In Chapter 5

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WHAT THIS CHAPTER SHOWS

Biodiversity underpins all ecosystem processes and is the foundation of Kenya's rich natural heritage. This chapter presents maps depicting both the breadth of Kenya's biodiversity and current pressures and trends affecting it. An initial set of maps outlines Kenya's endowment of mammals and the areas important for bird conservation. Maps showing agricultural cultivation and development of water sources in the rangelands then depict landscape-level pressures on Kenya's biodiversity. While agriculture is a significant factor in biodiversity decline, not all cropping has to be detrimental. A set of maps shows where farmers in central and western Kenya are making a positive contribution to biodiversity through crop selection and farming practices. The next series of maps shows how Kenya's diversity of rangeland species has been affected by human pressures. Maps showing the distribution of large grazing mammals in the rangelands reveal severe contractions in the size and distribution of wildlife populations since the 1970s, identifying areas that have witnessed declines in wildlife numbers and wildlife density. However, the maps and tables also indicate that not all the news about Kenya's rangeland species is bad. Two examples show a reversal in trends: the recovery of wildlife populations in Laikipia District and the stabilizing of elephant numbers. These demonstrate that national-level policies, community-based conservation efforts, and changes in local land use patterns can lead to outcomes that are more supportive of Kenya's unique biological endowment.

5

Biodiversity

Biodiversity—the full variety of plants, animals, and microorganisms found on Earth—is the source of many benefits crucial to human well-being. It provides the underlying conditions necessary for the delivery of ecosystem services (MA 2003). For instance, biodiversity provides the basis for crop varieties grown for food and fiber, as well as for traditional medicines. Biodiversity is also an important source of livelihoods, especially for poor people in rural areas, and underlies important sectors of the economy, such as nature-based tourism.

Kenya is fortunate to be endowed with a rich natural heritage. The country is home to over 6,500 plant species, more than 260 of which are found nowhere else in the world. With more than 1,000 bird species and over 350 species of mammals, Kenya ranks second highest among African countries in species richness for these animal groups (Biggs et al. 2004).

Perhaps most distinctive about Kenya's extraordinary biological endowment is its diversity of large mammals. Because Kenya straddles the boundary between Africa's northern and southern savanna zones (Bigalke 1978), more species of large mammals are concentrated in its rangelands than in virtually any other African country. For instance, distinct species of both giraffe and zebra inhabit Kenya's northern savannas as well as its southern savannas.

Box 5.1 **Biodiversity and Ecosystem Services**

Biodiversity, which includes variation at the level of genes, species, and entire ecosystems, is a necessary condition for ecosystems to function. The type and quantity of services people receive from ecosystems depend on the particular assemblages of plants, animals, and microorganisms present in a given ecosystem. Moreover, options for growing improved crop varieties or for obtaining genetic materials to develop new medicines depend strongly on the diversity of life forms supported by the surrounding environment.

While it is relatively straightforward to monitor changes in the provision of individual ecosystem services, ecologists understand far less about how to optimize a bundle of diverse ecosystem services and ensure that ecosystems can continue to provide these services over the long term. Studies indicate a relationship between the level of biodiversity, the types and quantities of specific ecosystem services, and the stability (sometimes referred to as resilience) of the system to provide these services. For example, scientists now know that grasslands containing greater numbers of plant species are often more productive and more capable of surviving periods of drought (Tilman et al. 1996). Studies have also demonstrated that greater biodiversity can act as a barrier to invasion by disruptive alien species (Kennedy et al. 2002).

Such evidence implies that the preservation of biological diversity is essential to maintain stable ecosystems. However, ecologists find it difficult to gauge how much biodiversity a system can afford to lose—for example, to boost the production of a single service, such as crop production or fish catch—without jeopardizing the entire system's stability. It is this unseen connection between biodiversity and the capacity of ecosystems to produce valued services that makes biodiversity a foundation of human health and well-being.

The Costs of Biodiversity Loss: The Example of Lake Victoria

The introduction of alien species into Lake Victoria—including fish species such as Nile tilapia and the Nile perch, as well as the invasive water hyacinth plant—provides an object lesson in how biodiversity underlies healthy ecosystem functioning. Within a few short years, these alien species have drastically changed the Lake Victoria ecosystem, diminishing its capacity to produce the ecosystem services required for local livelihoods, and dramatically shifting the distribution of human benefits derived from the lake.

The fish species introduced into Lake Victoria proved to be efficient predators of the native fish species, thus reducing overall biodiversity even as total fish catch grew considerably (Achieng 1990). Commercial fishers and processors profited from the increased catch of Nile perch, and Kenya's export earnings grew by some US$ 280-400 million per year due to perch exports. However, small-scale fishers, who could not afford the fishing and processing equipment required to fish for perch, were shut out of the new market and sustained serious losses to their livelihoods. In addition, the diets of many local people suffered as the availability of native fish species plummeted (Revenga et al. 2000).

At the same time, the proliferation of the water hyacinth plant began to choke local waterways, restricting transport and the ability of local fishers to access the lake. Despite these damages, the invading plants may have helped to prevent total extinction of local fish species by providing the smaller fish with hiding places to escape their new predators (Ogari 2001). Nonetheless, the drastic changes in the Lake Victoria ecosystem have caused some ecologists to question the long-term stability of the lake (Kaufman 1992). The lake's ecology has become a greatly simplified system of predators and prey with the Nile perch on top of the food chain, massive expansion of the invasive water hyacinth, and more frequent episodes of anoxic (i.e., low oxygen) conditions and algal blooms associated with pollution from land-use changes in the surrounding catchment area.

This chapter presents information on Kenya's biodiversity: its condition and trends, its importance to the economy and people, and potential mechanisms for safeguarding the country's biodiversity assets for generations to come. Special attention is devoted to large mammals—such as elephants, wildebeest, and zebras—because Kenya is such a special place for these animals, and also because of the excellent long-term data sets available on the spatial distribution of large mammals in Kenya. The questions addressed by this chapter include:

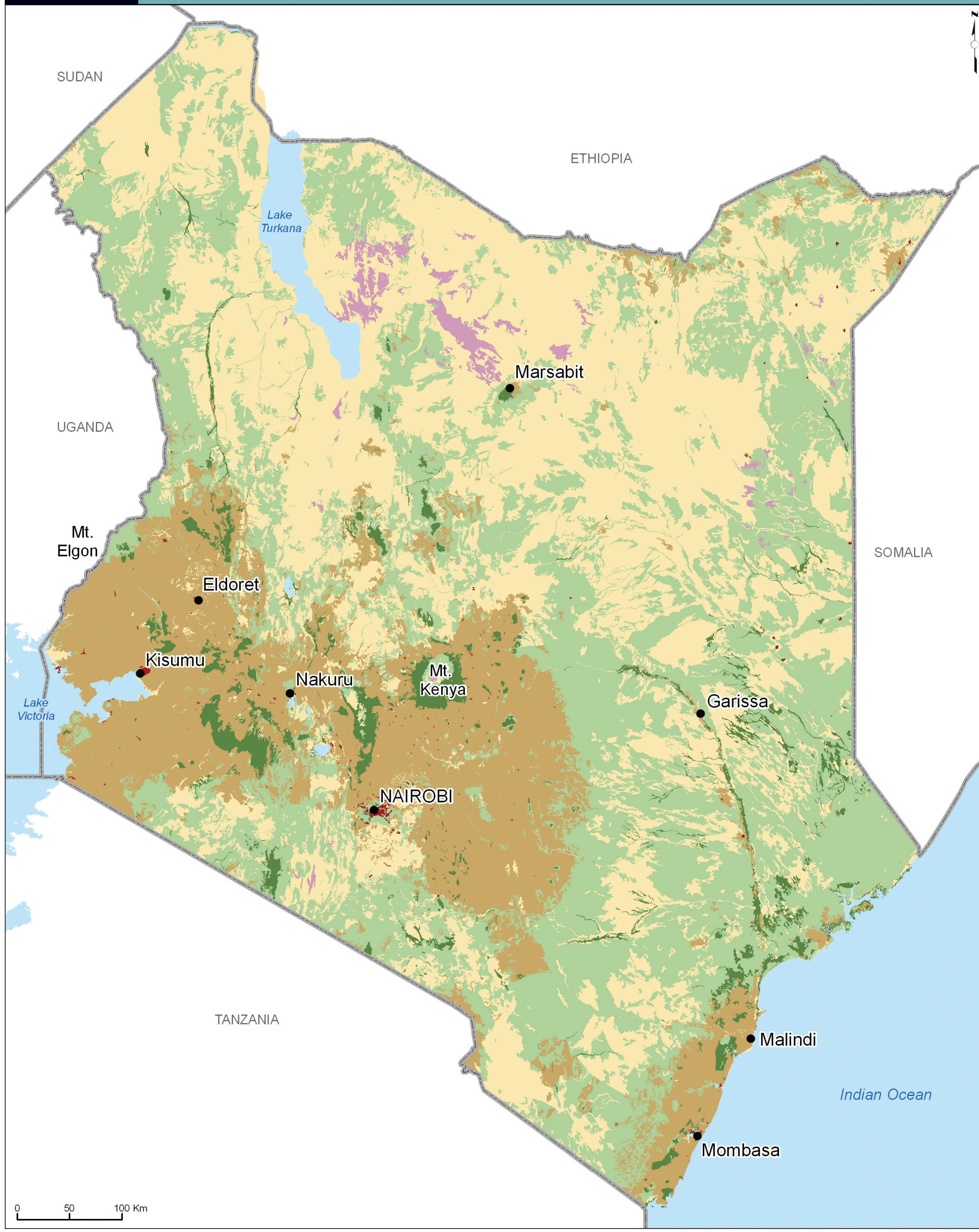
- Where are there high concentrations of species diversity for mammals and birds in Kenya?
- How have human activities affected biodiversity in Kenya?
  - What has been the impact of agricultural conversion and forest loss in the Kenyan highlands?
  - How has infrastructure development affected wildlife in Kenya's rangelands?
- What is the spatial distribution of wildlife populations in Kenya's rangelands?
  - How have these spatial patterns changed over time?
  - Where is rangeland wildlife in trouble, where is it recovering, and why?

SELECTED INDICATORS OF BIODIVERSITY

The following pages present mapped indicators of the diversity and distribution of Kenya's mammal and bird species. The focus on these animal groups reflects, in part, the availability of detailed, long-term data sets. Obtaining equivalent data on other categories of Kenyan biodiversity (such as insects, plants, aquatic species, etc.) is far more difficult.

To help orient the reader and provide context, Map 5.1 depicts the major ecosystem types found in Kenya. Each kind of ecosystem supports distinctive assemblages of plant and animal species; for instance, forest-dwelling animals and plants often are quite different from species that inhabit the desert (although there is usually some degree of overlap).

Map 5.1 **Major Ecosystem Types, 2000**



Sources: Cities (SoK and ILRI 2000), water bodies (FAO 2000), and major ecosystem types (FAO 2000).

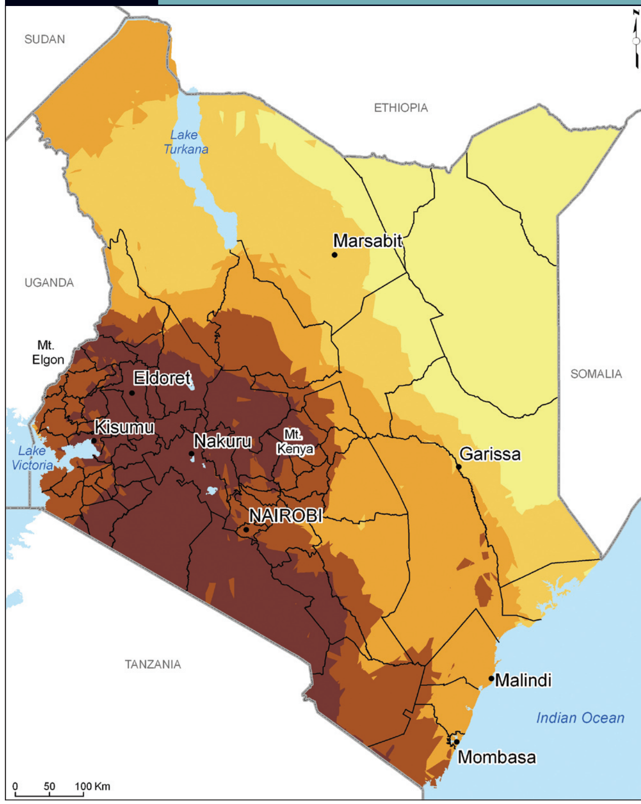
Kenya's biodiversity resources vary across the major ecosystem types found in the country. The predominant ecosystems (75 percent of Kenya) are bushland and woodland (light green-shaded map areas) and savanna and grassland (pale yellow-shaded map areas), which support a variety of wildlife, including Kenya's distinctive herds of grazing animals and its large carnivorous cats. Much of the land area that historically was covered by montane forest or coastal dry forest (White 1982) has been converted to cropland (shown in light brown), with significant impacts for primates and other forest-dwelling species. Kenya's lakes, rivers, and other aquatic ecosystems are also important sources of biodiversity.

Note: Forest is the aggregate of two categories in the *Africover* legend (closed and multilayered trees). Bushland and woodland combine various *Africover* classes such as open trees, thickets, and shrublands. Savannas are grasslands with shrubs or sparse trees. Bare areas include areas covered by rocks or rock fragments.

MAJOR ECOSYSTEM TYPES
- Forest
- Bush- and woodland
- Cropland
- Savanna and grassland
- Bare areas
- Urban areas
- Water bodies

More than 80 percent of Kenya's land area is classified as arid or semi-arid land (SoK 2003), ranging from desert landscapes to rangelands and other sparsely vegetated areas that support grasses, shrubs, and a few trees. Densely forested areas now make up only about 1.7 percent of the landscape (UNEP 2001). Agroecosystems have become the dominant land use in the Kenyan highlands and elsewhere, accounting for about 19 percent of the country's land area. Most Kenyans live in these densely populated croplands. Ecosystems characterized by human settlements and the built environment cover only about 0.2 percent of Kenya's land area, but about a third of the population lives in these urban areas (CBS 2001).

Map 5.2 **Predicted Diversity of Selected Mammal Species**



Sources: Administrative boundaries (CBS 2003), cities (SoK and ILRI 2000), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), and mammal diversity (IEA 1998).

The greatest concentration of mammal species (more than 69 species, indicated by the dark brown-shaded areas) is most likely to be found in Kenya's central and western highlands—areas that are now dominated by cropland and human settlements. Predicted species diversity are at similarly high levels in the adjoining rangelands (classified as bushland, woodland, savanna, or grassland in Map 5.1), such as those located south of Nairobi, near the Tanzanian border. Numbers of mammal species are smallest in areas of lower elevation and lesser rainfall (toward the border with Ethiopia and Somalia), signaling mammals' dependence on the availability of water and specific climatic and habitat conditions.

PREDICTED DIVERSITY OF SELECTED MAMMAL SPECIES

(total number of species)

69 - 79
63 - 68
56 - 62
48 - 55
37 - 47

OTHER FEATURES

District boundaries
Water bodies

Distribution of Mammal Species

Examining the number of species in a given area is one of the simplest ways to measure biodiversity. Map 5.2 depicts the number of mammal species expected in various ecosystems and habitat types across Kenya.

