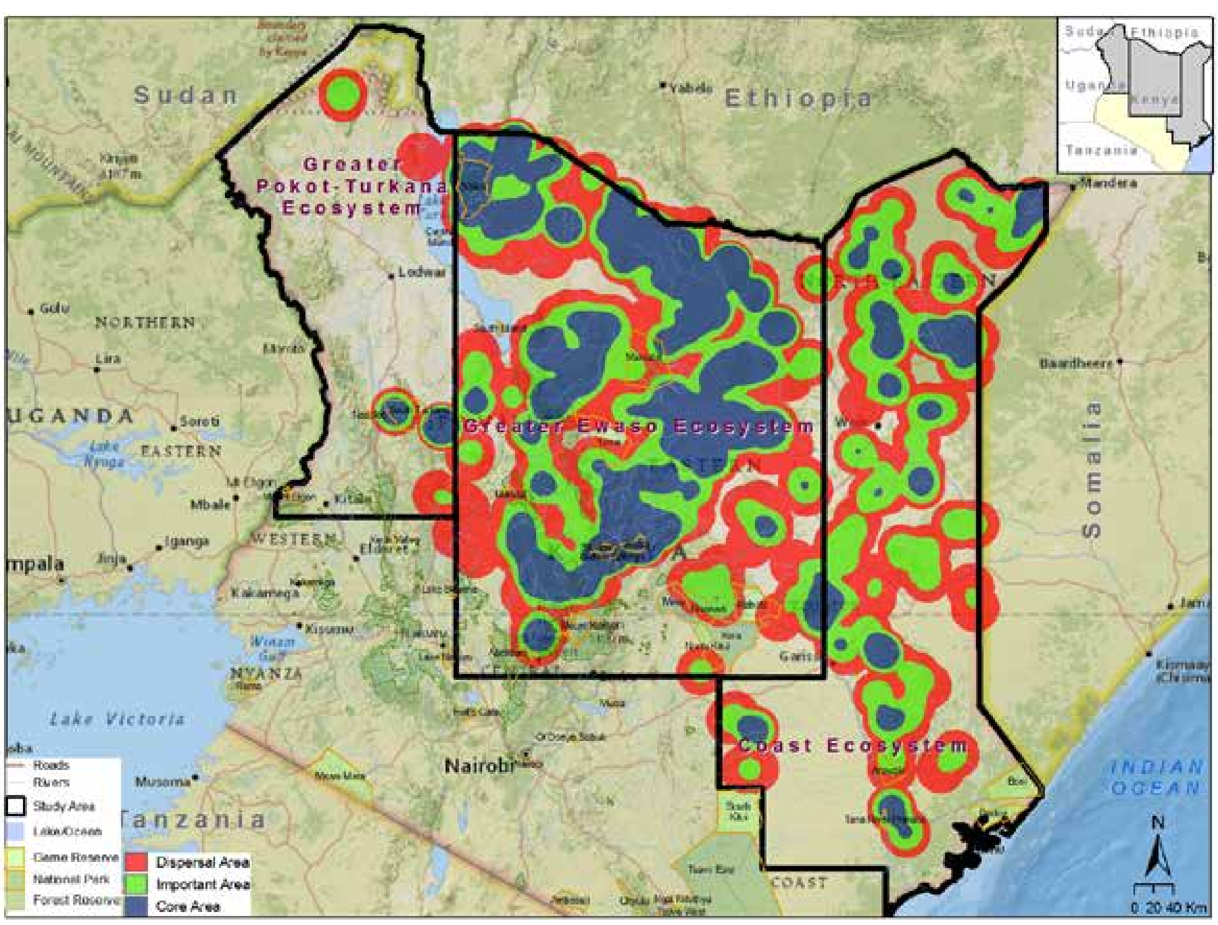
Kernel densities were used to identify core areas, important areas, and dispersal areas for oryx in the wildlife habitats of the Turkana-Mt. Elgon region, the greater Ewaso ecosystem, the north-eastern Kenya rangelands, and the north coast terrestrial ecosystem (Maps 7.28 a, b, c, d). In the 1970s, oryx were widely distributed across the greater Ewaso ecosystem. Now, core areas for oryx are in the north-eastern parts of the ecosystem and towards Mandera. Small herds also occur in Laikipia (on the Marmar, Colcheccio, and Solio ranches, for example).

**Map 7.28 (a):** Kernel densities and contracting range for oryx in 1970s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).



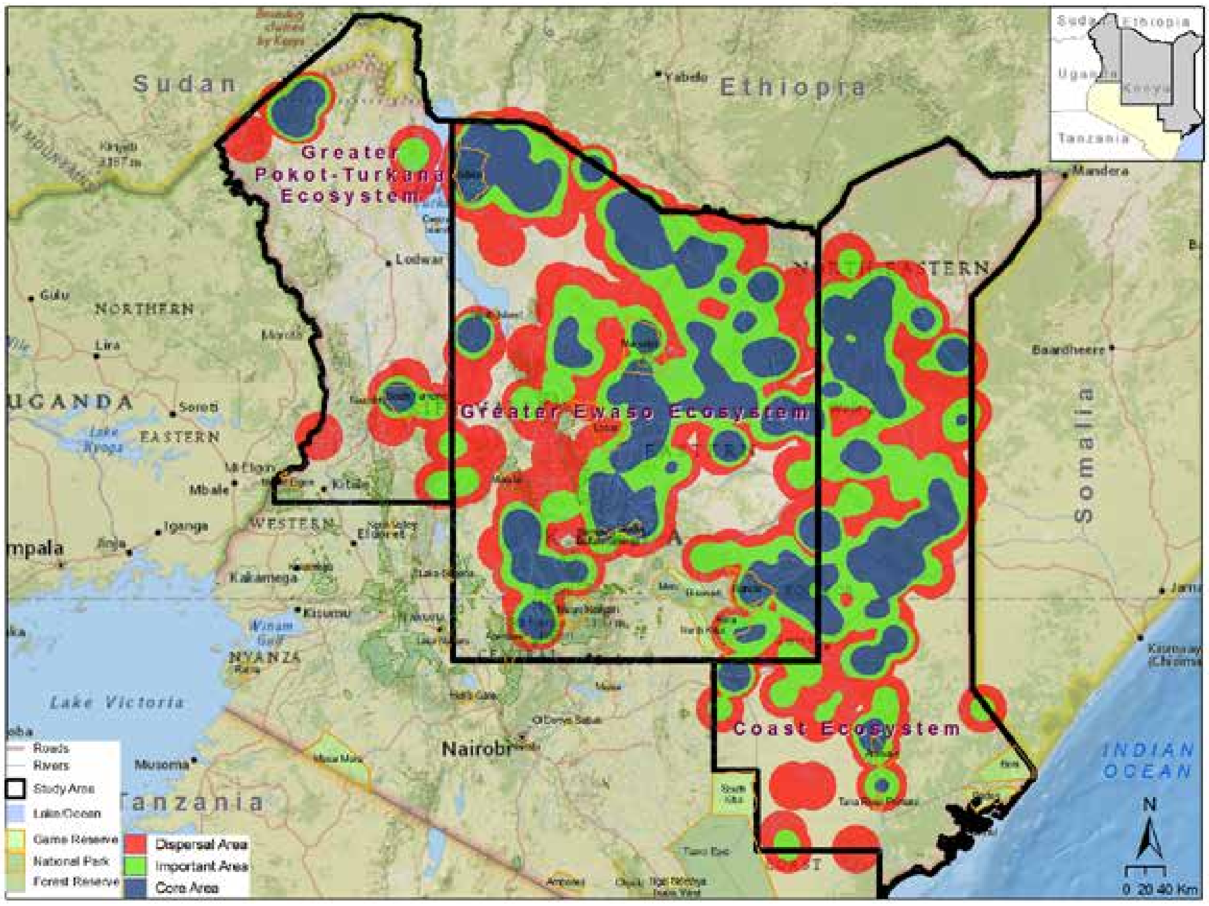

*Source: DRSRS.*

**Map 7.28 (b):** Kernel densities and contracting range for oryx in 1980s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).



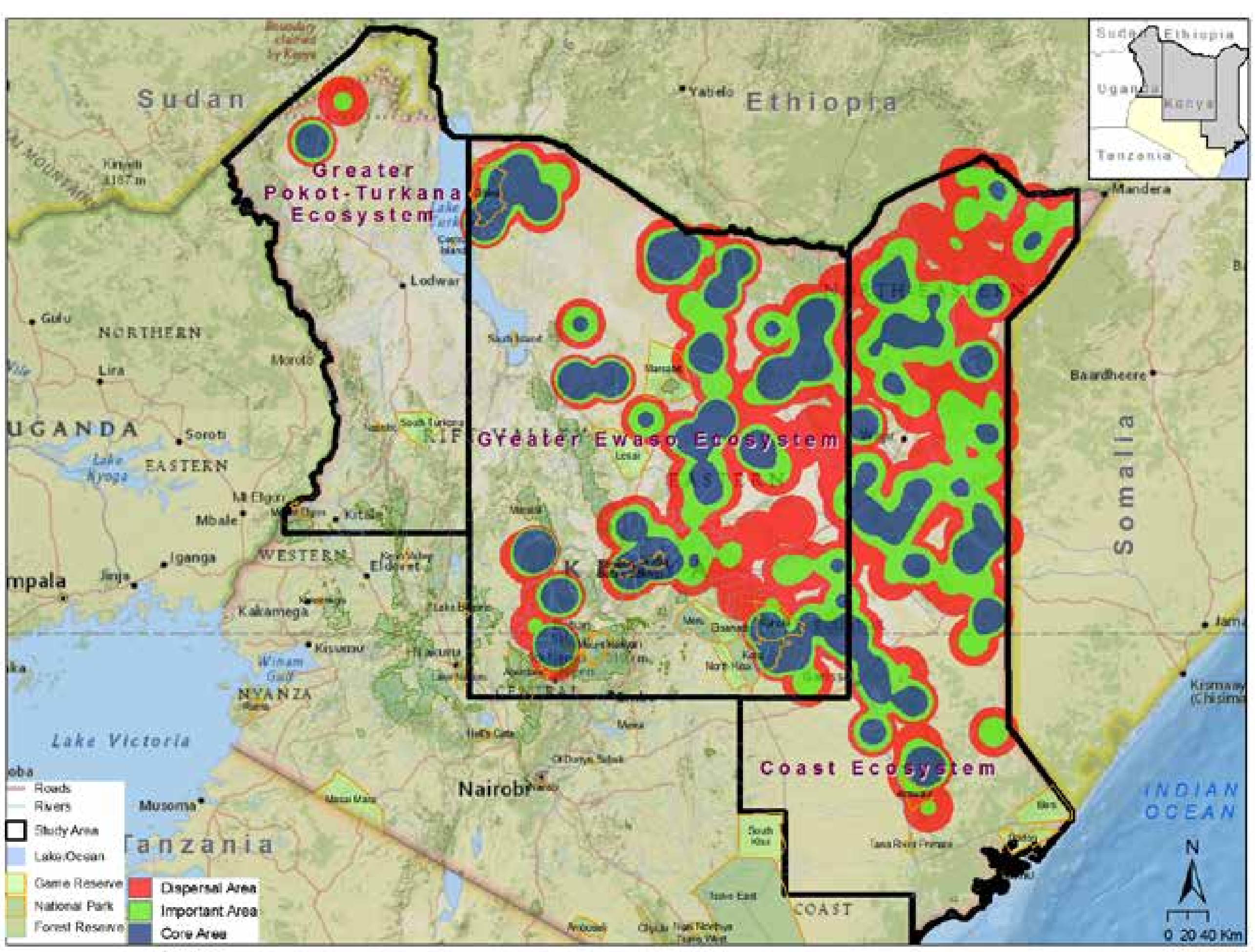

*Source: DRSRS.*

**Map 7.28 (c):** Kernel densities and contracting range for oryx in 1990s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).




Source: DRSRS.

**Map 7.28 (d):** Kernel densities and contracting range for oryx in 2000s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).



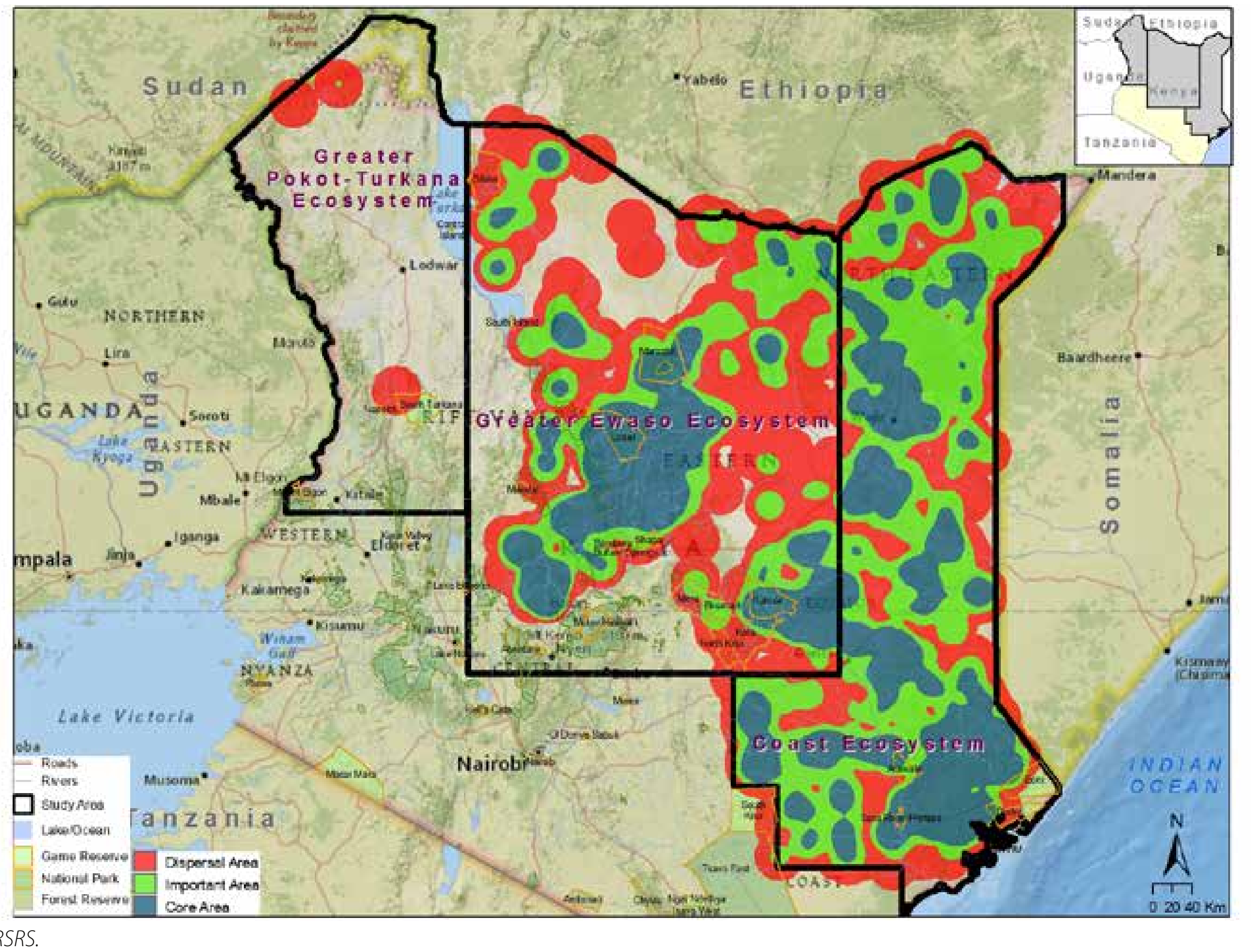

Source: DRSRS.

### 7.8.5. Giraffe Range

Kernel densities were used to identify core areas, important areas, and dispersal areas for giraffe in the wildlife habitats of the Turkana-Mt. Elgon region, the greater Ewaso ecosystem, the north-eastern Kenya rangelands, and the north coast terrestrial ecosystem (Maps 7.29 a, b, c, d). In the 1970s, giraffes were distributed widely across the greater Ewaso ecosystem and across north-eastern Kenya.

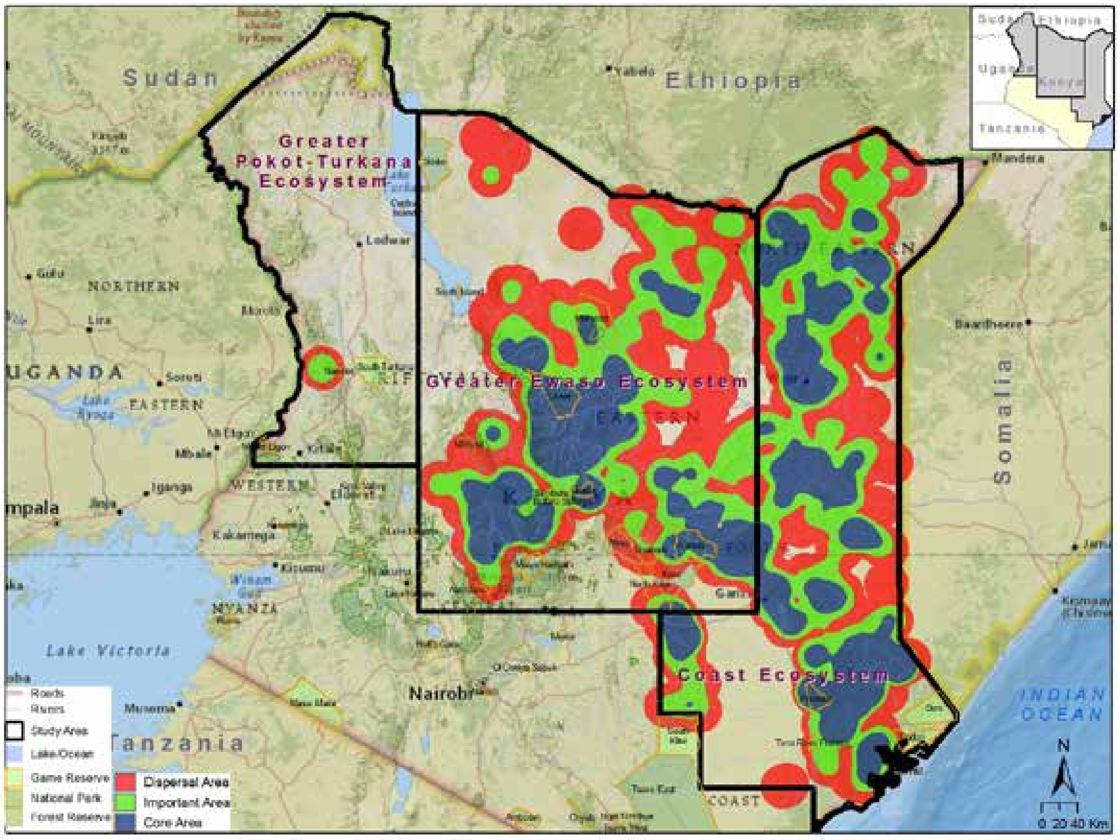
Current distribution of giraffes in Laikipia County shows they are found within the *Acacia drepanolobium* and dwarf woodlands of the southern, central and northern fringes, particularly on the Solio, Segera/Mukenya, Ol Pejeta, Ol Jogi, Colcheccio, Mugie, Sosian, and Kisima ranches. They are largely absent in the eastern, north-western and western parts of the county, due mainly to land-use changes and low availability of browse in the drier areas.

**Map 7.29 (a):** Kernel densities and contracting range for giraffes in 1970s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).



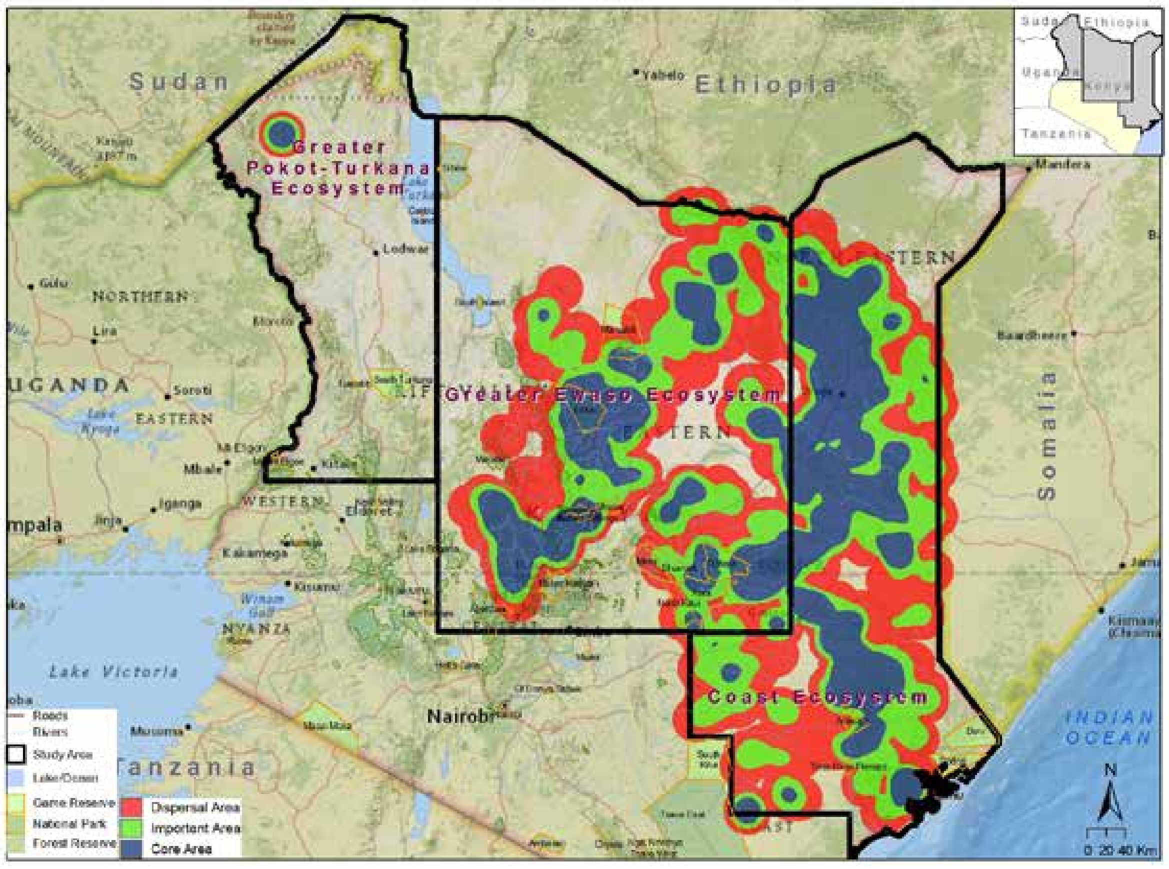

*Source: DRSRS.*

**Map 7.29 (b):** Kernel densities and contracting range for giraffes in 1980s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).



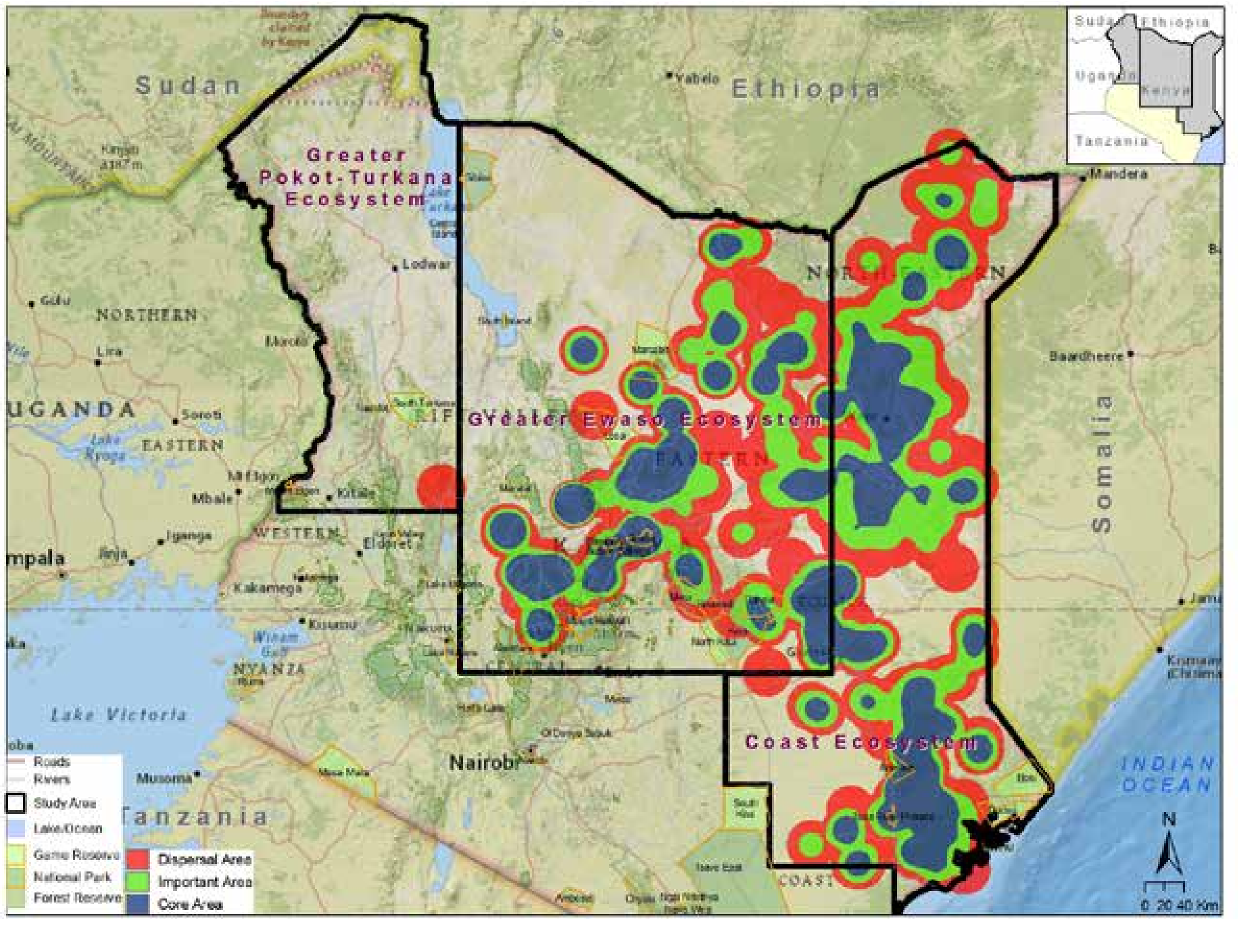

*Source: DRSRS.*

**Map 7.29 (c):** Kernel densities and contracting range for giraffes in 1990s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red)




*Source: DRSRS.*

**Map 7.29 (d):** Kernel densities and contracting range for giraffes in 2000s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).

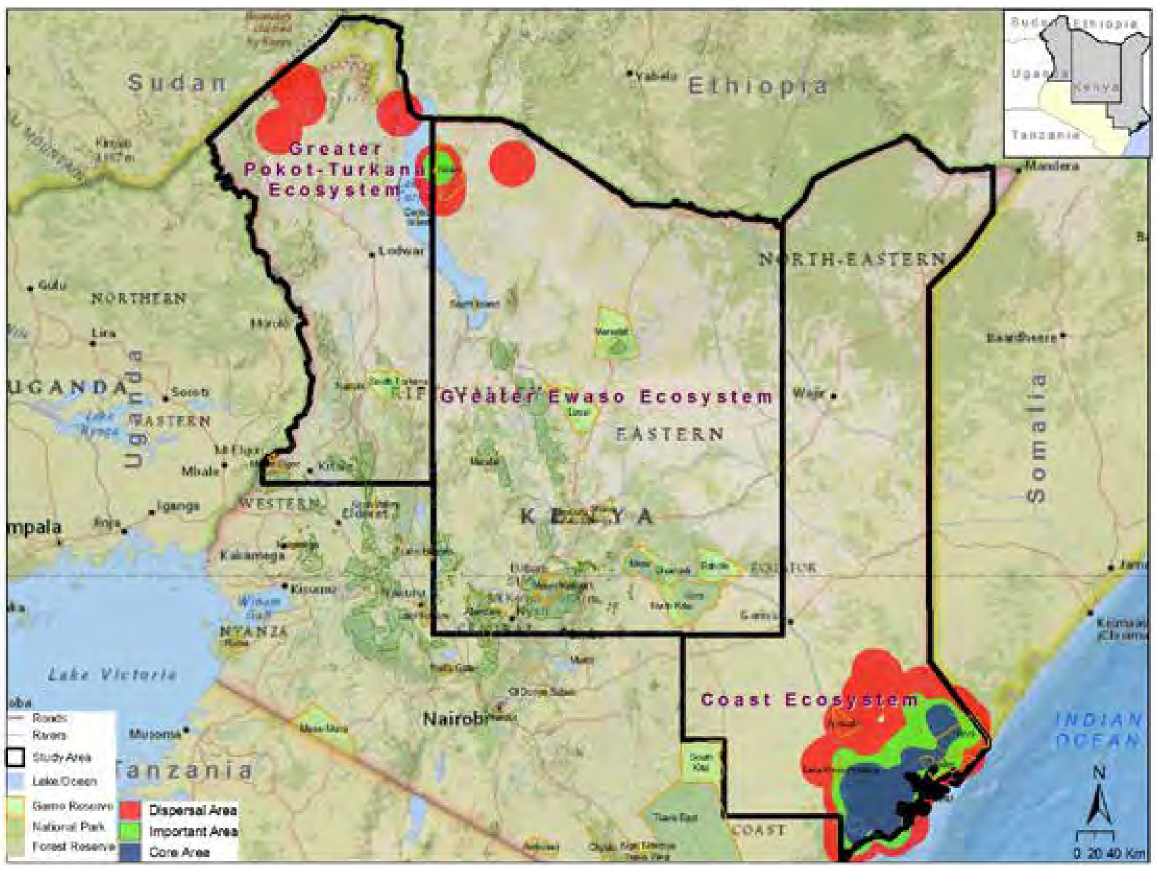



*Source: DRSRS.*

### 7.8.6. Topi Range

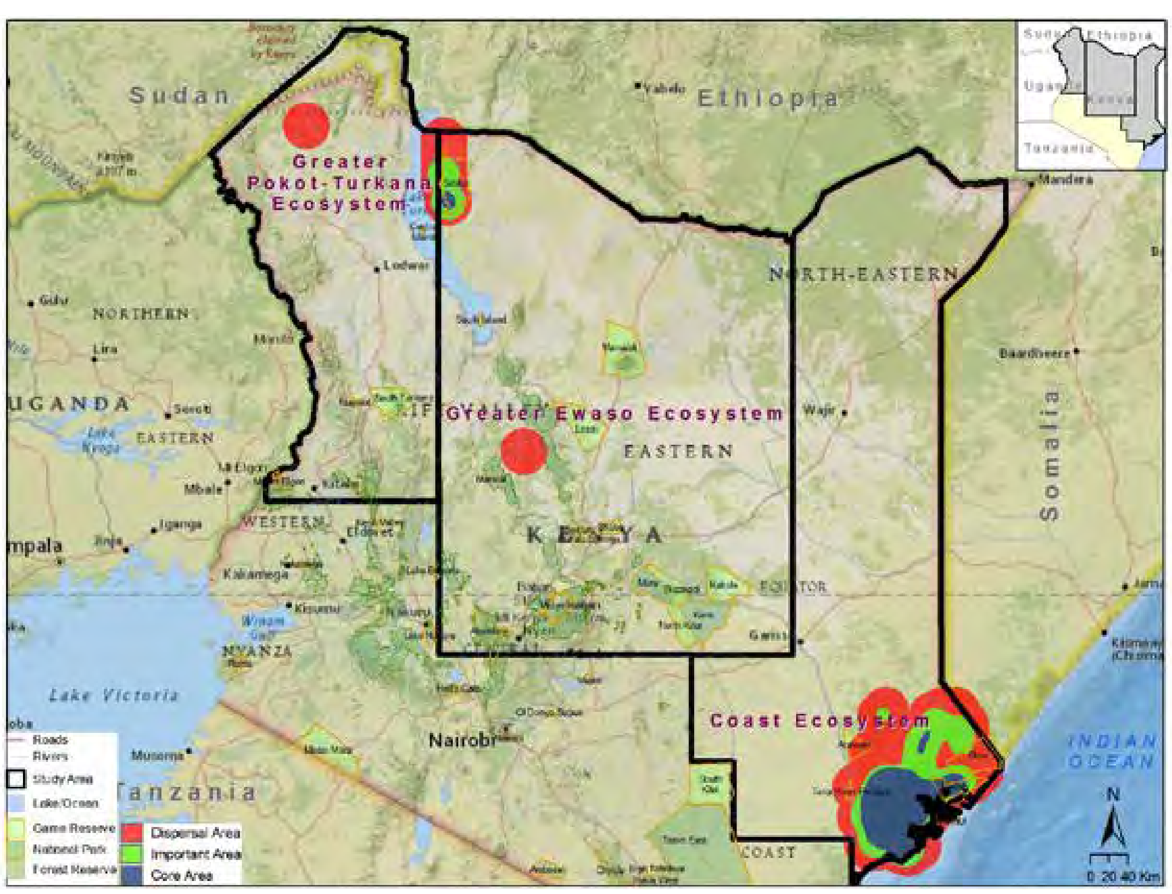
Kernel densities were used to identify core areas, important areas, and dispersal areas for topi in both the Sibiloi area of north-western Kenya and the north coast terrestrial ecosystem (Maps 7.30 a, b, c, d). Since the 1970s, overall topi numbers have declined. Today, their populations (Table 6.3) are relatively stable, by comparison with populations of other wildlife species.

