IN SEARCH OF SOLUTIONS FOR SUSTAINABLE WILDLIFE MANAGEMENT IN KENYA

The Wildlife Researcher

CONTENTS

- Saving the last Great Species and Places on Earth for Humanity 2
- Saving elephants in the face of changing land use in Narok County 4
- The opportunistic Sarcoptes scabiei: First ever case detected in giraffes 7
- New initiatives brighten the future of the large carnivores 9
- New to science, two species of fungi described by KWS scientists 13
- Intelligence bugs on elephants 16
- Kenya Wildlife Service takes lead in creating a road map on access and benefit sharing of biological resources in Kenya 19
- A race against time to save a critically endangered species 21
- Species introduction: The case of Grevy’s zebra in Tsavo ecosystem 24
Saving the last Great Species and Places on Earth for Humanity

Kasiki Samuel, PhD, OGW

Every living thing needs somewhere to live, find food and reproduce - this is known as its habitat. In order for a species to be viable, its habitat must have sufficient space to acquire food, water and a range of necessary physical features. These features can include tree cover, rocky hills or deep pools, as well as other organisms and ecosystems needed to complete a particular species life cycle.

Ecosystems have evolved over several thousands of years towards climax community that may be regarded stable though very dynamic with inherent resilience to natural perturbations (disturbances). Whereas natural perturbations are also responsible for species loss, the principle causative factor is human activities which insidiously result in dramatic changes.

The global human population has just passed the 7 billion mark, which means that conservation problems are bound to intensify. This condition may have significant implications on the fate of species and their habitats - call it biological diversity or biodiversity in short.

Biodiversity is a term used to describe the variety of life on earth. It refers to the wide variety of ecosystems and living organisms: animals, plants, their habitats and their genes. Biodiversity is the foundation of life on earth. It is crucial for the functioning of ecosystems which provide us with products and services without which we couldn’t live. Oxygen, food, fresh water, fertile soil, medicines, shelter, protection from storms and floods, stable climate and recreation all have their source in nature and healthy ecosystems. But biodiversity gives us much more than this. We depend on it for our security and health and it strongly affects our social relations and gives us freedom and choice.

Consequently, conservation is not an option but a necessity to ensure human survival. Indeed, if we are to have a culture as resilient and competent in the face of adversity as it needs to be, then it must somehow involve within itself concern towards biodiversity conservation.

“The more we exploit nature, the more our options are reduced, until we have only one: to fight for survival.” - Morris K. Udall and Stewart L. Udall Foundation

Time has come for concerted efforts towards saving the last great species and places on earth for humanity. The KWS Biodiversity, Research & Monitoring division (BR & M) endeavours to provide scientific information for conservation of our protected areas. Some of these protected areas are globally unique examples of wild species of fauna and flora. For instance, among unique places on earth, Lake Nakuru and Elementaita have earned the status of world heritage sites because of their uniqueness as home to world migratory water birds. On species Kenya hosts an estimated sub-population of the Grevy’s zebra of 2,500, which comprises 95% of the current global population. As such, Kenya has an enormous national and global responsibility to ensure that this species is conserved for posterity.

At KWS, we peer into the future of wildlife conservation and realize that this is the chance we have to be bold and begin the search and use of
innovative ideas and techniques. We are keen in empowering our scientists with novel skills, tools and techniques in the field to enable them predict and test scenarios for future challenges. It is not good enough just to know the species we have, their numbers and distribution but we must also begin to ask questions on the impacts of natural and anthropogenic phenomena such as climate change (e.g. frequency of extreme weather events), competing land uses, habitat fragmentation and transformation, invasive species and pollution on the long term survival of the species and the habitats and ecosystems in which they exist. Such knowledge will inform the formulation of appropriate and effective mitigation measures.

We are convinced that science-based management, and not guesswork, will enable KWS to overcome many of the numerous challenges and secure the future of our free-ranging wildlife. We are committed and passionate to ensuring that we save the last great species and places on earth for humanity as envisioned in our new ambitious, forward looking and proactive corporate strategic plan.

This second issue of *The Wildlife Researcher* e-bulletin is a simplified synopsis of a few of the many BR & M division’s activities and is tailor made to benefit not only park managers and conservation stakeholders but also the general public. We hope that reading this publication will provide a better understanding of the science-driven wildlife management of species and their habitats as a national heritage for posterity.
Human-wildlife conflict (HWC) is one of the main threats to the survival of many wild species in different parts of the world. It is also a major threat to local socio-economic development. It requires an innovative solution for a win-win situation where conservation of wildlife and local community livelihoods are both promoted and complement each other.