From the map, it is easy to see that wildlife are unevenly distributed across the countryside. Most (but not all) wildlife species prefer to live in places with plentiful rainfall, high-quality soils, and more abundant food sources—that is, in the Kenyan highlands, forests, and wet savannas. Areas where rainfall is lower and soils are less fertile generally support fewer species per unit of land area. However, the vegetation in such areas, though sparser, often provides a perfect habitat for small animal species and can even sustain modest populations of some large animals. Wildlife depend on specific kinds of ecosystems and habitats, creating distinctive spatial patterns of species distribution. Large numbers of species often are concentrated in certain locations that feature the preferred habitat types, abundant sources of food, and sufficient rainfall.

Understanding the spatial distribution of species diversity is important for assessing current and potential effects on wildlife from the ever-expanding reach of human activities and settlements into formerly undisturbed habitat. For instance, the expansion of large-scale mechanized agriculture and human settlements in the dry-season wildlife range can interfere with the annual migration of hundreds of thousands of wildebeest and zebras to Masai Mara National Park from the Serengeti plains of Tanzania (Serneels and Lambin 2001, Lamprey and Reid 2004, Norton-Griffiths et al. in press). (See Chapter 6 for detailed information on migration routes.)

Note that the following map does not indicate the *actual* presence of species on the ground, but rather the *predicted* number and spatial distribution of species based on an extensive database of African mammals (IEA 1998). The data underlying this map reflect the habitat preferences of 281 mammal species in Africa, and were used to estimate potential ranges for these species throughout the continent, adjusting for the effects of nearby human settlements and cropping activities. These data are useful for broad comparisons across significant expanses of land area.

Key Sites for Bird Diversity

Kenya is one of the richest countries in Africa in terms of diversity of bird life. About 1,090 different bird species are found here; some are full-time residents, while others are migrants within Africa, or between Africa and Asia or Europe. Some 11 species are endemic to Kenya, that is, they are found nowhere else in the world (African Bird Club 2006).

The birds of Kenya depend on various habitats. According to the African Bird Club, some 230 species rely exclusively on Kenya's forest habitats, and 110 species require habitats undisturbed by human activities to reproduce successfully (African Bird Club 2006). Wetlands are another habitat type critical for maintaining the diversity of Kenya's birds, including ducks, egrets, flamingoes, geese, herons, ibises, pelicans, and storks.

Countrywide data on the spatial distribution of specific bird species and populations were not readily available for use in this report. Thus, the maps in this chapter depict various sites that are generally important for conservation of bird diversity in Kenya, including Important Bird Areas (IBAs), Endemic Bird Areas (EBAs), and wetlands (see Map 5.3).

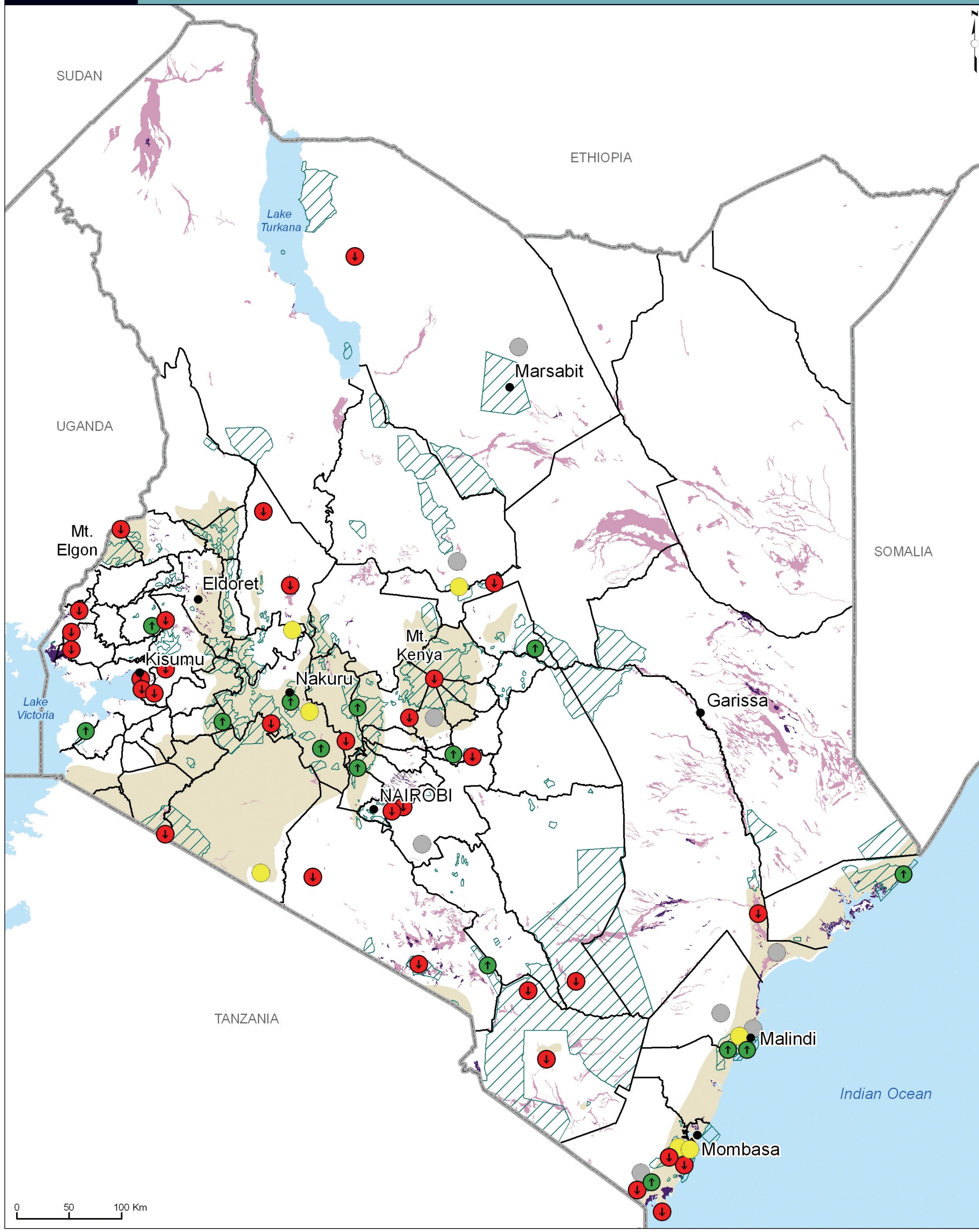
Important Bird Areas are globally important sites for bird conservation designated by BirdLife International and country partners (such as Nature Kenya, Kenya Wildlife Service, National Museums of Kenya, and Kenya Forest Department). They must meet certain criteria for international significance, such as the presence of key bird species that are vulnerable to global extinction or the presence of exceptionally large numbers of migratory birds or other irreplaceable bird populations. Conservation experts have identified 60 IBAs in Kenya (Bennun and Njoroge 1999), covering some 5.7 million ha (10 percent of the country's land area). These areas play a critical role in ensuring the survival of local and migratory bird species.

Of these 60 sites, only 35 are located inside parks, sanctuaries, reserves, or other protected areas (Bennun and Njoroge 1999). Thus, the survival of local and migratory species relies heavily on coexistence with people in landscapes that have been significantly altered by human activities. A recent assessment of the conservation status of Kenya's IBAs indicated that many are in decline—a finding that bodes ill for Kenya's rich bird diversity (Ng'weno et al. 2004). Indeed, some 27 bird species in Kenya have been listed as "critically endangered, endangered, or vulnerable" in the IUCN *Red List* (IUCN 2006).

A second category of key sites for bird diversity in Kenya consists of the Endemic Bird Areas (EBAs)—sites where two or more species of "restricted range" (less than 50,000 sq km) occur together (BirdLife International 2006). Most of Kenya's EBAs are located outside of parks and other protected areas, and all overlap or border densely settled, intensively farmed landscapes.

Also of great significance for bird diversity are Kenya's wetlands. Most of these are seasonal rather than permanent, and most are not legally protected as parks, wildlife reserves, or sanctuaries, particularly in the dry northern and eastern parts of the country. The largest wetland areas are found in Kenya's semi-arid and arid lands, with fewer and smaller wetlands located in agroecosystems. For instance, remnants of wetlands are located in the farmed landscapes north of Nairobi and southwest of Mount Kenya, but these are hard to distinguish on a national-scale map. (However, they can be seen on finer-scale maps of the upper Tana River in Chapter 8.)

Map 5.3 **Areas Important for Bird Conservation and their Status, 2003-04**



Sources: Administrative boundaries (CBS 2003), cities (SoK and ILRI 2000), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), centroid of Important Bird Areas (Fishpool and Evans 2001), status of Important Bird Areas (Ng'weno et al. 2004), Endemic Bird Areas (Stattersfield et al. 1998), and wetlands (FAO 2000).

Kenya's 60 Important Bird Areas (IBAs, represented by points in different colors reflecting their conservation status) encompass most ecosystem types and a broad range of habitat conditions. Other key sites for bird species diversity are Kenya's eight Endemic Bird Areas (EBAs, shown as beige-shaded map areas), which are concentrated in the western and central highlands, in coastal forests and lowlands, and in parts of the southern rangelands. Critical habitat for many species (including egrets, herons, and Kenya's famous flamingoes), is provided by seasonal and permanent wetlands (purple-shaded map areas), most of which are located outside of parks or other protected areas.

A 2003-04 assessment of the status of Kenya's IBAs (Ng'weno et al. 2004) found that half were in decline (mapped as red points), about a quarter were improving (green points), and eight were stable (yellow points), with the status of the remaining sites unknown (grey points).

Note: The map depicts each Important Bird Area by a point in the center of its associated area. Some IBAs are much smaller than the point shown in this national map and others cover a much larger area, such as IBAs associated with the large protected areas of Masai Mara or the two Tsavo National Parks. IBAs range from 1 hectare to more than 1 million hectares in size (Bennun and Njoroge 1999).

STATUS OF SELECTED BIRD AREAS (IBAs)
- Improving
- Stable
- Declining
- Unknown

AREAS IMPORTANT FOR BIRD CONSERVATION
- Endemic bird areas
- Permanent wetlands
- Seasonal wetlands

OTHER FEATURES
- District boundaries
- National parks and reserves
- Water bodies

HOW PEOPLE AFFECT KENYA'S BIODIVERSITY

One of the greatest challenges to Kenya's rich wildlife heritage is that concentrations of high biodiversity often overlap with the places where people prefer to live as well. In East Africa, interactions between people and wildlife have been taking place for thousands of years in landscapes rich in large mammals. However, in recent decades, human activities and settlements have brought unprecedented change to Kenya's ecosystems. The two primary ways in which people are modifying the natural landscapes are by conversion of forests, rangelands, and other natural systems to agricultural cultivation; and development of new water sources in rangelands. The following sections examine landscape-level indicators of human modification of Kenya's ecosystems.

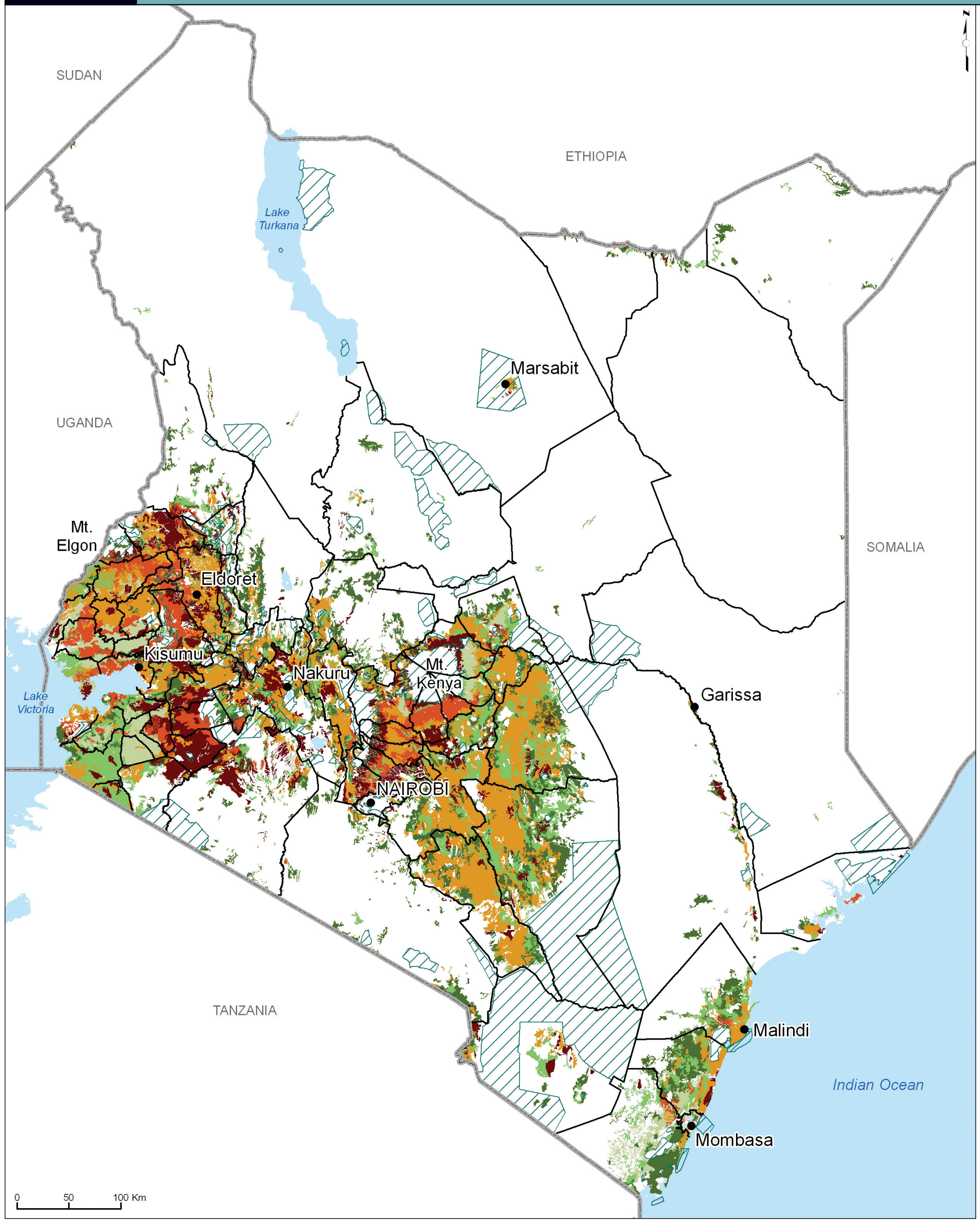
Intensity of Cultivation

Kenya's croplands are concentrated in zones of greater, more reliable rainfall, that is, the central and western highlands, the Lake Victoria basin, and a narrow strip of coastal lowlands. Across the remainder of Kenya's land area, the climate and soils are too dry and risky for rainfed agriculture.