Map 7.30 (a): Kernel densities and contracting range for topi in 1970s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).



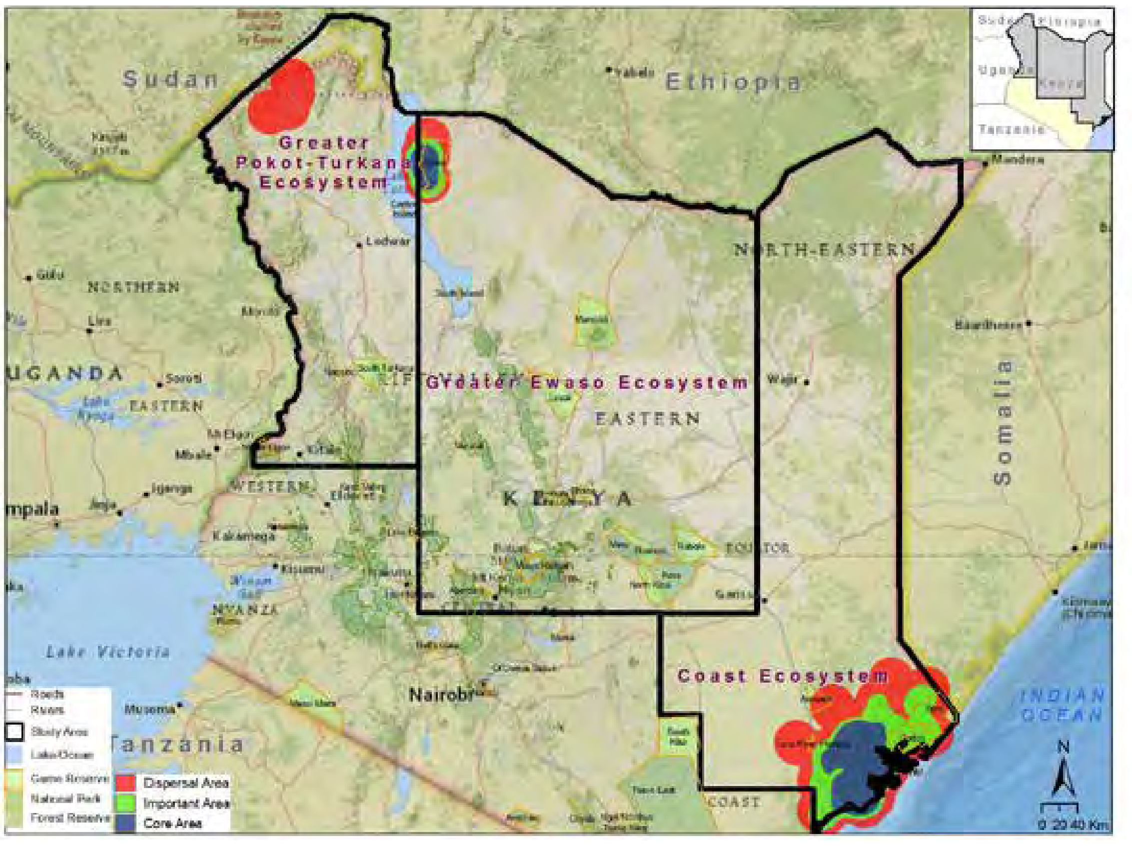

Source: DRSRS.

**Map 7.30 (b):** Kernel densities and contracting range for topi in 1980s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).



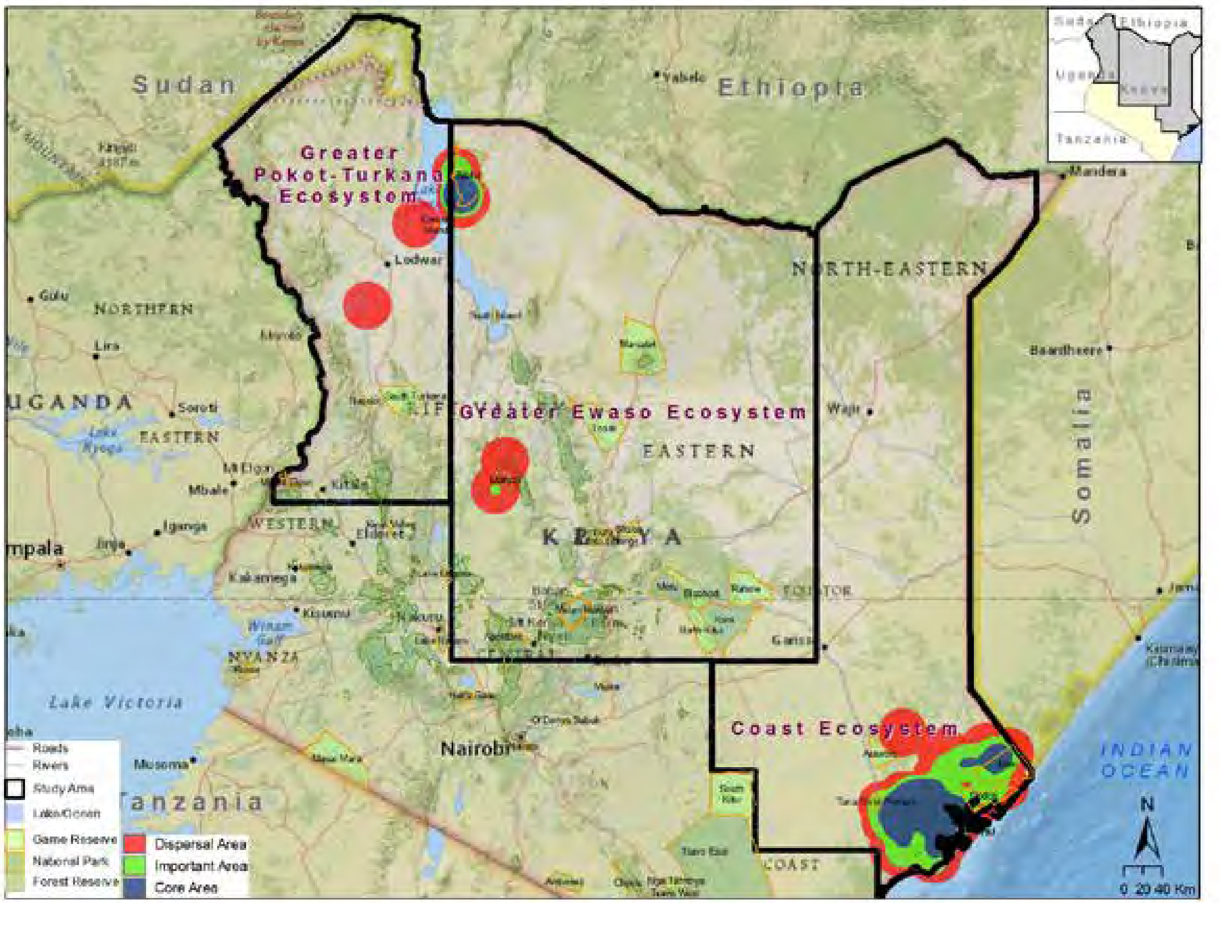

Source: DRSRS.

**Map 7.30 (c):** Kernel densities and contracting range for topi in 1990s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).




*Source: DRSRS.*

**Map 7.30 (d):** Kernel densities and contracting range for topi in 2000s in the northern rangeland and north coast region, showing the species' core areas (blue), important areas (green), and dispersal areas (red).




*Source: DRSRS.*

## 7.9. Migratory Routes and Corridors in the Northern Kenya Rangeland Ecosystems

In the landscapes of Turkana-Mt. Elgon, the greater Ewaso ecosystem, the north-eastern rangelands and the coastal terrestrial ecosystem, this study identified and described more than 50 wildlife migratory routes and corridors. In almost all cases, habitats linking wildlife dispersal areas were found to have been severely degraded or interfered with by human activities, to the extent that some routes have disappeared, while on others human-wildlife conflict is serious and needs urgent attention.

Over the past two decades, here have been considerable efforts to restore wildlife dispersal areas in the rangelands through the development of community conservancies and the creation of corridors enabling certain endangered species to move between critical habitats. Examples are the elephant underpass linking the Lewa Wildlife Conservancy with the Mt. Kenya forest, and the expansion of community conservancies in Samburu, Isiolo, and Marsabit Counties by the Northern Rangeland Trust (NRT). Dispersal areas and ranges available to species such as elephant and Grevy's zebra have slowly increased as a result. The current status of migratory routes and corridors in the central Rift, the northern and north-eastern rangelands, and the north coastal terrestrial ecosystem is given below:

### 7.9.1. Wildlife Movement Routes in the Turkana-Mt. Elgon Landscape

The Turkana-Mt. Elgon landscape contains important sites for biodiversity in the Western Conservation Area (WCA) and the Central Rift and Northern Conservation Area (CR&NCA). These include the Mt. Elgon NP, the South Turkana NR, the Nasolot NR, the Rimoi NR, the Kamnarok NR, and the proposed Lotikipi Plains reserve in northern Turkana.

#### State of Conservation Connectivity

**A. Drivers:**

i. High pressure on natural resource use attributed to exponential human population growth and associated anthropogenic activities.

ii. Insecure land tenure has led to the sub-division of communal lands to individual parcels. The privatization of land has resulted in increased fencing, expansion of settlements and agriculture, and mining concessions in Trans-Nzoia County, which has led to the fragmentation and/or loss of wildlife habitats.

iii. Infrastructure improvement and industrial development, including oil prospecting and drilling (the Ngamia wells) in Turkana County, construction of the Turkwel hydropower plant and of the Kitale-Kapenguria-Lodwar-Lokichogio highway, the expansion of nuclear settlements due to insecurity, and the proposed Lamu Port-South Sudan-Ethiopia Transport (LaPSSET) corridor.

iv. Impacts of climate change are already affecting surface water, boreholes, and underground aquifers. Inadequate and unpredictable rainfall is characteristic of arid and semi-arid lands. Frequent and severe droughts trigger mass movements of wildlife and of pastoralists with their livestock in search of pasture and water.

v. Expansion of dry-land cultivation (irrigation agriculture along the major rivers) and livestock incursions into conservation areas.

vi. Poor governance, and lack of (or inadequate) land-use policy and enforcement of legislation.

vii. The boundaries of most protected areas are both long and porous, which encourages human encroachment, livestock incursions, and poaching.

**B. Pressures:**

i. Increasing human population, high livestock densities, urbanization, industrialization (oil and gold prospecting, limestone quarrying), and expansion of irrigated agriculture.

ii. Sub-division of communal land to individual parcels. Wetter areas are converted to agriculture, as intensive crop cultivation expands.

iii. Pastoralists armed with guns to protect their livestock, grazing areas, and watering points pose a security threat, often resulting in the inaccessibility of dry season grazing areas, cattle rustling and inter-ethnic conflicts, and poaching.

iv. Invasive alien species such as *Prosopis juliflora* have reduced wildlife and livestock grazing areas.

v. High livestock densities lead to incursions into protected areas and ultimately land degradation through competition over limited resources.

vi. Human-wildlife conflicts, human encroachment and disturbance.

**C State**

a. Urbanization has led to unplanned nuclear settlements, while industrialization has intensified in the wake of oil exploration, gold mining, and hydropower energy generation.

b. Increasing human-wildlife conflicts, especially along the major rivers and in wetter areas, due to irrigation agriculture and crop intensification. In addition to crop damage, livestock predation, and injury or even death to humans, there is intense competition between wildlife and livestock for forage and water resources.

c. Although the Mt. Elgon NP and Forest Reserve are still intact, deforestation and conversion to agriculture in surrounding areas are a threat to elephants outside the protected area, and a major cause of human-wildlife conflicts.

d. Poaching is rampant in Turkana and West Pokot Counties, but the threat is critical along the long and porous international border between Kenya and Uganda.

**D. Impacts**

a. Populations of most wildlife species, and especially those of elephant and Burchell's zebra, have declined across the entire region. The declines are attributed to drought, poaching, and competition for forage and water resources. The severe decline of Burchell's zebra numbers in the South Turkana and Nasolot NRs is attributed to competition with livestock for forage and water resources.

b. Mt. Elgon's elephants are increasingly being isolated and confined to the forest within the park.

c. Irrigation agriculture along the Weiwei (Turkwel) River has interfered with wildlife movement between the South Turkana and Nasolot NRs.

d. Pastoralists who carry fire-arms while moving with their livestock in search of pasture and water are undermining the security of wildlife. Cattle rustling across the Uganda border and among neighbouring tribes, inter-tribal wars, and poaching are contributing to the insecurity situation.

e. The proposed LaPSSET corridor linking Lamu Port and South Sudan is likely to create a major physical barrier for wildlife, especially for elephants moving between the Kidepo NP (Uganda) and the South Turkana NR.

**E. Responses**

a. Conservation stakeholders and local communities are increasingly engaging in public-private partnerships (PPPs) to benefit from conservation areas established through land-lease and easement programmes, and from payments for ecosystem services. Several conservancies are being establishment to allow the communities to benefit from wildlife.

b. Proponents of the oil exploration and drilling project in Turkana County have conducted an Environmental Impact Assessment (EIA), as required by the wildlife agency (KWS) and NEMA.

c. KWS conducts security operations in national reserves to prevent firewood collection, charcoal burning, and livestock incursions.

d. County government authorities, community groups and KWS have acquired more land for conservation in the region, including the proposed Masol Wildlife Conservancy and the proposed Lotikipi and Logipi NRs.

**F. Threats to Conservation Connectivity**

1. Key threats to biodiversity conservation in the Turkana-Mt. Elgon region include land-use change, habitat fragmentation or loss, impacts of adverse climatic conditions, insecure tenure, insecurity and poaching, human-wildlife conflicts, land degradation as a result of woodland clearing and charcoal burning, and inadequate scientific data.

2. Other threats stem from lack of comprehensive land-use management plans, weak implementation of legislation, high livestock densities, and the lack of incentives.

**G. Conservation Connectivity Opportunities**

1. Potential economic developments in the Turkana-Mt. Elgon landscape are oil exploration, livestock production, eco-tourism, conservation offsets through land leases, easements and payments for ecosystem services, and REDD+ projects.

2. The Turkana-Mt. Elgon landscape has experienced increased eco-tourism-related development due to national and county government efforts to improve security by involving local communities in awareness creation and participatory resource management. Some local communities are now re-consolidating their lands to create community conservancies so they can benefit from payments for ecosystem services. KWS has purchased communal lands for the creation of new national reserves, which will form

**Table 7.9:** Summary of Drivers, Pressures, State, Impacts and Responses (DPSIR) in the South Turkana and Nasalot National Reserves

| **Drivers/*State*** | **Pressures** | **Impacts** | | **Responses** |
|---|---|---|---|---|
| | | *Details* | *Scale* | |
| South Turkana NR (109,100ha) and Nasolot NR (10,200ha)<br>Moderate space with soft boundaries and vast buffers | Energy production (oil) and mining entails developments (transport, commerce, and accommodation) | Potential to cause rapid environmental deterioration and affect wildlife populations | Severe | EIA conducted for proposed projects (e.g. Ngamia 1), KWS participated as lead agency |
| Vegetation within PAs is intact bushed grassland<br>Good for plains game conservation (90%)<br>low resilience and highly stress vulnerable | Livestock incursion<br>Invasive species - *Prosopis juliflora*<br>Charcoal burning | Sites within reserves infested by *Prosopis juliflora* from neighboring areas<br>Charcoal burning active in PAs | Minimal | No action on invasive species, but potential of elimination through uprooting<br>KWS regulate incursion and charcoal burning |
| Dry and riverine bushed / wooded grasslands<br>Moderate arable land and dry season grazing | Expansion and intensification of irrigation agriculture | Habitat reduction leads to species relocation (KWS, 2010) | Medium | Acquire more land e.g. proposed Masol wildlife conservancy, Lotikipi and Logipi NRs) |
| Supports 362 elephants, most concentrated in S. Turkana NR (KWS, July 2010) | Modification of natural systems<br>Poaching | Decline in population - 1997 (852 elephant), 1999 (792 elephant), 2002 (490 elephant), 2010 (362 elephant) | Severe | Monthly aerial surveillance involving KWS/community partnership and daily ground tracking *inter alia* |
| Community culture<br>Tendency to shift from nomadic pastoralism to sedentarism<br>Restrict pastoralists to agro-pastoral. | Impact of recurrent and severe droughts<br>External intrusion (insecurity and cattle rustling) | Cattle declined by 62% and shoats by 14% compared to previous 2002 counts | Medium | Pastoralists sought refuge in neighboring counties and relatives across the border. |
| Conservation is dependent on presence of large wildlife species<br>Increased human-wildlife conflicts | Expansion of human settlements and agriculture | Wildlife migration into NRs<br>Human-wildlife conflicts | Severe | Increased conservation awareness and education<br>Stakeholder/community engagement in leases and easement programmes |

critical conservation buffers around protected areas and increase the extent of wildlife areas.

### 7.9.2. North and West Turkana Elephant Routes

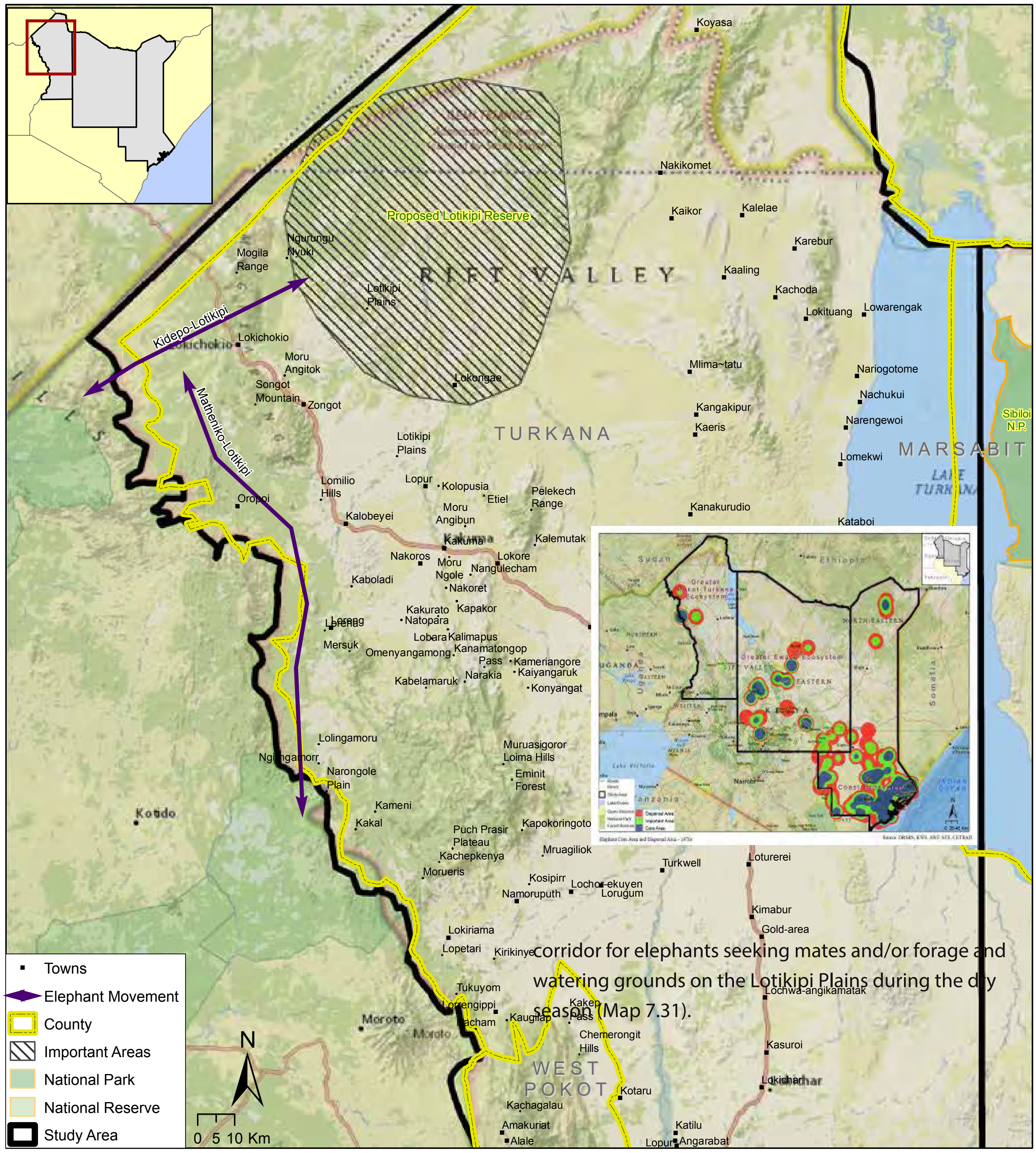
*1. Kidepo Valley National Park (Uganda) – Lotikipi Plains*

Kidepo Valley National Park is a small area covering about 134,400 ha in Uganda's north-eastern corner along the border with South Sudan and Kenya, and is surrounded by an extensive controlled hunting area complex. Its north-western boundary runs along the frontier with South Sudan, adjacent to the Kidepo Game Reserve. The park is dominated by gently undulating plains in arid savannah studded with hills and rock outcrops, and is traversed by the seasonal Kidepo and Larus Rivers with some permanent pools remaining in the latter during the dry season. It has a wide variety of ungulates and threatened species such as cheetah (*Acinonyx jubatus*), black rhino *(Diceros bicornis),* African elephant *(Loxodonta africana)* and the Karamoja apalis *(Apalis karamojae)*. Poaching is a serious problem, particularly from South Sudan, while elephant damage to *Acacia* trees is prominent (IUCN/UNEP, 1987).

The Lotikipi Plains lie between latitudes 3°52'-5°04'N and longitudes 34°18'-35°27'E, with about 500,000 ha of their total area of 720,000 ha in Turkana County, Kenya. Located in a semi-desert environment, Lotikipi is a grassy floodplain with scattered *Acacia* and *Balanites* trees, reeds and papyrus formed by irregular flooding of several rivers. It has been proposed that the plains be set aside for wildlife conservation and reserve development. Hughes and Hughes (1992) noted some hunting on the floodplain.

Elephants are known to migrate from the Kidepo Valley NP in Uganda to the Lotikipi Plains in Kenya's northern Turkana region during the dry season. DRSRS aerial surveys in late 1970s and similar surveys conducted 30 years later in the 2000s, found groups of elephants in the corridor linking the two areas (Map 7.31). This trans-boundary movement is critical for maintaining a viable elephant population in the wider Kidepo basin (Uganda/ South Sudan) and the Lotikipi Plains.

**Map 7.31:** Elephant movement corridors from Uganda's Kidepo NP and Matheniko Reserve to the Lotikipi plains in northern Turkana. Inset: Map showing distribution density for elephants in the northern rangelands and north coastal terrestrial ecosystem in the late 1970s.



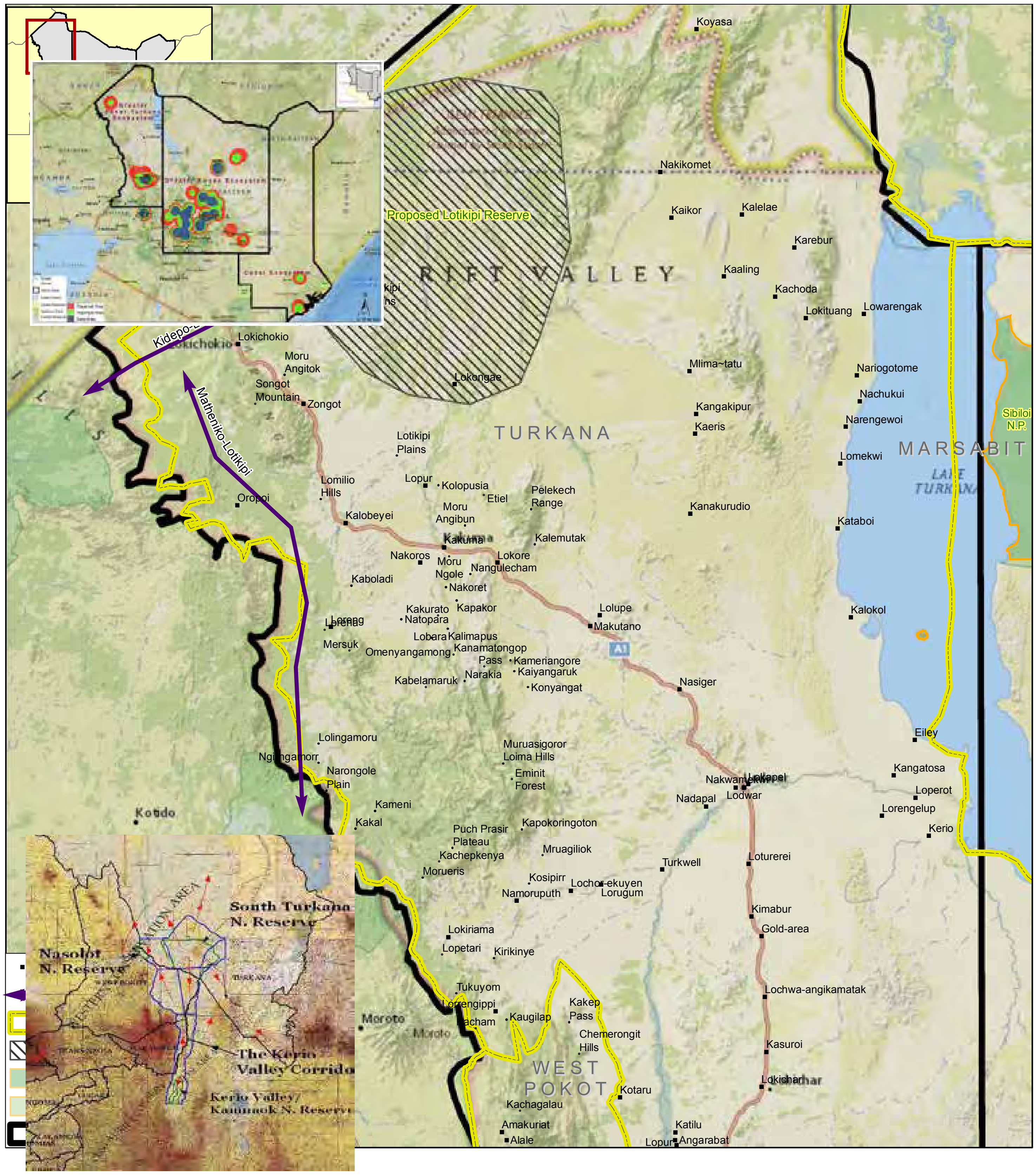

Source: DRSRS.

*2. Matheniko Reserve (Uganda) – Lotikipi Plains*

Uganda's Matheniko Reserve covers about 158,656 ha, and is part of the Karamoja plateau bordered to the east by the Great Rift Valley's western escarpments which form the Uganda/Kenya border. Thorny deciduous thicket is the predominant vegetation, and the area is used as traditional pasture for livestock migrating from the Pian-Upe plains in southern Karamoja during the wet season. There are several species of wild ungulates in the reserve, but with low and sparse populations, partly due to poaching, forest destruction, over-grazing by livestock, and encroachments by settlement. Recently, droughts and political unrest have exacerbated the situation.

The movement of elephants from the Matheniko reserve (Uganda) to the Lotikipi Plains (proposed wildlife reserve) is said to occur northwards along the Kenya-Uganda border and to join the main route from the Kidepo Valley NP (Uganda), before proceeding to the Lotikipi Plains. Moving along the border appears to provide a safe corridor for elephants seeking mates and/or forage and watering grounds on the Lotikipi Plains during the dry season (Map 7.31).

**Map 7.32:** South Turkana–Kerio Valley elephant movement corridors. Insets: Map (top) showing the distribution density for elephants in northern and eastern Kenya in the 2000s. Source: DRSRS Database; and (bottom) the Western and Central Rift Conservation Areas, showing the Kerio Valley elephant corridor (blue polygons) and major wildlife movement routes.




Source: DRSRS.

### 7.9.3. South Turkana-Kerio Valley Elephant Routes

The South Turkana-Kerio Valley-Mt. Elgon ecosystem falls within the Western Conservation (WCA) and Central Rift Conservation Area (CRCA). The Kerio Valley forms the critical linkage (corridor) between the two conservation areas. The South Turkana NR (109,100 ha) includes two prominent hills surrounded by plains bisected by seasonal watercourses. Gallery forest is dominant along the Kerio River, while dense thornbush and forest remnants occupy the hilltops, with sparse bushland on the plains. Elephant and greater kudu have been recorded in the reserve. Settlements have been encroaching, and livestock incursions (illegal grazing) are frequent.

The Nasolot NR covers about 9,200 ha, encompassing a portion of the Turkwell River gorge and flat plains drained by seasonal watercourses from the foothills of the Sekerr range. The vegetation is primarily thorn bushland, and the reserve supports elephants and lesser kudu. Elephants

**Table 7.10:** Elephant routes in South Turkana-Kerio Valley. To be read together with Map 7.32.

| Elephant Route | Description | Threat Level |
|---|---|---|
| Rimoi/Kamnarok NRs-S. Turkana NR | Linear corridor along the Kerio Valley stretching some 120Km from Rimoi NR (Marakwet) to Kamnarok NR (Baringo). The elephants pass through Kamaingor, Chegilet and Chepkundal, then across Kerio River near Kinyach, and proceed to Kolowa. They then scatters northwards into West Pokot and Turkana counties via different routes | High |
| Rimoi-Kamnarok NR-Masol-S. Turkana NR | It branches off from the Rimoi-Kamnarok route, passes to the east or west of Masol and Loturuk Hills to Kadongoi plains in South Turkana NR. Sometime the elephants branch off through Lochakula into the reserve | Low |
| Kadongoi-Lokwamising -Kapeidru | Kadongoi plains through Lokwamising Hills and Kapeidru to north of S. Turkana NR | Low |
| Rimoi/Kamnarok NRs-Orwa-Seker Forest-Nasolot NR | Elephants branch off the Rimoi/Kamnarok route to Orwa (proposed community conservancy), Sekerr Forest and disperse into Nasolot NR. | Low |
| S. Turkana NR-Amolem-Sekerr Forest | South Turkana NR through Amolem into Sekerr Forest | Moderate |
| Nasolot-S. Turkana NR | This is the area between Nasolot and S. Turkana NR, from Kainuk to Kaptir where the elephant route crosses Malmate River. It is a "hotspot" due to numerous irrigation farms adjacent to the river causeway. | High |
| Kapelbok-Juluk | South Turkana and Nasolot NRs to Juluk through Kapelbok | Moderate |
| Kamanarok NR-Lembus Forest Reserve | Elephants travel from Kamnarok NR through Mochongoi Forest into Lembus Forest Reserve in Mau Forest complex and back. | Moderate |

range widely in  moving between the protected areas and across the Kerio River. The routes followed by the elephants and relative threat levels are given in Table 7.9.