Rapid changes in the livelihoods of local communities in Narok County from pastoralism to agricultural land-use practices have worsened the relationship between humans and wildlife. This has led to increased human-elephant conflict (HEC). This is also exacerbated by the increasing human population and concomitant loss of elephant habitat. Unplanned human activities such as crop farming especially large-scale wheat farming, charcoal burning, wood logging and settlements have led to this dramatic loss of wildlife habitat and confinement of elephant populations to smaller pockets of habitat. Approximately 200 animals, considered a sub-population of Masai Mara elephants, inhabit parts of Narok North where they have been in conflict with the local communities.

Incidents of HEC are high in Narok North with frequent crop destruction, human injuries and occasional deaths.
Kenya Wildlife Service has previously tried various intervention measures to resolve HEC in the area albeit with low success. Such interventions include helicopter drives, strategic fencing, moat constructions, education and awareness, mobile problem animal control (PAC) and strategic location of PAC outposts. Ultimately it was resolved that translocation was the most effective and sustainable option for mitigating HEC in the area.

The moving of the elephants was preceded by several pre-translocation activities that included pre-translocation monitoring to identify the target families, community sensitization, and the identification of capture and release sites. The first phase of translocation moved 62 elephants from Siyapei area of Narok North to Masai Mara National Reserve, approximately 150 kilometers away.

Elephant families were identified by scientists using a fixed-wing aircraft. The elephants were immobilised by darting from a helicopter using appropriate dosages of etorphine hydrochloride combined with hyaluronidase. A maximum of five elephants were darted at a time to allow for efficient monitoring, recovery and loading. Immobilized elephants were loaded into recovery trucks using cranes and transported to the loading site. They were then transferred to a conveyor belt from where they were loaded to a transportation truck. Here, the elephants were revived from neurolepto-analgesia by intravenous administration of diprenorphine hydrochloride at a rate of three times the initial dose of etorphine. In addition, a tranquillizer, Azaperone tartrate (60 - 120mg depending on the size of the animal) was administered intramuscularly to keep the elephants calm during transportation. All the translocated elephants were fitted with plastic zip tags on the tails and numbered using a white water-proof paint on the back for post-translocation monitoring.

However for detailed post-translocation monitoring, four elephants, one male and three females named Ole-Nashuu, Olkeri, Marima and Siyapei respectively, were sampled from four groups and fitted with GPS/GSM collars.

The elephants were transported from Siyapei to Masai Mara in crates loaded onto trucks and released at two predetermined sites at Mara Ashnil and Sand River (Fig. 2). These sites were identified based on their close proximity to water points, presence of habitat preferred by elephants, distance from human settlements and good accessibility by the heavy transportation trucks.

![Fig. 2: Elephant capture and release sites](image)
Preliminary monitoring results after the translocation indicate that most of the translocated elephants have settled in both the Masai Mara region and the adjacent Serengeti National Park in Tanzania (Fig. 3). However, a group of 4 males including the collared male Ole-Nashuu returned to their original home. This is a challenge and is attributed to the fact that males are more territorial compared to females. The group of elephants represented by “Marima” is settling in Serengeti NP just a few kilometers from the release site in Masai Mara NR, while the “Siyapei” group moved towards Loita forest near Entasekra. No signal has been received from “Olkeri” but it is believed that they are within the Mara-Serengeti area.

In a community attitude assessment survey regarding this translocation, 64% of the respondents acknowledged that elephant translocation if fully implemented as per the KWS plans would greatly reduce human-elephant conflict in Narok North. A corresponding observation was reflected in school attendance survey where 36.6% of the respondents agreed that freedom of movement had improved; 40% did not agree while 21.6% did not respond.

Indeed as noted, only 4 elephants returned to their original home as compared to the original 62 elephants moved. This situation will improve further when Phase II of the translocation is undertaken to translocate the remaining elephants.

Fig. 3: The current locations of translocated elephants - Marima, Siyapei and Ole Nashuu
The opportunistic *Sarcoptes scabiei*: First ever case detected in giraffes

Gakuya Francis5, Ndeereh David7

The ubiquitous scab mite, *Sarcoptes scabiei*, is an unexplainable emerging and re-emerging ectoparasite, threatening biodiversity and human health. The parasite causes a contagious skin disease known as scabies in humans. It is also one of the causes of mange in more than 100 species of wild and domesticated mammals worldwide.