Human conversion of forests and rangelands into managed, farmed landscapes often brings fundamental changes in the plant and animal communities found there. In general, agroecosystems feature fewer species and less biodiversity than the natural systems they replace. Conversion to agriculture also changes hydrological patterns, that is, surface and subsurface water flows. These changes are most drastic when the land is converted to highly mechanized agriculture, which typically features large fields of a single cereal crop, such as maize, rice, or wheat.

It is important to note, however, that within Kenya's croplands, farmers use the land at different levels of intensity (see Map 5.4). Even in the most intensively cultivated landscapes, some remnants of natural vegetation remain. Depending on how these fragments are managed and incorporated into the larger agricultural landscape, small-scale farmers can make a potentially significant contribution to maintaining Kenya's biological heritage.

Map 5.4 **Intensity of Cultivation, 2000**



Sources: Administrative boundaries (CBS 2003), cities (SoK and ILRI 2000), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), croplands (FAO 2000), and cropland intensity (WRI calculation based on *Africover* legend for croplands in FAO 2000).

The most intensively farmed landscapes in Kenya (brown-shaded map areas, with more than 80 percent of local land area under cultivation) are found mostly in the central and western highlands and in small patches in the coastal lowlands. Most agroecosystems have 50 to 60 percent of their land area under cultivation (light green or orange-shaded map areas), with farmers' fields interspersed with patches of less-managed landscapes, such as forests, woodlands, and other natural habitats.

Note: The standardized Land Cover Classification System of *Africover* (FAO 2000) can be used to show to what degree the spatial units (polygons) within the *Africover* map are "natural and semi-natural areas" or "managed" (cultivated) areas. The *Africover* classification system and the associated rules used to interpret the satellite imagery allow the creation of six discrete classes of cropland intensity, reflecting a stepwise gradient from the lowest (only 15 percent of the polygon is covered by cropland) to the highest category (more than 80 percent of the polygon is cultivated). The *Africover* map does not provide sufficient information to create a continuous legend ranging from zero to 100 percent. The map cannot show cropping that falls below the 15 percent threshold.

CROPLAND INTENSITY
(percent of land under cultivation)

> 80
70
60
50
35 - 40
15

OTHER FEATURES

District boundaries
National parks and reserves
Water bodies

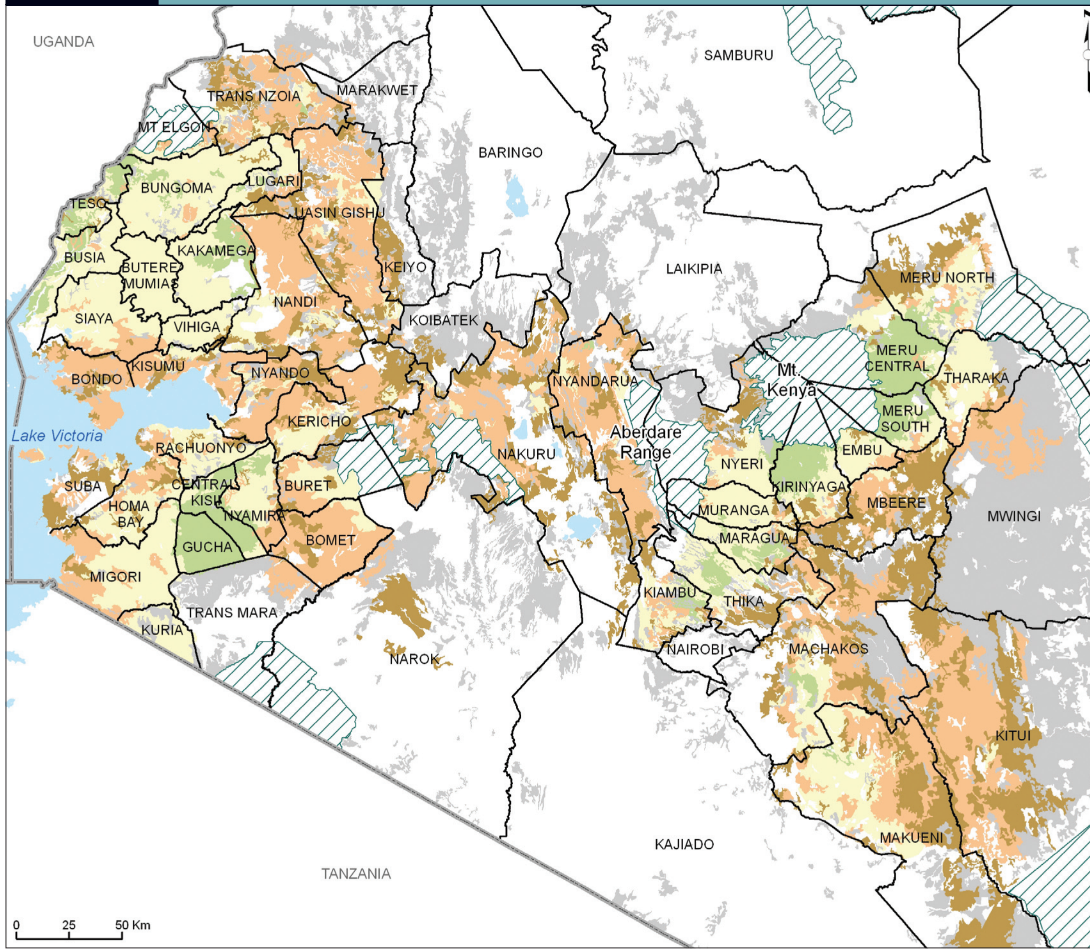
Agriculture and Biodiversity Conservation

Agricultural landscapes are often associated with reduced levels of biodiversity. However, this need not be the case. It is possible for farmers to grow their crops and manage their land in ways that contribute to, rather than detract from, the conservation of native plant and animal species.

Maps 5.5-5.7 depict landscape-level indicators that are related to biodiversity-friendly farming and land management methods. Based on analysis of remote sensing data and aerial photography of central and western Kenya (a priority area for both biodiversity conservation and agricultural production), we selected three indicators—average number of crops grown, extent of tree cover in croplands, and average size of farmers' fields. When combined, these indicators portray the quality of habitat provided by agricultural landscapes for native highland plants and animals.

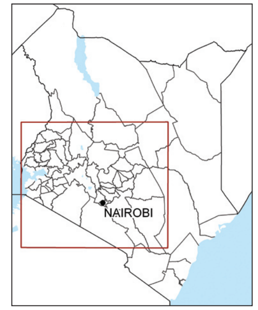
- Farmers contribute to agricultural biodiversity when they grow **multiple crop species**, either simultaneously or sequentially over the course of a single season (Map 5.5). In some parts of the highlands, farmers grow up to eight different crop species at one time. Analysis of remote sensing data and aerial photography reveals such concentrations of "polycropping" throughout the highlands.
- The **extent of tree cover in croplands** (Map 5.6) also can have an important bearing on habitat quality. The presence of more trees in agricultural landscapes—in hedgerows, woodlots, and forest remnants—clearly benefits bird life dependent on these habitats (Reid et al. 1997, Wilson et al. 1997). Trees also provide shade for streams that flow through croplands, which helps maintain lower water temperatures that promote replenishment of fish stocks. In several areas of the highlands, tree cover in farmlands exceeds 30 percent; at this proportion, the trees themselves can make a significant contribution to plant biodiversity as well as providing wildlife habitat. Fruit trees and trees in hedgerows and woodlots also provide an important source of food, fuel, forage, and building materials for farmers.

Map 5.5 Average Number of Crops Grown in Croplands of Central and Western Kenya, 1997



Sources: Administrative boundaries (CBS 2003), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), cropland areas (FAO 2000), and number of crops grown in sampled croplands (WRI calculation based on ICRAF and DRSRS 2001).

Note: The map combines detailed crop information from 5,747 aerial photos for a growing season in 1997, each providing a sample point of detailed crop information. These samples are averaged to spatial units (polygons) of croplands from Kenya's most recent land cover map (FAO 2000). These averages represent conservative estimates. The raw data indicate that in some sample points farmers grow up to eight different crop species simultaneously.



AGRICULTURAL CROPS IN SAMPLED CROPLAND
(average number)
- > 4
- 2 - 4
- 1 - 2
- <= 1
- Cropland not sampled

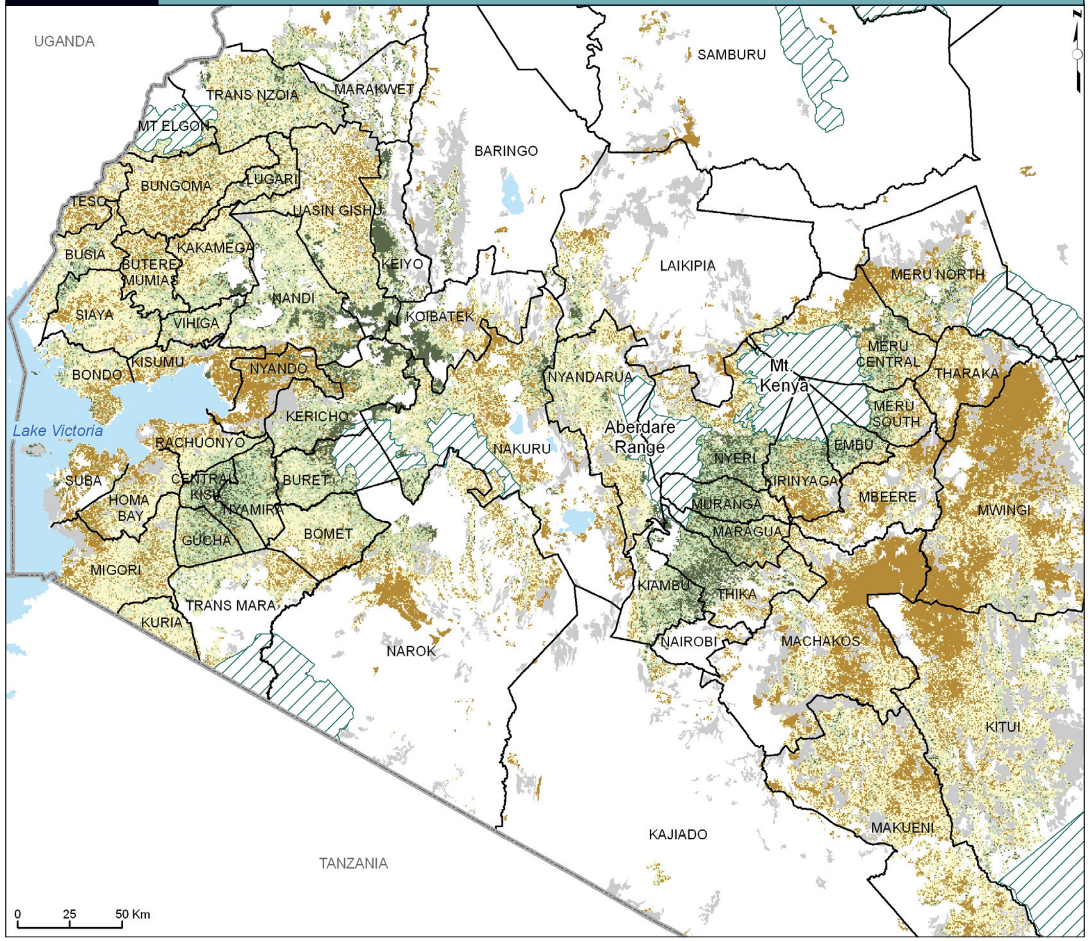
OTHER FEATURES
- District boundaries
- Major national parks and reserves (over 5,000 ha)
- Water bodies

On much of Kenya's most fertile cropland, farmers grow an average of two to four crops at the same time. Sites where farmers grow only one or two crops at a time typically are marginal farming areas with less rainfall, or highly productive areas where farmers grow a single cash crop, such as wheat-growing areas of Narok District or rice-growing areas in Mbeere District. Areas with the greatest number of crops grown at one time are concentrated in Gucha, Kirinyaga, and Meru Central Districts.

- The **average size of farmers' fields** (Map 5.7) is a key indicator for biodiversity because smaller fields have more edges and boundaries, often planted with diverse species of trees and shrubs. Such heterogeneous landscapes make for better habitat for native plants, birds, and small mammals than do large fields of a single crop, such as rice or wheat. On the other hand, small field size may also make agricultural production more labor-intensive and less efficient.

Simultaneously examining these three indicators can help identify priority areas for programs to further enhance biodiversity in agricultural landscapes, for instance through certified organic farming schemes, or programs to promote more planting of native tree species. Of course, these indicators do not account for other important factors that impact biodiversity on farmlands, such as pesticide and fertilizer use, soil conservation, and preservation of native vegetation on the banks of streams and other water bodies. However, ecologists currently understand the relationships between biodiversity and these factors only in very general terms. Farmers and other resource managers could benefit greatly from the availability of more specific guidance on these linkages.

Map 5.6 Extent of Tree Cover in Croplands of Central and Western Kenya, 2001



TREE COVER IN AREAS WITH MORE THAN 30% CROPLAND (percent)

- > 30
- 20 - 30
- 10 - 20
- <= 10
- Areas of < 30% cropland

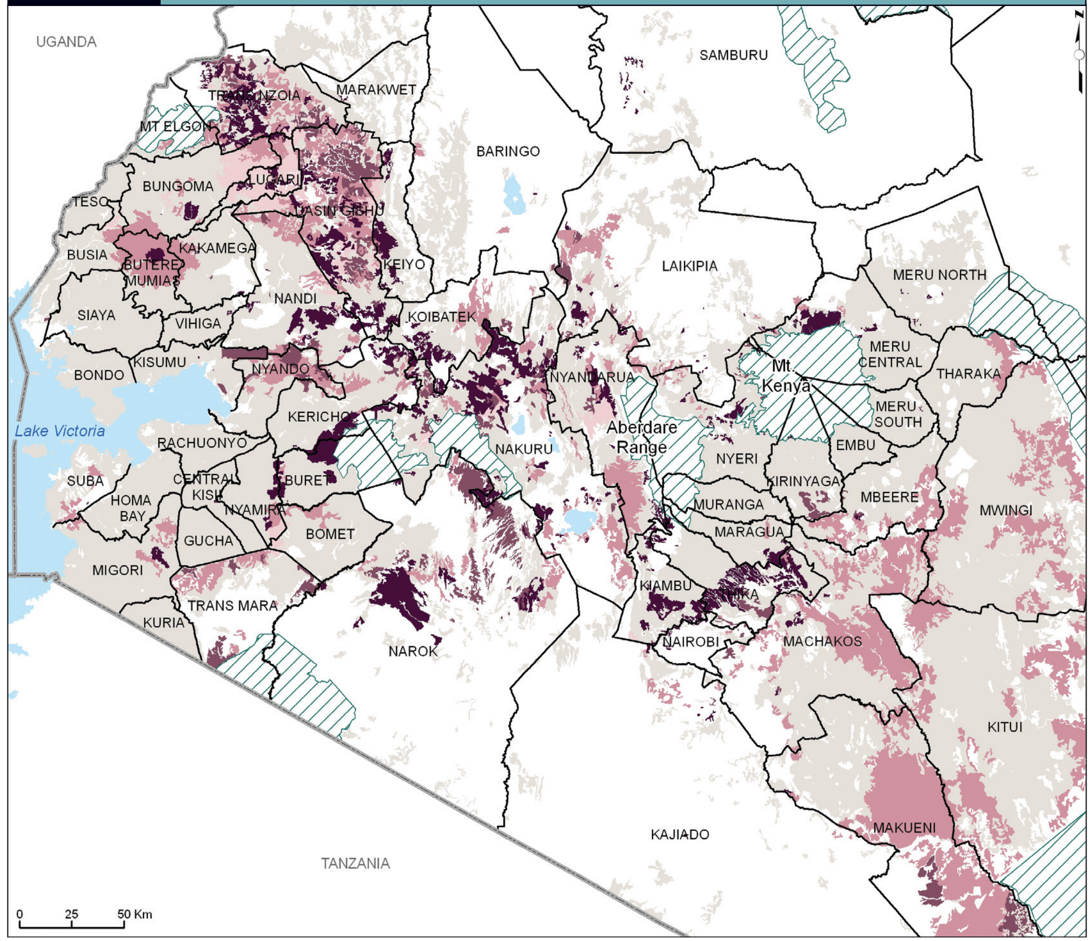
OTHER FEATURES

- District boundaries
- Major national parks and reserves (over 5,000 ha)
- Water bodies

Sources: Administrative boundaries (CBS 2003), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), areas with more and areas with less than 30 percent cropland (FAO 2000), and percent tree cover (Hansen et al. 2003).