### 7.9.4. Mt. Elgon Elephant Routes

Mount Elgon is a volcanic massif well known for its outstanding plant diversity, its role as a vital 'water tower', and its cultural significance. Half of the mountain is in Uganda, while the Mt. Elgon NP, which covers about 16,916 ha, is on the eastern flank in Kenya. It forms the core area, while the Mt. Elgon Forest Reserve and Chepkitale National Reserve together form a buffer zone covering about 90,905 ha. A 10-km strip of intensively farmed land on the foothills of the mountain, covering some 101,000 ha, makes up the transition area.

The Mt. Elgon NP has several altitudinal vegetation zones from upland forest to high-altitude moorland, and supports a varied fauna, including typical Afro-montane moorland species, as well as threatened mammals such as elephant, leopard, and African golden cat. The summit of Mt. Elgon contains a huge caldera, ringed by volcanic basalt columns. Numerous caves have been excavated in the forest by elephants in their search for salt. Over the past two decades, severe human encroachment has occurred in the western section and into the forest around the park (IUCN/UNEP, 1987). Extending the park boundary to include the Sosio Forest would benefit the elephants by enhancing their protection and increasing the extent of their range.

Several ongoing studies and monitoring activities are being undertaken in the Mt. Elgon region. These include the monitoring of water quality and flows in perennial and seasonal rivers, the geomorphology of the elephant caves, analysis of elephant dung samples, GPS tracking of elephant and monkey movement patterns and habitat use, and the monitoring of forest dynamics and human-wildlife conflicts. These studies are shedding new light on the ecology of the Mt. Elgon NP and adjacent areas, and on the issues that affect biodiversity conservation.

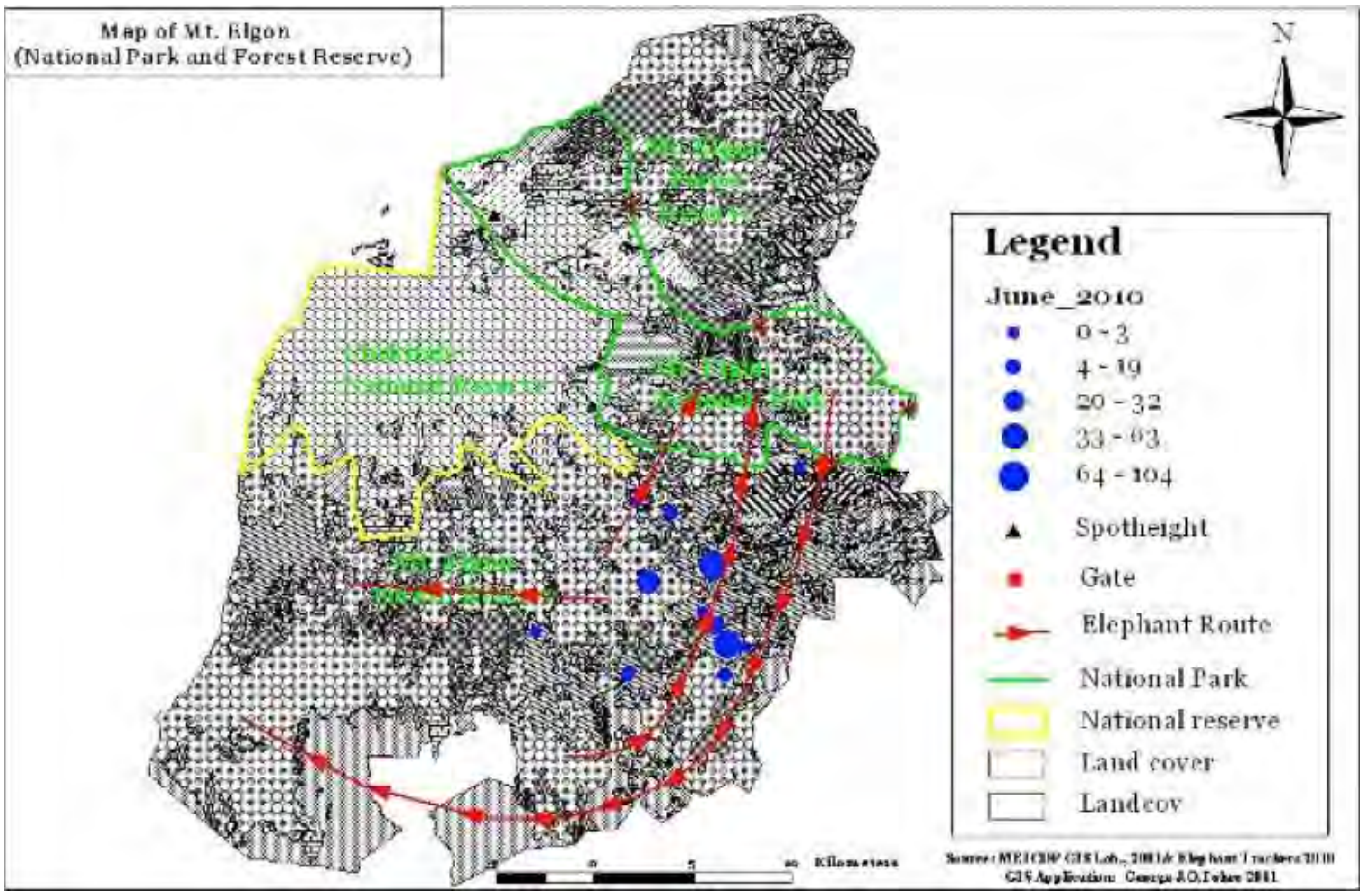
### Recommendations

1. Creation of conservancies through Public-Private Partnerships (PPPs) should be encouraged in areas perceived as wildlife corridors. Policy governing the setting up of conservancies is still lacking, but amendments to the Wildlife and Conservation Management Act, 2013, are expected to address the issue of wildlife management outside protected areas. *Responsible* – KWS, local communities, landowners, and conservation stakeholders.

2. Mechanisms for the Payment for Environmental Services (PES) should be encouraged and pursued to secure wildlife areas outside protected areas. *Responsible* – Conservation trusts and landowners.

3. Watershed management through carbon payments (REDD and REDD+ mechanisms) should be encouraged to rehabilitate the Mt. Elgon forest catchment and that of surrounding areas, and to

**Map 7.33:** Distribution density for elephants and movement routes in areas adjacent to the Mt. Elgon NP (June 2010). Large groups were observed outside the protected area, traversing buffer zones on the footslopes, which contain critical habitat within their wider range.




regulate intensive use of important habitats on the foothills. *Responsible* – Kenya Forest Service, KWS, and NEMA.

4. Management plans should incorporate emerging conservation programmes outside the protected areas. An ecosystem management committee should be set up, drawing membership from all local stakeholders, to steer implementation of management plans. Community conservation committees should promote conservation awareness and engage in alternative income-generating activities such as agroforestry and eco-tourism ventures. *Responsible* – KWS, County government.

5. Cooperation with Uganda should be encouraged, with a view to creating a future trans-boundary biosphere reserve encompassing the whole of the Mount Elgon ecosystem.

### 7.9.5. Migratory Routes and Movement Corridors in the Greater Ewaso Ecosystem

The greater Ewaso ecosystem is renowned for its abundant and diverse assemblages of wild ungulates. The Ewaso Ng'iro River catchment defines the range of migratory species such as elephant, and both Burchell's and Grevy's zebras within Laikipia, Samburu, Isiolo, Meru, Tharaka, Marsabit, and Wajir Counties.

#### State of Conservation Connectivity

**A. Drivers**

i. High pressure on natural resource use due to exponential growth of the human population and associated anthropogenic activities.

ii. Insecure land tenure leads to the sub-division of communal lands into individual parcels. The privatization of land encourages fencing, sedentarism, and the expansion of settlements and agriculture.

iii. Infrastructure improvement and industrial development, including the proposed Lamu Port-South Sudan-Ethiopia Transport (LaPSSET) corridor, high voltage power lines, Isiolo Resort City, and construction of the Gibe dam on the Omo River for hydropower generation.

iv. Impacts of climate change and variability are already affecting surface water, boreholes, and underground aquifers. Inadequate and unpredictable rainfall is characteristic of arid and semi-arid lands. Frequent and severe droughts trigger mass movements of wildlife and of pastoralists and their livestock in search of pasture and water, intensifying competition for these resources.

v. Expansion of agriculture (crop cultivation in wetter areas, and horticulture).

vi. Governance: Lack of, or inadequate, land-use policy, and of capacity to enforce legislation.

vii. Insecurity (caused by the proliferation of firearms, cattle rustling, and inter-tribal wars).

viii. Most protected areas have long and porous boundaries, which encourage livestock incursions, human encroachment, and poaching.

**B. Pressures**

i. Land-use changes, water abstraction, fuel wood harvesting, increasing human population, high livestock densities, urbanization, and the expansion of agriculture.

ii. Insecurity of tenure and land-use changes associated with the sub-division of communal lands to individual parcels. Most of the wetter areas are converted to agriculture, to feed expanding sedentary human populations.

iii. Pastoralists armed with guns to protect their livestock, grazing areas, and watering points pose a security threat, often resulting in the inaccessibility of dry season grazing areas, cattle rustling, internecine wars, and poaching.

iv. Human-wildlife conflicts, human intrusions, and disturbance.

v. The negative impacts of unregulated tourism developments.

**C. State**

i. Large-scale ranchers have embraced wildlife management practices on their properties, but in some areas fences are blocking the movements and migratory routes of certain species.

ii. Urbanization has led to a proliferation of unplanned nuclear settlements, while increased water abstraction is resulting in diminished downstream flows.

iii. Human-wildlife conflict is rampant, especially around the edges of protected areas. In addition to crop damage, livestock predation, and injury or even death to humans, there is intense competition for forage and water resources, especially during the dry seasons.

iv. Land sub-division and sedentarism has led to high livestock densities, deforestation, and land degradation.

v. Poaching is rampant, and threatens to undermine the viability of some protected areas and conservancies.

**D. Impacts**

i. Declines in the populations of most wildlife species in the ecosystem are attributed to drought, poaching, and competition for forage and water resources. On the Laikipia plateau, however, some species, such as elephant and Burchell's zebra, have increased in number. This is due to habitat resilience and to the fact that some large-scale ranchers have embraced effective wildlife management practices on their properties.

ii. Declining forest cover; decreasing water levels in the major rivers, and loss and/or reductions in wildlife ranges due to habitat fragmentation.

iii. Increasing vulnerability to climate change; loss of livelihoods, and high poverty levels.

iv. Wildlife security is threatened by pastoralists who carry firearms while on the move with their livestock in search of pasture and water.

v. The proposed LaPSSET corridor linking Lamu Port and South Sudan is likely to create a major physical barrier to wildlife movement, especially for elephants moving between the Buffalo Springs NR and the Samburu NR, and likewise along the entire transport corridor.

**Responses**

i. Creation of Water Resource Users' Associations (WRUAs) empowered to promote efficient water-use mechanisms;

ii. Joint land-use planning and collaborative management with county administrations;

iii. Empowerment of Community Forest Associations (CFAs);

iv. Establishment of more community conservancies (under the NRT and other bodies);

v. Improvements in security through actions at the local and national levels of government;

vi. Strengthening the management of protected areas;

vii. Integration of national development plans (e.g.

LaPSSET) with county management plans;

viii. The provision of incentives for the development of wildlife conservancies, and for those hosting wildlife on their properties, e.g. through Payment for Ecosystem Services (PES);

ix. Development of legal and economic instruments and easements for the establishment of eco-tourism facilities;

x. Signage of major wildlife crossing points, effective law enforcement, and human-wildlife conflict mitigation measures;

xi. Improvement of livestock management and marketing strategies.

**Threats to Conservation Connectivity**

1. The main threats to biodiversity conservation in the greater Ewaso ecosystem include land-use change (nomadic pastoralists shifting to sedentarism); expansion and intensification of agriculture; high livestock densities; climate change and variability; insecure tenure; insecurity (the illegal proliferation of firearms used in cattle rustling, banditry, and inter-tribal wars over pasture and water); fences (especially electric, chainlink, and stonewall); poaching; the lack of comprehensive land-use plans; weak implementation of legislation; human-wildlife conflicts, and inadequate scientific data.

1. The sub-division of communal lands and of large group ranches into individual parcels with titles has led to habitat fragmentation, logging and woodland clearing, charcoal burning, and over-grazing. Deforestation is taking place in the Mt. Kenya, Ngare Ndare, and Mukogodo forests, and in the Rumuruti area.

2. The conflicting agendas of the Kenya Forest Service (KFS) and KWS (in competing for control and management of resources on Mt. Kenya, for example, where logging and marijuana growing have created large glades and openings deep inside the forest, and where the impact of wildfires on the vegetation is severe and irreversible in the short term). Exotic plantation forest cultivated in the indigenous forest blocks is a threat to the entire ecosystem.

3. Fences threaten conservation areas by blocking wildlife access to out-lying resources, but are beneficial to communities living in adjacent areas through reducing human-wildlife conflicts. The Rhino Ark Kenya Charitable Trust has plans, within five years, to complete a fully wildlife-proof perimeter fence around the entire Mt. Kenya Forest. The Mt. Kenya Wildlife Trust and other organizations have already fenced off some parts of the forest (to Imenti), while the Chogoria area is buffered by a Nyayo tea zone.

4. Funds have been allocated for the upstream damming of rivers on Mt. Kenya, but without consideration for the downstream impacts on pastoralists and livestock in the lowlands.

5. Tourism infrastructure in the vast wilderness of northern Kenya is comparatively limited.

**Conservation Connectivity Opportunities**

1. Eco-tourism-related developments in the greater Ewaso ecosystem have been increasing due to growing awareness of the benefits for local communities. Most of the communal lands adjacent to protected areas are considering re-consolidation to form conservancies, while some private ranches with substantial wildlife on their properties have been turned into sanctuaries, with lodges and camping facilities. The new Laikipia NP has been created, the Lotikipi NR has been proposed, and several conservancies are being developed through Public Private Partnership (PPP) initiatives involving local communities.

2. Potential economic development in the greater Ewaso ecosystem is based on livestock production, eco-tourism, and conservation offsets through land leases and payments for ecosystem services. The recent exploration and drilling for oil in Turkana, and the discovery of vast water aquifer reserves, may leasd to increased industrialization and crop cultivation through irrigation.

### 7.9.6. Mt. Marsabit Forest and the Adjacent Lowlands

*i. Mt. Marsabit Forest-Dirib Gombo-Bule Marmar Route*

This elephant route is about 90 km north-east of the Mt. Marsabit Forest. Elephants move from the forest, and pass between Badassa and the Gabbra scheme to the Dirib Gombo area after the onset of the rains, and then proceed to Bule Marmar (Map 7.34), where they encounter lava-strewn terrain, which slows their movement and forces them to rest, for about a day, after every 40 km covered. They usually return to the forest in the dry season, when water sources in the lowlands have dried up, but they may remain at Bule Marmar for the entire year, especially when rainfall is above normal.

*ii. Mt. Marsabit Forest-Jaldesa Route*

Elephants migrate from the Mt. Marsabit Forest during the rainy season, and pass between Kituruni and Songa or Karare, and then proceed to the Jaldesa area in the lowlands, before returning to the forest in the dry season. This short route (of 20-30 km) is also important for dispersal during the dry season, as different groups (families) move out of the forest at nightfall and return at sunrise (or vice-versa). The main threats to elephant survival in the Jaldesa area are frequent droughts and poaching.

*iii. Mt. Marsabit Forest - Karare-Logologo Route*

Elephants from the Mt. Marsabit Forest pass through areas east or west of the Karare and Kamboe settlements and spend time around the Logologo Centre to the west. They move out the forest in the wet season and return at the beginning of the dry season. This route (of 30-40 km) is important for dispersal during the dry season, as different groups (families) move out of the forest at nightfall and return at sunrise (or vice-versa). Poaching and drought are the main threats along this route.

*iv. Mt. Marsabit Forest-Karare-Logologo-Mathews/Ndoto Range Route*

A bull elephant from the Mt. Marsabit Forest travelled east of Karare and west of Logologo to the Mathews/Ndoto ranges during one dry season (July 2007), and then back after the onset of the rains in October-November of the same year. It is speculated that this elephant might have been looking for a mate.

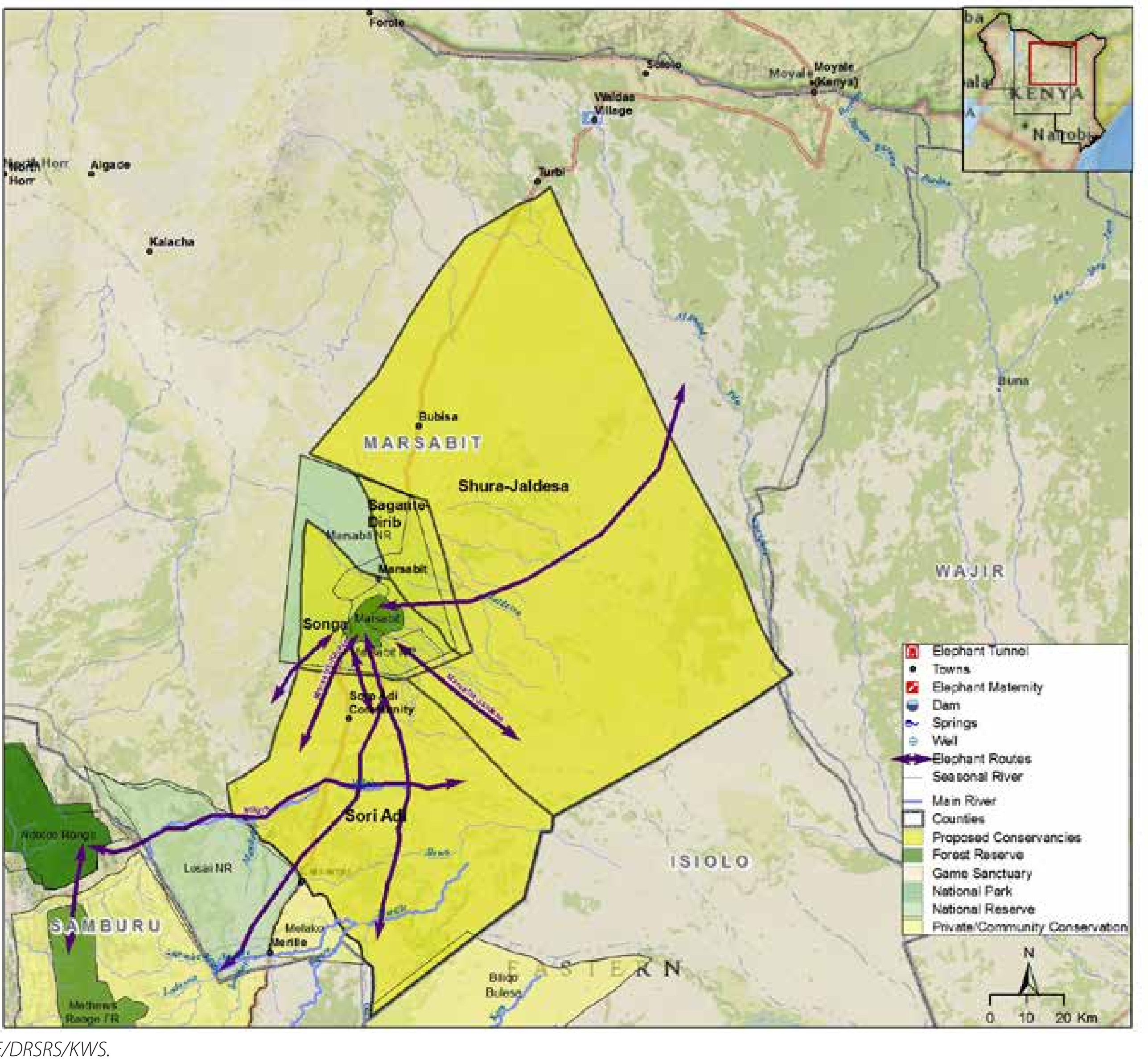
*v. Mt. Marsabit Forest-Hula Hula Route*

Elephants using the Hula Hula route (of 10-15 km) pass between Hula Hula and Kijiji, and Hula Hula and Marsabit town, during the dry season. They then proceed to the lowlands at nightfall, and return at sunrise. During the wet season, they disperse out of the forest and occupy the Hula Hula and Kijiji settlement areas.

### 7.9.7. The Meru-Isiolo-Samburu Ecosystem

The Meru National Park covers an area of 870 km$^2$ in Meru County, on the north-eastern side of Mt. Kenya, which is one of the geographical features that influence climate

**Map 7.34:** Movement of elephants from the Mt. Marsabit Forest to the Bule Marmar, Logologo, Karare, and Jaldesa lowlands, and further southward to the Mathews range along the Milgis River. Source: STE/DRSRS/KWS.




*Source: STE/DRSRS/KWS.*

patterns in the region. The Nyambene Hills, located in the county, also affect rainfall and temperature patterns in the area.

Meru National Park (MNP) lies within the semi-arid agro-ecological Zone V. It receives bimodal rainfall, amounting to between 380 mm and 1,000 mm annually. The park receives long rains between March and June, and short rains between late October and December. The area has a moisture index of -42 to -51, with rainfall seldom exceeding evaporation. Rainfall varies with changes in elevation, and is highest in north-western areas, and lowest in the south-east. The high rate of evaporation is the result of the low altitudes found within the ecosystem, and of the high temperatures that prevail throughout the year. Desiccating winds are a feature of the dry season, when temperatures rise above 33°c during the day and drop below 20°C during the night. The park is bisected by 15 rivers, some of which are seasonal.

The composition of the park's flora is extremely varied, given local variations in rainfall and climate and the presence of contrasting soil-types. The vegetation ranges from *Acacia-Commiphora* bush land and *Acacia-Combretum* wooded grasslands to swamps along the rivers. Other habitats include riverine forest vegetation, rocky inselbergs, and ground-water forests. *Combretum* wooded grassland prevails in the northern parts, where *Combretum apiculatum* is the dominant plant species. This grades into *Acacia* wooded grassland in the east, with *Acacia tortilis* and *Acacia senegal* prominent on rocky ridges and in riverine thickets. *Commiphora* bushland is dominant in the south, with *Acacia-Terminalia* wooded grasslands along watercourses and around riverine swamps. Dense riverine forests of doum palms (*Hyphaene* and *Raphia* spp.) grow along the watercourses and around the wetlands. Other riverine trees include *Phoenix reclinata*, *Ficus sycomorus*, *Newtonia hildebrandtii*, the Tana River poplar (*Populus ilicifolia*), *Acacia elatior*, and *Acacia robusta*. There are numerous riverine swamps with sedges (*Cyperus* spp.) and grasses, including *Pennisetum mezianum* and *Echinochloa haplacelada* (KWS, 2007). Trees on the inselbergs include *Albizia tanganyikensis*, *Terminalia brownii*, *Sterculia stegonocarpa*, *Sclerocarya birrea*, and *Euphobia* spp.

Meru NP was once a haven for a wide variety of wildlife species. However, between the 1980s and the mid-1990s, the park and adjacent areas were characterized by intense insecurity and poaching, which resulted in major reductions in the numbers of large herbivore species (Litoroh, 1992). The KWS and its conservation partners re-secured the area, and in 1999 a wildlife-restocking programme was initiated, followed by the re-introduction of various species into the ecosystem. The ecosystem is now home to almost 35 species of mammals, including elephants, reticulated giraffes, Burchell's zebras, Grevy's zebras, impala, white and black rhinos, hippopotamus, beisa oryx, hartebeest, buffaloes, bushbuck, elands, Grant's gazelle, gerenuk, Bohor reedbuck, waterbuck, and greater and lesser kudu, as well as a variety of small-bodied ungulates (Ngene *et al.*, 2007). Carnivores found in the park include lions, leopards, cheetahs, striped and spotted hyenas, African wild dogs, and black-backed jackals. The park and its surroundings support a high diversity of small mammals (mainly rodents and bats), along with numerous reptile species, and birds of more than 300 species.

The park straddles parts of Isiolo, Mwingi, Tharaka, and Meru Counties. The Kamba, Mbeere, Meru, and Tharaka communities, whose main livelihoods are subsistence crop farming and animal husbandry, occupy areas to the west and south-west of the park. Areas to the east, south, and north of the park are inhabited mainly by Borana and Somali pastoralist communities which depend on livestock for their livelihoods. Livestock incursions into the park are common from the pastoralist-dominated areas, while opportunistic cultivation and bush-meat hunting are rampant in the western and south-western parts of the ecosystem. Activities in urban areas surrounding the park are mainly commerce-driven. Irrigation schemes at Kinna and Rapsu have turned irrigated farming into a major land-use, where the crops grown include maize, beans, sesame, onions, chillies, fruits, and vegetables.

Commercial development and some light industries, run by central government, local authorities and NGOs, have attracted people to centres such as Kinna, Garba Tulla, and Kulamawe. Areas north-west of the ecosystem, such as Thankatha (Tigania East) and Kuguru town in Igembe, are densely populated. Kinna town in the north is a trading hub for goods and services emanating from Isiolo, Marsabit, Moyale, and even Ethiopia. These activities have attracted many people to the area, contributing to a rapid population increase in areas around the ecosystem. Movements of people from the north-west and south-west are driven by the need for agricultural land and settlement, while those from the east are driven towards the park by the need to find water and pasture for their livestock, and to visit trading points. The growing of miraa (*Catha edulis*) is a major driver of land-use change in the area, as more and more unoccupied land is converted to farmland. The miraa trade also fuels urban growth, as new centres are established as trading points for miraa.

Elephants disperse from the Shaba NR to the Meru Ecosystem through Garba Tulla. Some of the main routes are critical to the survival of the species. The dispersal area in Wayam Dilu Arba, which means "place for the elephant placenta" in the Borana language, is a small forest where elephants give birth. Elephants and other wildlife species use several water points in the region, including the Mado Yaka springs, Kilewe, Ardimtu, Dambala Daka, Harbuyo, Harbaloni, Duse, the Bwana Cook and Moliti dams, and the Burabate wells.

i. *Roka-Asoka-Moju-Kora-Bisanadi route:* Elephants move from Roka, Asako, and Moju to the Kora NP, Bisanadi NR, and Meru NP, and back. The Roka sub-population moves to Mbalabala and across the Tana River to Asako and Moju, and back to Roka by the same route. The Asako sub-population moves through Moju to the Kora NP and across the Tana River to the Bisanadi NR and the Meru NP, and back by the same route.

ii. *Rodgers (Kara Arba) route:* Elephants from the Bisanadi NR visit several luggas and water points, including Kurobarata, Boji, Darer Bura, Machesa, Duse, Eskot, and Korbesa, on their way to South Horr and Hola, and back.

iii. *Kara Matasara route:* Elephants from Boji Didiko pass through Ardimtu, Bwana Cook, and Duse dam, on their way to Wayam Dilu Arba, and back.

iv. *Sabans Sira Sokone route:* Elephants from Kinna pass through Wayam Dilu Arba and the Darer Bura lugga on their way to Ardimtu dam during the April and November wet seasons.

v. *Shaba-Kachuru route:* Elephants from the Bisanadi NR and the Meru NP pass near the Kachuru Centre, before crossing the Goth Jaldesa lugga on their way to the Shaba NR.

vi. *Shaba-Charfa Gate route:* Elephants from the Shaba NR pass through Charfa Gate, and cross the Ya Parsali, Shable, Kokota, and Ndolo Parkasa luggas, and the Moliti water hole, on their way to the Bisanadi NR and Kinna, mainly in July.

vii. *Kuro Takan route:* The elephant route through the Kubi Kalo area splits into two, before converging at a small lugga near the Ewaso Ng'iro River.

viii. *Iyan Mayo route:* Elephants using the Rodgers route sometimes divert through the Mado Yaka springs in heading for the Ewaso Ng'iro River.

### 7.9.8. The Samburu-Laikipia-Mt. Kenya Landscape

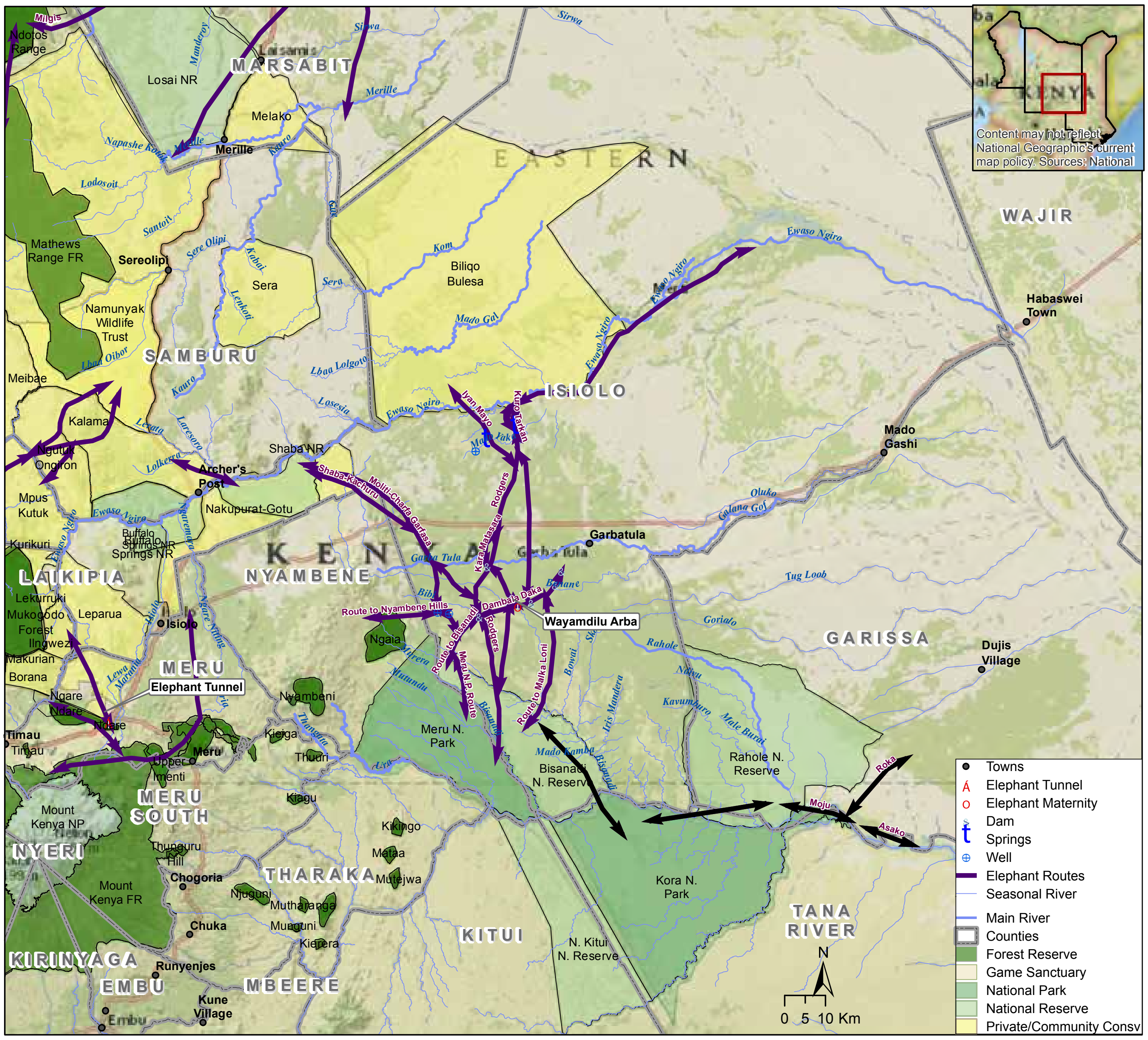
The Laikipia plateau is mostly marginal land which is occupied primarily by large-scale private ranches. There are also a few game reserves and forest patches, some small- to medium-scale farms, and some communal lands (mainly in the drier Mukogodo area). Prior to the 1960s, the dominant land use was large-scale low-intensity ranching, which kept the natural vegetation in relative equilibrium without traumatic influence (Taiti, 1992). The ranches became useful for wildlife conservation, as the landscape contained a great diversity, and high densities, of large wildlife species (almost 8 % of the country's wild herbivores), co-existing with livestock in the natural habitats on the ranches.