It is thought that *Sarcoptes* mite originated from a human ancestor and spread to domestic and then free-ranging animals. There have been attempts to understand the molecular epidemiology of *Sarcoptes* mite to differentiate between isolates of *S. scabiei* from different hosts and geographic regions. However, there is still a lot to be understood.

An epidemic can result just from the introduction of a single case of scabies into crowded living conditions. This may cause devastating mortality in wild and domestic animals. Numerous epidemiological studies have been reported from different human, wild and domestic populations. No study has been reported of *S. scabiei* infestations in giraffe.

In July and August 2010, during routine monitoring of the health status of wild animals in Wajir County, decaying carcasses of three sub-adult reticulated giraffes, two females and one male, were found. Besides obvious signs of extreme starvation revealed on post-mortem examination, localized crusted lesions with a mange-like aspect were noted on the lips and the muzzle. It was not desirable to obtain samples from the decayed carcasses. Therefore, extra surveillance was undertaken to identify similar cases in giraffes and other sympatric wild and domestic ruminants from which samples would be obtained for diagnosis.

Five reticulated sub-adult giraffes showing intense itch and overt skin lesions were spotted while apparently none of the other observed species were affected. These giraffes, three females and two males, were captured for sample collection and treatment. The lesions were generalized alopecic areas on the legs, back, shoulders, neck and muzzle (Fig. 4).

![Fig. 4: Photos of decaying carcasses and mange-infested giraffes showing signs of mange-like lesions](image)
Deep skin scrapings were collected from affected skin areas of all giraffes, preserved wet in tap water and subjected to examination for ectoparasites within 48 hours. Several egg shells and mites at the various stages were present in all samples. They could be easily identified as *S. scabiei* on the basis of known morphological criteria.

Even though the reticulated giraffes were in contact with other wild and domestic animals, the other species were apparently not infested. In view of this observation, two hypotheses were considered:

(i) The scabies outbreak is a ‘genuine’ emergence of an infestation which is new to the giraffe population. In this case, other infested domestic and wild animals sharing pastures with the reticulated giraffes are suspected to be the reservoir and source of the mites through cross-infestation. In ruminants, the possibility that mites adapted to a “main” reservoir host may infest other sympatric species has been documented in scabies foci in Europe, and field evidence has been supported by the results of experimental infestations. Though no scabietic ruminants other than giraffes could be observed in this study, scabies is prevalent in goats in the Horn of Africa. In an interview study in Kenya, sarcoptic mange is perceived by herders to have been the most important disease in goats and one with high fatality rates. It was also determined that although the disease has been known in the rural areas for a long period of time, its unusual severity and rapid spread is a recent phenomenon. Under these circumstances, the large availability of moribund or recently dead scabietic goats may have favored transmission of *S. scabiei* to the new host.

(ii) There is pre-existing infestation of *S. scabiei* which becomes apparent probably due to change in environmental conditions. The prevailing weather condition could have resulted in the deterioration of the health of the giraffe population making them susceptible to infestation. Wajir County experiences frequent droughts, and during this occurrence of giraffe infestation, the drought was severe. Wildlife was especially affected, suffering not only from the absence of water resources but also from the competition with the pastoral communities and their livestock. The limited extension and severity of mangy lesions on the carcasses that we found suggests that giraffes did not die because of *Sarcoptes* infestation but rather because of starvation. Hence, “discovering” mange in giraffes was simply the consequence of the unusual availability of carcasses due to other mortality factors, and the increased monitoring that followed. In parallel, it cannot be ruled out that stressful conditions related to malnutrition may have implied immuno-suppression and eventually, the modification of a pre-existing (though putative) host-parasite equilibrium.

All affected giraffes were sub-adults and no cases were reported from adults even though in a normal giraffe population, adults would be more numerous and are certainly in direct contact with sub-adult individuals within the same social groups. Giraffes use olfactory
cues to recognize one another. Adult giraffes especially tend to act curious towards young conspecifics, often approaching, sniffing and nosing them. The absence of overt mangy lesions in adult giraffes spotted in the wild can be attributed to age-related acquired immunity and/or better body condition than sub-adults.

Giraffes of both sexes were affected (three males and five females). Though conscious of the limited sample size, it is noted that in wild ruminants in other outbreak areas, either males were more susceptible to *Sarcoptes* infestation or no sex-related difference was found.