Across most of the heavily cultivated landscapes of the highlands, farmers' fields contain 10 to 30 percent tree cover, consisting of fruit and other trees grown for fuel, forage, and building materials. Farmlands with relatively higher levels of tree cover are found in the eastern foothills of the Aberdare Range and on the southern slopes of Mount Kenya, as well as in Gucha, Central Kisii, and Nyamira Districts in the western highlands. Small belts of farmland with high levels of tree cover can also be seen in agricultural areas that border forest plantations and reserves in Kericho, Koibatek, and Keiyo Districts.

Map 5.7 Field Size in Croplands of Central and Western Kenya, 2000



FIELD SIZE

- Large (> 5 ha)
- Large mixed with medium
- Medium (2 - 5 ha)
- Medium mixed with small
- Small (< 2 ha)

OTHER FEATURES

- District boundaries
- Major national parks and reserves (over 5,000 ha)
- Water bodies

Sources: Administrative boundaries (CBS 2003), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), and field size in croplands (WRI extraction from FAO 2000).

Throughout Kenya's highlands, farmers tend to grow their crops in small fields. Sites where fields are large generally correspond to farming enterprises engaged in production of specific cash crops, such as wheat farming in Narok District or coffee growing in Kiambu and Thika Districts. Some of the large fields shown for Buret and Kericho Districts represent large fields of tea and tree plantations.

Impact of Rangeland Development on Biodiversity

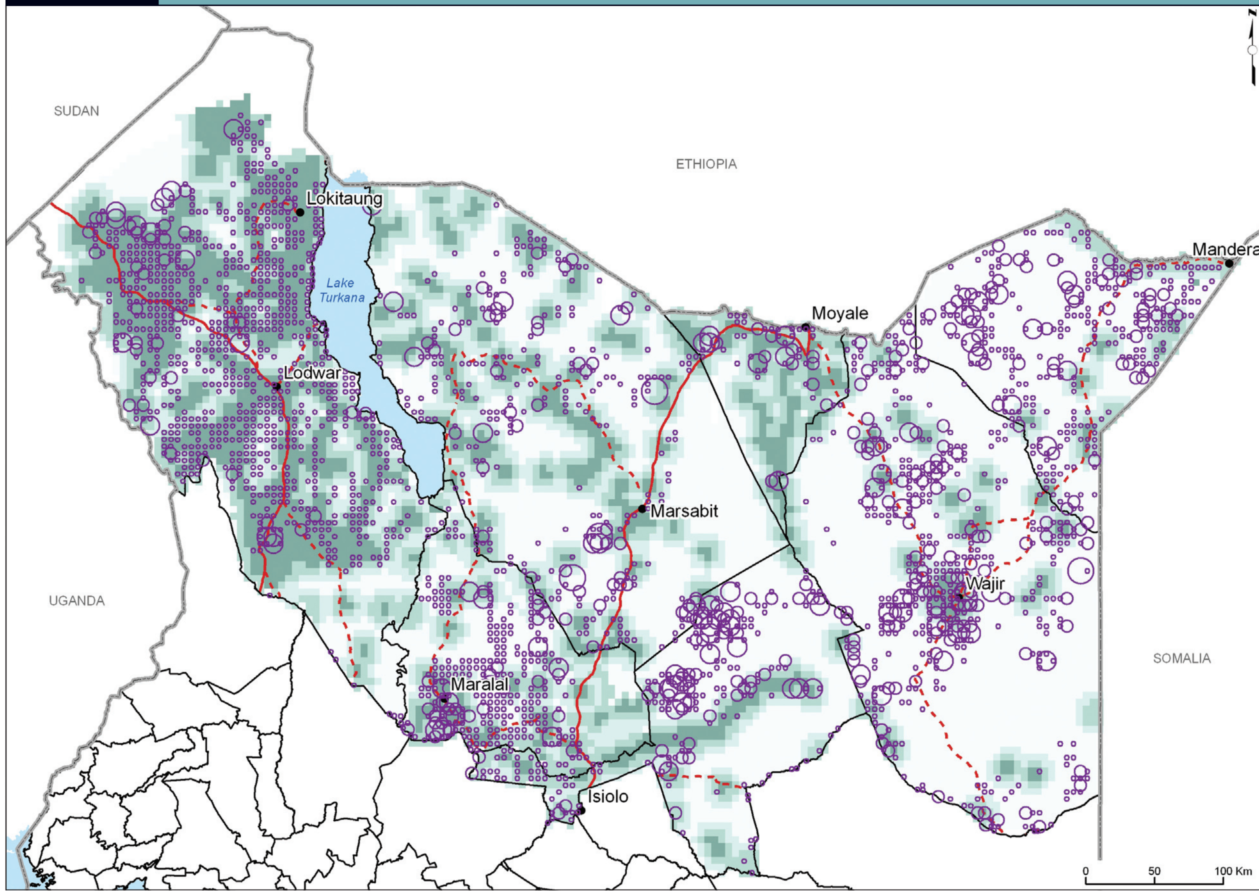
Most of Kenya is too dry for rainfed agriculture. In the country's semi-arid and arid regions, people do little farming, but their use of the land for grazing livestock and for building towns, roads, water points, and other infrastructure can still affect biodiversity, although usually not as much as farming does. For instance, grazing of livestock by pastoral people near water points in northern Kenya "pushes" wildlife away from water, at least during the daytime (Williams 1998, de Leeuw et al. 2001). Recent studies in the southern Kenya rangelands of the Mara have shown that density of human settlement has an impact on wildlife densities. At lower human densities (less than 7 people per square kilometer) wildlife density increases, and at higher human densities wildlife density declines rapidly (Reid et al. 2003).

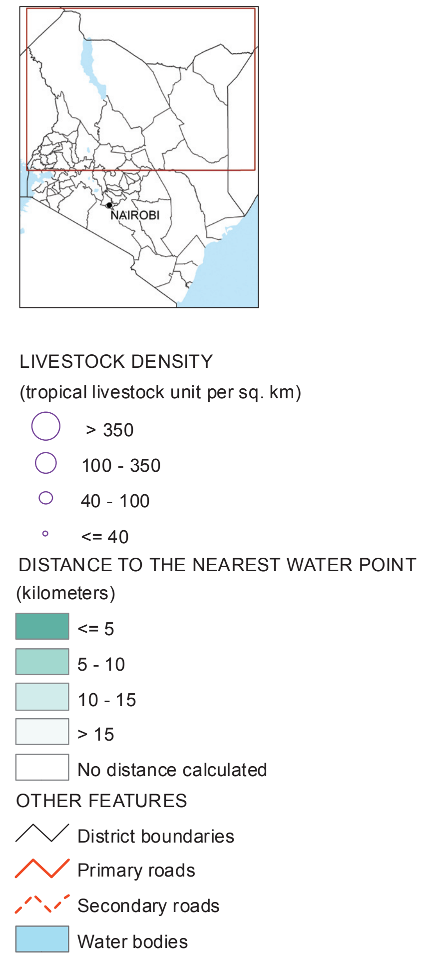
Maps 5.8 and 5.9 show how developing boreholes and other water points in northern Kenya impacts livestock and wildlife. In this region, rangelands dominate, consisting of savannas, grasslands, bushlands, and woodlands.

The species composition of livestock and wildlife herds varies considerably across this region, depending on vegetation type as well as availability of water. For instance, livestock herds in Turkana District are made up mostly of cattle, while herds in Samburu District typically include a mix of cattle and smaller livestock, such as goats and sheep. In the northeast, camels are more prevalent than elsewhere in the northern rangelands.

To compare the impacts of livestock on wildlife herds composed of different species, data on animal populations are converted to a common unit, known as a *tropical livestock unit* (TLU). Each TLU is equal to an animal weight of 250 kg; thus, one cow accounts for 0.7 TLU, one camel is counted as 1.8 TLUs, and it takes 14 goats or sheep to make up one TLU. For wildlife species, one elephant is equivalent to 7.0 TLUs, one buffalo counts as 2.5 TLUs, and one wildebeest accounts for 0.9 TLU. Meanwhile, it takes ten Thomson's gazelle to make one TLU.

Map 5.8 **Water Points and Livestock Density in the Northern Rangelands, 1994-96**



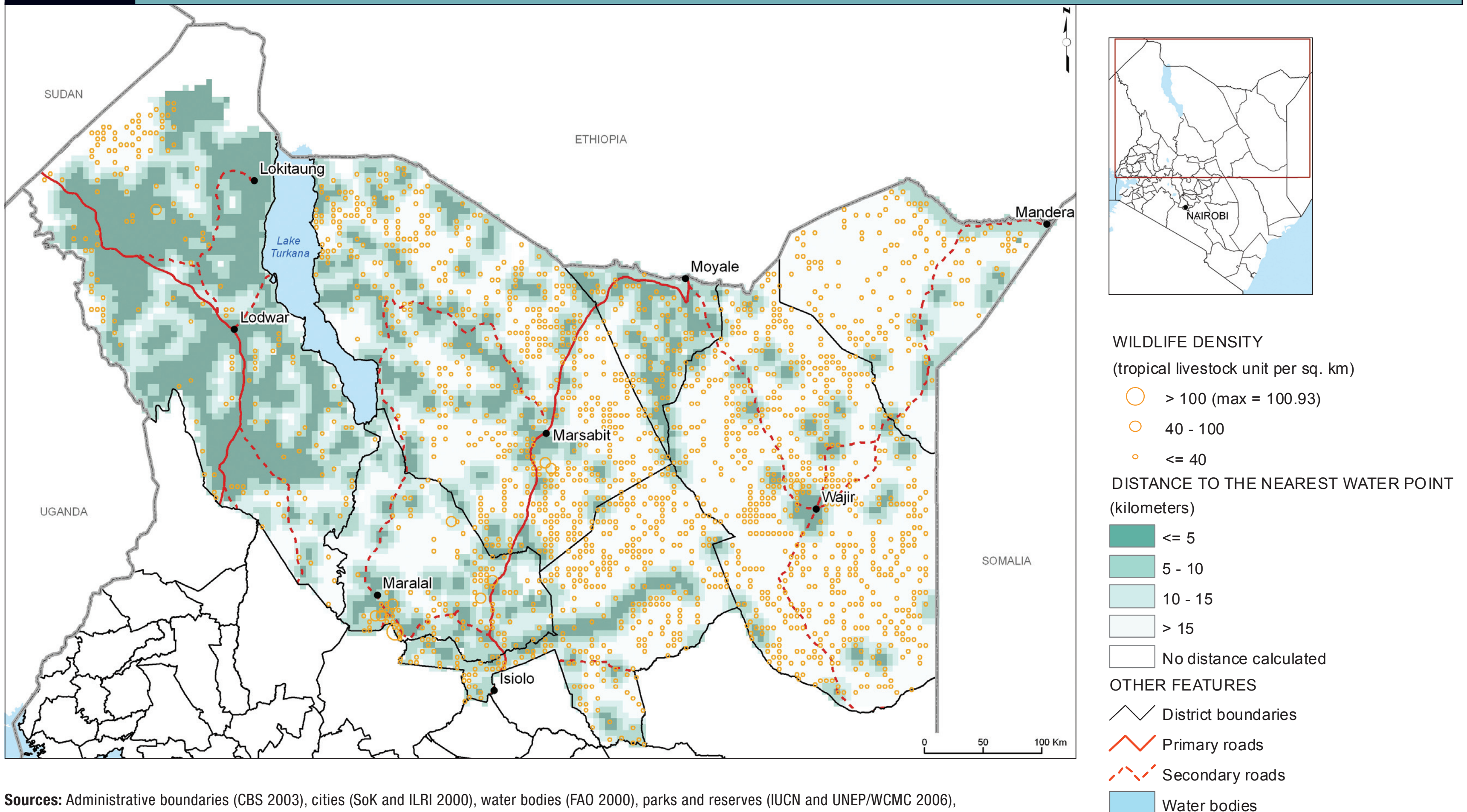


Sources: Administrative boundaries (CBS 2003), cities (SoK and ILRI 2000), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), primary and secondary roads (SoK and ILRI 1997), water points (GTZ 1996), distance to water points (WRI calculation based on GTZ 1996), and 1994-96 livestock density (ILRI calculation based on DRSRS 2003, Grunblatt et al. 1995, Grunblatt et al. 1996).

Areas closest to water points (that is, zones less than 5 km from a water point, shown as dark-shaded map areas) tend to support the greatest density of livestock populations (shown as purple circles). For instance, livestock are prevalent throughout Turkana District (west of Lake Turkana), which has the densest network of boreholes and permanent water sources.

Note: Livestock numbers are aggregated (using TLUs) to squares of 5 km by 5 km, averaged by square kilometer, and then represented by a circle proportional to their density. Livestock includes cattle, sheep, goats, camels, and donkeys that were observed during low-altitude flights.

Map 5.9 Water Points and Wildlife Density in the Northern Rangelands, 1994-96



Sources: Administrative boundaries (CBS 2003), cities (SoK and ILRI 2000), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), primary and secondary roads (SoK and ILRI 1997), water points (GTZ 1996), and 1994-96 wildlife density (ILRI calculation based on DRSRS 2003, Grunblatt et al. 1995, Grunblatt et al. 1996).

The greatest densities of wildlife (mapped as orange circles) are found in zones that are located at least 15 km from the nearest water point (shown as light-shaded areas). The drilling of boreholes in Turkana District, west of Lake Turkana, and elsewhere in the northern rangelands has permitted grazing of more livestock, but has pushed wildlife farther away from water sources. Note also that wildlife densities tend to be less (by weight) than densities of livestock in this region.

Note: Species numbers are aggregated (using TLUs) to squares of 5 km by 5 km, averaged by square kilometer, and then represented by a circle proportional to their density. The wildlife counts include 21 different large grazing animals that can be observed during low-altitude flights.