In more recent years, land-use changes have occurred throughout the landscape, except on a few large-scale ranches which still have a substantial wildlife presence. Today, the landscape faces huge challenges arising from increasing human population pressure. The former wildlife dispersal areas are diminishing. The sub-division of some large ranches and increasing crop cultivation have led to habitat fragmentation. Land on more than 30 % of the ranches has gradually been transformed into high-density settlements, while communal lands now have enormous stocking densities, stemming primarily from the changing lifestyle of pastoralists from nomadism to sedentarism. Land degradation is widespread in areas where traditional pastoralism persists, especially in the Mukogodo area, which has a limited rangeland carrying capacity. Livestock keeping is an essential livelihood in the pastoralist areas, and is also the economic base for the large-scale ranching enterprises. Over-stocking and the impacts of recurrent droughts have affected many areas. Competition for forage and water resources during dry periods results in the mass movement of livestock and wildlife alike. Displacement of livestock by wildlife creates tensions which often degenerate into human-wildlife conflicts.

For several decades, wildlife populations across the Laikipia plateau have increased or remained stable. This is due to the region's heterogeneous and resilient habitats, and to the conservation initiatives of some of the large-scale ranching enterprises. In marginal areas, wildlife management offers better economic prospects, and is an essential component of sustainable utilization in terms of conserving ecosystem processes and species (Croze & Mbuvi, 1981; Cumming, 1991; Western, 1994; Voeten, 1999). In the human-dominated landscapes of Laikipia, community conservation plays a significant role in the restoration of ecosystem integrity and in conserving wildlife outside the protected areas. The continued existence of wildlife in these landscapes depends on collaboration with local communities, with the emphasis on economic benefits that will improve livelihoods.

The Laikipia-Samburu-Mt. Kenya region's enormous eco-tourism potential has yet to be developed. Eco-tourism,

**Map 7.35:** Elephant movement routes in the Samburu-Isiolo-Meru-western Garissa landscapes.




*Source: STE/DRSRS/KWS/AWF.*

though, will have to contend with traditional pastoralism, forestry, and crop cultivation (particularly in the wetter highlands). The critical issue is the degree of trade-off that is required in opting to pursue a combination of different land uses. The owners of several pro-wildlife properties have turned to non-consumptive wildlife utilization, and have developed accommodation facilities (bandas, campsites), or converted their ranching infrastructure into amenities comparable with those found in national parks and reserves, complete with luxury game viewing safaris, curio shops, cultural manyattas and camel and horseback safaris. There are also a number of community conservancies. These include the Gallmann Africa Conservancy, the Il Ngwesi Group Ranch, the Lekurruki Conservation Trust, the Naibunga Conservation Trust, the Ngare Ndare Forest Trust, the Lewa Wildlife Conservancy, and the newly established Laikipia National Park.

To the north of Laikipia lies Samburu County, where most of the land is communal and where people reside in nuclear settlements to access water resources and relief food, and for reasons of security. The county has significant populations of elephants, Burchell's zebras, and Grevy's zebras. The Samburu, Shaba, and Buffalo Springs NRs are major wildlife areas. But there are also several conservancies, including the Kalama Community Wildlife Conservancy, the Meibae Community Wildlife Conservancy, the Namunyak Wildlife Conservation Trust, the Sera Conservancy Trust, and the West Gate Community Conservancy. The distribution of elephants in the Laikipia-Samburu landscape changed considerably between the 1970s and the 1980s, with a general southward movement (Thouless, 1992). Elephants are migratory, and part of this region's population is known to move onto the Laikipia plateau at the beginning of the dry season, and then to disperse northward to pastoralist areas in Samburu, a distance of more than 100 km, with the advent of the short rains (Thouless, 1994, 1995). At the end of short rains, many of the elephants may return to the Laikipia plateau, before dispersing northward again with the onset of the long rains. In the 1980s, large concentrations of elephants appeared on the Laikipia Ranching, and the Kisima, Mpala, Ol Jogi, Vananda, and Ol Pejeta ranches. In the 1990s and 2000s, their dispersal area expanded to include the central plains, ADC Mutara, Ex-Lekurruki, Colcheccio, Mugie, the Mukogodo Forest, and Il Ngwesi (Georgiadis *et al*., 2007; Ojwang *et al.*, 2012).

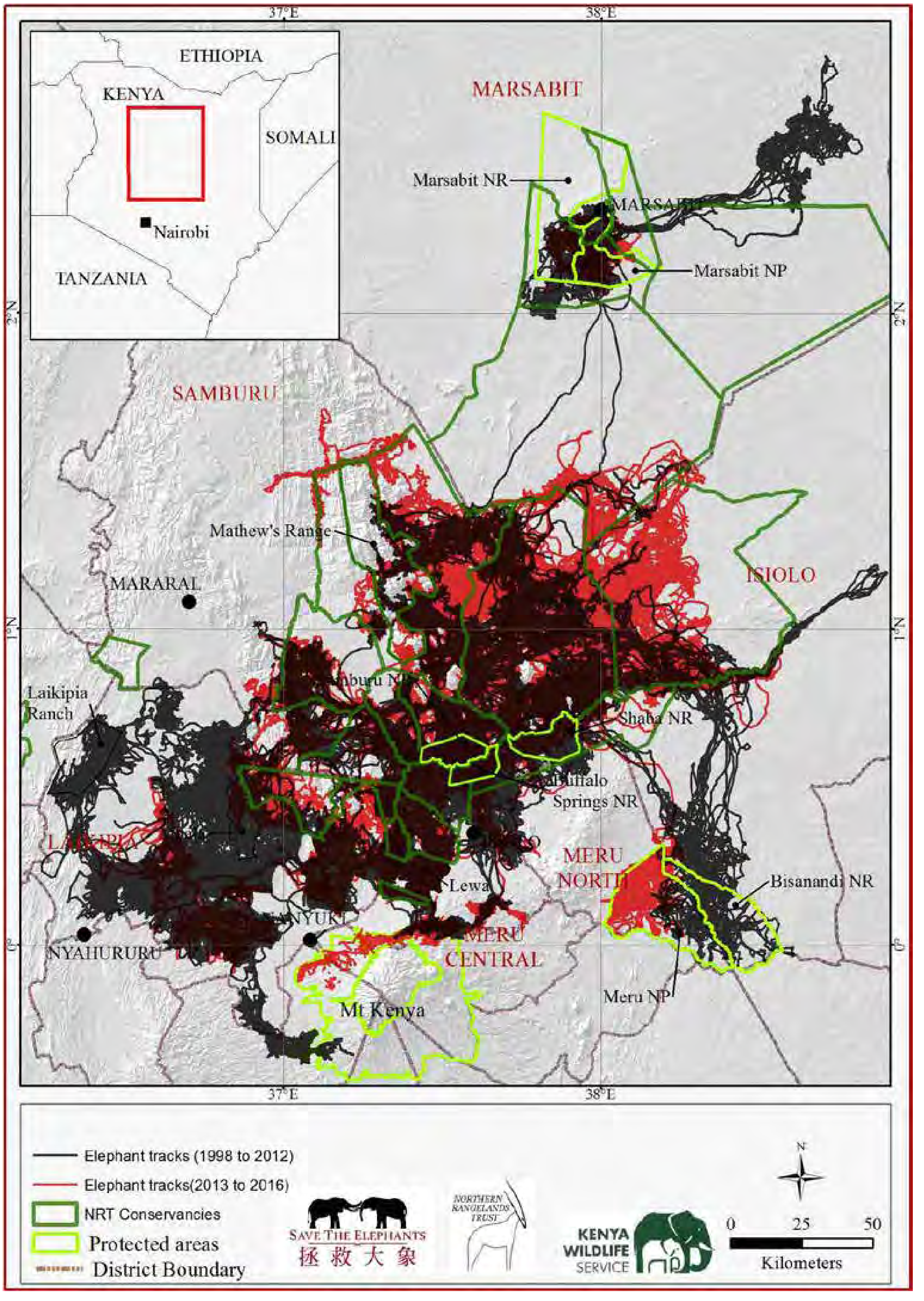
Poole (1996) predicted that increased human settlement in elephant dispersal areas around protected areas will lead to increased human-elephant conflicts. She suggested that migration routes will become restricted or blocked completely. It has been observed that conservation planning could be improved greatly by the relatively small investment of keeping open the critical corridors identified through radio tracking, so that the elephants and their impacts can be spread among different segments of their range. The viability of many mammalian metapopulations may also depend on linkages provided by these corridors. Through monitoring the Samburu-Laikipia elephant movements, it has been possible to identify crucial corridors which, if these are recognized and restored, are likely to benefit, not only the elephants, but other wildlife species as well.

The current status of connectivity between the western and southern parts of laikipia, and the Aberdare Range and the Mt. Kenya Forest is as follows:

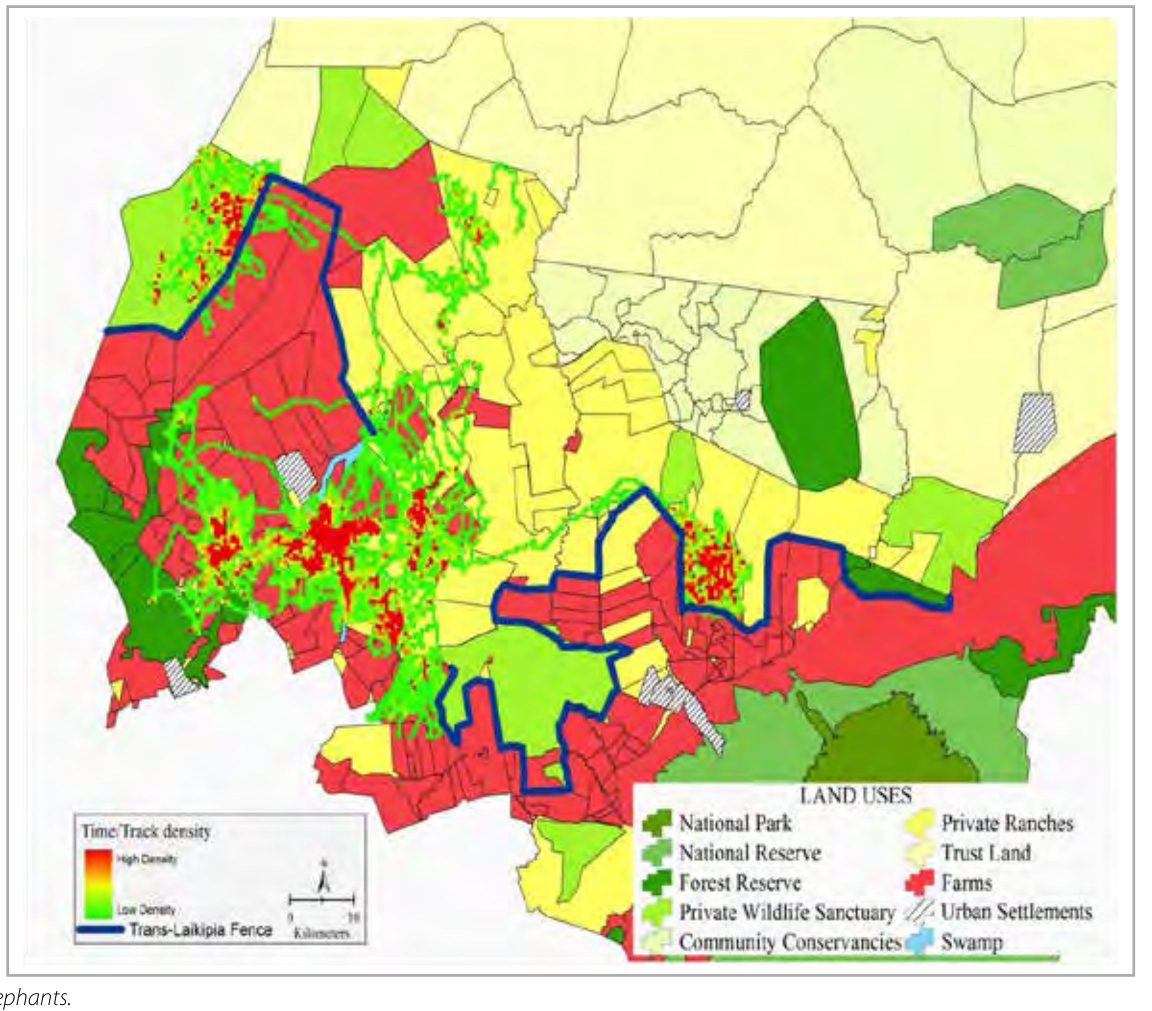
1. In west Laikipia, the Lariak-Rumuruti corridor is completely blocked by agriculture and settlements. The Kieni-Rumuruti Swamp passage is blocked, mostly by the trans-laikipia fence but also by agriculture and settlements (plate 7.12 a). The Solio-Mt. Kenya passage is partially blocked, but a complete blockage by settlements on both sides of the Nairobi-Nanyuki highway is imminent (Plate 7.12 c).

2. The Aberdares-Mt. Kenya Forest passage through south Laikipia has been completely blocked by the Nairobi-Nanyuki-highway, and by land sub-division on both sides of the road.

**Map 7.36 (a):** Movement patterns – red tracks (newly generated data; 2013-June 2016) overlaid on black tracks (historical data; 1998-2012). The new data show elephant movements in the Meru NP, the Mt Kenya Forests, the Milgis lugga, and Biliqo.

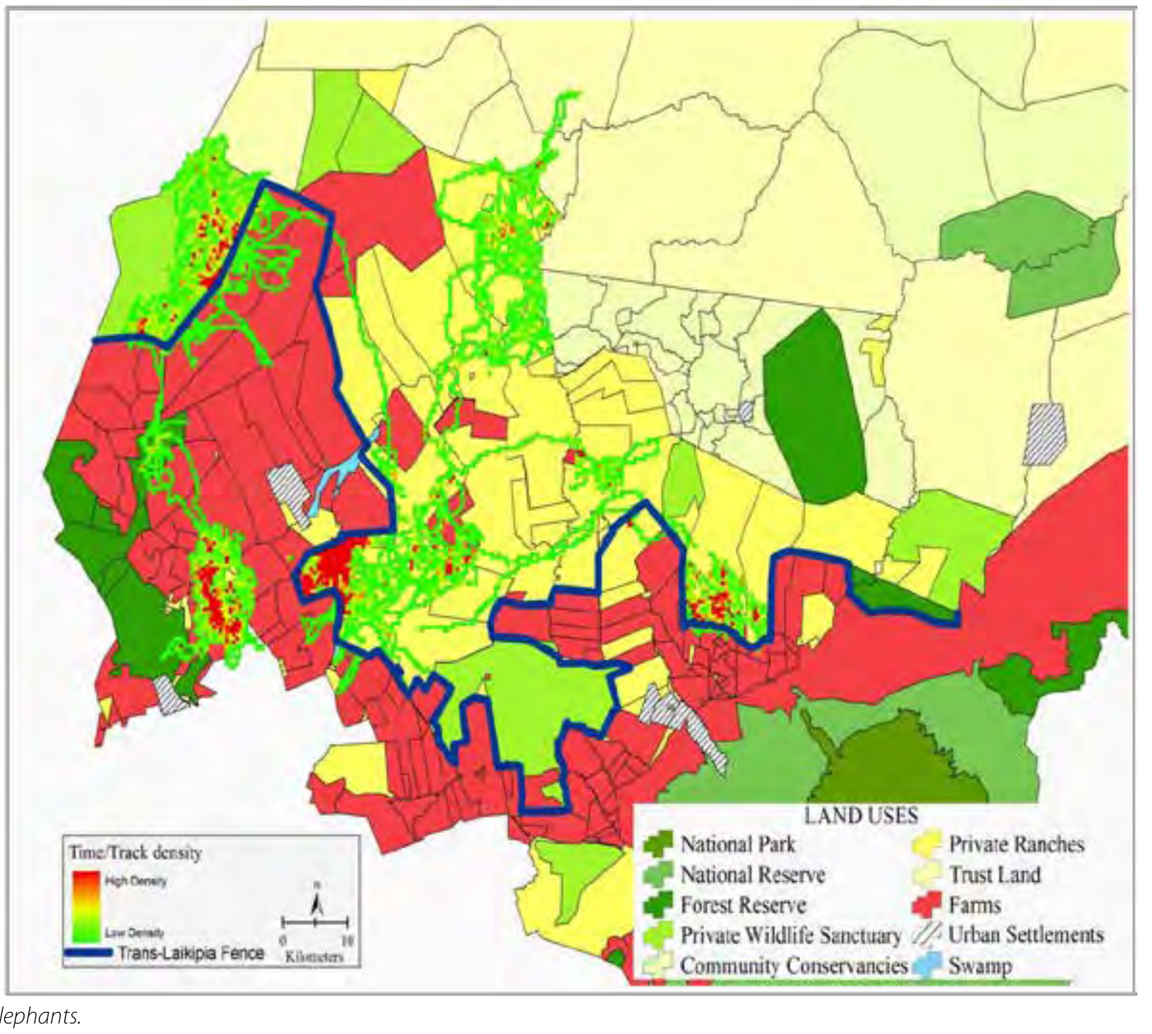


**Map 7.36 (b):** Movement of five collared elephants in the Laikipia landscape before completion of the trans-Laikipia electric fence separating pro-wildlife properties from agro-pastoralist areas. Human-elephant conflicts are rampant, especially in the wetter western parts.




*Source: Save The Elephants.*

**Map 7.36 (c):** The completed trans-Laikipia electric fence and farmlands separating elephant sub-populations in Laikipia west, Mukogodo, and in central areas, but human-wildlife conflicts have remained high.

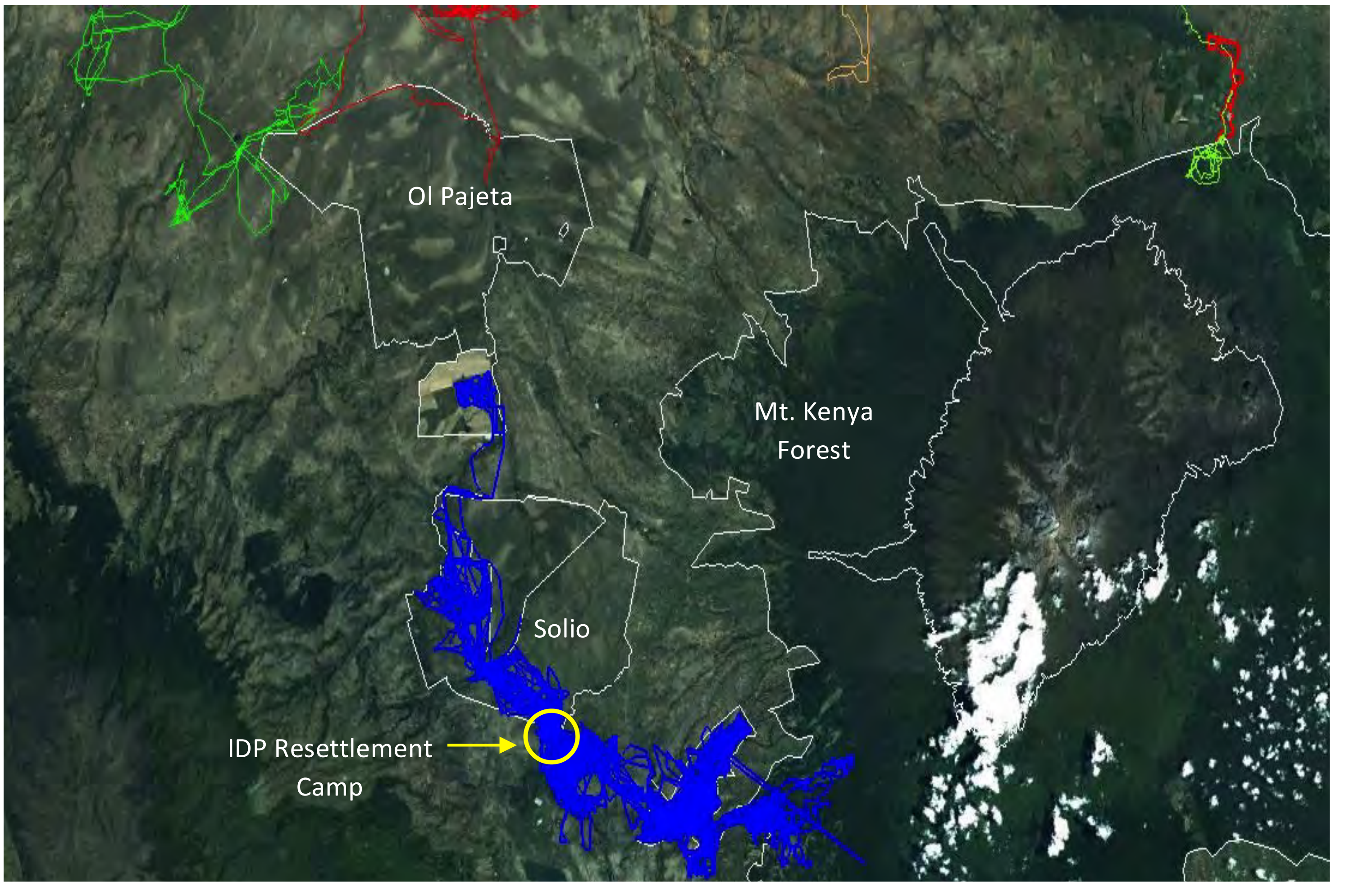



*Source: Save The Elephants.*

**Plate 7.12 (a):** Section of the trans-Laikipia fence damaged by elephants moving from the Rumuruti swamps into the Kieni community farmlands. Inset: Crops destroyed on a nearby farm. Photo: courtesy Gordon Ojwang.


**Plate 7.9.8(b):** Types of the fences on some ranches and conservancies in the Laikipia landscape include combo stonewall/electric fences, chainlink cum electric fences (top inset), and live danglers across motorable pathways (bottom inset). Photo Coutessy: Gordon Ojwang'.

**Plate 7.12 (c):** Elephant corridor linking the Solio Conservancy with the Mt. Kenya forest is facing imminent blockage near Naro Moru due to the re-settlement of Internally Displaced Persons (IDPs) practising crop cultivation and high-density settlement. *Image: courtesy Save The Elephants, Field Check: DRSRS.*




### 7.9.9. Mt. Kenya Forest-Lewa-Ngare Ndare Forest

*i. Mt. Kenya Elephant Underpass Corridor*

Most wildlife populations and habitats are becoming increasingly isolated, owing to partial or complete blockage of migratory routes and corridors by infrastructure developments, fences, agriculture, and settlements. A novel solution, that of constructing artificial pathways, has proved workable, however, in helping to re-establish conservation linkages. The first successful such pathway in Kenya takes the form of a 4.5 m-high tunnel underpass on the busy Nanyuki-Meru highway (Plates 7.13 a and b). This underpass has enabled elephants to go on using the Mt. Kenya elephant corridor between the Mt. Kenya Forest and low-lying rangelands on the Lewa Wildlife Conservancy and in the Ngare Ndare Forest. The underpass has thus re-established the only remaining connection between Samburu, which holds Kenya's second largest elephant population (about 7,500 animals), and the Mt. Kenya Forest, which is home to an estimated 2,000 elephants.

The underpass in the Mt. Kenya elephant corridor was the brainchild of the KWS and its conservation partners (Kisima and Marania farms, the Mt. Kenya Trust, the Ngare Ndare Forest Trust, and the Lewa Wildlife Conservancy). It was built with donations from Richard Branson (Virgin Atlantic), and the Dutch government, among other donors. Kisima dedicated two family farms (some 272 ha) to providing a thoroughfare for the elephant corridor into the Mt. Kenya Forest. Dr. Iain Douglas Hamilton, founder of Save The Elephants, provided equipment and technical back-up for the collaring of seven elephants on either side of the corridor, in recognition of the need to obtain credible data on elephant movements.

*ii. Marania Passage*

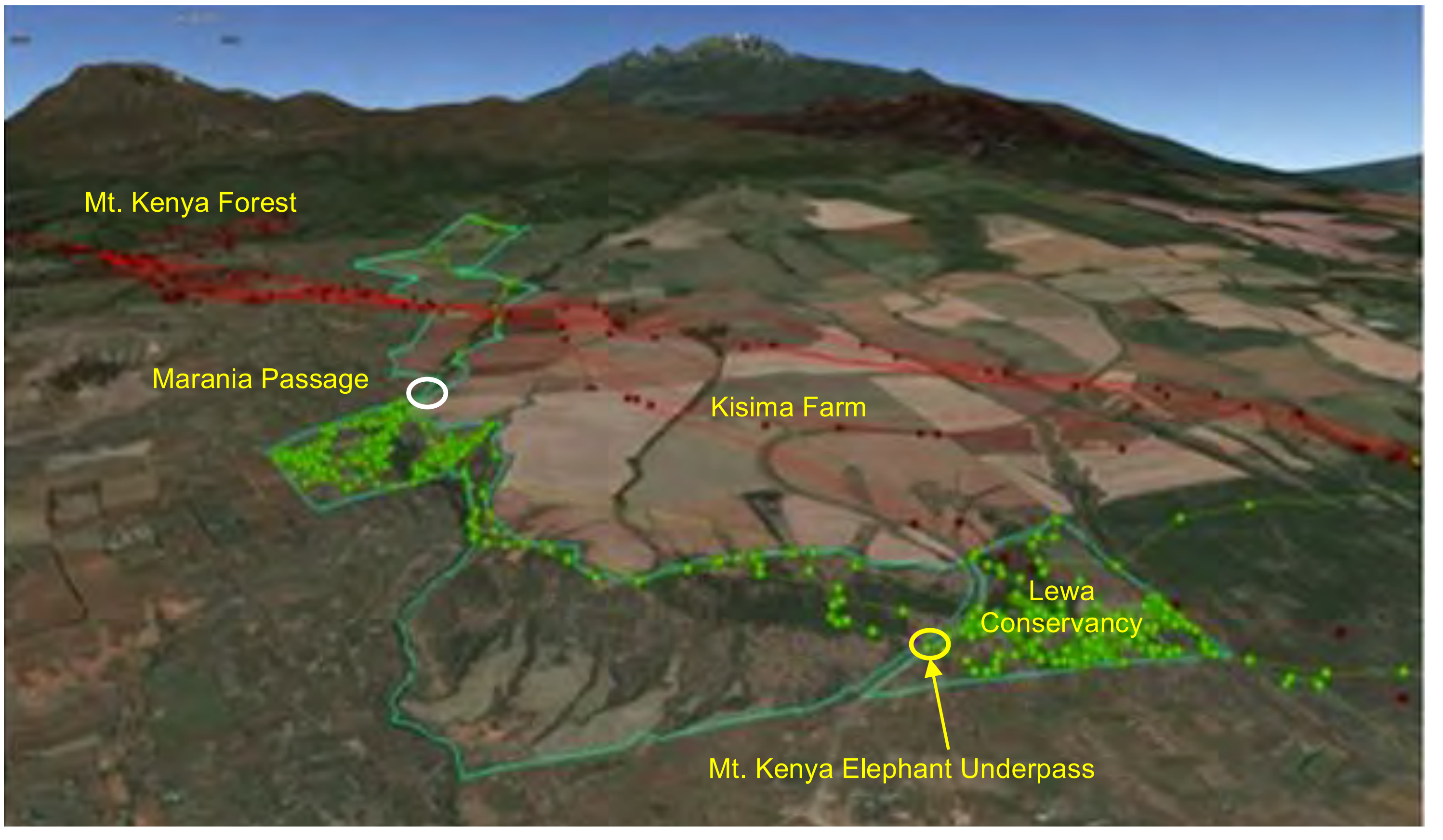
The Marania passage is a narrow strip in the upper portion of the Mt. Kenya elephant corridor between Lewa and the Mt. Kenya Forest (plate 7.13 c). Crossed by the road connecting the Mirania community on the upper slopes with the Nanyuki-Meru highway, this passage is crucial in giving elephants access to the upland forest resources within their range.

*iii. Borana-Kisima Farm Passage*

This is a direct passage used by elephants passing through the Borana and Kisima farms to gain access to the Mt. Kenya Forest through the Kisima Gate. On this route, the elephants cross the busy Nanyuki-Meru highway, and pass through cultivated and ranching areas on both the farms.

The long-term benefits of maintaining these elephant corridors are massive in terms of re-establishing and

**Plate 7.13 (a):** Two elephants tracked by Save The Elephants, one (green dots) using, first the underpass (yellow circle; plate 7.13 b) to cross the Nanyuki-Meru highway, and then the Mirania passage (white circle; plate 7.13 c); and the other (red dots) passing through the Borana and Kisima farms to get to the Mt. Kenya forest. Google Map: *courtesy Save The Elephants.*




strengthening population genetic connectivity, while reducing pressure on habitats in the Mt. Kenya Forest, the Lewa Wildlife Conservancy, and the Ngare Ndare Forest. However, cheaper solutions are required, in addition to the underpass. The setting up of manned gates along the Nanyuki-Meru highway, where traffic can be stopped to allow safe crossing by elephants, has been suggested (MKT, LWC, STE websites). An example is Oronaisi Gate 18, which is manned throughout the day and night, and which is left open at certain times so that elephants from the Borana and Lolldaiga ranches can pass through the Olenaishu ranch into the Ngare Ndare Forest, and back (Plate 7.13 e).

**Plate 7.13 (b):** The elephant underpass below the Nanyuki-Meru highway links the Mt. Kenya forest to Lewa and Ngare Ndare. Inset: Maiden use of the underpass (on January 1, 2011), led by a bull elephant tracked by Save The Elephants. *Photos: courtesy Gordon Ojwang', Jason Straziuso (inset).*

**Plate 7.13 (c):** A narrow passage for elephants between cultivated fields at the Marania crossing, north of Timau. High-voltage danglers across the road allow vehicles and people to pass through, but keep the elephants inside. Inset: Fresh elephant dung. *Photo: courtesy Gordon Ojwang'.*


**Plate 7.13 (d):** Fence gap between the Borana and Olenaishu ranch boundaries, used for exit and entry by several species, including elephant, giraffe, zebra, and large predators, while deterring rhinos. Inset: A camera trap used for monitoring wildlife movements. *Photo: courtesy Gordon Ojwang'.*

**Plate 7.13 (e):** Manned Gate 18 at Oronaisi allows elephants to move from the Borana, Lolldaiga, and Oronaisi ranches to the Ngare Ndare Forest and back. *Photo: courtesy Gordon Ojwang'.*

### 7.9.10. Grevy's Zebra Movement Routes

Today, the most important areas for Grevy's zebra are in central Laikipia, the 'pan handle' extension of Isiolo County between Laikipia and Samburu land; in the Laisamis area; in central Samburu County south and west of the Mathews Range; in the Lewa Wildlife Conservancy, and in National Reserves in these areas (Map 7.37 a and b). The identification of key areas is based on species abundance, as well as on distribution of important water holes, grazing areas, and threats from people.

Well-connected Grevy's zebra sub-populations travelling between central Laikipia, the Samburu parks complex, and the Elbarta plains are still evident. These corridors are easily confirmed, but others are anecdotal only, being based on infrequent reported sightings. The protection of all known routes and range areas calls for the careful planning of development and infrastructure, if the goals of Vision 2030 are to be realized. The distribution and movements of Grevy's zebra in five zones are defined in the National strategy for the conservation of Grevy's zebra in Kenya (2007-2011) (Map 7.37).