Affected giraffes were given a salvage treatment with 1% subcutaneously injected ivermectin (Kelanectin 1% w/v), at the approximate dose of 300 µg/kg. Affected areas of the skin were also sprayed with a broad spectrum of antibiotics against opportunistic infestations. No more cases were diagnosed in the area in the following ten months, but the number of treated giraffes was too small to justify any beneficial effect of the adopted strategy at the population level.

In this study, *Sarcoptes* mite outbreak in giraffe in the wild is reported for the first time. Prompt detection and treatment of the affected animals was potentially successful in the outbreak control. The presence of parasites in any ecosystem generates complex parasite webs within the system, and it is through these webs that parasites may move from one host to another. More studies are needed to understand the *Sarcoptes* navigating web, including potential molecular analyses of *Sarcoptes* mites from different host species and geographical localities, and the underlying causal factors of its unexplainable emergence and re-emergence, which poses a substantial threat to the conservation of the global biodiversity.

New initiatives brighten the future of the large carnivores

*Musyoki Charles*, *Chege Monica*, *Kuloba Bernard*

Kenya has six species of large carnivores, three in the cat family: lions, leopards, and cheetahs, and three in the dog family: spotted hyenas, striped hyenas, and wild dogs. These are considered threatened in Kenya.

**Lions**

Kenya’s national population of lions (*Panthera leo*) is estimated to be 2,000 individuals. Lions occur in a number of Kenya’s protected areas, with large populations in the Masai Mara and the Tsavo complex. In addition, there are significant lion populations outside protected areas in Laikipia, Kajiado and Narok.

![Fig. 6: Trend in national lion population 2002 - 2010](image)
Cheetahs
The national population of cheetahs (*Acinonyx jubatus*) is estimated to be 1,200 individuals. The cheetah is one of the unique and specialised species of the cat family. It can reach a speed of about 100km/hour making it the fastest creature on land. Until the last three decades, cheetahs were widely distributed in Kenya. However, they have experienced a reduction of their geographic range by 77 percent. Important populations of cheetahs occur in the Tsavo, Mara-Serengeti and Laikipia-Samburu ecosystems.

Striped hyenas
The national population of striped hyenas (*Hyaena hyaena*) in Kenya is estimated at 1,000 individuals. Striped hyenas constitute the least well known of the six large carnivores native to Kenya. Apart from superficial similarities in appearance, striped hyenas differ from spotted hyenas in virtually every aspect of their biology. Although it is often considered a cowardly animal due to its habits of feigning death when attacked, it is known to stand its ground against larger predators such as leopards over food. Unlike the spotted hyena, it’s mainly nocturnal, primarily a scavenger but has also been known to kill its own prey.

Striped hyenas are present in some protected areas in Kenya, including the Tsavos, Samburu National Reserve, and Lake Nakuru National Park. However, a number of striped hyenas have also been sighted outside protected areas, in Kajiado, Laikipia and Samburu, and Lake Turkana region.
Wild dogs
The current national population of wild dogs (*Lycaon pictus*) is estimated at 850 individuals. The species was widely distributed across Kenya but currently occupies about 13% of its former range. The largest populations are in parts of Samburu, Laikipia and Isiolo where they seem to be recolonizing since the 1990s following a period of 15 years of no recorded sighting. Likewise, sighting frequencies in the Tsavo ecosystem have increased relative to those in the early 1990s. Wild dogs are also gradually increasing in number and re-colonizing the Mara-Serengeti ecosystem following a die-off in 1990-1991.

Leopards
Leopards (*Panthera pardus*) remain widespread both inside and outside protected areas, although quantitative data on their numbers and distribution are sparse.

Kenya’s large carnivores have an important function in structuring ecological communities and also play a critical role in Kenya’s tourism industry. However, the populations of these large carnivores have been on the decline in recent years.

The key threats facing large carnivores in Kenya are:

- Habitat loss due to land use changes and human encroachment into areas that were previously occupied exclusively by wild animals. This is having a major impact on the space available for large carnivores.
- Killing of large carnivores as a consequence of predatory attacks on livestock.
- Reduction of prey species.
- Cultural beliefs particularly myths that stigmatise some of the species. Hyenas are portrayed in a negative light in Western art and literature, they are mocked and derided by Hollywood producers, and they are feared and disliked by many African communities. This dark public image currently represents one of the most serious obstacles to the conservation of hyenas.

The decline in large carnivore numbers and distribution has been a major concern to stakeholders in large carnivore conservation. Consequently, KWS is on the forefront in organizing the stakeholders and providing a leadership role towards addressing this problem and providing a roadmap to ensure the future survival of the species. It has initiated the formulation of
conservation strategies through a participatory approach.