LOSING AND GAINING WILDLIFE

East Africa is one of the few places on Earth where people can watch the spectacle of migrating herds of millions of wildebeest, gazelle, antelopes, and other grazing animals. Several of Kenya's most celebrated natural areas—such as the savannas of the Mara, Athi-Kapiti, and Amboseli ecosystems—still support grand migrations of wildebeest and zebra. Elephants are another species that is on the move in large numbers in Kenya, in the Mara, Amboseli, Tsavo, and Laikipia-Samburu ecosystems.

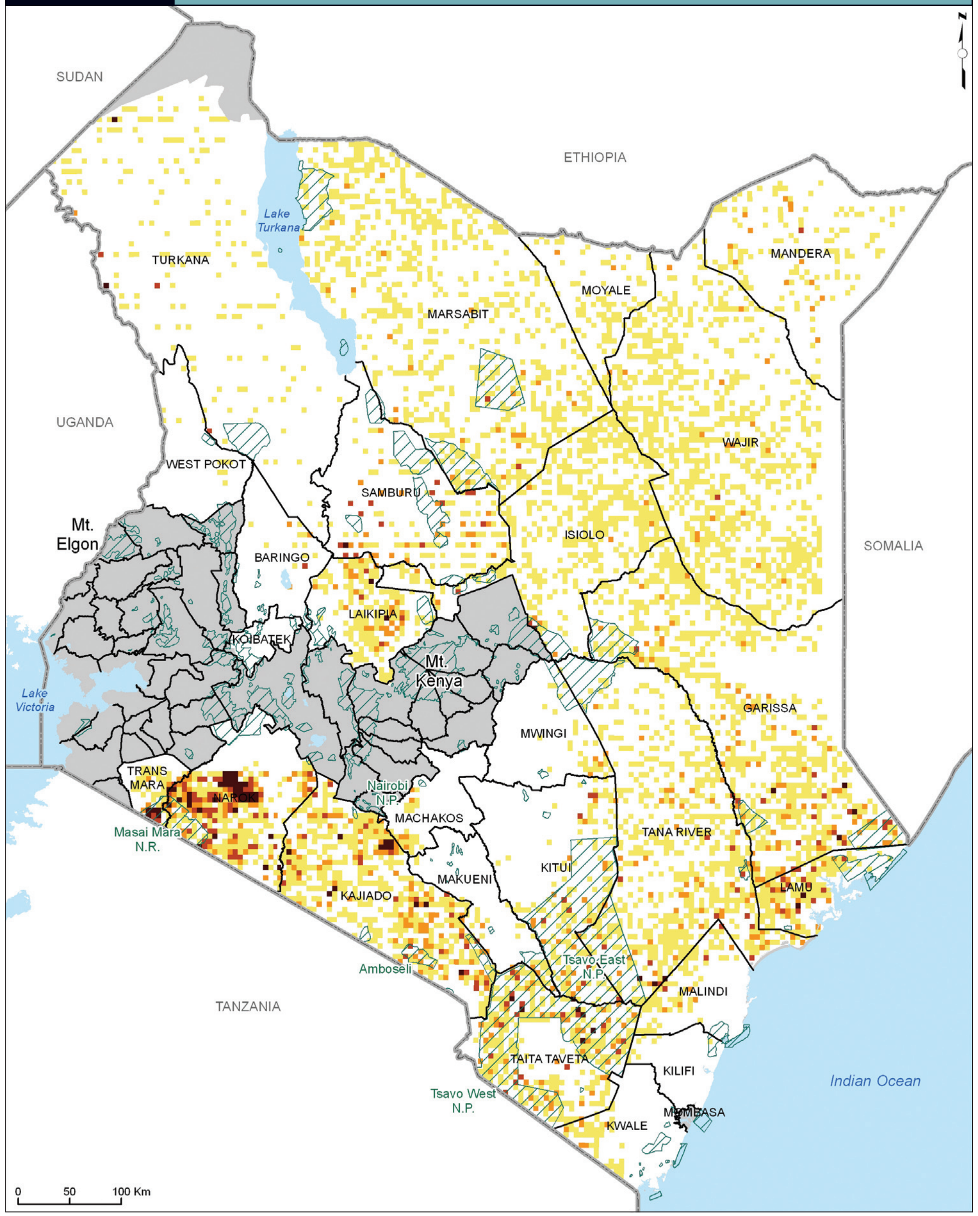
In pastoral lands, humans and wildlife can coexist peacefully most of the time. However, conflicts with wildlife can erupt when people settle permanently and establish farms. Sometimes people kill wildlife purposely for food, for trophies, or to protect their crops and their lives. Most devastating to wildlife, however, is the loss of habitat that comes from competing human uses of the land for farms, towns, water points, or heavy grazing of domestic livestock.

The following section looks at Kenya's wildlife populations and how they have changed in recent decades. The maps and table presented here are based largely on data from aerial wildlife counts conducted periodically since the 1970s by the Department of Resource Surveys and Remote Sensing, as well as data from the Kenya Wildlife Service. Using this information, national-scale maps showing wildlife numbers over time for Kenya's rangelands as a whole can be constructed; finer-scale maps showing changes in the distribution of selected wildlife species in specific locations can also be made.

As these maps and the table demonstrate, Kenya has experienced severe contractions in the size and distribution of wildlife populations since the 1970s. For some species and in some areas, declining trends have been reversed and recovery has begun. In other cases, the losses continue and may even be accelerating. Assessments of Kenya's mammal populations, for example, show that 51 species (14 percent of the total number of species) are now threatened with extinction (IUCN 2006).

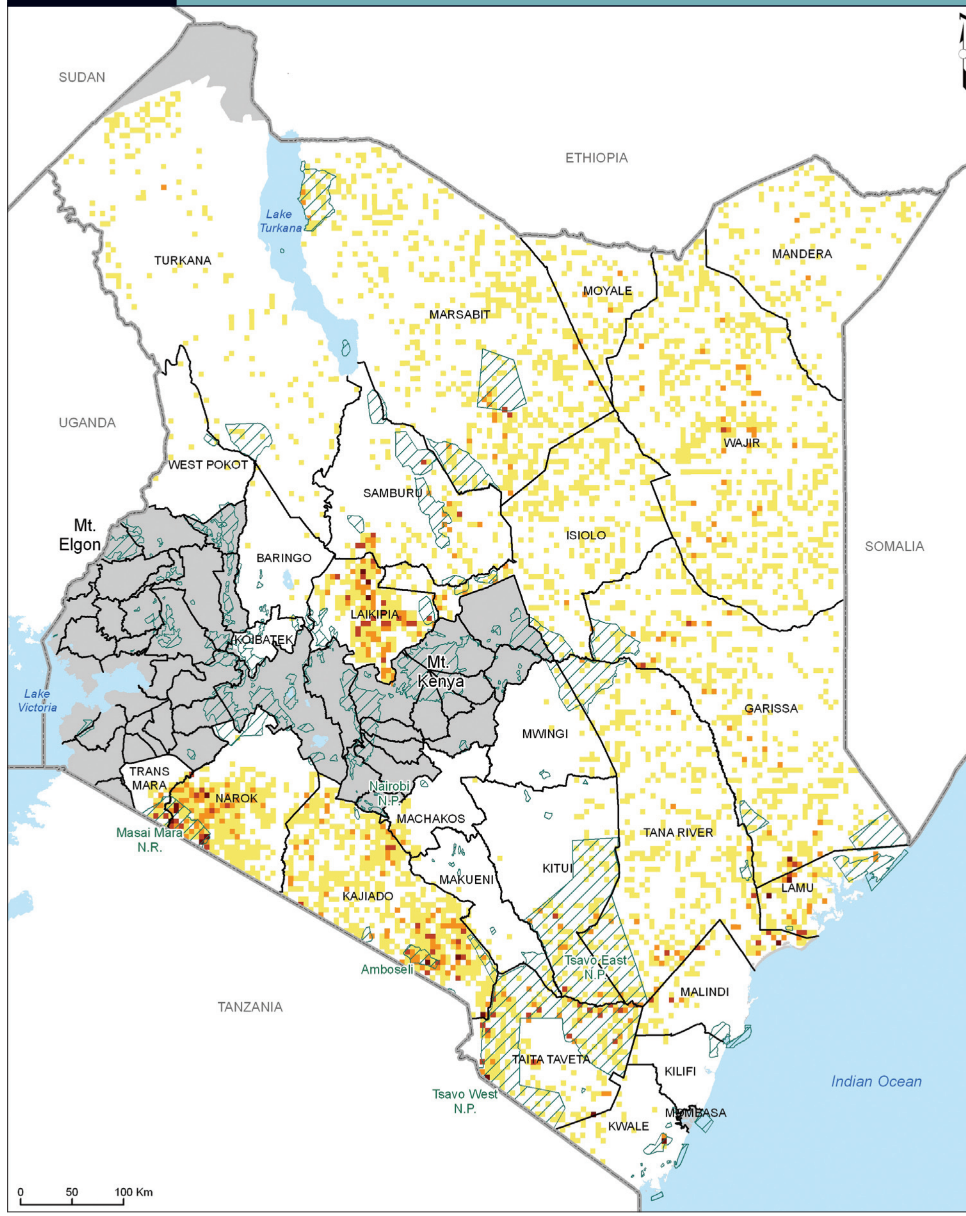
Data analysis and mapping indicate that wildlife populations have tended to fare better in or near Kenya's parks and game reserves. However, many species, especially the large grazing animals, spend

Map 5.10 Wildlife Density in the Rangelands, 1977-78



Sources: Administrative boundaries (CBS 2003), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), and 1977-78 wildlife density (ILRI calculation based on DRSRS 2003, Grunblatt et al. 1995, Grunblatt et al. 1996).

Map 5.11 Wildlife Density in the Rangelands, 1994-96



Areas of high wildlife density (dark brown-shaded areas) are less prevalent in the 1990s than in the 1970s. Especially striking is the disappearance of sites with dense wildlife populations in central Narok District, north of the Masai Mara Game Reserve. In general, declines in wildlife density have been steeper in communal and privately owned lands than in parks and reserves.

Note: Species numbers are aggregated (using TLUs) to squares of 5 km by 5 km and then averaged by square kilometer. The wildlife counts include 21 different large grazing animals that can be observed during low-altitude flights.

WILDLIFE DENSITY
(tropical livestock unit per sq. km)

- > 125
- 45 - 125
- 15 - 45
- 0 - 15
- No observation of wildlife
- No data

OTHER FEATURES

- District boundaries
- National parks and reserves
- Water bodies

Sources: Administrative boundaries (CBS 2003), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), and 1994-96 wildlife density (ILRI calculation based on DRSRS 2003, Grunblatt et al. 1995, Grunblatt et al. 1996).

a significant amount of their life cycle outside the borders of these protected areas. The way people use private and communally held lands strongly affects Kenya's wildlife and will play an increasingly important role in ensuring the long-term survival of many species.

Trends in Spatial Distribution of Wildlife

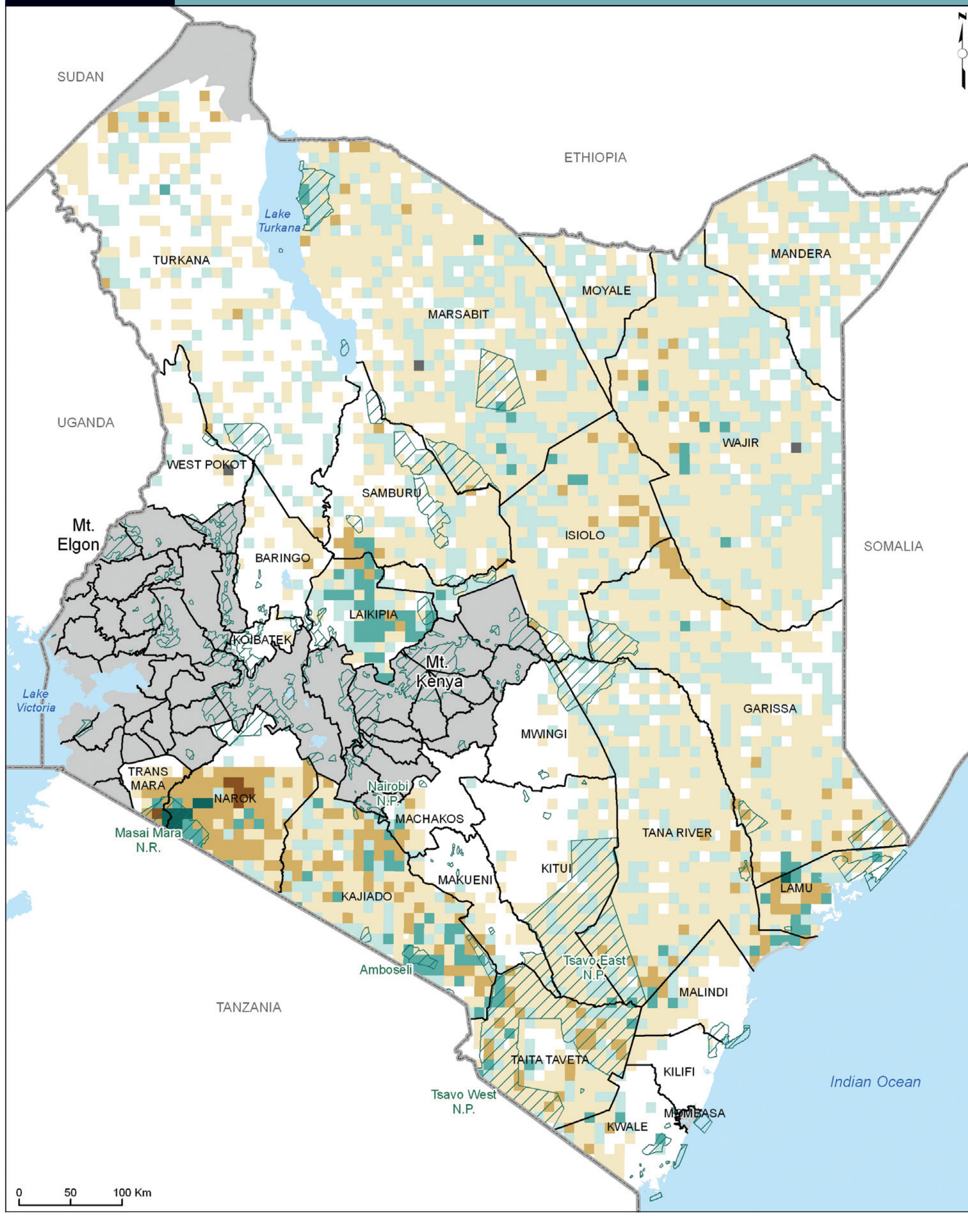
Most of Kenya's rangelands contain wildlife, but the density of wildlife populations varies over time and space according to several factors. The most important factors are the availability of water and forage, as well as competition with human uses of the land for growing crops; raising domestic livestock; and building towns, roads, and water points.