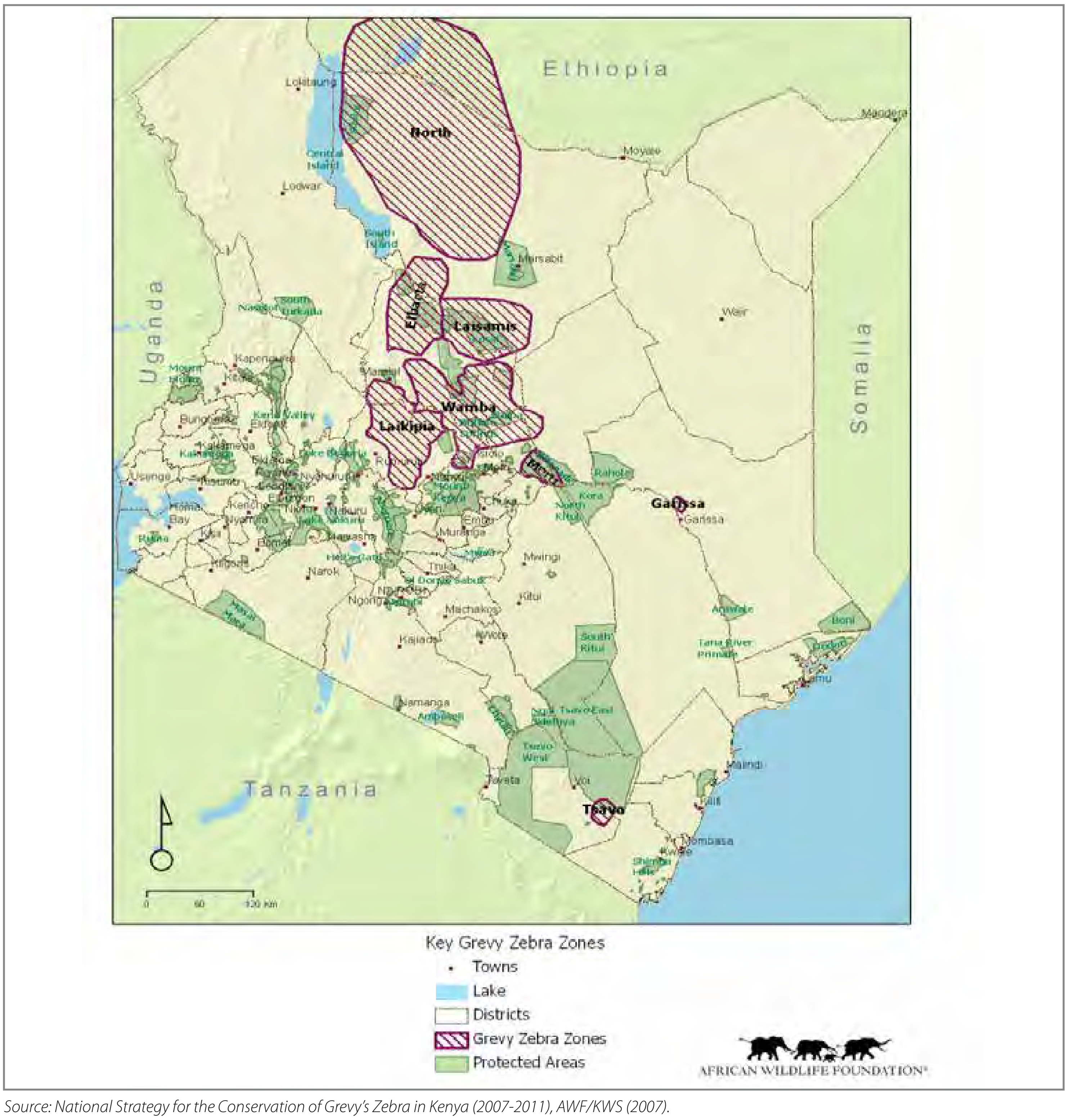
*i. North Zone*

The territory extending from the eastern shore of Lake Turkana as far east as Mt. Marsabit and south to the Ndoto Mountains is a remote and poorly developed landscape populated by diverse pastoralist communities. The Turkana, Rendille, Borana, Samburu, Maasai, and Dassanach tribes compete for resources in an arid belt of semi-desert, which receives low and unpredictable annual rainfall. Wildlife has been marginalized here by a combination of intensifying drought periods with ever shortening intervals between droughts, and by increasing human population pressure, often resulting in insecurity and conflict. A small cluster of Grevy's zebras (about 16 animals) is regularly sighted in the Sibiloi NP. Infrequent but persistent reports suggest that some animals are moving between there and Chew Bahir in southern Ethiopia, via Buluk, where a police post still functions.

Grevy's zebras have not been seen in the Huri Hills within the past seven years. This coincides with the development of water harvesting facilities, using artificial hillside drainage and large storage tanks. A permanent population of pastoralists now remains in the Huri Hills, and there is some conflict over resource use, which has most likely led to the exclusion of Grevy's zebra from this area. Since 1978, there have been no reports of Grevy's sightings in the area to the east of the Marsabit NP and towards Wajir County. However, records do show that their range extends south-east along the Tana River and towards Garissa, where one small herd was observed in 2012.

A 2010 investigation in the northern zone, combining questionnaires with ground surveys, produced several sightings in the Chalbi and Kaisut areas, and reports of regular crossings of the Chalbi Desert by small herds of Grevy's zebras moving between grazing areas to the west and water sources such as the Keroli and Maidahat springs on the eastern side. Signs of Grevy's zebra were also observed around the settlement of Kargi, where water projects (including community pan dams and reservoirs) attract wildlife regularly. Four Grevy's were sighted in two groups of two animals, which may have been the same individuals, in the Kaisut Desert during the same survey. Another recent survey of Grevy's zebras in the Laikipia, Marsabit, and Samburu areas, completed on 30 November 2012, found eight animals on community land around the Milgis delta, near Logologo.

**Map 7.37:** Grevy's zebra range in five zones (North, Elbarta, Laisamis, Wamba, and Laikipia), with additional small clusters in the Meru NP, Garissa, and south of the Tsavo East NP.



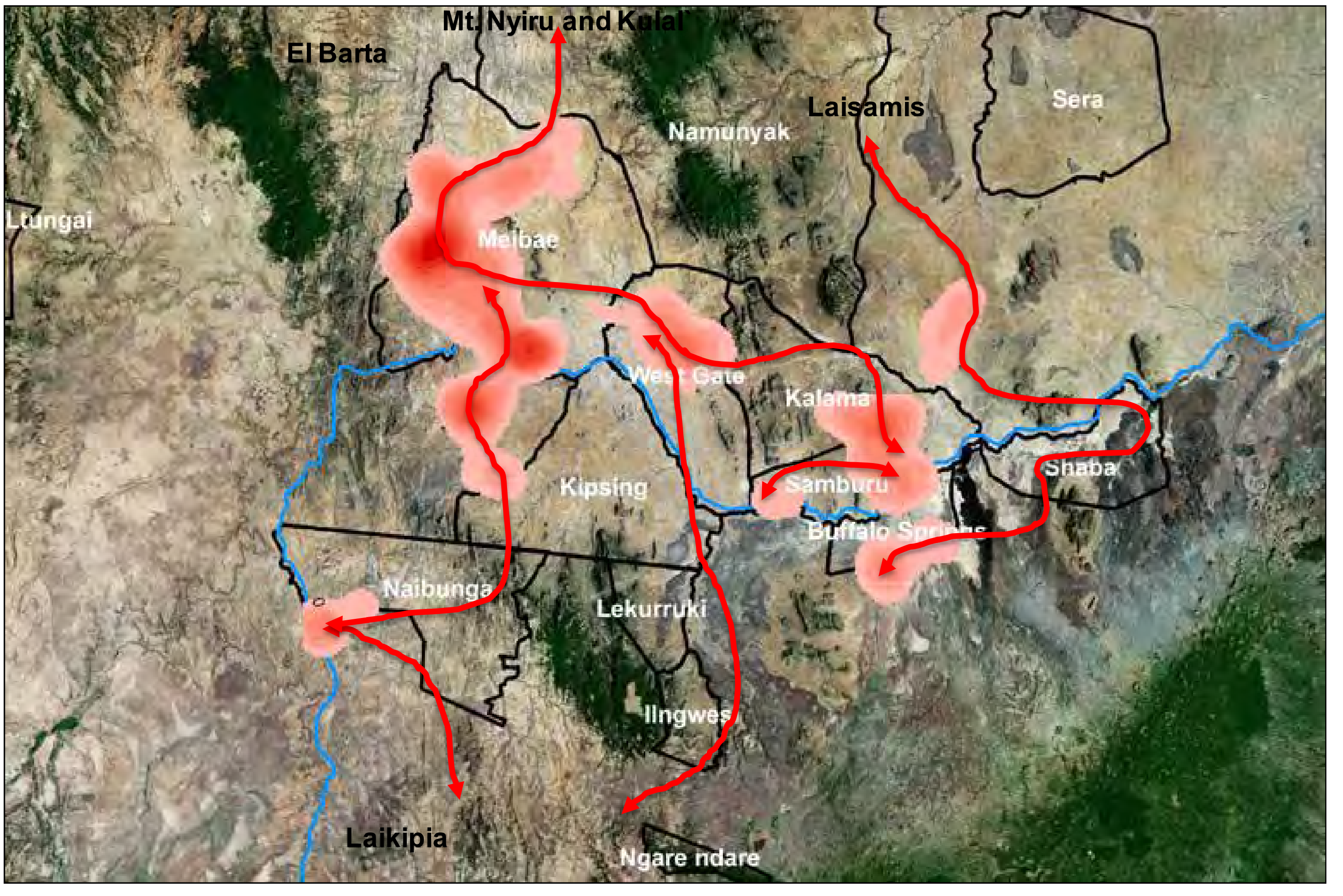

*Source: National Strategy for the Conservation of Grevy's Zebra in Kenya (2007-2011), AWF/KWS (2007).*

*ii. Elbarta Zone*

This zone extends from Mt. Kulal in the north to the foothills of the Karisia Range in the south, and encompasses the Elbarta Plain between roadway R44 in the west and the Mathews range in the east. Most of the data on Grevy's zebras in this zone was collected by community scouts working with members of the Grevy's Zebra Trust and the Milgis Trust. A recent survey, using camera traps, was carried out in 2011 and 2012 on the northern side of the Ndoto Mountains, from the north-western boundary of the Losai NR, and from Arsim and Ngurunit, to the settlements of South Horr and Anderi in the west.

The 2011 aerial survey located seven animals further south on the plain, along its western margin near the settlement of Barsaloi. Here, dense *Acacia* scrubland provides good cover, so it is possible the Grevy's population is higher in this southern part of the plain. Data show there is a small resident Grevy's zebra population (10-15 animals) on the northern end of the Elbarta Plain. These animals move between the southern footslopes of Mt. Nyiru and the settlement of Lesirikan, covering roughly one-third of the length of plain on the southern and eastern sides. These animals appear to exploit a natural drainage line which has been dammed at several points, and which holds water into the dry season. The animals tend to migrate southward as water sources in the north dry up.

**Plate: 7.14:** Core areas and movement routes for Grevy's zebra in the Samburu and Isiolo landscapes. *Courtesy: Zeke Davidson*




Grevy's zebras, along with elephants and other species, have been seen moving southward from the southern Chalbi Desert and the Kaisut Swamp towards the Ndoto Mountains. The settlement of South Horr, on the eastern side of Mt. Nyiru, is a barrier to wildlife movements and a souce of potential conflict, especially over access to water resources. However, a 2012 patrol by KWS rangers found two large groups of Grevy's zebras, numbering about 120 animals in all, moving between the settlement of Anderi and the open plains leading to Mt. Kulal, some 50 km to the north. Efforts are under way to quantify this population.

Camera traps at the Anderi Springs have confirmed the presence of small groups of Grevy's zebras, numbering 10-15 animals. Mountain springs in the foothills of the northern ranges provide perennial sources of water on which pastoralists and their livestock also depend. Most of the springs have dense vegetation barriers on three sides, and a water trough on the fourth. This makes it difficult for wildlife to access the water. Nevertheless, Grevy's zebras have been seen drinking from the springs.

The Elbarta zone is both of historic and future importance for the conservation of Grevy's zebras. Located at the interface of the Turkana community to the west and that of Samburu to the east, it is an area of constant insecurity, where violent disputes over grazing grounds and access to water points are commonplace. Pastoralists from the two communities are well armed with illegal guns, and engage in frequent skirmishes and cattle rustling. The illegal killing of wildlife is an ongoing threat to conservation on the northern Kenya rangelands. The Elbarta zone abuts on the Wamba zone to the south via a narrow passage of relatively flat terrain which links the two zones along the eastern edge of the Karisia Hills. Telemetry data show that the Elbarta zone is an important corridor for wildlife movement in what may be a seasonal foraging migration to and from the grassy plains.

*iii. Laisamis Zone*

The Laisamis zone extends from the Laisamis plateau in the east to the eastern edge of the Elbarta zone in the west, and borders on the Mathews Range in the south. It encompasses some desert areas to the south of the Marsabit NP as well. The Laisamis and Merille luggas run eastward from the Mathews Range through this zone, and are potentially a source of water for wildlife, and especially for animals passing through the Melako Community Conservancy. Pastoralists, though, have excavated deep wells along the length of these luggas, and the wells do not provide water for wildlife. In years of good rainfall, the luggas hold natural pools of water well into the dry season.

Recent telemetry data show that Grevy's zebras migrate away from the Laisamis zone when water becomes scarce in the luggas, and there is also some evidence of movement toward the Marsabit NP. It is likely that the Grevy's sub-population in Garissa may once have been connected to the Laisamis and Wamba zone sub-populations.

*iv. Wamba Zone*

The Wamba zone is the most critical area for Grevy's zebra conservation. Centrally located between both the Elbarta and Laisamis zones in the north and the Laikipia zone in the south, the Wamba zone includes the protected area complex of Samburu, Buffalo Springs, and Shaba. The Lewa Conservancy to the south harbours more than 13 % of the remaining Grevy's zebra population. Several community conservancies have been established in the Wamba zone. Since 2006, ongoing GZTC telemetry studies have monitored the movements of more than 30 individual animals. Three community conservancies are vital to the movement and conservation of Grevy's zebra in this area. The Kalama, West Gate, and Mebai Conservancies hold core sub-populations and are key rangelands for the species today. It is in these areas that much of the research and conservation efforts of recent years have been focused. Here, it has been possible to reverse the declines of the past.

Grevy's zebra use the following corridors to access the Wamba landscape:

1. The east-west elephant/livestock corridor between the Kalama and West Gate conservancies passing through Loijuk swamp;

2. The pathway between the Buffalo Springs and Shaba NRs and the Kalama Conservancy and the Army Training Area. Here, the Meru-Isiolo highway is a major threat to Grevy's zebra and other wildlife species using the corridors;

3. Movement to Laikipia through Kipsing (the Mpus Kutuk Conservancy), also used by elephants;

4. Movement from southern Samburu to the Elbarta plains, west of the Ndotos Range, and to Serolipi, Ndonyo Wasin, and Laisamis, east of Mathews-Ndoto ranges.

The Grevy's zebra sub-population on the Lewa Wildlife Conservancy has been shown to be isolated from the metapopulation. This is apparently not owing to fencing, but to the geographic location of Lewa, which is potentially not a natural habitat for the species. Grevy's zebras first appeared on Lewa in the 1970s, when about 70 animals arrived. These animals were not translocated there forcibly, but were retreating during a time of intense persecution for their skins. The population on Lewa has been stable (at 360–400 animals) over the past five years, despite having declined from about 700 animals in the early 1990s. There is no evidence of movement of these Grevy's between Lewa and any of its surrounding landscapes, despite the migratory fence gaps created for this purpose. The few animals that do use these gaps are regular commuters moving back and forth, but over short distances only.

Conversely, elephants and giraffes appear to use the exits in Lewa's boundary fence *en masse*, with large groups passing through seasonally. Passage through Lewa, for elephants using these gaps, has become critical in enabling elephants to move between their well established rangeland areas further north in Samburu County and the highland forests in the south, via the Mt. Kenya elephant corridor. Several other species (27 in all, including giraffe, Burchell's zebra, baboon, and large predators such as lion and hyena) have been seen moving through the gaps in the Lewa boundary fence.

*v. Laikipia Zone*

The Laikipia zone is unique having been utilized for commercial cattle ranching for several decades. Parts of the zone are heavily fenced, and support dense communities of informal pastoralists and agro-pastoralists alike. The Grevy's zebra zone within Laikipia extends from Maralal township in the north to the Ol Pejeta Wildlife Conservancy in the south. In the north, the zone extends as far west as the eastern rim of the Rift Valley, while in the south it abuts on the Aberdare Range. Its eastern boundary adjoins the Wamba zone in the north, and follows the western boundaries of the Mukogodo Forest and of the Borana ranch southward towards Ngobit, west of Nanyuki town.

Laikipia's Grevy's zebra population numbers in excess of 400 animals, which are spread over several large commercial ranches, including Ol Jogi, Pyramid, Mpala, Mugie, Ole Naishu, Loisaba, and Ol Pejeta. Monitoring of individually identified Grevy's zebras has shown that they move from Laikipia to the Samburu NR and onward to the Mebai Conservancy. This identifies the land between the Laikipia and Wamba zones as important commuting territory.

While there is certainly some movement of individual animals between the populations in Laikipia and those in Samburu, the precise routes that are used have yet to be recorded. It is likely that the same general pathways used by other migratory species are followed. Important conservancies for Grevy's zebra include West Gate, Kalama, and Mebai, which are closely linked to the protected areas of the Samburu, Buffalo Springs, and Shaba NRs. The main routes linking the Laikipia and Wamba zones would appear to be via the Kirimun and Kipsing areas. Pastoralists, who are rapidly settling in these areas, may soon permanently obstruct wildlife movements along these routes.

Historically, in the absence of fences and other barriers, Grevy's zebras could move freely through central Laikipia and across its northern boundary via Kipsing. Today, the trans-Laikipia elephant fence acts as a permanent barrier to wildlife movement from much of southern Laikipia. This fence was erected in an effort to mitigate conflicts between elephants and the Internally Displaced Persons (IDPs) who had been re-settled in the Laikipia landscape. In conservation terms, the trans-Laikipia elephant fence has had negative, as well as positive, consequences.

More recently, many new fences have been erected on ranches in Laikipia. These fences are less restrictive, as most are not entirely wildlife-proof, especially on ranches which have adopted wildlife conservancy models. In some cases, where highly restrictive fencing has been used to protect rare and endangered species, such as black rhinos, huge imbalances in other wildlife populations have resulted. An example is the fenced boundary between the El Karama and Ol Jogi ranches, which has prevented large herds from dispersing across the two properties. Today, Grevy's zebra and beisa oryx numbers on El Karama are extremely low, while on the adjacent Ol Jogi property numbers for the same species are at an all-time high.

*vi. Observation of Grevy's Zebra Movement*

Over the past 15 years, conservation efforts centered on Grevy's zebra have significantly increased. The species has become a focus for many programmes, concerned not only with wildlife conservation but also with community development, because the fates of both Grevy's zebra and human livelihoods in the fragile semi-arid and arid ecosystems of northern Kenya are inextricably linked. Community-led conservation in this context has been particularly successful, as reflected in the growing number of community conservancies.

Mt. Nyiru and Mt. Kulal are historically important wildlife refuges. Both have cloud forests on their summits and act as water towers in the same way as the Mathews and Ndoto ranges. Springs along the many gullies on the lower slopes of these massifs provide reliable perennial water sources for animals and people from miles around. The importance of the fragile resources in these foothill areas should be recognized when plotting and mapping wildlife corridors. Communities should also be encouraged to protect these resources, both for their own well-being and for the sake of wildlife.

Access for wildlife to water and foraging resources on important migratory routes needs to be secured in areas where pastoralists and livestock are found in high densities. This includes areas in which the *ad hoc* re-settlement of displaced people is threatening to obstruct wildlife passages. Some progress has been made in recent years, on community conservancies such as West Gate and Kalama, where self-imposed land zonation has been used to demarcate core conservation areas, grazing buffer zones, and areas for settlement.

Particular attention should be paid to connecting areas where Grevy's zebra and other wildlife populations are stable or increasing. Where Grevy's populations are threatened or decreasing, but are still large enough to form aggregated herds, consideration should be given to relocation. Sub-populations under increasing threat should be moved to areas where the species is already thriving (*and not to areas where no animals currently exist*). This would prevent unnecessary population losses, while boosting populations that are in a position to grow and to disperse into adjacent areas.

The restoration of historic corridors linking the remaining key habitats and sub-populations should be prioritized, particularly in central and eastern Laikipia; the Lolldaiga area; the Kipsing and Wamba areas; between Wamba and Sera, Laisamis, and Marsabit; and between Wamba and the Shaba, Elbarta, and Kor/South Horr areas, as well as between Laikipia and Garissa. The eventual aim should be to restore links with the far northern populations in north-western Marsabit (Sibiloi) and Ethiopia (Chew Bahir).

**Recommendations**

1. *Creation of Conservancies*: Creation of more conservancies through public-private partnerships should be encouraged in areas perceived to be migratory routes/corridors to ensure the contiguity of wildlife habitats. Policy governing the creation of conservancies is still lacking, but provisions in the Wildlife and Conservation Management Act, 2013, when these are implemented, are expected to address this, and other issues relating to participatory wildlife management outside protected areas. *Responsible*: KWS; Ministry of Environment and Natural Resources, regional development agencies; Ministry of Lands; County governments; conservation stakeholders and development partners; local communities.

2. *Payment for Environmental Services (PES) through Easements*: Mechanisms to secure land in wildlife areas should be encouraged and pursued. Special funds or trusts should be set up, with supporting legislation. *Responsible*: Conservation trusts, landowners, and private entrepreneurs.

**Table 7.11:** Some of the critical wildlife dispersal areas and corridors in the greater Ewaso ecosystem (Laikipia, Isiolo, Samburu and Marsabit Counties).

| Wildlife Route | State of Habitat | Threats |
|---|---|---|
| ADC Mutara | Wildlife safe heaven | Poaching, livestock incursion |
| ADC Mutara-Rumuruti | Highly fragmented forest segments | Clearing and logging, settlement |
| ADC Mutara-Solio Ranch | Highly threatened | Fences |
| Pyramid | Completely fenced, no connectivity to Nasalot or Ol Pajeta ranches | Fences |
| Northern Approach Ranch | Open | Absentee landlords |
| Kimani Ranch | Open | No threat, landowners to sell |
| Ndaragwa-Nyahururu, and Nyahururu-Rumuruti (1 km) | Completely blocked | Fences, settlement and agriculture |
| Solio-Mt. Kenya corridor | Blocked by IDP settlement and highway | Fenced, Nairobi-Nanyuki highway |
| Rumuruti-Lariak-Laikipia NC | Farming and settlement activities | |
| Rumuruti-Kifugo-Sosian-Laikipia Nature Conservancy | Inaccessible | Electric and stone wall fences |
| Ol Jogi-Loldaiga Ranches | Partly accessible | Blocked by Mugwooni fence |
| Mpala-Oldonyiro-Mathews | Open, used by elephants and Grevy's | |
| Il Ngwesi-Leparua-Nasuulu-Buffalo Springs NR | Open, used by elephants and Grevy's zebra in Kipsing area | Isiolo resort city and LaPSSET corridor |
| Mugie-Louniek-Kirisia | Open | |
| Mt. Kenya-Lewa-Ngare Ndare Forest | Constricted, salvaged through underpass and open gate, also used by wild dogs | |
| Buffalo Springs-Isiolo-Imenti | | LaPSSET corridor |
| Shaba-Buffalo Springs NPs | Nakuprat community conservancy established in 2012, used by Grevy's zebra | Army training camp splits the corridor crosswise to north and southern portions |
| Loldaiga-Borana-Il Ngwezi | | Insecurity and cattle rustling |
| Samburu-Wamba-Mathews Range | Open, secured by West Gate, Namunyak and Kalama, used by Grevy's zebra | |
| Meru NP and Bisanandi NR | Secure inside the park | |
| Meru NP-Nyambene Hills-Shaba NR | Open | Insecurity |
| Bisanandi-Biliqo Bullesa | Open | Insecurity |
| Biliqo Bullesa-Sera Community Conservancies | Open | Insecurity and poaching |
| Ewaso Ng'iro River from Shaba NR to Lorian Swamp | Seasonal water scarcity | Insecurity |
| Namunyak-Sera Conservancy | Secured by community conservancies | |
| Marsabit NR-Mathews Range. | Open | Insecurity and LaPSSET corridor |
| Marsabit NP-Jaldessa-Dirib Gombo-Bule Marmar | Encroached by anthropogenic activities | Poaching and drought |
| Marsabit NP and NR | Secure inside the protected areas | Farming/settlement at park edge, |
| Ndoto Range-Marsabit NR | Partially open | Insecurity and poaching |
| Samburu NR-Kalama, Borana Naibunga. | Secured by Kalama, used by Grevy's zebra, | |
| Shaba NR-Merti-Laisamis/ Seleolevi/Lodosoit | Used by Grevy's zebra | Insecurity |
| Meibae-Elbarta plains | Used by Grevy's zebra | Insecurity |
| West Gate, Meibae, Mt. Njiru | Used by Grevy's zebra | Insecurity |

3. *Watershed Management through Carbon Payments*: REDD and REDD+ mechanisms should be encouraged to rehabilitate water catchments on Mt. Kenya, the Aberdare Range, Mt. Njiru, Mt. Kulal, and the Mathews Range. Preservation of these catchments is crucial if wildlife is to flourish in the greater Ewaso ecosystem. Pastoralists and their livestock also depend on the Ewaso Ng'iro River and on foothill springs for their water. *Responsible*: KWS, KFS, and County governments.

4. *Resource Management and Spatial Plans*: Management plans need to be revised, to incorporate new programmes such as integrated spatial planning and the development of conservancies outside protected areas. *Responsible*: Ministry of Tourism, County governments, the Ewaso N'giro Development Authority, and the Northern Rangelands Trust.

## 7.10. Migratory Routes and Corridors in the North Coast Terrestrial Ecosystems

Most of the landscapes in the Counties of Garissa, Tana River, Lamu, and Kilifi are arid or semi-arid, consisting of undulating plains, generally sloping south-eastward, and interrupted by few low hills. Altitudes range from sea level to 200 m above sea level. Some parts are flooded, especially during high tides and during the rainy season in the hinterland. Off the coast, there are several islands, especially in Lamu County, namely Lamu, Manda, Pate, Ndau, and Kiwayuu, whose wide sandy beaches and dense mangrove-protected bays are surrounded by coral reefs and deep blue ocean channels. The delta of the Tana River interrupts the sandy beaches on joining the Indian Ocean. Here, the rolling dunes of the beaches give way to thick vegetation and stands of coconut palms and tropical mangoes towards the hinterland.

The land cover consists mainly of closed to open woody vegetation (thicket) and open woodland and shrubland, with closed trees (mangroves), rain-fed herbaceous and tree crops, savannah, and natural wetlands (Oduori, 1990; Ojwang' *et al*., 2006). The vegetation, generally very sparse and dominated by *Acacia commiphora*, can be classified in five broad categories: dry bushland, riverine forest (tall evergreen trees along the Tana River delta), transitional zones, mangrove forest, and plantations (GOK, 1996).

Land uses in Lamu County are mainly arable farming, livestock husbandry, agroforestry, and fisheries. Hinterlands in the Counties of Tana River and Garissa are mainly rangelands which support nomadic pastoralism. The exception is the Tana River delta, where rice, sugarcane, and other crops are grown under irrigation. The delta is also a dry season grazing area.

The Tana and Dodori Rivers are the region's main sources of fresh water, but seasonal luggas also cover extensive areas and provide water for livestock and wildlife during the rainy season. The Tana delta is a large wetland system with many pools along its former channels and meanders, fed in part by recharge through ground-water seepage and periodic flooding (GOK, 2012). The delta is biodiversity-rich and contains some rare and threatened remnant indigenous plant communities, and wildlife species whose continued existence depends on the protection of these habitats (GOK, 2012).

Various critical habitats in the region are recognized as biodiversity hot spots and have been designated as UNESCO Biosphere Reserves. These include the Boni (1358 $km^2$), Dodori (877 $km^2$), and Kiunga Marine (2,590 $km^2$) NRs in Lamu County, and the Kora NP and the Tana River Primate NR in Tana River County (GOK, 2000). The Tana River Primate NR is home to two of the world's most threatened primates, namely the Tana mangabey and the Tana River red colobus. The Boni NR, contiguous with the Somalia border, was established as a sanctuary for the elephant population of east Lamu and south Garissa (Gazette Notice, 1976). The Dodori NR is a major breeding ground for coastal topi, and contains small numbers of elephants, buffaloes, giraffe, lesser kudu, and duikers, among other animals. The Dodori creek, where the Dodori River empties into the Indian Ocean, is a major breeding site for the threatened dugong.

Lamu is a prime tourist destination, with increasing enterprises. Escalating resource exploitation and insecurity (especially terrorism from neighbouring Somalia), however, are major threats to sustainable development. Over the past decade, land-use conflicts in the Tana River delta have increased, owing to human population increase, competition over declining resources, delineation of land (agriculture versus pastoralism), encroachment into fragile ecosystems, and rising poverty levels. The lack of a framework to guide decision-making on developments within the delta remains a challenge (GOK, 2012). In addition, the Boni people of Lamu are hunter-gatherers who depend on the use of natural resources in the Boni and Dodori NRs (for honey collection, wild fruits and medicinal plants, and water), as well as for cultural practices (forest shrines). Now, connectivity between the two reserves is under threat, as an important corridor spanning about 475 $km^2$ has been encroached upon by settlements and agricultural activities.

## The State of Conservation Connectivity

**A. Drivers**

i. *Human population*: Population growth has led to increased settlement and cultivation. Wildlife migration has declined, amid increasing insecurity over land ownership in the region, as highlighted recently by unrest among the Aweer community and adjacent villages in the Lamu area, and by the demands of some communities surrounding the Arabuko-Sokoke Forest Reserve.

ii. *Land tenure*: Large parts of the Lamu area, treated as 'public' land, are occupied by squatters. Much of the land in the Tana River, Garissa, and Kilifi Counties is also still under communal tenure. Insecurity over land tenure has led to a clamour for land adjudication and the issue of individual titles. A pilot land-adjudication process was initiated to allocate individual land parcels in several villages of Bajun (Mkokoni, Mvundeni, and Ashuwei), adjacent to the Dodori NR, but this elicited angry demands from the nearby Aweer villages for similar rights. The ongoing re-settlement process, if not well planned, will lead to the loss of wildlife dispersal areas and/or the blocking of critical migratory corridors. The quest for private land ownership, especially for crop cultivation and settlement, encourages fences and leads to fragmentation.

iii. *Socio-economic development*: The Grand Lamu Port-South Sudan-Ethiopia Transport (LaPSSET) corridor project will have potentially severe impacts on wildlife movements and corridors. Unless underpasses or overpass greenways and potential security threats are incorporated in the super highway planning process, wildlife movements will be curtailed. The movement of elephant sub-populations in the Dodori-Boni NRs will be cut-off from Tana River Primate NR and from the Tsavo East NP. Furthermore, areas of Lamu County allocated for development of the airport and resort facilities will reduce overall wildlife dispersal to the west of the transport corridor. The proposed sugarcane plantation in the Tana River delta will block the elephant corridor through the riverine forest. While infrastructure and industrial developments may improve the economic prospects of several towns along the main super highway corridor, such developments are likely to have negative impacts on wildlife conservation.

iv. *Climate Change and variability*: This influences land use in many ways, not least through the effects on agriculture and livestock production of more frequent droughts. During drought periods, pastoralists in the Mandera, Wajir, Garissa, Tana River, Lamu, and Kilifi Counties often graze their livestock inside the protected areas, such as the Meru NR, the Arawale NR, the Tsavo East NP, the Dodori NR, the Boni NR, the Tana River Primate NR, and the Malka Mari NP, which leads to competition with wildlife for forage and water. Equally, wildlife will disperse over wide areas outside the parks and reserves during wet periods, leading to increased human-wildlife conflicts. The impact of climate change is expected to be a slight decrease in rainfall (-100mm) in the region, while the frequency of droughts and failure of the long rains will increase. Maximum temperatures are expected to increase by about 1.1°C, and minimum temperature by about 0.5°C. Unpredictable rainfall will have severe effects on water, pasture, and agricultural activities.

**B. Pressures**

i. *Land use*: Over the past decade, agricultural expansion in the 'Dodori corridor' (the Aweer settlement area between Bodhei and Kiunga) and in western parts of Lamu around Mpeketoni have led to increased human-wildlife conflicts. The Lamu port project has also taken up a huge tracts of land, which will curtail the migratory corridors of elephants and other wildlife species, including the Dodori-Mangogoni-Manda Island corridor. The region is already experiencing increased encroachment, deforestation, cultivation, and charcoal burning on 'public' land, especially in Mpeketoni, where the elephant movement route from Lamu into the Tsavo East NP is threatened.

ii. *Livestock incursions*: Livestock is increasingly displacing wildlife in the Dodori and Boni NRs, especially during periods of drought, and this is leading to over-grazing and habitat degradation.

**C. State**

i. *Elephant migratory routes/corridors*: Continued agricultural expansion and implementation of LaPSSET-associated projects will shrink wildlife dispersal areas and block elephant corridors. Potential economic developments in the region include livestock production, eco-tourism, and conservation offsets through leases, game ranching, and payments for ecosystem services (PES).

ii. *Land tenure*: This is changing rapidly, as many public and communal areas undergo conversion to individual private ownership. Speculation, fuelled by the prospects of the LaPSSET corridor, is driving land adjudication and sub-division without due regard for the integrity of ecosystems and wildlife migratory routes/corridors.

iii. The Boni and Dodori NRs have long protected coastal forest vegetation between Kiunga and Mkokoni. The Boni people, as hunter-gatherers, rely heavily on these forests (for cultural shrines) and on their resources (including honey, wild fruit, medicinal plants, and water). Other communities use the reserves for dry season livestock grazing. Connectivity between the two reserves has been compromised by encroaching settlements and agricultural activities.

**D. Impacts**

i. Wildlife populations throughout the north coast region have declined, as the result of habitat loss and degradation, over-grazing, and poaching, which has decimated most wildlife species, especially in the Kiunga Marine, Dodori and Boni Conservation Area (KBDCA). Elephants have been particularly badly affected. Their population in the Dodori and Boni NRs has declined to an estimated 150 animals, and today these elephants are rarely seen. The enhancement of security operations will be critical in controlling the poaching menace.

ii. Livestock incursions into the Dodori and Boni NRs and other conservation areas are rife, in periods of drought especially. Competition between livestock and wildlife for water and forage has intensified, and displaced wild animals have invaded adjacent farmlands. Improvements in the management of grazing pastures in pastoralist areas, with provision for better access to water through the development of pans, might help to mitigate the situation.

iii. The development of Lamu Port (and of its associated infrastructure, including an airport and resort facilities) will lead to a mushrooming of human settlements and activities, which will significantly reduce wildlife dispersal areas, and which may also alter vegetation communities.

iv. Human-wildlife conflicts (in relation to crop raiding in particular) have increased, with the expansion of arable agriculture and irrigated cultivation along the Tana River delta.

**E. Responses**

*i. Conservancies*: There has been an increase in community-based conservation initiatives, although traditional pastoralism still predominates. Existing community conservancies include Ishaqbin, Ndera, Hanshack-Nyangoro, Lamu, and Kipini. Local communities and private landowners have proposed several conservancies in critical areas that are still rich in wildlife, including the Awer Conservancy, established by the Aweer community, and Dareem, adjacent to the Boni NR, established by the Somali community. Other initiatives have focused on raising conservation awareness and on providing incentives for local communities to improve their livelihoods sustainably, in ways that will reduce their dependence on the reserves.

*ii. Management Plans*: A management plan for the Kiunga Marine, Dodori, and Boni Conservation Area (KBDCA), as well as for existing and proposed conservancies, has been developed, with an emphasis on sustainable resource use within the reserves and adjacent areas. The setting up of community conservancies is identified in the plan as a means of securing wildlife migratory corridors and benefiting local communities through Payments for Ecosystem Services (PES).

*iii. Anti-poaching operations*: KWS has scaled up anti-poaching and security operations, with a view to eradicating poaching country-wide.

**F. Migratory Routes and Corridors in the Lamu and Malindi Region**

The Kiunga Marine, Dodori and Boni Conservation Area (KBDCA) and the Tana delta are crucial wildlife areas in the north coast terrestrial ecosystem (Map 7.38). Several proposed conservancies will provide important linkages between critical wildlife habitats in the region (Table 9.12).

**G. Migratory Routes and Corridors in Arabuko-Sokoke Forest Reserve and Adjacent Areas**

The Arabuko-Sokoke Forest Reserve is entirely fenced, and is surrounded by small-scale cultivation. The fence is a management intervention to reduce human-elephant conflict by limiting crop-raiding by large mammals such as elephants. However, the fences are a major barrier to elephant movements, and have limited their access to watering points outside the reserve. Seasonal ponds and wetlands in the forest provide water for limited periods only, being dry for much of the year. Temporary measures to provide piped water to central troughs within the forest reserve during drought periods are not practicable, owing to financial constraints.

**H. Elephant Movement Corridors**

Six elephant corridors have been proposed in the Arabuko-Sokoke Forest region, linking the reserve in the north with the Sabaki River, the Ox-bow Lake adjacent to the river, and Lake Jilore (Maps 7.39 and 7.40). Another five corridors have been proposed, linking the forest reserve with expansive hinterlands in the south-east. The northern corridors provide access to permanent water sources outside the forest reserve, and create connectivity with landscapes in the Dakatcha Woodlands IBA, the Galana

**Table 9.12**: Existing and proposed wildlife corridors in the north coast terrestrial ecosystem (Lower Tana River and Garissa, and Lamu Counties).

| Corridors | Threats | Responses |
|---|---|---|
| Boni-Dodori Corridor- | Expansion of agriculture in Dodori corridor | Establish the proposed Aweer and Dareem conservancies |
| Mangogoni-Manda Island-Dodori NR | Lamu Port development threatens Mangogoni-Manda route<br>Dredging of Mkanda channel (Manda Island-main land) cuts off access to island | Establish the proposed Aweer conservancy |
| Nairobi Ranch-Kichongwe-Mkunumbi-Amu Ranch | Encroachment and cultivation between Kichongwe and Mkunubi | Establish the Kipini and Lamu Conservancy |
| Kipini-Witu forest-Galana ranch-Tsavo East NP | Proposed jatropha cultivation in Galana ranch | Establish a conservancy on western bank of Tana River to link Ndera conservancy and Tsavo East NP |
| Amu ranch-Nairobi ranch-Witu forest-Ishaqbin-Tana River PNR | Encroachment and cultivation separates the two ranches<br>Proposed sugarcane plantation cuts off the Witu-Ishaqbin link | Establish Ishaqbin, Hanshak-Nyangoro (proposed) and Ndera (proposed) conservancies |
| Boni-Tana River PNR | Development of LaPSSET corridor and agriculture around Bodhei | Establish Dareem (proposed) and Ishaqbin conservancies |

and Adu Ranches, and the Tsavo East NP. These corridors vary in length and have widths from 100 m to 1 km.

### I. Proposed Community Conservation Area

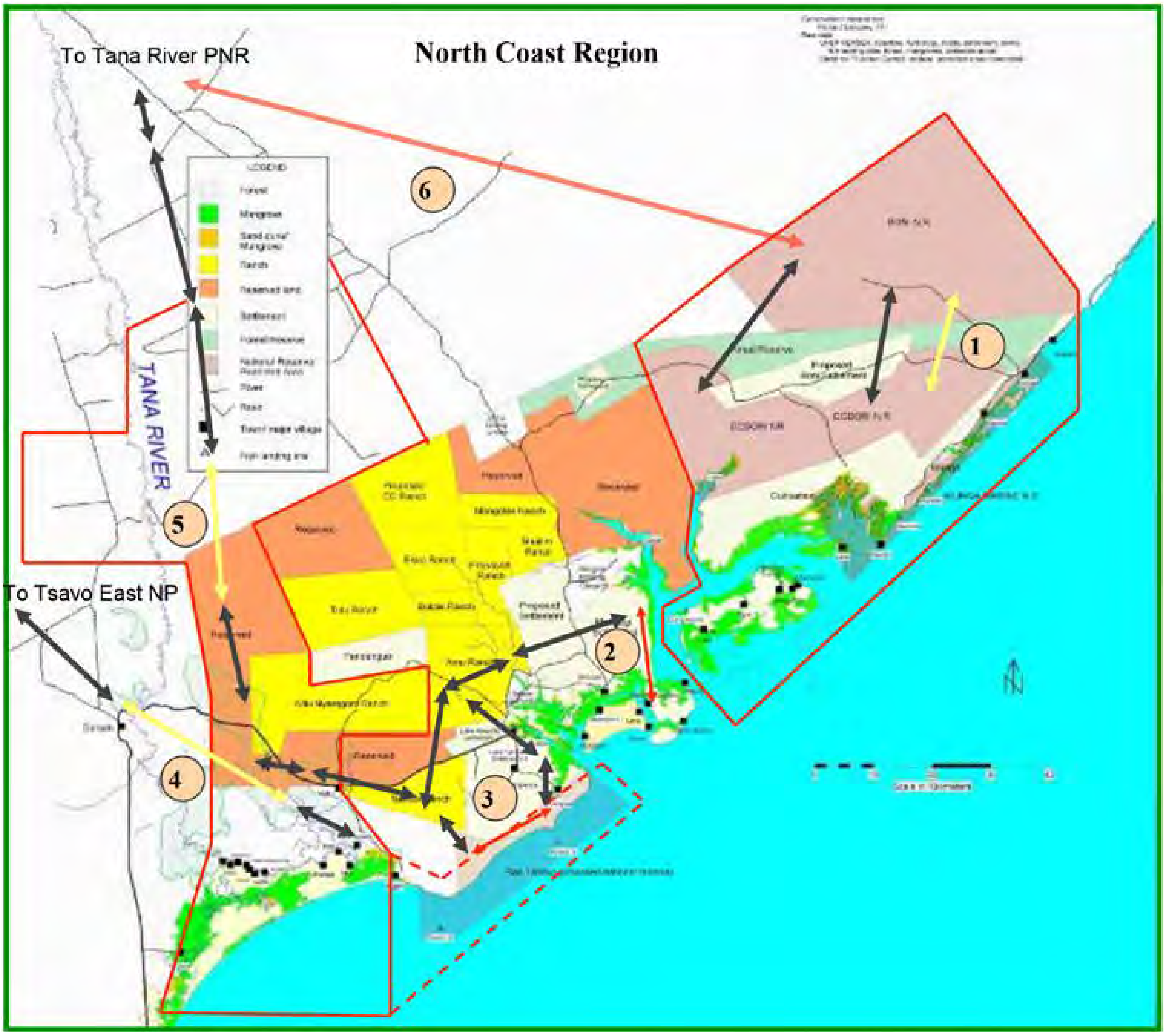
Natural areas rich in biodiversity are ideal for eco-tourism and for the conservation of landscapes that provide essential ecosystem services, while supporting cultural practices that form part of the heritage of local people. A community conservation area has been proposed to surround the elephant corridors north of the Arabuko-Sokoke Forest Reserve (Map 7.41). This will create investment opportunities for Kilifi County to capitalize on biodiversity hotspots through a diversification of nature-based activities. The proposed community conservation area covers 38 km$^2$, in extending north across the Sabaki River from the forest reserve. This area holds great potential for eco-tourism, given that the dispersal routes run towards the Dakatcha Woodlands and other conservation areas, including the Galana and Adu Ranches, and the Tsavo East NP.

### J. Threats to Conservation Connectivity

1. The key threats to biodiversity are land-use change; insecure land tenure; insecurity; conservation area management and partnership issues; infrastructure development (e.g. the LaPSSET project); illegal off-take (poaching) of wildlife and the bush meat trade; human-wildlife conflicts; lack of comprehensive management plans; weak implementation of legislation; inadequate scientific data, and the impacts of adverse climatic conditions.

2. Land adjudication and sub-division, forest clearing and charcoal burning, settlements, and the spread of intensive agriculture, especially in the Tana delta and Lamu areas.

**Map 7.38:** Elephant movement routes (arrows) and land use in the north coast terrestrial ecosystem. Arrows and colours show possible connectivity and threat levels. Source: Moses Litoroh




| Route | Threat Level | State | Action |
|---|---|---|---|
| 1 | | Depend on establishment of Aweer community conservancy | Policy to support Aweer community conservancy existence on public land |
| 2 | | Ongoing Lamu Port construction | No Action |
| 3 | | Cultivation and settlements | Work with communities to develop compatible land use plans |
| 4 | | Jatropha in Galana ranch | Consult development partners |
| 5 | | Expansion of agriculture in Tana River delta | Work with local communities to establish conservancies |
| 6 | | Intensive poaching | Work with communities<br>Involve communities to develop and implement security strategy |

None Low Medium High Blocked

**Map 7.39:** Potential elephant movement routes (arrows) from Arabuko-Sokoke Forest Reserve across the Sabaki River to the landscapes in the north and Tsavo East NP. Source: ASF Elephant Conservation Action Plan, 2013.

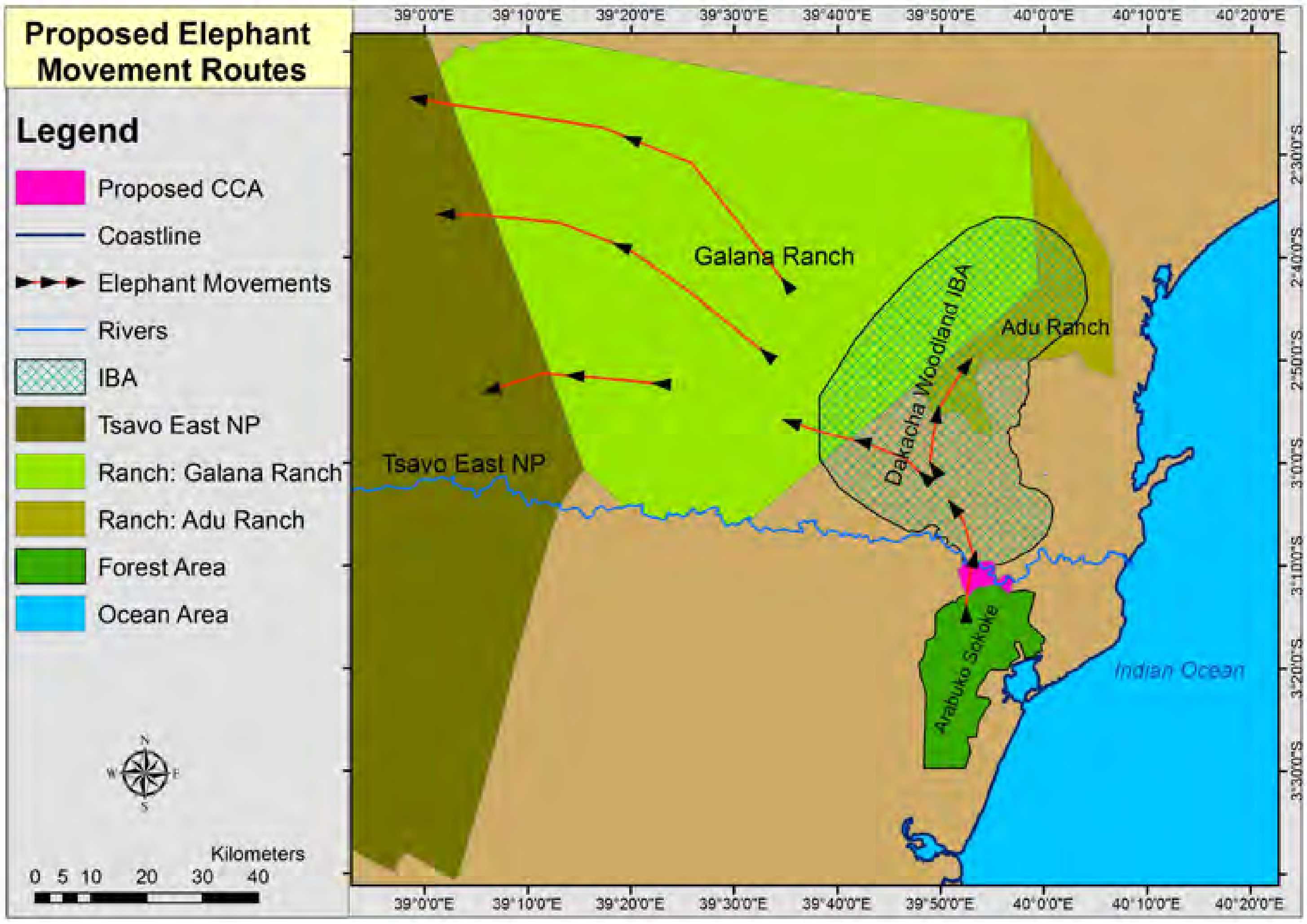
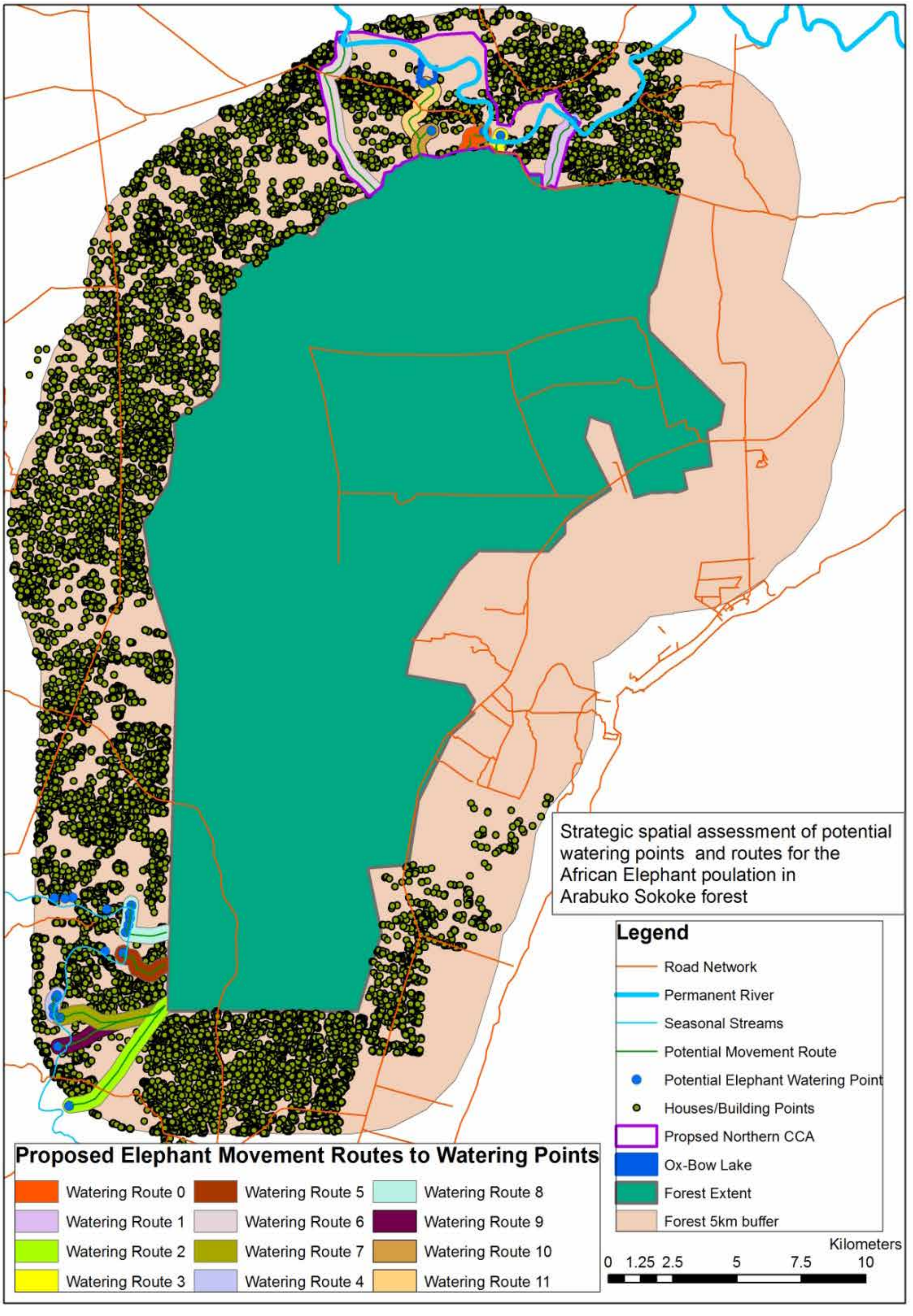



**Table 9.13:** Summary of advantages and disadvantages of the routes illustrated above

| Route | Description | Remarks |
|---|---|---|
| 0 | Connects Arabuko Forest to Sabaki River through Madunguni forest reserve | Affects 56households; traverses through agricultural fields and busy Malindi-Tsavo Road. Provisioning has to be made to cross the road |
| 1 | Connects Arabuko Forest to Sabaki River through Madunguni forest reserve | The route is challenging due the steep and cliff terrain; Traverses the busy Malindi-Tsavo Road; Provisioning has to be made to cross the road |
| 3 | Connects Arabuko Forest to Sabaki River | Shortest route to Sabaki river; Route cuts through agricultural fields ; Route is challenging due the steep and cliff terrain; Traverses the busy Malindi-Tsavo Road; Provisioning has to be made to cross the road |
| 6 | Connects Arabuko Forest to Sabaki River | Affects more than 300 households |
| 10 | Connects Arabuko Forest to Ox-bow lake Jilore | Affects the least number of households (7); Route has the least resistance and is in good proximity to Arabuko Forest Reserve; Lake Jilore is seasonal |
| 11 | Connects Arabuko Forest to Ox-bow lake next to river Sabaki | Affects more than 100 households |

**Map 7.40:** Proposed elephant movement corridors outside the Arabuko-Sokoke Forest Reserve, into adjacent northen and southern areas. Source: ASF Elephant Conservation Action Plan, 2013.



## 7.11. Impacts of Climate Change (Precipitation and Temperature) on Biodiversity

### Introduction

A rise in global temperature (warming), rather than variations in local weather (changes in cloudiness and precipitation), is chiefly responsible for the rapid loss of ice from Mt. Kilimanjaro in Tanzania, Africa's highest peak (Thompson *et al.*, 2009). The remaining snow fields on top of the mountain are melting so fast that they could be gone within two decades. After having remained intact for 11,700 years, the ice fields shrunk in area by nearly 85 % between 1912 and 2007, with more than one- quarter of the ice present in 2000 now gone (Thompson *et al.*, 2009). Calculations of ice volume loss have shown that, between 2000 and 2007, losses resulting from thinning are roughly equal to those caused by shrinking (http://researchnews.osu.edu/archive/lonkilipnas.htm).

The changing global climate is to blame for the melting glaciers on Mt. Kilimanjaro and Mt. Kenya, the highest peak in Kenya. Of the 18 glaciers that were present on Mt. Kenya in 1900, only seven now remain. This explains the decline in downstream water flows in major rivers emanating from the mountain, including the Tana and Ewaso Ng'iro Rivers. Although Kenya contributes little to the anthropogenic causes of global warming, it is one of the countries most affected by the climate change phenomenon. The effects are likely to become severe, and could slow down the nation's projected economic growth, which is heavily dependent on climate-sensitive sectors such as agriculture and tourism.

### Precipitation and Temperature Changes

Studies of related Indian Ocean and Pacific warming trends suggest that droughts are likely to become more frequent across eastern Africa, and that precipitation may continue to decline over the coming decades. La Niña years tends to be drier, with east-west winds blowing in from over the Indian Ocean bringing drier air across the Horn of Africa. Warming over eastern Africa exacerbates evaporation and crop-water deficits. This rising temperatures and declining rainfall may lead to progressive habitat desiccation and reduced vegetation productivity in the rangeland ecosystems (Ogutu *et al.*, 2007).

At the same time, it has been observed that the long rains in central Kenya have declined by more than 100 mm since the mid-1970s in central Kenya (FEWSNET, 2010). This decline is probably linked to warming of the Indian Ocean, and seems likely to continue. A warming of more than 1°C may exacerbate drying impacts, especially in lowland areas. FEWSNET has warned that critical surplus crop growing areas in central Kenya are threatened, and that the extent of prime arable land could diminish substantially. Similar rainfall declines in other agricultural areas may push human populations into wildlife areas on the rangelands. In the FEWSNET study, 70 rain-gauges and 17 air temperature stations were used to analyze long rains periods (March to June) between 1960 and 2009.

Precipitation records since 1975, and future projections (to 2025), show substantial rainfall declines in the Mara, the South Rift, and Kitengela. The pattern for the Amboseli and Tsavo Ecosystems will be mixed, with some places receiving less rainfall, and others more rainfall. Estimates for temperature change over the same period show a general warming trend, by 1.1˚C in the case of the Mara (FEWSNET, 2010; Ogutu *et al.*, 2007); by 0.7-0.9˚C in Amboseli (FEWSNET, 2010); by 1.1˚C in the South Rift; by 0.9-1.1˚C in Kitengela (FEWSNET, 2010; Ogutu *et al.*, 2015), and by 0.7˚C in Tsavo. Changes in precipitation during the long rains (March-June) over the same period show declines in the Mara (-50 mm); Amboseli (-50mm); the South Rift (-100mm), and Kitengela (-100mm), and an increase in Tsavo (+50mm). The combined effects of warming and diminishing rainfall are likely to intensify the impacts of environmental degradation and habitat loss across much of Kenya.

### The State of Conservation Connectivity

**A. Drivers**

Prognoses suggest that a warming climate will accelerate the desiccation and deterioration of vegetation, and engender phenological shifts, in wildlife breeding seasons and in the flowering and fruiting cycles of plants, which may disrupt existing faunal and floral associations and ungulate migrations (Ogutu *et al.*, 2007).

**B. Pressures**

A warming climate will amplify the impacts of environmental degradation caused by increasing human populations and expanding anthropogenic activities, in the form of settlements, agriculture, forest destruction for fuelwood and timber, and charcoal burning.

**C. State**

Climate change is evident in a general rise in temperatures and in increased variability of rainfall in most regions. Both minimum (night-time) and maximum temperatures have been rising steadily. Minimum temperatures have generally risen by 0.7-2.0˚C, and maximum temperatures by 0.2-1.3˚C (Analysis from this study). Rainfall has also shown increased variability from year to year, and there has been a general decline in precipitation during the long rainy seasons (March-June). Failure of the long rains has meant that droughts, in lieu, have become more frequent and prolonged. On the positive side, more rain is falling over the short rainy season (October-December) and at other times of the year, albeit unpredictably.

**D. Impacts**

Climate change affects biodiversity directly through warming temperatures and through declining or irregular precipitation, and indirectly through the greater frequency of severe disturbances such as droughts and floods. Anthropogenic activities, by exerting additional pressure on biodiversity, exacerbate the impacts of climate-mediated biodiversity losses, through land-use changes, forest clearing for agriculture and settlements, logging, soil erosion, water pollution, water abstraction and diversion for irrigation and urban systems, fragmentation of wildlife habitats, and the spread of invasive alien species. All these activities are progressively reducing, or precluding, the ability of wildlife species to disperse into habitats that are climatically more suitable (Ogutu *et al*., 2007).

The impacts of climate change are generally compounded by environmental degradation:

a. Increasing desertification and soil erosion, especially in the arid and semi-arid lands (ASALs); a dwindling natural resource base (loss of biodiversity, receding rangelands for pastoralists and wildlife, animal displacement, and increasing competition and conflict).

b. The increased frequency, magnitude and severity of natural disasters, especially droughts and floods, lead to loss of vegetation cover, water resource scarcity, the spread of vector- and water-borne diseases, infrastructure destruction, increased human-wildlife conflict, and livelihood loss.

Recent studies on the impacts of climate (rainfall and temperature) on wildlife in the Nairobi NP-Athi-Kaputiei and Mara ecosystems have shown that rainfall exerts a pervasive influence on the abundance of herbivores on the Kenya rangelands, but that different species respond contrastingly to rainfall variability. Population growth among kongoni and warthog in the Nairobi NP correlated negatively with wet season rainfall, while the correlation for migratory wildebeest and zebra was positive. Rising minimum temperatures were associated with declining population growth rates among Grant's gazelle, waterbuck, wildebeest, and zebra in the Athi-Kapiti ecosystem (Ogutu *et al*., 2016), while high rainfall advanced the onset, and increased the synchrony, of calving for topi and warthog in the Mara (Ogutu *et al.*, 2009).

**E. Responses**

1. Several institutions and stakeholders are focusing increasingly on research into climate change and its effects, with a view to building capacity for coping and adaptation, while at the same time developing mitigation mechanisms. Communities are diversifying their livelihoods through sustainable resource use and conservation practices, and are benefiting from the setting up of community conservancies, and from participation in schemes such as payments for ecosystem services (PES) and REDD programmes.

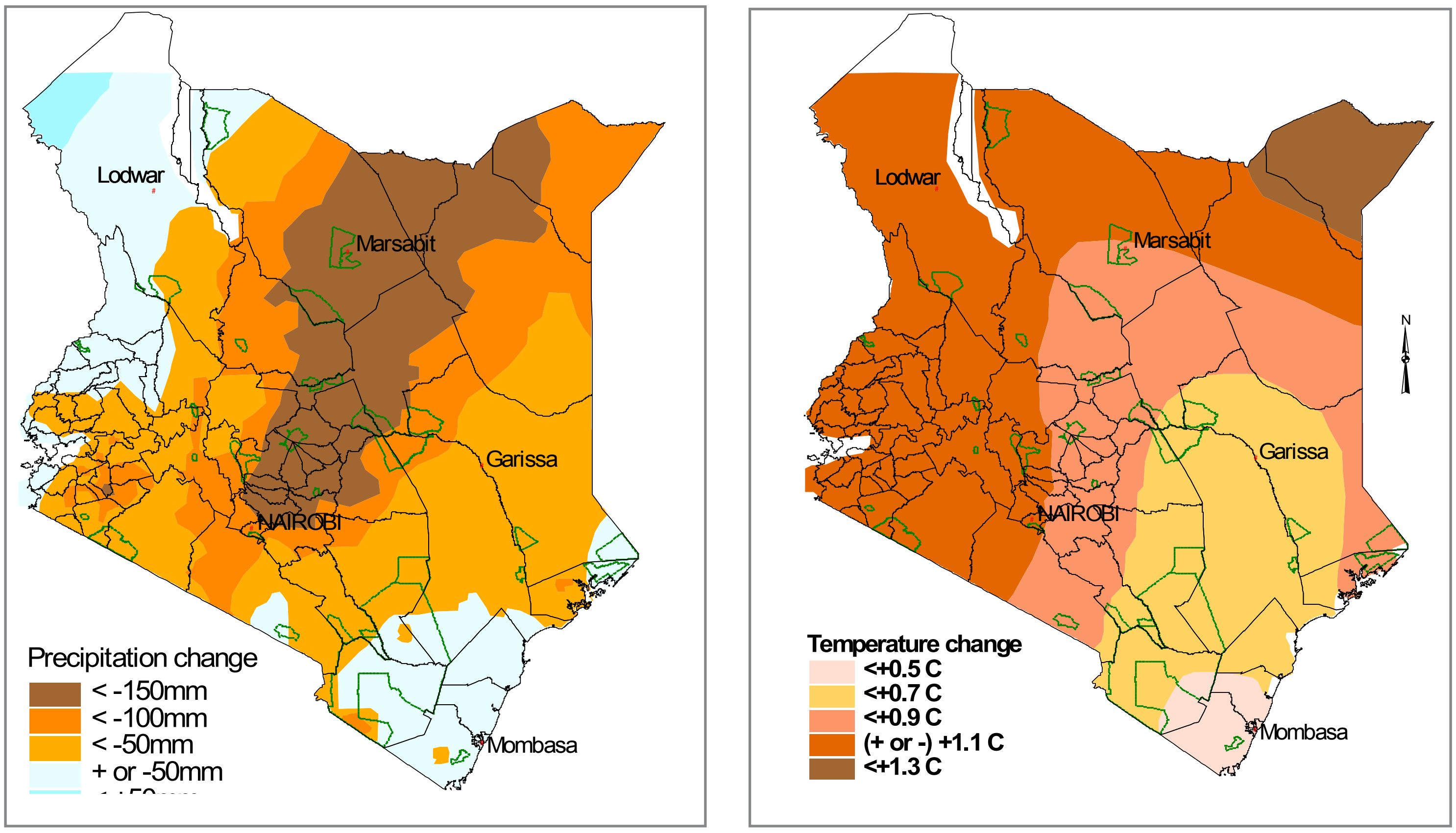
2. Conservation stakeholders are increasingly applying 'green economy' climate-change strategies to protect water catchments, to increase re-afforestation, and to reduce carbon emissions through 'green' energy programmes.