In three Districts—Laikipia, Kajiado, and Narok—wildlife are especially abundant. Here, large herds of many different species congregate, especially in areas close to some of Kenya's best-known national parks and reserves, including Masai Mara National Reserve, Amboseli National Park, and Nairobi National Park. Wildlife by no means restrict their ranges to these protected areas; they also migrate across private and communally held lands and even across international borders.

Maps 5.10 and 5.11 depict the density of wildlife populations across Kenya's rangeland Districts. As indicated earlier, animal densities are converted to a common unit (known as a *tropical livestock unit* (TLU), which is equivalent to an animal weight of 250 kg) to represent the density of wildlife herds composed of different species.

Note that the maps depict *average* wildlife densities (in terms of TLU per sq km) over the course of a year, and do not show the significant differences in wildlife populations that occur between the rainy and dry seasons. These maps are most useful for pinpointing areas with the highest average wildlife densities and comparing these areas to other mapped features, such as the boundaries of parks and reserves, or extent of land under cultivation versus less modified ecosystems. For instance, in Map 5.10, areas of Narok District that showed high wildlife densities in the 1970s but not the 1990s correspond in large part to areas in which rangelands have been converted to croplands (see Maps 5.1 and 5.4).

Map 5.12 **Changes in Wildlife Density in the Rangelands, 1977-78 to 1994-96**



Sources: Administrative boundaries (CBS 2003), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), and changes in wildlife density between 1977-78 to 1994-96 (ILRI calculation based on DRSRS 2003, Grunblatt et al. 1995, Grunblatt et al. 1996).

Many places in Kenya experienced gains in wildlife density between the 1970s and the 1990s, with sites of most rapid recovery (dark bluish-green areas) concentrated in southwest Narok District, near the Masai Mara Game Reserve; in Kajiado District, near Amboseli National Park; in Laikipia District, northwest of Mount Kenya National Park; and in selected areas near the coast in Lamu District. Sites with sharp declines in wildlife density (dark brown-shaded areas) are found throughout large parts of central Narok District, south of Nairobi in Kajiado District (see also detailed Map 5.15 of Kitengela dispersal area), northern Laikipia District, locations along the Samburu-Laikipia border, and in Isiolo and Garissa Districts near the Wajir border.

Note: To estimate changes in wildlife densities, species numbers are aggregated (using TLUs) to squares of 10 km by 10 km and then averaged by square kilometer for each reference period. The wildlife counts include 21 different large grazing animals that can be observed during low-altitude flights.

CHANGE IN WILDLIFE DENSITY

High increase (> 10,000 TLU/ sq. km)

No change

High decline (> 28,000 TLU/ sq. km)

No observation of wildlife at both dates

No data

OTHER FEATURES

District boundaries

National parks and reserves

Water bodies

Map 5.12 pinpoints areas of gains and losses in wildlife density. (Note that, in order to depict a more robust measure of local change, the data underlying this map have been aggregated to a resolution of 100 sq km (mapped squares of 10 km by 10 km) versus the 25 sq km resolution (mapped squares of 5 km by 5 km) of Maps 5.10 and 5.11.) Sites in which wildlife density is on the rise are clustered near Kenya's parks and game reserves, particularly the more popular tourist destinations. These results are in broad agreement with studies indicating that wildlife losses in Kenya's protected areas have been much smaller than in unprotected lands—31 percent versus 48 percent between 1977 and 1994 (Norton-Griffiths 1998).

Table 5.1 presents the data of Maps 5.10-5.12 in terms of District-level changes in the size of total wildlife populations (expressed in TLU) between 1977-78 and 1994-96. It also shows the comparable trends for livestock. For all 24 Districts, the total wildlife population declined by 61 percent during that period. Only Laikipia and Kwale Districts witnessed an increase in their total wildlife populations. Total livestock population for the 24 Districts also shrank—but only by 30 percent—leading to an overall decline in the total of grazing animals in these rangelands. Total wildlife declines were greater than total livestock declines in all but five Districts (Laikipia, Lamu, Kwale, Wajir, and Kilifi Districts), resulting overall in a greater share of livestock consuming rangeland resources. In 1994-96, the total livestock numbers represented about 84 percent of all the grazing animals in the 24 rangeland Districts.

Numbers in green highlight where the livestock-wildlife ratio improved in favor of wildlife between 1977-78 to 1994-96. But in some Districts, such as Kwale, Kilifi, and Lamu, these gains may be outweighted by increases in cropping. District averages mask local changes, for example overall wildlife declines in Kajiado District are a combination of lower numbers in Kitengela and elsewhere in the District but stable conditions close to Amboseli (see Map 5.12).

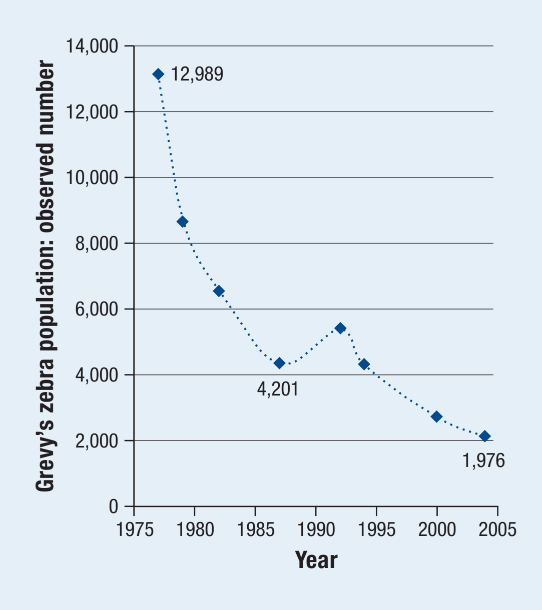
Table 5.1 Wildlife and Livestock Trends for the Rangeland Districts, 1977-78 to 1994-96

	WILDLIFE		LIVESTOCK		ALL ANIMALS		RATIO LIVESTOCK TO WILDLIFE	
DISTRICT NAME (average wildlife density in tropical livestock units per sq. km)	TOTAL 1994-96 (TLU)	CHANGE 1977-78 TO 1994-96 (%)	TOTAL 1994-96 (TLU)	CHANGE 1977-78 TO 1994-96 (%)	TOTAL 1994-96 (TLU)	CHANGE 1977-78 TO 1994-96 (%)	1977-78	1994-96
Very High Average Wildlife Density (>1.8 TLU per sq. km)								
Trans Mara (9.41 TLU per sq. km)	26,796	-84	115,798	40	142,594	-44	0.5	4.3
Laikipia (9.13 TLU per sq. km)	86,550	80	133,151	22	219,700	40	2.3	1.5
Narok (7.03 TLU per sq. km)	106,110	-81	307,301	-32	413,410	-59	0.8	2.9
Kajiado (5.48 TLU per sq. km)	120,071	-46	360,728	-16	480,799	-26	1.9	3.0
Lamu (5.20 TLU per sq. km)	32,089	-44	6,690	-76	38,778	-55	0.5	0.2
Taita Taveta (4.35 TLU per sq. km)	74,378	-59	60,607	-26	134,985	-49	0.4	0.8
TOTAL 6 DISTRICTS	**445,994**	**-64**	**984,274**	**-17**	**1,430,268**	**-41**	**1.0**	**2.2**
High Average Wildlife Density (0.9 – 1.8 TLU per sq. km)								
Tana River (1.44 TLU per sq. km)	55,112	-50	186,400	-28	241,512	-35	2.3	3.4
Malindi (1.44 TLU per sq. km)	11,152	-48	22,989	16	34,141	-17	0.9	2.1
Kwale (1.38 TLU per sq. km)	11,399	47	52,932	-62	64,332	-56	17.9	4.6
Samburu (1.24 TLU per sq. km)	26,161	-56	170,736	-29	196,898	-34	4.1	6.5
Kitui (1.04 TLU per sq. km)	21,306	-58	107,878	7	129,184	-15	2.0	5.1
Garissa (1.01 TLU per sq. km)	45,230	-69	350,021	-25	395,250	-36	3.2	7.7
TOTAL 6 DISTRICTS	**170,360**	**-57**	**890,956**	**-27**	**1,061,316**	**-35**	**3.1**	**5.2**
Medium Wildlife Density (0.4 – 0.9 TLU per sq. km)								
Machakos (0.88 TLU per sq. km)	5,460	-41	87,055	-35	92,515	-35	14.5	15.9
Wajir (0.71 TLU per sq. km)	40,265	-27	396,737	-28	437,003	-28	10.0	9.9
Isiolo (0.66 TLU per sq. km)	16,815	-59	233,351	-10	250,166	-17	6.3	13.9
Marsabit (0.55 TLU per sq. km)	34,067	-43	239,685	-39	273,752	-40	6.6	7.0
Makueni (0.53 TLU per sq. km)	4,275	-70	84,342	-34	88,617	-38	9.1	19.7
Moyale (0.49 TLU per sq. km)	4,706	-24	48,902	25	53,609	18	6.3	10.4
TOTAL 6 DISTRICTS	**105,589**	**-43**	**1,090,073**	**-28**	**1,195,662**	**-29**	**8.1**	**10.3**
Low Wildlife Density (< 0.4 TLU per sq. km)								
Mandera (0.22 TLU per sq. km)	5,774	-67	216,822	-19	222,596	-22	15.3	37.6
Mwingi (0.10 TLU per sq. km)	999	-80	82,625	-8	83,624	-12	18.4	82.7
Turkana (0.07 TLU per sq. km)	5,017	-82	278,386	-62	283,403	-62	25.8	55.5
Kilifi (0.07 TLU per sq. km)	329	-10	43,159	-58	43,488	-58	280.5	131.2
Baringo (0.05 TLU per sq. km)	390	-92	80,459	-49	80,850	-51	31.0	206.1
West Pokot (0.04 TLU per sq. km)	409	-85	86,512	-25	86,921	-27	41.1	211.4
TOTAL 6 DISTRICTS	**12,919**	**-78**	**787,963**	**-46**	**800,882**	**-47**	**24.8**	**61.0**
TOTAL 24 DISTRICTS	**734,862**	**-61**	**3,753,266**	**-30**	**4,488,128**	**-38**	**2.9**	**5.1**

Sources: ILRI calculation based on DRSRS 2003, Grunblatt et al. 1995, Grunblatt et al. 1996.

Note: All percentage declines of animals are shown in red. Increases in total wildlife TLU for Laikipia do not necessarily mean that all species have grown in numbers. The major contributors to this total are zebras and elephants (all heavy species with high TLUs).

Figure 5.1 Trends in Grevy's Zebra Populations, 1977–2004



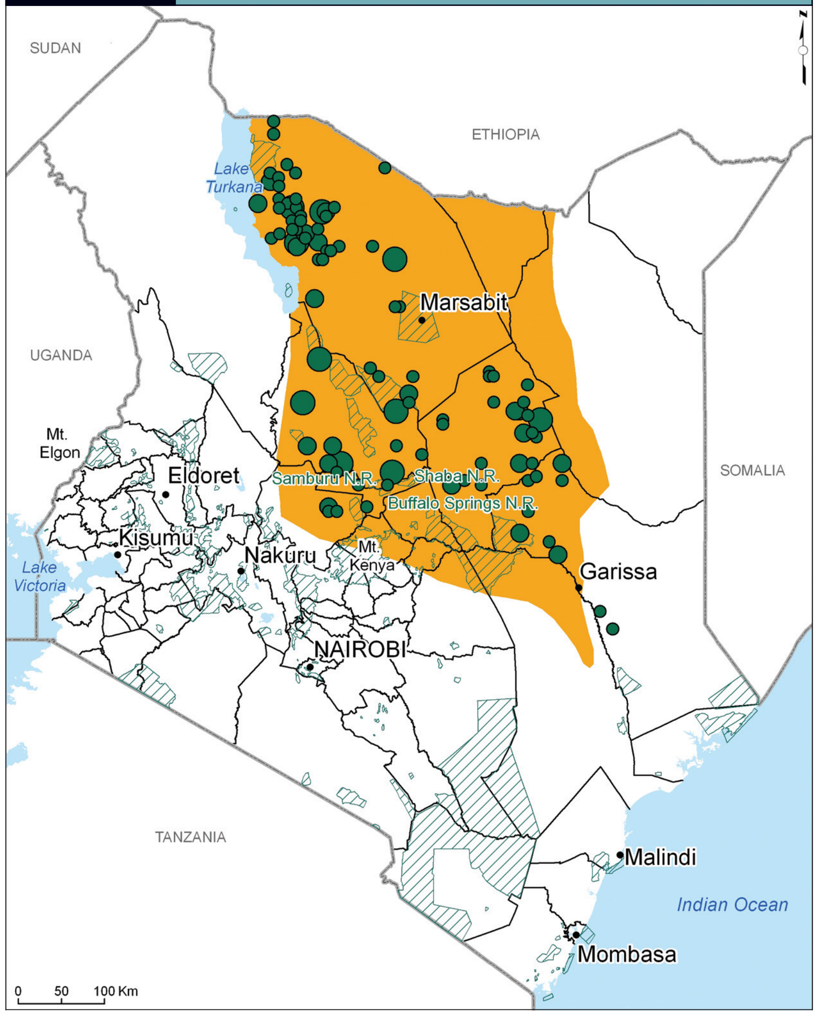
Source: Wargute and Said 1997, Moehlman 2002, Department of Remote Sensing and Resource Surveys (2005 unpublished data).

Local Declines in Selected Wildlife Species

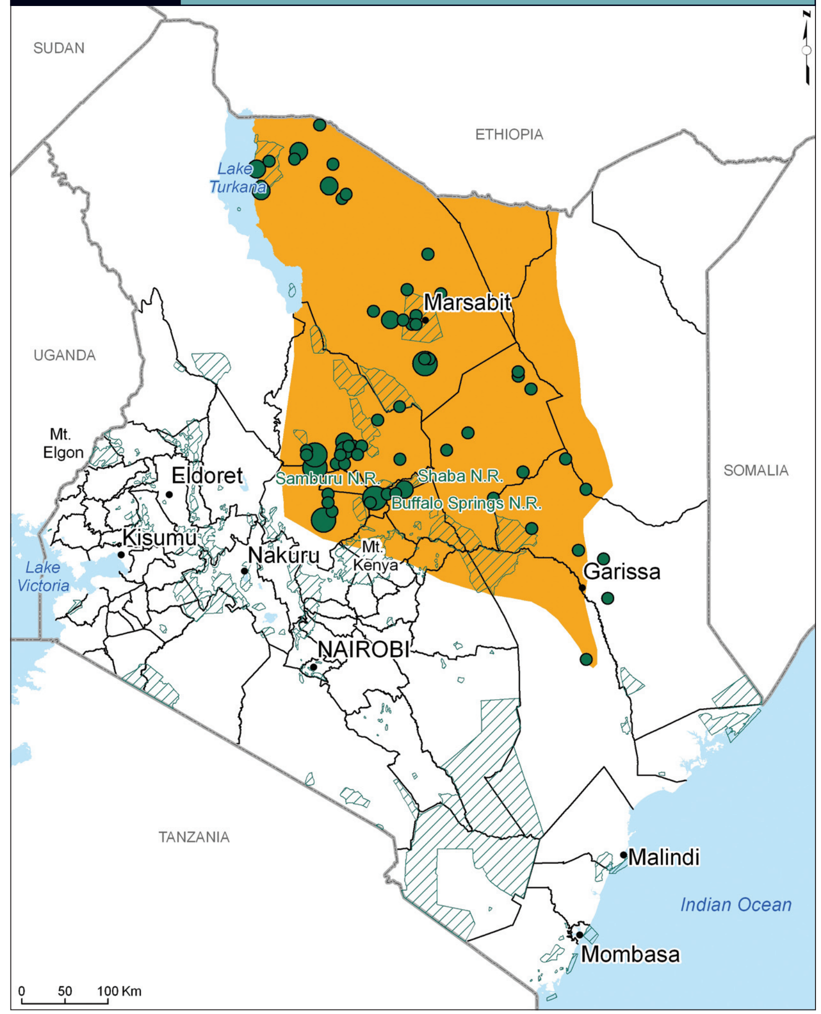
Moving beyond a picture of the general status of wildlife in Kenya's rangelands, the following maps and tables enable a closer look at population trends for particular wildlife species. This section examines the spatial distribution of two different species in two separate localities: populations of Grevy's zebra in the northern rangelands, and populations of wildebeest in the Kitengela plains in Kenya's southern rangelands.