**Recommendations**

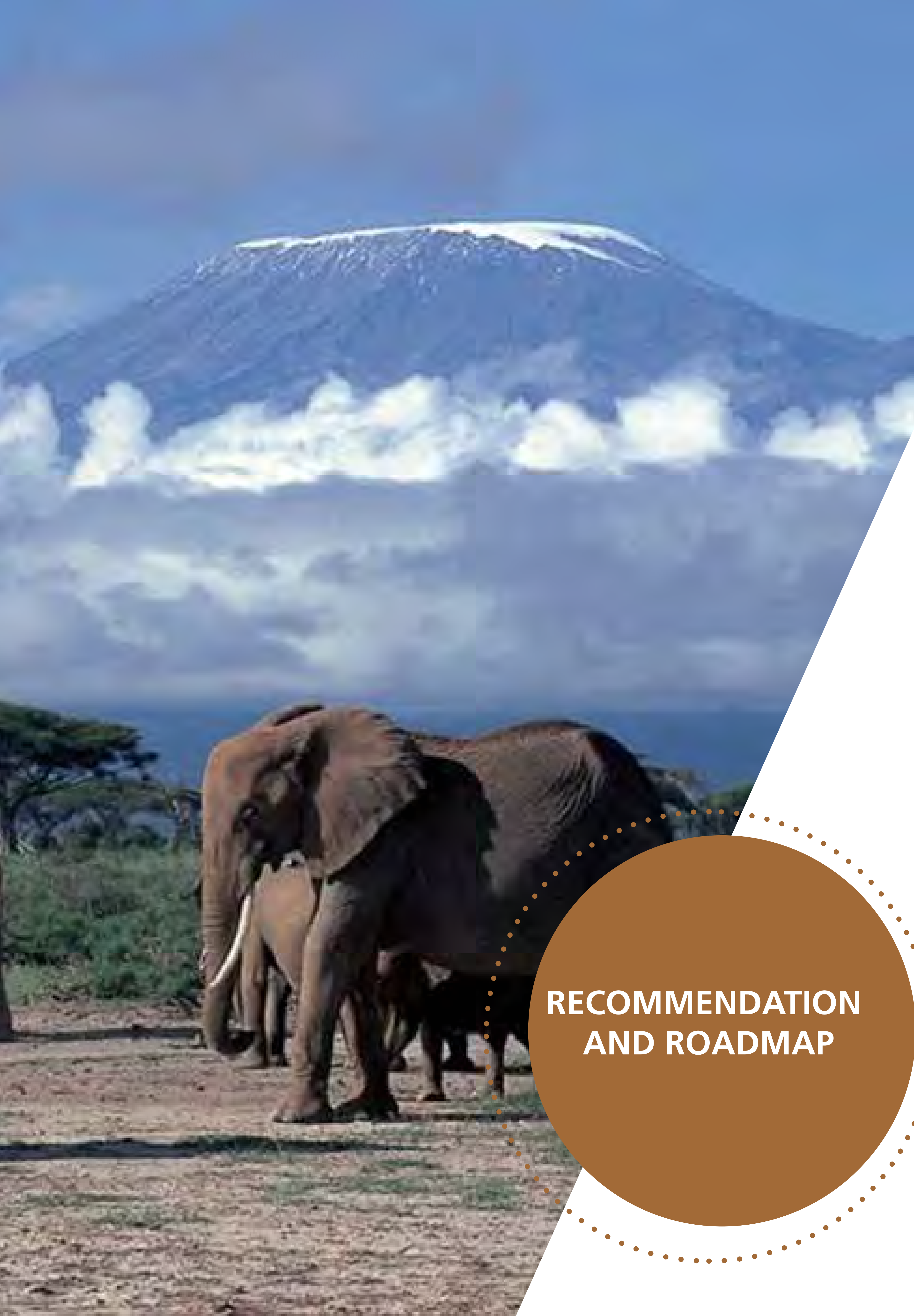
1. Most wildlife species are adapted to particular conditions in the natural habitats in which they live. Even slight changes in these conditions can trigger migrations. There is a need to develop a climate-change strategy for wildlife adaptation and coping mechanisms, as well as to undertake further research on the threats posed by climate change, and on the impacts of climate change on wildlife migratory routes and corridors.

2. The potential impacts of climate change should be assessed on a species-by-species basis. The tracking of daily wildlife movements and seasonal migrations, along with the monitoring of wildlife habitats, is essential, as climate change is likely to alter migratory routes and breeding cycles and other aspects of wildlife behaviour, which may affect the seasonality of movements.

**Map 7.41:** Projected changes in precipitation (left) and temperatures (right) in Kenya (1975-2025). Source: FEWSNET, 2010




*Source: FEWSNET 2010*



# RECOMMENDATION AND ROADMAP

# Chapter 8

# Recommendation and Roadmap

## 8.1. Reclaiming Wildlife Migratory Routes/Corridors

The findings of this study show that human population growth and associated increases in activities such as agricultural expansion along rainfall gradients, settlements and fencing, increasing livestock densities, and the removal of woodlands for timber and fuelwood have disrupted wildlife populations and interfered with their distribution and movements within and between habitats and ecosystems. Populations of most wildlife species, across the country, have declined over recent decades as a result of habitat loss and degradation, as well as poaching and the impacts of climate change-related impacts such as flooding and drought. The distribution ranges for most wildlife species have shrunk, leading wildlife to disperse into human- and livestock-dominated landscapes, where heightened competition over diminishing resources (especially forage and water) and space has resulted in an escalation in human-wildlife conflicts.

Wildlife populations, of the larger mammals especially, have long depended, for their survival, on being able to utilize dispersal areas and migratory routes/corridors outside the protected areas provided by the national parks and reserves. Although many of these wildlife dispersal areas and corridors are either blocked already or are in danger of becoming blocked, there are still opportunities to secure avenues of connectivity between habitats and ecosystems. Connectivity is essential, moreover, in safeguarding the biodiversity that underpins the healthy function of ecosystems on which people also depend for their well-being and their livelihoods. This study identifies wildlife corridors and dispersal areas country-wide that can, and should, be maintained, for the benefit of wildlife and people alike. A number of strategies and priority actions are proposed, together with recommendations on how these measures can be implemented.

Most of the wildlife in the country is found outside protected areas, on land that is either communally owned, or which has been privatized and subdivided into clan, family, or individual properties. The cooperation and participation of these landowners is critical to the success of wildlife conservation, as most of these areas are subject to multiple land uses, some of which are incompatible with wildlife conservation. Land uses, such as intensive agriculture and settlement, which exclude wildlife through habitat loss and the blockage of wildlife migratory routes/corridors can be confined to appropriate areas. Landowners in wildlife areas who embrace wildlife management on their properties will require a commensurate trade-off for establishing conservancies and sanctuaries, and/or for implementing measures that promote sustainable conservation. Communities in wildlife areas will require incentives to engage in partnerships that will enable them to benefit from conservation on their lands.

So, while there is an urgent need to secure wildlife dispersal areas and migratory routes/corridors, and to reclaim and increase the space available to wildlife outside the protected areas, the attainment of habitat connectivity and linkages requires more than just the physical delineation of boundaries. It will involve a wider consultation with local communities whose lands are perceived as wildlife areas, and a concerted effort on the part of landowners, stakeholders, wildlife agencies, and County government officials. It will also require political goodwill and the implementation and enforcement of policies and legislation on integrated land-use planning and wildlife conservation management based on landscape approaches, as well as on the use of existing economic and legal instruments.

### 8.1.1. Integrated Land-use Planning and Management

Rapid human population growth and a concurrent increase in anthropogenic activities is putting ever greater pressure on land resources. The competing demands of conflicting land uses have, in many areas, resulted in sub-optimal and unsustainable resource use. A landscape-based approach, under which different land uses can be integrated, is essential, if the current and future aspirations of all land users in an area are to be fulfilled. The landscape approach is a holistic way of ensuring that the integrity of ecosystems is maintained, so that the vital ecological processes on which all forms of socio-economic development depend can continue to sustain productivity. Only through innovative planning, which provides for effective and equitable resource use in the interests of sustainable development for all, can the conflicting demands of competing land uses be resolved.

Integrated land-use planning and management is based on informed decision-making, coordinated across sectors, and on trade-offs between socio-economic activity and infrastructure development, on the one hand, and biodiversity conservation and natural resource management, on the other. The preservation of wildlife dispersal areas and migratory routes/corridors is a critical aspect of effective integrated land-use planning and management. The participation of communities in the planning and decision-making process is crucial, if wildlife resources outside protected areas are to be conserved and managed in a way that allows the communities to benefit from the presence of wildlife on their lands. Trans-boundary ecosystems should be managed under coordinated inter-governmental policies and actions that maintain connectivity between critical cross-border wildlife habitats.

#### 8.1.2. Policies and Legislation

Legal and economic instruments relating to land-use and biodiversity conservation, as set out under a number of existing Government statutes, including the National Land Policy, the Wildlife Conservation and Management Act (2013), and the Forest Policy and Act, should be implemented without further delay. This will pave the way for negotiations with both local communities and private landowners over participation in conservation programmes and partnerships designed to secure wildlife dispersal areas and migratory corridors, and to create more space for wildlife outside protected areas. Mechanisms will include easements, leases, or direct land purchases; concessions; grazing levies; the establishment of new community conservancies, and benefit schemes for communities, through receipt of payments for ecosystem services (PES), and in the form of community development projects.

#### 8.1.3. Community Participation in Biodiversity Conservation

Programmes and initiatives that involve local communities in wildlife conservation are recognized as a viable trade-off for sustainable wildlife conservation and management outside protected areas. The promotion of community conservancies, wildlife sanctuaries, wildlife scout associations, and related eco-tourism ventures that directly benefit rural communities will help to protect wildlife and wildlife habitats. Standards of performance should be monitored through indices designed to evaluate the efficacy of wildlife conservation programmes, to ensure that national conservation and management goals are achieved.

Support for conservation education, dissemination of public awareness, and capacity building will further help to bolster wildlife conservation, through changing attitudes towards wildlife among local communities. The proliferation of conservation awareness will lead to broader public participation in, and support for, the conservation and management of wildlife resources outside protected areas.

#### 8.1.4. Resources for Conservation Connectivity Management

Adequate resources should be allocated to the management of the wildlife corridors/migratory routes, to ensure there is sufficient human capacity (multi-disciplinary expertise) with enough financial backing to achieve the objectives set for securing these areas.

#### 8.1.5. Research and Monitoring

The conservation and management of wildlife and biodiversity requires a thorough understanding of the ecology and habitats of species. Long-term monitoring of wildlife population dynamics is crucial in providing a scientific basis for management actions and interventions. Scientific data, coupled with indigenous knowledge, can be used to develop innovative management solutions.

## 8.2. Conservation Connectivity and Implementation Strategy

The application of recommendations contained in this report will be through adoption of the proposed Conservation Connectivity Implementation Framework (CCIF) outlined in Figure 8.1.

#### 8.2.1 Review of Proposed Connections

The conservation linkages proposed in this report will be reviewed continually to assess their viability, effectiveness, and sustainability.

#### 8.2.2 Development of a Collaborative Implementation Plan

Regular participatory assessments will be carried out, to make sure that ongoing efforts to secure and manage wildlife dispersal areas and migratory routes/corridors are aligned with the conservation methodologies outlined in this report.

### 8.2.3 Institutional Framework

A multi-skilled task force will be appointed to oversee collaborative implementation of the proposed conservation connectivity strategies. The team will include wildlife managers, landscape and land-use planners, land surveyors, land administrators, land economists, ecologists, and legal experts. This task force will be appointed by the Ministry of Environment and Natural Resources.

### 8.2.4 Implementation and Actualization Plan

The task force responsible for implementing the conservation connectivity strategies will draw up actualization plans (both financial and in terms of human resource needs) based on the assessments outlined in this report, with respect to the viability and sustainability of wildlife dispersal areas and migratory corridors, and prioritization according to relative threat levels.

### 8.2.5 Stakeholder Consultation

The consultation process will, in each area of operation, involve all stakeholders, including the MENR; the Ministry of Devolution; the Ministry of Lands; the Ministry of Water; the NLC, KWS, DRSRS, KFS, KEFRI, and NEMA; the County governments; NGOs, and the local communities and landowners.

### 8.2.6. Adaptation, Devolution and Re-Assessment

Recommendations proposed for each ecosystem will be further devolved to specific sites on migratory routes/corridors, based on localized threats and conservation issues unique to those particular sites. As in this report, threat levels will be identified as high, medium, and low, with appropriate action needs identified accordingly.

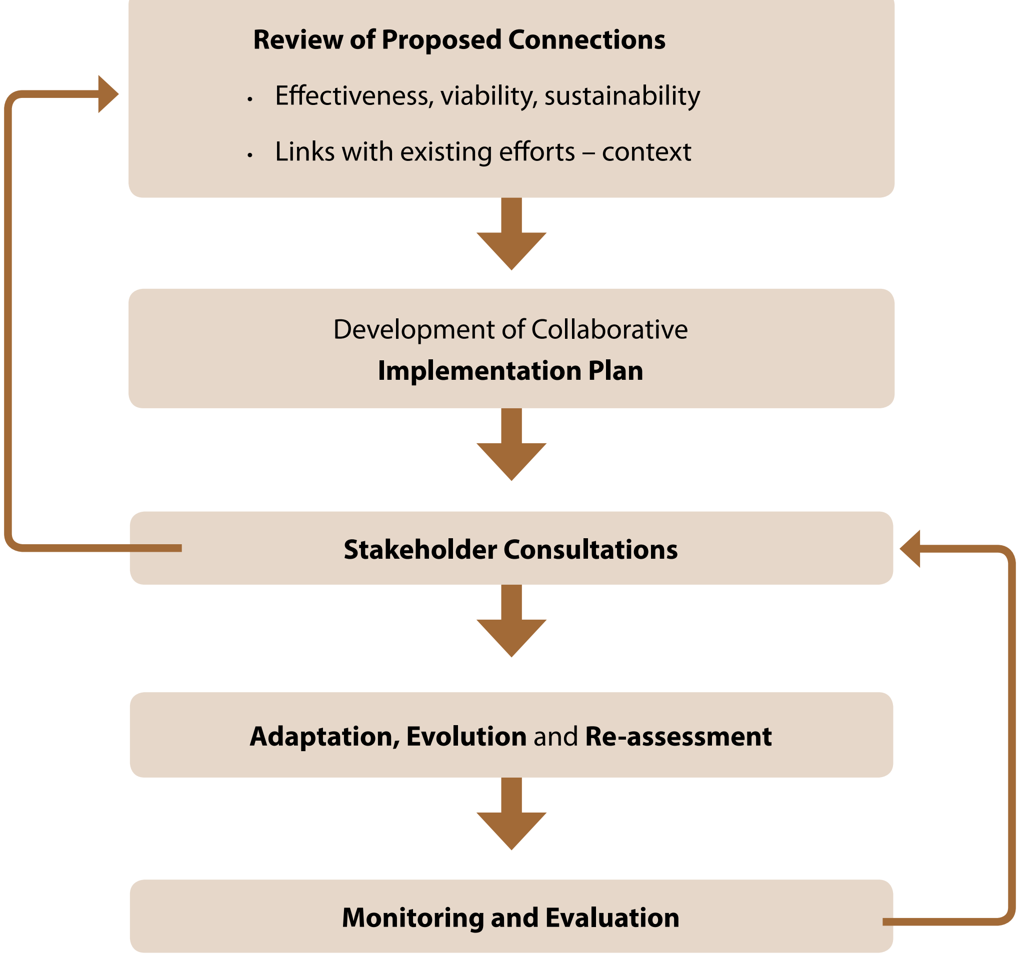
### 8.2.7. Monitoring and Evaluation

Continual monitoring and evaluation of the implementation and actualization process is paramount to ensuring the effectiveness and sustainability of secured wildlife migratory routes/corridors.

## 8.3. Policy on Wildlife Dispersal Areas and Migratory Corridors in Kenya

All land in Kenya belongs to the people of Kenya collectively as a nation, and both as communities and as individuals. Land in Kenya is classified as public, community, or private. Land in Kenya shall be held, used and managed in a manner that is equitable, efficient, productive, and sustainable, in accordance with the

**Figure 8.1:** Conservation Connectivity Implementation Framework (CCIF).



following principles: (**a**) equitable access to land; (**b**) security of land rights; (**c**) sustainable and productive management of land resources; (**d**) transparent and cost-effective administration of land; (**e**) conservation and protection of ecologically sensitive areas; (**f**) elimination of gender discrimination in law, customs and practices related to land and property in land; and (g) encouragement of communities to settle land disputes through recognized local community initiatives consistent with the Constitution. These principles shall be implemented through a National Land Policy, developed and reviewed regularly by National Government, and through legislation.

*Natural resource obligations with respect to the environment*: The State shall: (a) ensure sustainable exploitation, utilisation, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits; (b) work to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya; (c) protect and enhance intellectual property in, and indigenous knowledge of, biodiversity and the genetic resources therein; (d) encourage public participation in the management, protection, and conservation of the environment; (e) protect genetic resources and biological diversity; (f) establish systems of environmental impact assessment, and of environmental audit and monitoring of the environment; (g) eliminate processes and activities that are likely to endanger the environment; and (h) utilize the environment and natural resources for the benefit of the people of Kenya.

Every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and to ensure that development and use of natural resources is ecologically sustainable. The first comprehensive policy on wildlife management is contained in Sessional Paper No. 5 of 1975. This policy recognizes the value of wildlife both within and outside protected areas, and identifies the primary goal of wildlife conservation as the optimization of returns from wildlife, as defined broadly to include aesthetic, cultural, scientific, and economic gains, and taking into account the income derived from other land uses. The policy recognizes that wildlife needs space outside protected areas, if it is to flourish without intensive management and ecological impoverishment. It envisions that additional space for wildlife management will be secured from landowners willing to accommodate wildlife on the basis of their reaping the benefits. Moreover, the policy indicates a preference for flexible regulations able to capture local needs and anticipate future changes in generating optimum returns from wildlife, rather than rigid legislative provisions.

### 8.3.1. The Kenya Constitution, 2010

Kenya's Constitution 2010 guarantees its citizens a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures [Article 42(a)]. It further requires that the land be used and managed in a manner that is equitable, efficient, productive, and sustainable. It promotes sound conservation of ecosystem functions and processes, and the protection of ecologically sensitive areas.

### 8.3.2. Environmental Management and Co-ordination Act (EMCA), 1999

Assented to in 1999 and introduced in 2000, the Environmental Management and Co-ordination Act (EMCA) provides for the establishment of an appropriate legal and institutional framework for the management of the environment and for all matters connected therewith and incidental thereto. The environment is seen as constituting the foundation of national economic, social, cultural, and spiritual advancement. It is recognized that improved legal and administrative co-ordination of diverse sectoral initiatives is necessary in order to improve national capacity for the management of the environment. The framework environment legislation was promulgated to establish an appropriate legal and institutional basis for the management of the environment.

### 8.3.4. Water Bill, 2014

An Act of Parliament providing for the regulation, management, and development of water resources; water and sewerage services, and other related functions. The Water Act, No. 8 of 2002, is an Act of Parliament providing for the management, conservation, use, and control of water resources, and for the acquisition and regulation of rights to use water. The Act further provides for the management and regulation of water supply and sewerage services; the repeal of Water Act (Cap. 372) and of certain provisions in the Local Government Act; and for other, related aspects of water management and use.

### 8.3.5. Forest Conservation and Management Act, 2016

An Act of the National Assembly providing for the conservation, management, and sustainable use of all forest resources, in the interests of the country's socio-economic development.

### 8.3.7. Wildlife Conservation and Management Act, 2013

The Wildlife Conservation and Management Act, 2013, provides for the protection, conservation, sustainable use, and management of wildlife in Kenya. It applies to all wildlife resources on public, community, and private land, and in Kenya's territorial waters. It devolves responsibility for wildlife conservation and management to landowners and managers where wildlife resources occur, and establishes measures to incentivize landowners and communities to conserve and benefit equitably from the sustainable utilization and management of natural resources. Conservation is recognized as a land use, and wildlife conservancies are promoted as an avenue for protecting dispersal areas, wildlife corridors and habitats outside protected areas (parks and reserves).

The Act and its regulations further provide for a diversification of avenues used for the conservation of wildlife and wildlife habitats, through both consumptive and non-consumptive user rights, including game farming/ranching, land leases and conservation easements, partnerships with communities and landowners to create community wildlife associations, wildlife sanctuaries, and conservancies, among other economic instruments. The National Wildlife Conservation and Management Strategy provides for the use of integrated land-use and ecosystem-based planning as the basis for creating more space for wildlife in human- and livestock-dominated landscapes outside protected areas, so that habitat connectivity can facilitate wildlife movements between core habitats and dispersal areas. Other central pillars of the National Wildlife Conservation and Management Strategy include provision for the use of innovative measures for mitigating human-wildlife conflict; regional cooperation in the management of shared (trans-boundary) resources, and adaptation to climate change.

County wildlife conservation and compensation committees have created new avenues for national and county governments to collaborate with local communities over the securing of wildlife dispersal areas and corridors connecting various parks and reserves. Partnerships between government and the local communities, with support from other conservation stakeholders (NGOs, tourism investors, and donors), will ensure that wildlife habitats are better protected, and that both the parks and reserves are able to function as viable ecological areas.

i. *What data are needed to meet the potential and to monitor the effectiveness of WCMA, 2013?*

- Closer and more regular monitoring, by DRSRS, KWS and STE, of wildlife numbers both inside and outside protected areas.

- Monitoring of data on the poaching and poisoning of wildlife, and on the killing of wildlife with illegal firearms. Although the Kenya Government banned trophy hunting in Kenya in 1977 to stem large-scale poaching attributed to weak regulation and weak law enforcement, wildlife numbers have continued to decline despite the ban, partly due to poaching.

ii. *Will the WCMA, 2013 mark a turning point in declining wildlife and diminishing range in Kenya?*

The East Africa region still supports the richest concentrations of wildlife on earth, but without far-reaching and far-sighted changes to current conservation and management practices, the future of this wildlife is in serious jeopardy.

- The WCMA, 2013, by devolving wildlife conservation and management rights, opportunities, and responsibilities, has paved the way for pluralistic, inclusive, and integrated approaches to wildlife conservation. 'Devolution' means the transfer of rights, authority, and responsibilities away from the national wildlife agencies and to the local geographic domains. This approach is rapidly winning space for wildlife and biodiversity conservation on the Kenyan rangelands.

- The Act recognizes that environmental imperatives have progressed far beyond 'conservation' to 'recovery' and 'restoration' in the face of wildlife declines and range contractions over much of Kenya. To reverse these trends, several additional steps should be taken:

- Careful planning and enforcement of regulations is needed to minimize the adverse impacts of large development projects on wildlife conservation areas and rangelands. Such projects include the construction of transport infrastructure, rapid and unplanned urban expansion, the establishment of irrigation schemes in ecologically important and sensitive ecosystems, the exploration for and mining of oil and other minerals, uncontrolled agricultural expansion along rainfall gradients and in transitional zones, and land sub-division on the rangelands.

- The zoning of conservation areas, as provided for in the WCMA, 2013, will enhance the management and protection of wildlife habitats and dispersal areas or migratory routes.

- Existing land-use policies and legislation should be vigorously applied, so that human-wildlife conflicts, and the degradation, fragmentation, and loss of wildlife habitats can be averted, or reduced. Settlements, fences, cultivation, and annexation of water resources to farms and towns should be strictly regulated. The practice of compatible land uses within the same landscape will also help to reduce human-wildlife conflicts, and overturn negative attitudes towards wildlife (Gadd, 2005; Child et al., 2012).

- Policies should include development models for optimal integration of livestock with wildlife in conservancies, so sustainable and economically viable mixed livestock-wildlife enterprises can be established, rather than seeking to separate the two. Integrated wildlife and livestock management on private and communal lands can have mutually beneficial effects on the habitats of rangeland ecosystems (Augustine et al., 2010).

- Wildlife conservation and management legislation and policies should be harmonized across sectors, so there is coordination over the management of natural resources that are shared by different user groups with contrasting needs.

iii. *What provisions in Wildlife Act, 2013, have the most potential to reverse declining wildlife trends and contractions in range?*

- Promotion of community conservation, amid the transition from open-access to private property regimes: Communities are being empowered to use, manage, and receive expanded economic benefits from wildlife (Norton-Griffiths and Said, 2010; Child et al., 2012). Greater benefits enhance the importance of wildlife as a component of livelihoods; help pay the costs of conservation, and reduce human-wildlife conflicts. Yet, widespread poverty and inequality deny many landowners the opportunity to benefit from wildlife. Understandably, attitudes of people towards conservation on private or communal lands are often shaped by the amount and distribution of financial benefits from supporting wildlife on their lands (Romañach et al., 2010). Communities deriving no benefits from wildlife and with little say in national policy (i.e. most pastoralists) are understandably more likely to be intolerant of wildlife. Policies and legislation should therefore provide a variety of options enabling landowners to benefit from wildlife conservation, rather than relying (as is the case at present) solely on photographic tourism, if wildlife is to become a valued asset, rather than a liability, in wildlife-rich areas. The Act recognizes and encourages wildlife conservation and management on community and private lands as a form of land use. The Act also allows land users to derive benefits from wildlife conservation, through regulated and sustainable non-consumptive and limited consumptive utilization of wildlife resources as a form of gainful land use. The eco-tourism industry is responding with more diversified tourism products and is offering more diverse benefit streams. However, regulations governing these user rights have yet to be developed and implemented.

- Conservancies are fast emerging as the mainspring for natural resource conservation on the rangelands. Development institutions are championing community development projects around the conservancies, with a focus on sustainable land-use planning; the management of wildlife, livestock, rangelands, and forests; trade in beef and organic products, and participation in carbon projects. Given that traditional institutions have collapsed, communities are benefiting from these projects, which have reduced their dependence on external donor funding. The conservancies are also emerging as effective instruments for developing and implementing pluralistic and locally-adaptive solutions to regionally varied conservation challenges. Conservancy ranger networks have emerged as useful vehicles for combating poaching, controlling cattle rustling, and enforcing community rules, among other diverse functions. But the rangers need better training. Even so, the Act recognizes conservancies, and also creates mechanisms for setting up regulations for their establishment and operation with full community participation. By 2015, some 230 conservancies had been created, driven largely by the WCMA, 2013.

- Community conservation is important in complementing the capacity and skills of state agencies with dwindling resources for conservation in the face of mounting conservation challenges (Western et al., 2015). The Wildlife Act, 2013, devolves wildlife conservation and management rights, opportunities, and responsibilities to counties, landowners and managers of lands where wildlife occurs, but mandates KWS to conserve and manage wildlife in public conservation areas and sanctuaries. The county governments also support conservancies. The Act mandates KWS to grant permits for operating conservancies, and to monitor compliance with the terms of the licenses, while promoting and undertaking extension services to enhance wildlife conservation and education and to train and maintain a register of all conservancies and rangers. The Act also requires conservancy management plans to be submitted to KWS for approval and gazetting. The Act requires effective public participation in devolution of wildlife management and conservation to counties, and to community and private conservancies. It further requires public participation in the preparation of management plans and the declaration of conservation areas. More precisely, the Act requires that community and private wildlife conservancies or sanctuaries, game farms, and ranches form community wildlife associations and committees at the county and national levels. By 2014, 12 such committees had been formed. The Act requires that members of community and privately managed wildlife areas are represented on the Board of Trustees of KWS and the national wildlife research and training institute.

- Landscape-based land-use planning and ecosystem management for biodiversity conservation and pastoralist livestock production has created more space for wildlife by encouraging the exchange of land parcels, both through negotiated purchase and through leases and conservation easements. This, along with payments for ecosystem services, has encouraged voluntary land re-consolidation among pastoralists to establish wildlife conservancies and sanctuaries in the rangelands. Other measures have included: stiffer penalties for those convicted for committing wildlife offences; clarification, and robust enforcement, of policies and legislation on protection and rehabilitation of degraded wildlife habitats; creation of a wildlife endowment fund to support the management and restoration of degraded wildlife habitats in protected areas and conservancies; strengthening and prioritizing the protection of endangered species, habitats, and ecosystems; the imposition of effective deterrents for control of problem animals, and more effective and timely compensation for human injuries, fatalities or damage to property caused by wildlife, so as to minimize retaliatory killings of problem animals (Hazzah et al., 2014).

- The status of all species found in Kenya which are listed under the Appendices of the Convention on Trade in Endangered Species of Wild Flora and Fauna (CITES) and the IUCN Red List is to be reviewed and re-assessed on a regular basis, so that rapid response mechanisms can be triggered, in the event of any sudden increase in threat levels. The publication from time to time of a national list of wildlife species that are critically endangered, threatened, near-threatened, or vulnerable, is envisaged. In 2013, seven species of large mammals were critically endangered, including Ader's duiker, the hirola, and the roan and sable antelopes, while 19 other species of mammals were endangered, and 37 species were vulnerable (WCM Act, 2013; Sixth Schedule).

- How effectively does Wildlife Conservation and Management Act (WCMA), 2013, address the root causes of wildlife declines?

- While the Act addresses several root causes of wildlife declines and range contractions, it does not address some very important contributing causes, which may weaken its effectiveness. Here are some notable examples of root causes of wildlife declines not adequately addressed by the Act.

- Developing and enforcing clear guidelines for regulating stocking rates to minimize over-grazing by livestock and rangeland degradation due to overstocking: Pastoralists must reduce stocking levels to ensure economic viability and sustainability of wildlife conservation on human- and livestock-dominated rangelands. High livestock densities are associated with declines in the species richness, abundance, and distribution of large mammals (Kinnaird and O'Brien, 2012). Regulating stocking levels and developing a grazing share system will ensure that pastoralists do not regularly move their livestock into protected areas in response to loss of grazing land to conservancies (Butt, 2011). Reliance on natural woodlands as the primary source of charcoal, fuelwood, and building materials should also be reduced, to stem the widespread destruction of woodland habitats.

- Conservancies are critical in creating more space for conserving biodiversity and ecological services and for buffering protected areas from the growing human impacts at the edges. But the necessary subsidiary regulations, access rights, mechanisms for benefit sharing with communities living in wildlife areas, and the incentives necessary for their success are still lacking. As most pastoralists still earn more from livestock than wildlife, it is crucial to maintain a balance between livestock and conservancies; to make and enforce rules that control livestock grazing in conservancies; to train pastoralist landowners about conservancies, and to create awareness of realistic expectations of benefits. There is also a need to improve communication between pastoralists and external investors in conservancy enterprises, so there is transparency, accountability, and equity in the sharing of revenue between the owners of and the investors in conservancies. These measures will ensure that communities can benefit from wildlife without necessarily having to sacrifice their major livelihood, which is livestock.

- The capacities of communities engaging in wildlife conservation need to be strengthened in many ways, including management and planning, security operations, conservation business enterprises, technical and negotiating skills, access to information, and effective democratic organization for collective or collaborative actions (Child *et al*., 2012; Notenbaert *et al*., 2012).

- Despite noble provisions within the Act, there is often considerable external interference in the management and operations of conservancies and other wildlife areas. Wealthy elites are often both landowners and investors in tourism ventures in conservancies. There is a need for stronger representation among ordinary landowners in decision-making in conservancies. Some pastoralist landowners do not understand the contents of agreements signed with private investors in the conservancies'arrangement, nor the rules set by the managers of conservancies. As a result, some disillusioned pastoralist landowners have resettled in conservancies after initially vacating their lands, while others are erecting fences at the edges of conservancies to protect their livestock pastures and crops from wildlife. This impedes the free movement of wildlife, including migrants, and is already evident, for example, in the Talek and Aitong areas of the Masai Mara region. Dense settlements of people who have vacated their land to make way for conservancies are also springing up along the boundaries of some conservancies.

- Collaborative natural-resource conservation and management partnerships between government agencies, conservation organizations, the private sector, and pastoralist communities need to be strengthened. Community participation needs to be encouraged, along with investment initiatives that enhance socio-economic development through flows of wildlife revenues to the communities. Policies and legislation should embrace a paradigm shift away from the current bureaucratic uncertainty characterized by crippling restrictions on use, the extraction of most wildlife revenues earned in community areas, and centralized state monopolization of wildlife. Instead, communities should be empowered with responsibility for and authority over local conservation decisions within a wider and carefully crafted framework of accountability, regulation, and governance (Kabiri, 2010; Nelson, 2010; Child et al., 2012; Niamir-Fuller et al., 2012).

*iv. What are the most promising areas for wildlife population recovery and restoration, and why?*

- Wildlife populations may not be restored in areas that have experienced permanent changes, e.g. large parts of the Athi-Kaputiei ecosystem. Wildlife numbers are increasing in some areas, where there is active private and community involvement in conservation, e.g. Laikipia County, the Nakuru Wildlife Conservancy, and the Masai Mara Conservancy Association areas (Ogutu et al., 2015). This highlights the potential of private and communal lands to support more wildlife on conservancies that are well-managed.

## 8.4. Roadmap for implementation

Implementation of this report will require:

i. Preparation of a comprehensive implementation starategy, a roadmap on preparation of the strategy, an action plan, and budgetary allocation.

ii. A national steering committee to spearhead implementation of the formulated strategy and action plan will be appointed by the Cabinet Secretary responsible for wildlife conservation and management.

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# ANNEXES

## 1. Task Force Members

This report is submitted by a Task Force comprising ecologists, GIS and remote sensing experts, land-use planners, wildlife managers, and meteorologists from various government institutions and conservation stakeholder and development partner NGOs. Specifically, these institutions have a wealth of data and information on rangelands ecological monitoring in Kenya that extend over three decades. The task force was spearheaded by the Directorate of Resource Surveys and Remote Sensing (DRSRS), then under the Ministry of Environment and Mineral Resources, and presently in the Ministry of Mining.

## 2. Parameters for Definition: Criteria Matrix for Wildlife Corridors Prioritization

**Ecological Importance**: Overall ecological/environmental importance of the area. This could include rare, endemic, or threatened species, key habitats, or essential ecosystem processes. For example, a dispersal area that acts as a key breeding ground for a particular species would have a high ecological importance value. It is important to recognize that importance values are often species or taxon specific and that balancing these different perspectives across an ecosystem can be challenging. One option would be to break this factor down further to include different sub-sections such as: rare and endemic species, drought refuge, large populations, key ecosystem processes, essential habitats, etc. Each of the sub-sections could then be scored and a composite score produced. This would provide a more transparent and repeatable process, and would have the added benefit of giving decision makers more information on which to base interventions. The added complexity may be a challenge, however. As always, a balance between complexity and simplicity is essential. Regardless, a clear description of the key ecological issues considered when giving an ecological importance score will be useful.

**Threats**_:_ Widely understood, but like ecological components (above), it might be worth breaking these down into different sub-sections – agriculture, population, fragmentation, degradation, etc. As above, the idea is to rank areas based on the level of particular threats. This is of course species and taxon dependent, so care and clarity must be exercised when considering a threat matrix and calculating the threat score.

**Opportunities**_:_ Represent the opposite of threats. They could include things like presence of a protected area or conservancy, existing land-use plans which favour conservation, proactive and motivated communities or landlords, healthy core populations or potential for rehabilitation. Opportunities and threats will

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| Ezekiel Muigai | Kenya Meteorological Department (KMD) |

directly inform the types of interventions and actions recommended. These may be cross taxa, but are likely to be taxon and species specific.

**Viability**: Represents the general viability of the area, given the threats and opportunities listed above. An area with lots of opportunity and low threats would have a high viability score. This is an attempt at representing the likelihood that any interventions in the area would be viable in the long term. For example, an area with relatively low threats in the short term, and with a conservancy, may not be viable in the long term if there are national plans for compulsory acquisition, or if land-use or tenure is about to change.

**Priority**: This is an index that captures all the previous indices (importance, threats, opportunities, viability) in a single metric to highlight areas in need of intervention. Priority scores should be weighted in favour of ecological importance, but must also contain information about threats and opportunities, as resources will always be limiting and difficult decisions will have to be made. We might consider breaking priority down into sub-sections based on time e.g. short-term versus longer term priorities, which would essentially reflect the urgency of threats.

**Partners***:* All the individuals, agencies, organizations, and institutions that should be included in the assessment and implementation process.

**Recommendations/Actions**: Key actions and interventions that are required at the site level in each particular area. The combination of priority scores, partners, and actions should give decision makers a useful starting point for further assessment, broad stakeholder agreement and engagement, and timely and effective intervention.

# 3. Glossary of Terms

**Anthropogenic**: resulting from or produced by human beings. Human or anthropogenic impact on the environment includes impacts on biophysical environments, biodiversity, and other resources. The term anthropogenic designates an effect or object resulting from human activity. It also refers to human influences, but applies broadly to all major human impacts on the environment.

**Adaptation**: responses that reduce the vulnerability of people and ecosystems to climatic changes. Adjustments in response to actual or expected climate change or its effects ('anticipatory' or 'proactive' adaptation is adaptation that takes place before the impacts of climate change are observed).

**Benchmark**: A standard by which something can be measured or judged.

**Biodiversity**: the variability (and relative abundance) of life, and encompasses diversity at all scales and levels of organization from genetic through populations, species, ecosystems (communities) and landscapes in a particular area. Biodiversity includes diversity within species, between species, and between ecosystems.

**Biomass**: the total mass or volume of living organisms in a given area (dead and decaying plant material is often included as dead biomass).

**Bio-technology**: the use by humans of organisms to make useful products in fields such as agriculture, food production and medicine, or the use of living organisms and their products to modify human health and human environments.

**Bio-prospecting**: searching for, collecting, and deriving genetic material from samples of biodiversity that can be used in various fields, such as medicine and agriculture; or the search for organic compounds in living organisms (plants, animals, micro-organisms) from which useful products can be made.

**Clean Development Mechanism (CDM)**: As defined in Article 12 of the Kyoto Protocol, this allows a country with an emission-reduction or emission-limitation commitment (under Annex B) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of $CO_2$, which can be counted towards meeting Kyoto targets.

**Climate**: the 'average weather' in a general sense; or more rigorously the statistics-based description of mean conditions and variability of relevant quantities over a period ranging from months to thousands or even millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO). The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is a statistical description of the state of a 'climate system'.

**Climate change**: refers to a statistically significant variation in either the mean state of the *climate* or in its variability, persisting for an extended period (typically decades or longer). Climate change may be driven by natural internal processes, or *external forces*, or by persistent *anthropogenic* changes in the composition of the *atmosphere* or in *land use*. The United Nations' Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: "a change of climate that can be attributed directly or indirectly to the effects of human activity in altering the composition of the global atmosphere, and which, in addition to natural climate variability, is observed over comparable time periods.

**Connectivity**: the degree to which a landscape either facilitates or impedes the movement of species among resource patches.

**Corridors**: linear landscape features that serve as linkages between historically connected areas of natural habitat, and which facilitate movements (connectivity) between important habitats.

**Desertification**: defined by the U.N. Convention to Combat Desertification as "land degradation in arid, semi-arid and dry sub-humid areas, resulting from various factors, including climatic variations and human activities."

**Disaster**: a serious disruption in the functioning of a community or society, causing widespread human, material, economic, or environmental loss, the effects of which exceed the ability of an affected community or society to cope using its own resources.

**Dispersal**: the spread in the distribution of animal populations; refers to the tendency, among large mammals, to range widely in the wet season, and to concentrate in narrower core areas during the dry season.

**Drivers**: natural or human-induced factors that change ecosystems. There are indirect and direct drivers. Indirect drivers affect ecosystems by influencing the direct drivers. Habitat change and over-exploitation, for instance, are direct drivers. These influence ecosystem processes explicitly. Examples of important indirect drivers are changes in human population, economic activity, and technology, as well as socio-political and cultural factors. Important direct drivers include habitat change, climate change, invasive species, over-exploitation, and pollution.

**Drought**: a phenomenon that arises when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems.

**Early warning**: The dissemination of timely information enabling people to take precautionary steps that will reduce the impacts of impending hazards, such as droughts and floods.

**Ecosystem**: a natural unit of living things (animals, plants, and micro-organisms) and their physical environment, or a dynamic complex of plant, animal, and micro-organism communities and their non-living environment, interacting as a functional unit. An ecosystem is a collection of plants, animals, and micro-organisms interacting with one another and with their surroundings.

**Ecosystem services**: services provided by the natural environment that are of benefit to people. Some ecosystem services are well known. These services include the provision of water and food, as well as the cultural and spiritual benefits associated with recreation and the appreciation of nature. Other services provided by ecosystems are not so well known. These include regulation of the climate, the purification of air and water, flood protection, soil formation, and nutrient cycling – all processes that create the conditions necessary for life on Earth. The concept "ecosystem goods and services" is synonymous with ecosystem services. Ecosystem services are the benefits that people derive from nature.

**Ecosystem processes**: the intrinsic processes and fluxes whereby an ecosystem maintains its integrity (in terms of primary productivity, trophic transfer from plants to animals, decomposition and nutrient cycling, evapo-transpiration, carbon sequestration, etc.).

**Ecosystem approach**: is a strategy for the integrated management of land, water, and other natural resources in a way that promotes conservation and the sustainable, equitable use of resources, recognizing that humans are an integral component of many ecosystems.

**Edge**: the contact zone between two different types of habitat; an 'edge effect' is the consequence of ecological changes that occur on the often abrupt and artificial margins of fragmented habitats.

**Environment**: All living and non-living things on earth.

**Extinction**: The complete disappearance of an entire species.

**Endemic:** restricted or peculiar to a locality or region. With regard to human health, endemic can refer to a disease or agent present or prevalent in a population or geographical area at all times.

**Environmental Impact Assessment (EIA)**: an appraisal of the impact of a project on the environment.

**Geographic Information System (GIS)**: A **c**omputer-based method of organizing, analyzing, integrating, manipulating, storing, retrieving, and modelling spatially or geographically located phenomena or features.

**Habitat**: the particular environment or place where an organism or species tends to live; a more locally circumscribed portion of the total environment, or any place or type of place where an organism or community of organisms can normally live and thrive.

**Hazard**: a potentially dangerous or damaging physical event, phenomenon, or human activity that may cause loss of life or injury, property damage, social and economic disruption, or environmental degradation.

**Food Web**: the complex patterns of energy flow in an ecosystem, summarized by the known feeding relationships in a biological community. A food web illustrates how each type of organism in a community is typically consumed by, or consumes, more than one other type of organism, and that different types of organisms compete for the same food sources.

**Genes**: hereditary units consisting of a sequence of DNA that occupies a specific location on a chromosome and determines a particular characteristic in an organism.

**Innovation**: a new way of doing something; may reflect an incremental, radical, or even revolutionary change in thinking, or in how products, processes, or organizations are deployed.

**Invasive species**: an introduced species that invades natural habitats.

**Land degradation**: the decline or loss of a landscape's biological or economic productivity; drylands are especially fragile, and prone to degradation, resulting in desertification.

**Land use**: the social and economic activities and arrangements for which a landscape is used and managed.

**Nutrient cycling**: the process by which nutrients, such as phosphorus, sulphur, and nitrogen, are extracted from their mineral, aquatic, or atmospheric sources, or recycled from organic matter, and ultimately returned to the atmosphere, water, or soil.

**Mitigation**: an anthropogenic intervention to reduce emissions of greenhouse gases, or to enhance the sinks for such emissions, with a view to reducing the magnitude of climate-change impacts in the long term. Mitigation may also refer to human interventions that are designed to curb the impacts of other harmful or destructive long-term trends.

**Meta-population**: any spatially structured local population or system of populations that is connected by dispersing populations; a set of discrete populations of the same species, in the same general geographical area, which may exchange individuals through migration, dispersal, or human-mediated acgtivity.

**Patch**: the area in which a local population lives.

**Pollution**: the presence in, or introduction into, the environment of a substance or object that has harmful or poisonous effects.

**Primary production**: the formation of biological material through the assimilation or accumulation of energy and nutrients by organisms.

**Risk**: the probability or likelihood of a population's suffering the disruptive effects of a disaster. Risk is determined by a combination of the hazards that threaten a population, and the vulnerability of that population to such hazards.

**Rescue effect**: high rates of immigration which may protect a population from extirpation or extinction.

**Resilience**: the amount of change a system can withstand without changing its state.

**Sink**: A sink is a population in which deaths exceed births, and where extinction is averted only because immigrants exceed emigrants.

**Source**: a source is a population with a net outflux of individuals. The identification of sources and sinks is complicated by temporal and spatial variability, and by density dependence in demography and dispersal.

**Species**: one of the basic units of biological classification; the lowest taxonomic rank. A species is defined as a group of organisms which are capable of mating or inter-breeding and producing fertile offspring.

**Species diversity**: biodiversity at the species level, often combining aspects of species richness, relative abundance, and variety.

**Species richness**: the number of species within a given sample, community, or area.

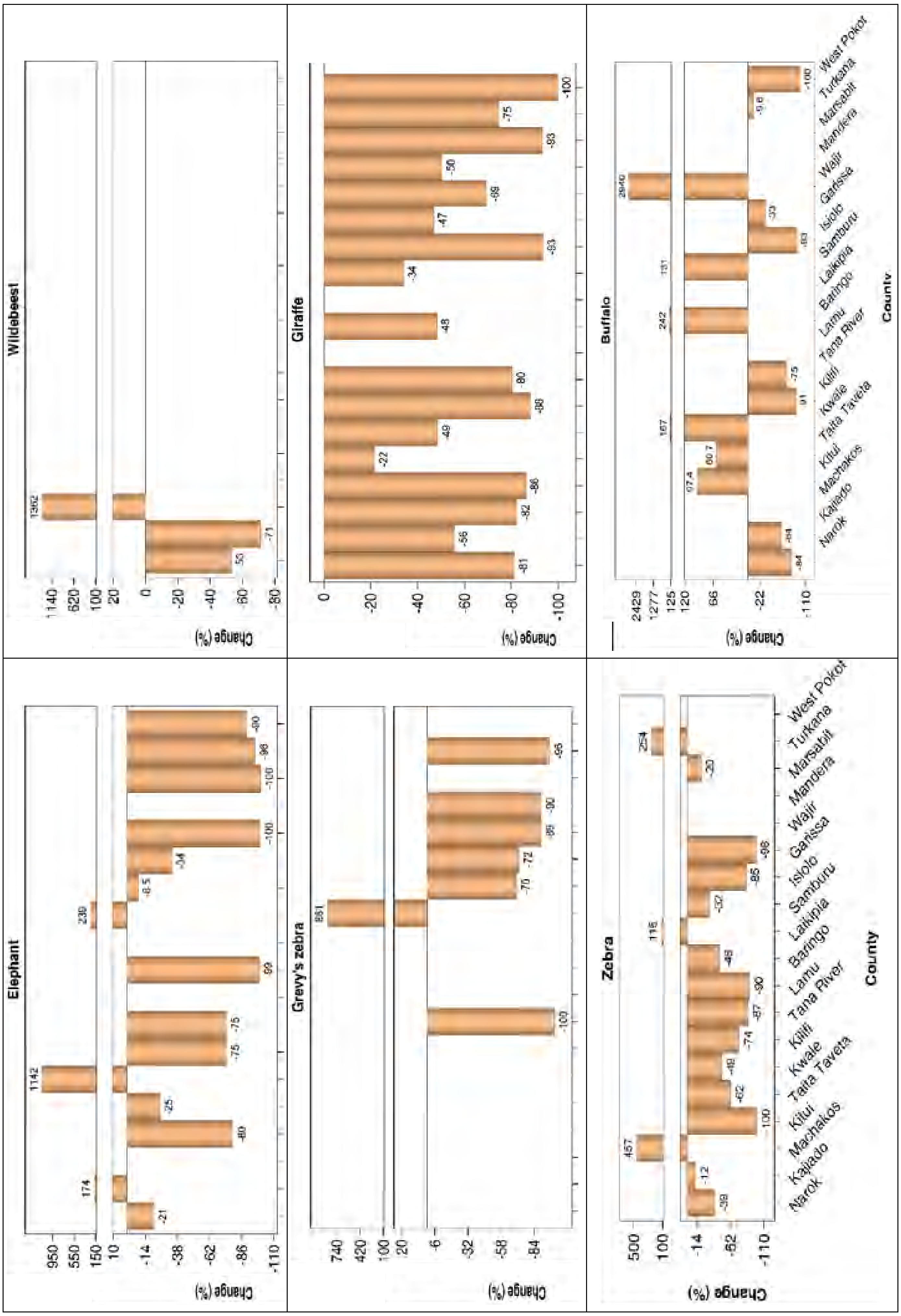
**Water catchments**: areas drained by a river system. A drainage basin includes all areas that gather rainfall and direct the water to a particular stream, stream system, lake, or other water body.

**Wildlife Telemetry**: the transmission of information from a transmitter fitted on a free-ranging animal to a receiver. Advances in wildlife telemetry have made it possible remotely to acquire detailed fine-scale data on many aspects of wildlife ecology, including habitat use, home ranges, ranging patterns, and migration timing and routes, with the help of a Global Positioning System (GPS). A GPS-enabled collar is attached to an animal, which records location data at pre-determined intervals, then relays the data to a central data processing store. The wildlife locations are then plotted in near real-time against a map, allowing animal movements to be analyzed, using a GIS platform.

# APPENDIXES

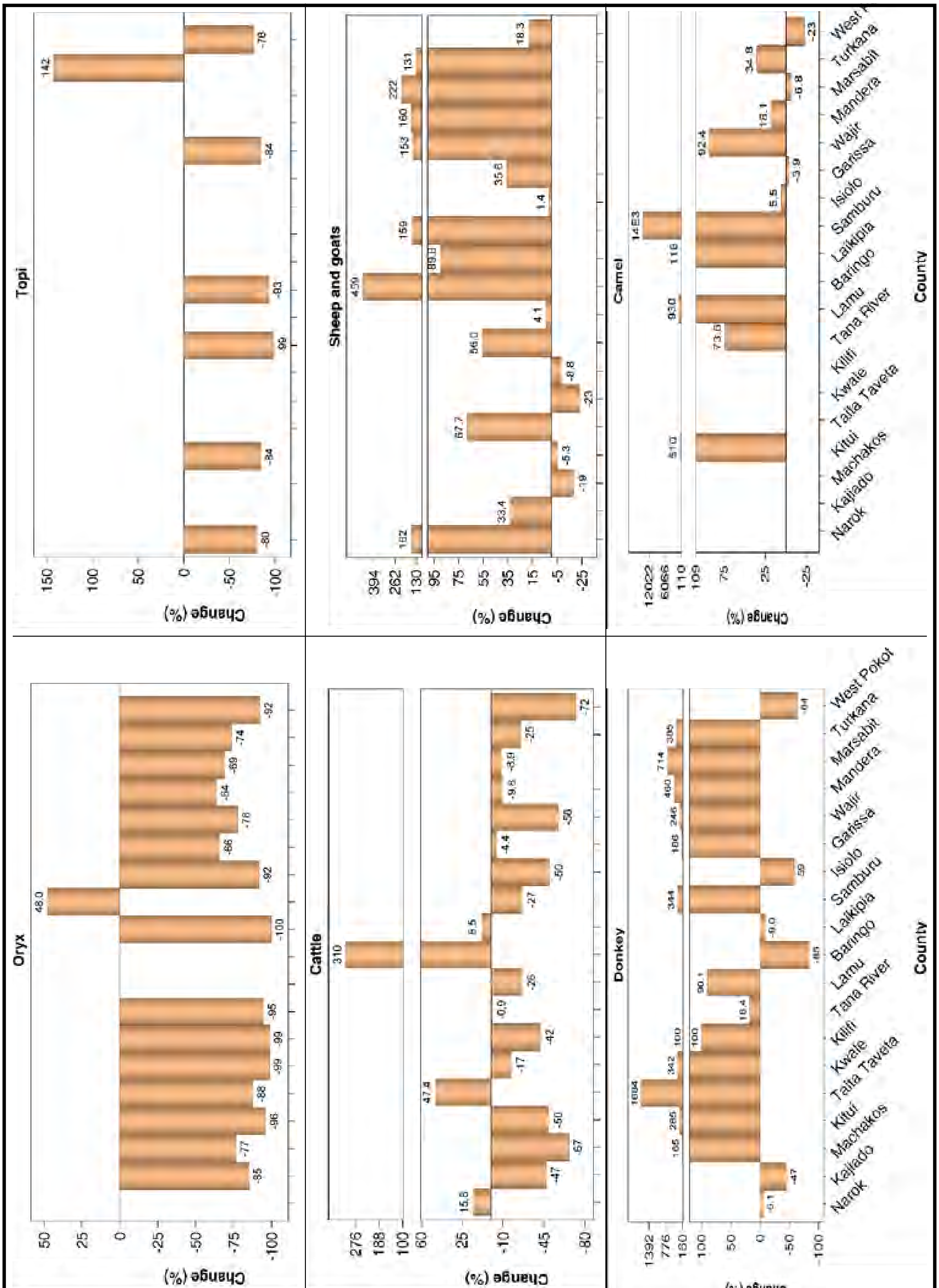
## Changes in Wildlife Populations in the Kenya Rangelands

Figure 1: Percentage changes in the numbers of each wildlife species in each of the rangeland counties between 1977 and 1980 and 2011 and 2013.



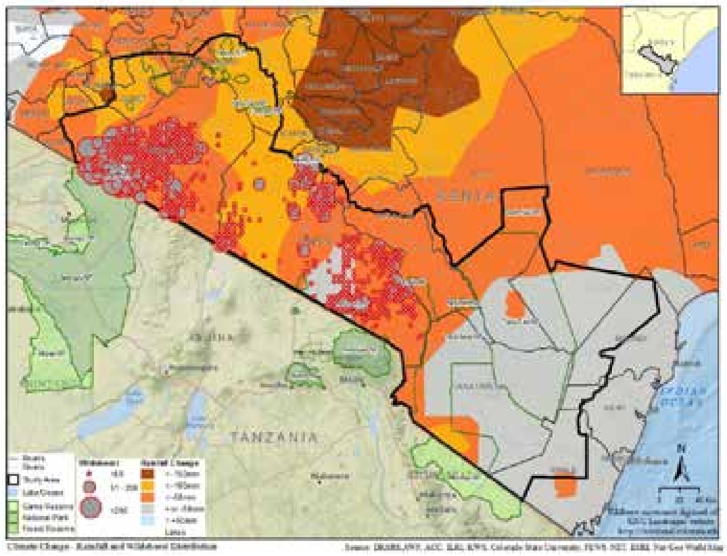

*Source: Ogutu et al., 2016*

**Figure 2:** Percentage changes in the numbers of wildlife and livestock species in each of the rangeland counties between 1977 and 1980 and 2011 and 2013. Source: Ogutu et al., 2016

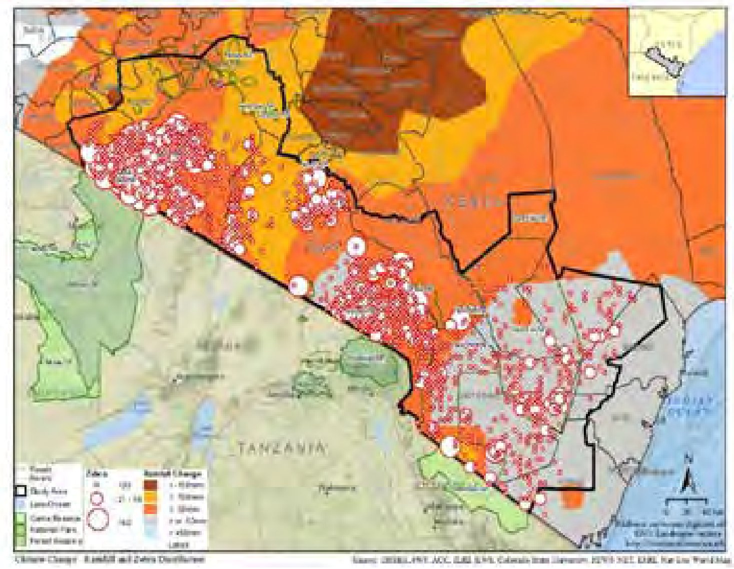


## 2. Wildlife Distribution in Relation to Rainfall and Temperature

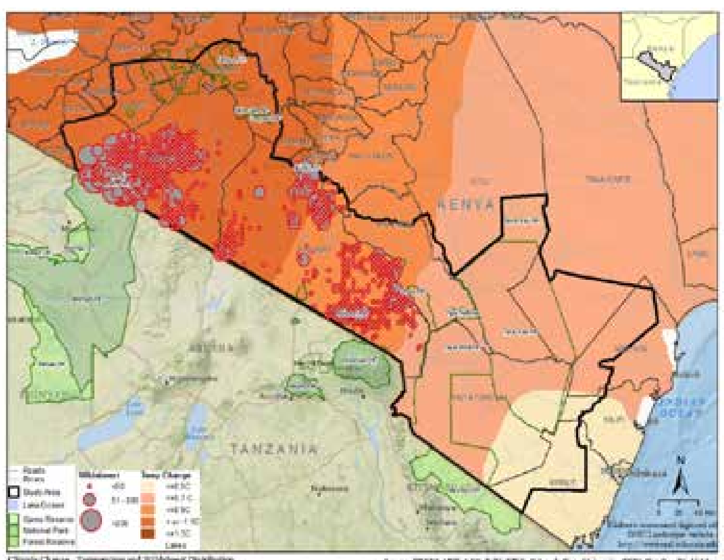
Map 1: Precipitation change zones and wildebeest distribution in southern Kenya rangeland ecosystems.



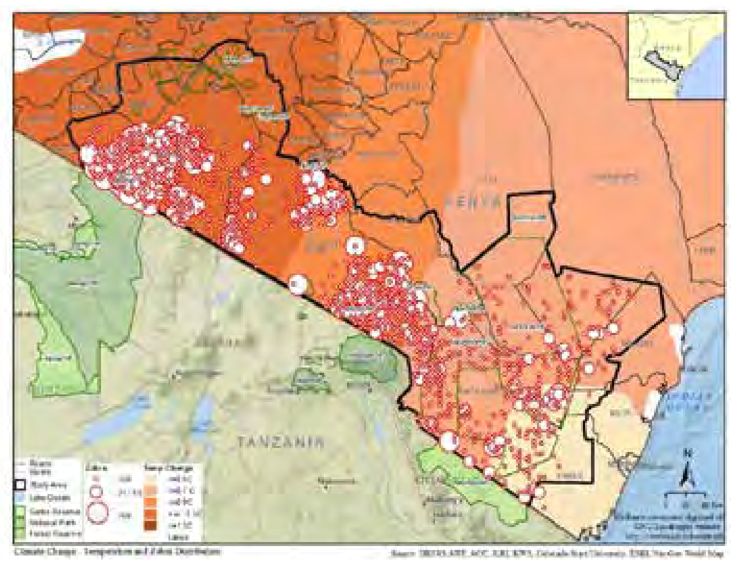

Map 4: Precipitation change zones and zebra distribution in southern Kenya rangeland ecosystems.



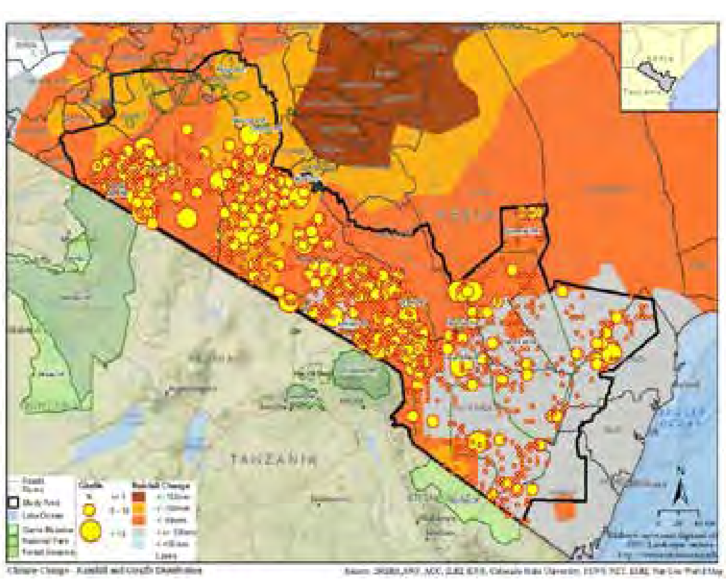

Map 2: Temperature change zones and wildebeest distribution in southern Kenya rangeland ecosystems.



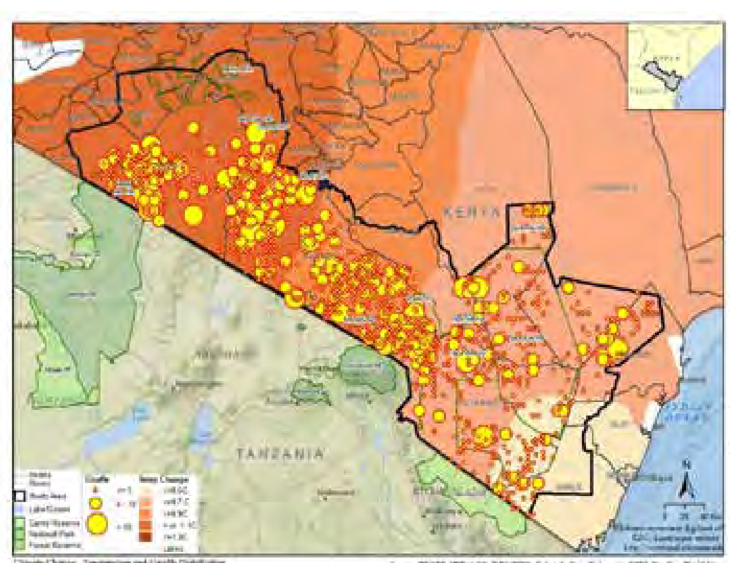

Map 5: Temperature change zones and zebra distribution in southern Kenya rangeland ecosystems




Map 3: Precipitation change zones and giraffe distribution in southern Kenya rangeland ecosystems.




Map 6: Temperature change zones and giraffe distribution in southern Kenya rangeland ecosystems.



This report provides a vivid depiction of the state of Kenya's conservation connectivity both within and outside protected areas, complete with maps and information on historical and recent wildlife migratory routes and corridors on the Kenya rangelands and coastal terrestrial ecosystems. The report is organized under seven major themes: an introductory overview, a brief treatment on the importance of biodiversity conservation for human well-being, and on the Kenya Vision 2030 flagship project on the environment; objectives and study areas; understanding animal movements and connectivity; the methodological approach to conservation connectivity, and the conservation connectivity framework (CCF); migratory routes and corridors for conservation (drivers, pressures, states, impacts, responses, constraints, opportunities, and strategies for securing habitats already interfered with by human activities); infrastructure development, and climate change impacts; and recommendations and a roadmap.

Despite the crucial role of migratory routes and corridors in ensuring connectivity of core habitats with critical dispersal areas, these conservation linkages continue to be degraded or lost to human activities, imperilling the integrity of ecosystems and increasing human-wildlife conflicts, hampering efforts to promote eco-tourism,, and impoverishing local communitys' livelihoods, both of which reduce the speed to meet the Sustainable Development Goals (SDGs). This worrying situation can be attributed largely to multi-faceted anthropogenic pressures. The report also provides a set of options for securing conservation connectivity outside protected areas, based on harmonious co-existence between humans and wild animals, and on enabling people to benefit from the preservation of vital ecosystem goods and services.

It is envisaged that this report will serve as an importance reference tool for policy makers, legislators, wildlife managers, land-use planners, conservation stakeholders, development partners, pastoralist communities, and landowners residing in wildlife areas.

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