Grevy's zebra is a unique species found only in northern Kenya, eastern Ethiopia, and Somalia. The largest of Kenya's zebra species, Grevy's zebra is distinct from the more common Burchell's zebra found elsewhere in Kenya and the rest of Africa. The population of this zebra species has fallen dramatically in the past 30 years, from about 13,000 in 1977 to less than 2,000 in 2004 (see Figure 5.1). The decline has slowed in recent years, but has not yet reversed itself. Areas experiencing the sharpest declines are found in Isiolo District and parts of Samburu District (see Maps 5.13 and 5.14).

Map 5.13 Spatial Distribution of Grevy's Zebra Population, 1977-78



Map 5.14 Spatial Distribution of Grevy's Zebra Population, 1994-96



Sources: Administrative boundaries (CBS 2003), cities (SoK and ILRI 2000), water bodies (FAO 2000), parks and reserves (IUCN and UNEP/WCMC 2006), and potential Grevy's zebra range and Grevy's zebra numbers (Wargute and Said 1997).

PRESENCE OF GREVY'S ZEBRA
(number observed)

- High (> 300)
- Medium (100 - 300)
- Low (<= 100)

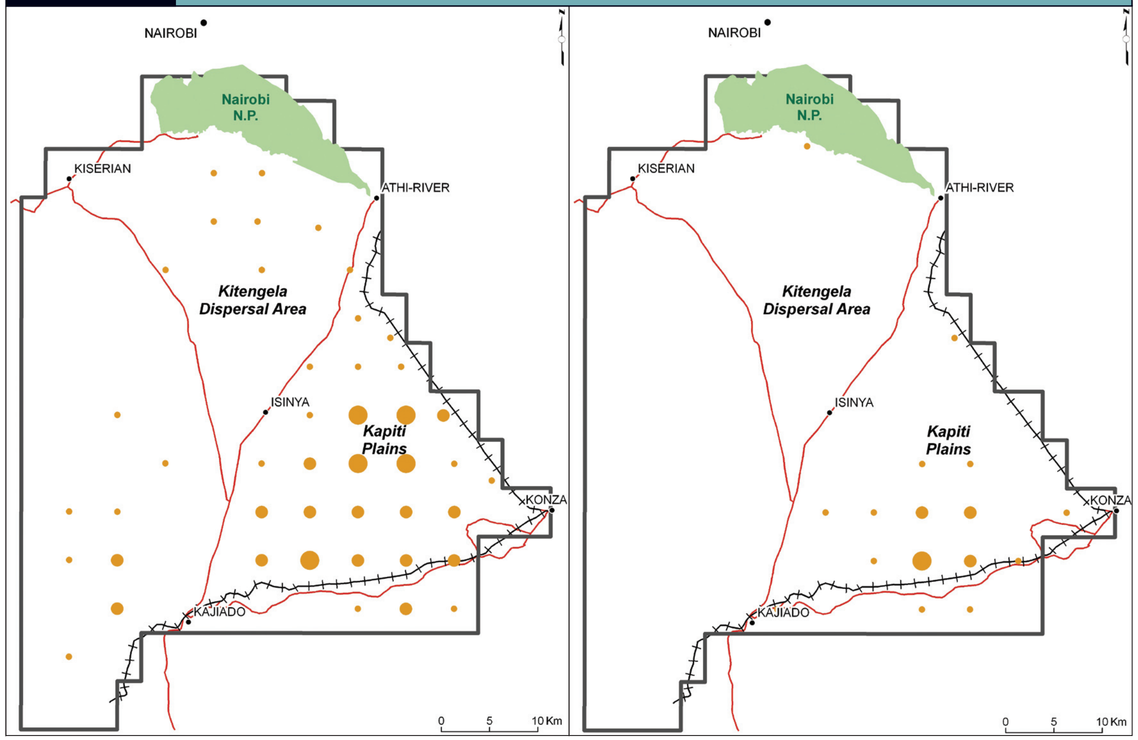
OTHER FEATURES

- District boundaries
- Potential Grevy's zebra range
- National parks and reserves
- Water bodies

Within the potential range of Grevy's zebra (shown as gold-shaded areas), populations of this zebra declined in size and number between the 1970s and the 1990s. Populations also were less evenly dispersed across the entirety of the species' potential range, and were instead being squeezed into a few narrow zones. The most stable population of Grevy's zebra (approximately 1,000 animals) occurs at the southern end of their range using the Buffalo Springs, Samburu, and Shaba National Reserves (Moehlman 2002).

Note: Grevy's zebras observed during low-altitude flights are aggregated to squares of 5 km by 5 km and then represented by a circle proportional to their numbers.

Map 5.15 Spatial Distribution of Wildebeest Population in the Athi-Kapiti Plains, 1977-78 to 1994-96



1977-78 **1994-96**

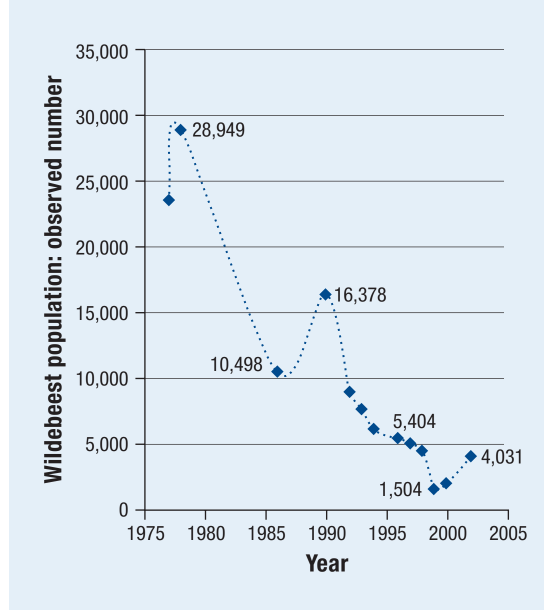
Sources: Towns and market centers (SoK and ILRI 2000), parks and reserves (IUCN and UNEP/WCMC 2006), and presence of wildebeest (Reid et al. 2006, Gichohi 1996).

PRESENCE OF WILDEBEEST
(number observed)
High (> 45)
Medium (15 - 45)
Low (<= 15)
OTHER FEATURES
Study area boundary
Railroads
Roads
National parks and reserves

The number and size of wildebeest populations in the Athi-Kapiti plains south of Nairobi National Park declined sharply between the 1970s and the 1990s. Historically, these plains provided migration corridors and rainy-season grazing grounds for vast herds of wildebeest, but land-use changes and fencing of private lands for domestic livestock ranching now threaten seasonal wildlife movements.

Note: Wildebeest observed during the wet season by low-altitude flights are aggregated to squares of 5 km by 5 km and then represented by a circle proportional to their numbers.

Figure 5.2 Trends in Wildebeest Populations in the Kitengela Dispersal Area, 1977–2002



Source: Reid et al. 2006, Gichohi 1996.

The plight of Grevy's zebra exemplifies the broader problems of wildlife in the northern rangelands, including competition for land and water from humans and their domestic livestock, as well as illegal hunting. These problems also affect other wildlife species in northern rangelands, such as Hunter's hartebeest, lesser kudu, and giraffe (de Leeuw et al. 2001, Adanje and Ottichilo 1999).

Map 5.15 shows the distribution of wildebeest populations in the Athi-Kapiti plains of Kenya's southern rangelands. Historically, wildebeest herds numbering in the tens of thousands migrated through this area of southern Kenya, moving between their dry-season grazing grounds in what is now Nairobi National Park and their wet-season dispersal zone in the Athi-Kapiti plains. In recent years, subdivision of land and erection of fences by private landowners has blocked access to traditional wildlife migration routes and dispersal areas.

Wildebeest and zebras that once migrated without hindrance are finding it increasingly difficult to move between their rainy- and dry-season grazing grounds. As shown by Figure 5.2, wildebeest numbers in the Kitengela pastoral area plummeted from a peak of almost 29,000 in 1978 to just over 1,500 in 1999. Although these populations regained ground to reach more than 4,000 in 2002, managing human-wildlife conflicts in the privately owned lands of the Kitengela plains remains a major challenge (see Box 5.2). Wildebeest and other wildlife sometimes trample fences and crops during their attempts to follow their historical migration routes. Landowners also face hardships due to outbreaks of livestock diseases that are carried by migrating wildlife, as well as loss of livestock to lions and other predators that follow migratory herds out of the park and into private ranchland.

Maintaining viable migration corridors and dispersal areas outside of parks, game reserves, and other protected areas is critical to the future of many of Kenya's migratory species, including much of the wildlife that draws thousands of international visitors each year. Although wildlife numbers appear stable in Amboseli National Park, other parks and reserves, such as Masai Mara and Tsavo, are not faring so well (Hansen et al., submitted). The search for land-use management options and other measures to conserve wildlife while also protecting people, their livelihoods, and their aspirations is an urgent priority.

Box 5.2 **Creating Economic Incentives to Maintain Wildlife Corridors on Private Lands**

One of the biggest challenges facing wildlife conservation in Kenya is how to encourage private landowners to manage rangelands in ways that allow seasonal migration of grazing animals while also providing local income and livelihoods. The presence of wildlife often creates uncompensated financial losses for local people, who share in few if any tourist revenues or other wildlife-related benefits. This need not be the case, however.

The Kitengela Wildlife Conservation Lease Program is demonstrating that appropriate economic incentives can be highly effective in promoting peaceful coexistence of people, livestock, and wildlife. Established in April 2000, the program provides monetary compensation to landowners in the Kitengela area who agree to keep their fallow land unfenced; refrain from cultivating, building on, or selling the designated land; and actively manage their land for wildlife protection and sustainable livestock grazing. At Ksh 725 (about US$ 10.36) per hectare per year, program payments to participating households average Ksh 28,000 (US$ 400) to Ksh 56,000 (US$ 800) annually (Gichohi 2003), a figure close to the income that households earn from rearing livestock. Lease payments are made in three installments at the beginning of each school term to encourage families to use the revenue for school fees, the largest item in the household budgets of many local pastoralists.

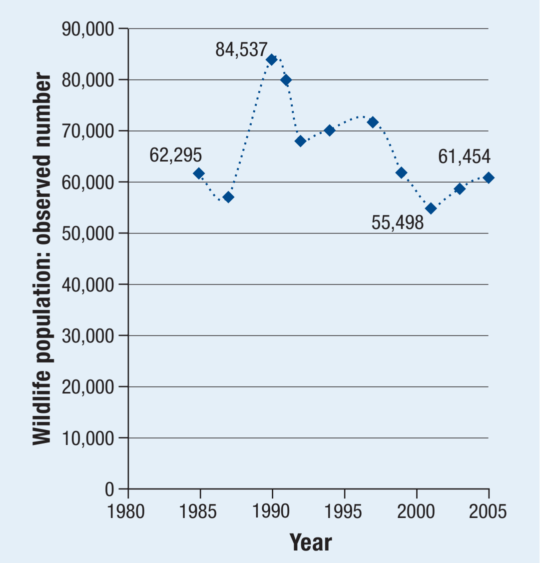
Since the program's inception, the land area covered by conservation leases in the Kitengela has grown from 89 hectares in 2000 to more than 1,120 hectares in 2001 and, by July 2003, to about 3,500 hectares held by 115 participating families. Local landowners offering an additional 5,800 hectares for conservation leasing are waiting to join the program, pending availability of sufficient funding (Gichohi 2003). The program has relied on external funding (The Wildlife Trust, Friends of Nairobi National Park, and the Wildlife Foundation) for its initial phase. Plans are underway to raise US$ 1 million to include an additional 25,000 hectares under the program (Gichohi 2003).

A key element behind the success of the Kitengela conservation leasing program has been the partnership formed between the local community and the International Livestock Research Institute (ILRI). With a long history of custodianship of the wildlife that shares their land, local Maasai pastoralists asked ILRI to help them evaluate the economic returns of various land-use options, including conservation leasing. ILRI's analysis showed that the income available from livestock was low and unreliable, and the returns from cropping were even less profitable. ILRI also made available high-resolution maps of income levels throughout Kenya, helping the local Maasai to evaluate their opportunities in a national context (Dawson 2004).

Empowerment of the local Maasai community to understand their economic options and make informed decisions about their future has thus become one of the most important program outcomes. Moreover, education levels have risen significantly among local children, especially girls (Gichohi 2003)—a critically important development benefit widely considered to be the most powerful means of lifting communities out of extreme poverty.

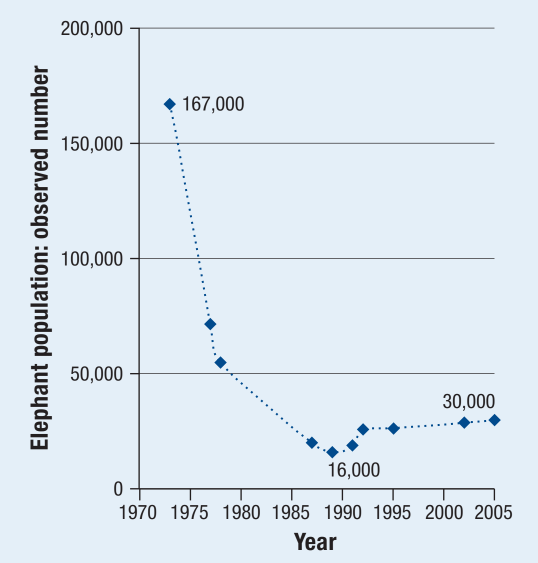
In sum, the Kitengela Wildlife Conservation Lease Program has proved successful in enabling the local community to see wildlife in a more positive light and to share in the economic benefits that wildlife bring to Kenya as a whole. Its long-term sustainability will depend on securing sufficient funding for the cash transfers, particularly in light of rapidly changing land values in such close proximity to Nairobi.

Figure 5.3 **Trends in Total Wildlife Population in Laikipia District, 1985–2005**



Sources: Grunblatt et al. 1995, Georgiadis and Ojwang' 1997, 1999, 2001, Georgiadis et al. 2003.

Figure 5.4 **Trends in Elephant Population, 1973–2005**



Sources: Said et al. 1995, Kenya Wildlife Service (2005 unpublished data).

Wildlife Areas and Species in Recovery

Although overall national trends show declining wildlife populations, not all the news about Kenya's wildlife is bad. As seen earlier in Map 5.12, local gains have been registered in several areas, with the strongest rises in wildlife populations occurring in Laikipia District, as well as in particular areas close to Masai Mara National Reserve and Amboseli National Park. Moreover, in some species, such as elephants and rhinos, the population crashes experienced in the 1980s and 1990s have bottomed out, and steady progress toward recovery has begun.

The factors driving these and other "success stories" vary from place to place and species to species. In general, many different organizations and initiatives play a role—from national-level policies to community-based efforts and changes in local land-use patterns. Success in maintaining Kenya's unique biological endowment demands an understanding of both national-level trends and a more localized, landscape-level perspective.

Figure 5.3 charts the recovery of wildlife populations in Laikipia District. Steady increases have been seen since 2001, following a decade of persistent drought and serious wildlife declines in the 1990s. Although the trend toward decline has been reversed, wildlife have not yet regained the numbers that prevailed prior to the population crashes of the 1990s. For the most part, the conservation efforts under way in Laikipia have been supported by private and communal landowners rather than through initiatives based in national parks or reserves. These landowners, many of which own large ranches, receive significant economic benefits from wildlife, especially through ecotourism, giving them a powerful incentive to preserve wildlife habitat and prevent poaching.

A second wildlife success story is the recovery of elephant populations (see Figure 5.4). Gains in elephant numbers are being recorded in several different parts of the country, including the rangelands north of Mount Kenya in Laikipia and other Districts, as well as southern rangeland areas near Amboseli and Tsavo National Parks. After suffering huge losses from poaching in the 1970s and 1980s, elephant populations have begun to recover, stabilizing in the 28,000-30,000 range. This figure is less than a fifth of the initial 1970s population, but well above the low points of 16,000-20,000 reached in 1987 to 1991. Crucial factors behind the recovery of Kenya's elephant populations have been the anti-poaching and community conservation efforts led by the Kenya Wildlife Service and others, as well as the international ban on trading in ivory and other elephant products.

Box 5.3 Mapping Biodiversity: Links to National Decision-Making

Below are a few of the questions prominent in current biodiversity-related policy debates in Kenya. For each of these questions, we highlight how additional research and geospatial analysis can help inform the policy development process.

- **What is the status of wildlife in Kenya's rangelands?** Spatial data on wildlife status have been collected systematically since 1977, enabling decision-makers to examine not only national trends but also District- and local-level changes in wildlife populations (see, for example, Map 5.12 and Table 5.1). Data can be examined for individual species or for groups of species, such as grazing animals.
- **Where do we target conservation efforts for rangeland species?** Using spatial information on wildlife status, resource planners and communities can decide where and how to target conservation efforts for selected species, such as elephants or Grevy's zebra. Analysts can combine mapped information on species population and distribution (such as Maps 5.13 and 5.14) with other spatial data, for example on cropping or water points, to identify potential conflict areas, such as areas where crops might be vulnerable to damage by wildlife or areas with competing water demands.
- **How are changing patterns of land use affecting rangeland species?** Satellite images, aerial photos, and map products derived from these sources are useful in identifying land cover and land use in a specific location (see, for example, Map 5.5) and detecting changes over time. By combining information on land cover and land use with data on wildlife distribution and migration, analysts can gain insights into the possible causes of changes in wildlife populations. This can inform policy and program responses, such as setting aside specific areas for wildlife-compatible land uses or targeting payment mechanisms to compensate farmers who use their land in ways that maintain wildlife migration corridors, as is now being done in the Kitengela dispersal area south of Nairobi National Park (see Box 5.2). Such maps and analyses would also be useful inputs for national or local land-use planning.
- **What are the tradeoffs or synergies between biodiversity and local farming practices?** Maps that combine spatial information on local agricultural landscapes (such as average field size, extent of interplanting of trees with other crops, and location of remaining fragments of natural habitat) with data on the ranges of wildlife species can help resource planners identify areas of potential importance for biodiversity conservation, even in densely settled, intensively cultivated lands. Armed with this information, decision-makers will be able to develop programs that create appropriate economic incentives for farmers to grow certain tree species, diversify their crops, or leave natural vegetation buffers along water bodies. Much additional research is needed, however, to increase understanding of the precise relationships between farmers' land-use practices, biodiversity conservation, and sustainable flows of ecosystem services.
- **How could local livelihoods be enhanced by changes in the delivery and valuation of ecosystem services such as wildlife, water, or forests?** Maps that compare biodiversity and related ecosystem services to the spatial distribution of livelihoods and poverty can help decision-makers better understand the relationships between poverty and natural resource use. For example, the expansion of cropping into forested or marginal lands often alters hydrological processes in ways that impact the livelihoods of downstream water users. (See maps in Chapter 8 for an illustration of how livestock keepers, wildlife, and protected areas are impacted by upstream development in the upper Tana River region.)

Box 5.4 Creating a Poverty and Demographic Profile for Rangeland Districts with Different Wildlife Densities

Table 5.2 draws on information about the density of wildlife populations in each of Kenya's 24 rangeland Districts and combines it with District-level data on poverty indicators and other demographic features. The wildlife averages rely on counts from low-altitude flights and include 21 different large grazing animals, such as elephants, giraffes, zebras, wildebeest, and impalas. (To permit comparison of animal densities across herds with different species mixes, wildlife counts are converted to a common unit, known as a *tropical livestock unit* (TLU), equivalent to 250 kg of animal weight.)

Using the table, analysts can look for relationships between a District's poverty indicators and the status of its wildlife populations. Districts are grouped according to the average density of their total wildlife populations in the 1990s, enabling comparison of the demographic and poverty characteristics of Districts with high, medium, and low levels of wildlife. For instance, one could examine whether Districts with high densities of wildlife tend to have higher or lower than average poverty rates, or whether Districts with similar wildlife densities have similar poverty rates.

What Does the Poverty Profile Show?

- The six Districts with the highest wildlife densities have a total population of 1.34 million, of whom 668,000 are poor, for a combined poverty rate of 50 percent.
- Meanwhile, the six Districts with the lowest wildlife densities are home to 1.1 million poor people, among a total population of 1.8 million people, making for an aggregate poverty rate of 61 percent. The other 12 Districts with mid-level wildlife densities have comparable high poverty rates. (Tana River is an exception with a poverty rate of 38 percent—CBS (2005) indicates that this rate, however, is associated with a higher standard error and underestimates the poor.)
- Kenya's top five Districts with the highest wildlife densities have lower poverty rates (just slightly better than the national rural average of 53 percent). Community conservation efforts targeting these Districts should recognize that these communities are slightly better off and choose appropriately tailored approaches and communication strategies. Wildlife interventions in the remaining rangeland Districts, however, are facing a double challenge: levels of well-being that are much below Kenya's rural average and fewer total numbers of animal species.
- Among the Districts with the highest wildlife densities, Laikipia and Kajiado Districts have the lowest poverty rates (39 and 44 percent, respectively). All other Districts in this group have poverty rates greater than 50 percent.
- Correlations between poverty rate and wildlife abundance are difficult to interpret and should not be seen as causal. It is important to bear in mind that data on District-wide averages can mask significant spatial variation. For instance, the low average poverty rate for Laikipia District is a composite of poverty rates for many diverse localities, ranging from relatively affluent areas of high rainfall and fertile pastureland near Mount Kenya and the Aberdare Range, to drier, poorer areas in the central and northern parts of the District. Local poverty rates are likely to diverge substantially between these areas, with much higher incidence of poverty in the latter than in the former.

Similar tables could be constructed comparing other wildlife and poverty indicators, including the indicators of human well-being presented in Chapter 2. For example, comparing poverty maps with areas that show changes in wildlife in more specific locations (below District-level) could help to pinpoint which poor communities could still benefit from wildlife viewing as a revenue source and which had foregone that option. Similarly, a profile that combines poverty and species range maps, such as elephants, could examine whether poor communities and their crops share a greater risk of potentially harmful wildlife interactions.

Table 5.2 People, Poverty, and Wildlife Density in the Rangeland Districts

DISTRICT (average wildlife density in *tropical livestock Units* per sq. km)	AREA (SQ. KM)	NUMBER OF PEOPLE (000)	AVERAGE POPULATION DENSITY (PERSON/ SQ. KM)	NUMBER OF POOR (000)	AVERAGE POVERTY RATE (%)	KSH NEEDED PER MONTH TO REACH POVERTY LINE[1] (MILLIONS)
Very High Average Wildlife Density (>1.8 TLU per sq. km)						
Trans Mara (9.41 TLU per sq. km)	2,848	159	55.8	93	59	26.5
Laikipia (9.13 TLU per sq. km)	9,480	246	25.9	97	39	15.6
Narok (7.03 TLU per sq. km)	15,104	325	21.5	168	52	39.5
Kajiado (5.48 TLU per sq. km)	21,905	306	14.0	136	44	27.0
Lamu (5.20 TLU per sq. km)	6,171	107	17.3	56	53	13.2
Taita Taveta (4.35 TLU per sq. km)	17,109	203	11.9	118	58	33.6
TOTAL 6 DISTRICTS	72,617	1,346	18.5	668	50	155.4
High Average Wildlife Density (0.9 – 1.8 TLU per sq. km)						
Tana River[2] (1.44 TLU per sq. km)	38,218	176	4.6	67	38	8.0
Malindi (1.44 TLU per sq. km)	7,754	214	27.6	140	65	43.4
Kwale (1.38 TLU per sq. km)	8,252	420	50.9	264	63	78.5
Samburu (1.24 TLU per sq. km)	21,074	109	5.2	50	46	10.5
Kitui (1.04 TLU per sq. km)	20,451	490	24.0	345	70	124.0
Garissa[2] (1.01 TLU per sq. km)	44,665	193	4.3	123	64	33.5
TOTAL 6 DISTRICTS	140,414	1,602	11.4	989	62	297.9
Medium Wildlife Density (0.4 – 0.9 TLU per sq. km)						
Machakos (0.88 TLU per sq. km)	6,227	810	130.1	485	60	132.2
Wajir[2] (0.71 TLU per sq. km)	56,702	276	4.9	181	65	49.3
Isiolo (0.66 TLU per sq. km)	25,353	67	2.6	35	52	8.2
Marsabit (0.55 TLU per sq. km)	61,426	100	1.6	53	53	12.5
Makueni (0.53 TLU per sq. km)	7,995	728	91.1	454	62	135.0
Moyale (0.49 TLU per sq. km)	9,589	38	4.0	27	71	9.4
TOTAL 6 DISTRICTS	167,292	2,019	12.1	1,235	61	346.6
Low Wildlife Density (< 0.4 TLU per sq. km)						
Mandera[2] (0.22 TLU per sq. km)	25,987	195	7.5	124	64	33.8
Mwingi (0.10 TLU per sq. km)	10,090	289	28.6	181	63	51.6
Turkana (0.07 TLU per sq. km)	68,380	332	4.9	207	62	66.7
Kilifi (0.07 TLU per sq. km)	4,778	462	96.7	332	72	127.5
Baringo (0.05 TLU per sq. km)	8,645	242	28.0	112	46	23.6
West Pokot (0.04 TLU per sq. km)	9,102	288	31.6	151	53	35.5
TOTAL 6 DISTRICTS	126,982	1,808	14.2	1,107	61	338.7
TOTAL 24 DISTRICTS	507,305	6,775	13.4	3,999	59	1,139

Sources: Poverty and demographic estimates (1999) are WRI/ILRI calculation based on CBS 2002, CBS 2003, CBS 2005. Average wildlife density (1994-96) is an ILRI calculation based on DRSRS 2003, Grunblatt et al. 1995, Grunblatt et al. 1996.

Note: [1] The poverty gap measures the average expenditure shortfall (gap) for the poor in a given administrative area relative to the poverty line. It is a crude estimate of the minimum amount of resources needed to eradicate poverty (see Chapter 2).
[2] Poverty data are by Constituency level and have a higher standard error (see Chapter 2).

SUMMING UP

- Biodiversity—the full variety of plants, animals, and microorganisms found on Earth—is the source of many benefits crucial to human well-being. It provides the underlying conditions necessary for the delivery of ecosystem services.
- With over 6,500 plant species, more than 1,000 bird species, and over 350 species of mammals, Kenya is second in Africa in species richness for these species groups. Bushland, woodland, savanna, and grassland ecosystems together cover 75 percent of Kenya. Agro-ecosystems extend over 19 percent of its area.
- Of the 60 Important Bird Areas set up to ensure the survival of local and migratory bird species, half were in decline, about a quarter were improving, and eight were stable, as indicated in a 2003-04 assessment.
- Throughout large parts of Kenya's agroecosystems, farmers' fields are interspersed with patches of forests, woodlands, and other vegetation types. This suggests that farmers could manage their lands in ways that support biodiversity. Average field size, extent of tree cover in croplands, and average number of crops grown represent important components of agrobiodiversity in a landscape. Maps of these three indicators show the following: Throughout central and western Kenya, field sizes are small (less than 2 hectares). Croplands with high levels of tree cover are east of the Aberdares, south of Mount Kenya, as well as in Gucha, Central Kisii, and Nyamira Districts. Kirinyaga, Meru Central, and Gucha are the Districts where farmers grow the greatest number of crops at one time.
- Kenya's rangelands support primarily livestock and grazing mammals such as gazelle, wildebeest, zebras, and other wildlife species—an important source of tourism revenues. In 1994-96, livestock numbers dominated the rangelands, representing about 84 percent of all the grazing animals in Kenya's rangelands.
- The total population of large grazing wildlife species in the rangelands declined by 61 percent between 1977-78 and 1994-96. Central parts of Narok District, areas in northern Kajiado District, locations along the Samburu-Laikipia District border, and parts of Isiolo and Garissa Districts experienced the sharpest declines. Competition for land and water from humans and their livestock, as well as illegal hunting, have been behind these declines. For example, maps of water sources, wildlife, and livestock distribution in the northern rangelands show that livestock near water points is "pushing" wildlife away from water.
- Trends for particular rangeland species parallel these aggregated declines. Grevy's zebra, a species unique in the northern rangelands, numbered less than 2,000 in 2004, down from about 13,000 in 1977. Wildebeest in the Kitengela pastoral area south of Nairobi plummeted from almost 29,000 in 1978 to just over 1,500 in 1999.
- Despite these overall and local declines of large grazing mammals, their densities have increased in some areas between 1977-78 and 1994-96. Such gains were near the Masai Mara Game Reserve and Amboseli National Park, as well as in Lamu and Laikipia Districts. In the latter District, private and communal landowners have been a major contributor to this trend reversal, rather than initiatives based on new government policies.
- After suffering huge losses from poaching in the 1970s and 1980s, elephant populations have begun to recover, stabilizing around 28,000-30,000. Antipoaching and community conservation efforts, as well as the international ban on trading in elephant products, have been the crucial factors behind this recovery.