This process began with the creation of a national large carnivore task force in the year 2000 to champion the process. The strategies development process put emphasis on ensuring the participation of stakeholders that included wildlife biologists, wildlife managers, local communities, conservation NGOs, IUCN chairs of Cat, Canid and Hyena Specialist Groups, carnivore experts, and others with a professional interest in carnivore conservation. These stakeholders through consultative workshops developed the strategies.

The national carnivore conservation strategies aim to achieve three critical objectives:

1. Achieve viable and functional populations of large carnivores in Kenya
2. Achieve viable and functional populations of prey species
3. Eliminate or at least limit the proportion of livestock killed by large carnivores

Some parts of Kenya can and do support reasonable densities of large carnivores. However, in other areas the presence of large carnivores is incompatible with existing land uses. Given that large carnivores live both inside and outside government designated protected areas, the populations inside protected areas are almost certainly dependent on adjoining unprotected lands for their long-term viability. Hence, conservation activities outside protected areas are absolutely critical if populations are to be conserved, both inside and outside protected areas, in the long term.

In this respect, the strategies that have been proposed are to enhance conservation within and outside protected areas and to particularly manage human-carnivore interactions, local community enterprise development, capacity building in problem animal control, scientific management of the carnivore population and predator-prey dynamics from an ecosystem perspective.

Overall, by carefully examining the needs of each of the species, the strategies seek to implement actions that will go a long way in ensuring that these species are sustainably conserved and managed for the benefit of the people of Kenya and as a world heritage.

---

**STRIPED HYENA FACTS**

- The striped hyenas do not emit whooping calls that the spotted hyenas emit.
- Striped hyenas were once found from Great Britain to China.
- When it becomes excited or feels threatened, the raised hair on the striped hyena’s back makes the animal look much larger.
- More often than not, the striped hyena is nocturnal, foraging alone or with a single companion.
- It has been declared as a ‘Near Threatened’ species and has an average lifespan of 10 to 12 years. However if kept in captivity, it could reach a lifespan of 24 years.
New to science, two species of fungi described by KWS scientists

Mungai Paul, Njogu James

Like the plant and animal kingdoms, fungi constitute another kingdom for living organisms that consists of a large collection of over 100,000 species. In many ways fungi are closer to the animal than to the plant kingdom (a topic for another day). Generally they are found everywhere and are not photosynthetic (they cannot make their own food like plants from soil and sunlight) but are saprophytic (they derive nourishment from decaying organic matter from both animal and plant remains).

Coprophilous (a.k.a. dung fungi) are very fascinating free-living macro- and microscopic organisms that grow on animal dung and whose spores require passing through the digestive tract of an animal (insects, reptiles, fish, mammals and birds) to germinate. Interestingly, their spores are explosively ejected at maturity from their sac-like containers with a force that is thought to be the highest naturally occurring blast. This phenomenon is an adaptation for dispersal (yet another topic for tomorrow).

Coprophilous play an important role in biomass recycling by decomposing organic matter. In their very unique digestive processes, dung fungi produce many metabolites such as enzymes, ethanol, methanol, alkaloids, pigments, toxins among many others. One such very useful fungal metabolite is the life-saving antibiotic, penicillin, from an ascomycete fungus from the genus *Penicillium*. Everyone living today has used this product to treat a variety of bacterial infections at one stage in their lives. We enjoy our beer, wine, cheese, yoghurt and many more fermented foods thanks to fungi. Fungi have a diverse number of genes capable of encoding for far more natural products than they actually produce if subjected to biotechnology. On the flip side, several fungi are known to cause both animal (mycosis) and plant diseases.

Although a lot of organisms have been described in science, there are still new discoveries being made implying that not all organisms are known. Describing an organism is the first step towards its scientific study. This is a very challenging and involving taxonomic task that results in the organism being given a name following an internationally recognized scientific nomenclature system.

New discoveries by Kenyan scientists are indeed a demonstration of the excellent skill and commitment of our staff. In this article we present results of a study that has led to description and naming of two fungi species that hitherto were unknown to science. The study was conducted in Nairobi and Tsavo East National parks in 2010 by a team of KWS scientists. The objective of the study was to characterize and inventory dung fungi in selected parks and reserves and create awareness on the need for their conservation and management.

The study process included an initial collection of dung from the field followed by artificial incubation and isolation of the various fungi at KWS Veterinary Department under appropriate controlled conditions. The study resulted in the isolation of two unknown organisms. The first organism belonging to the genus *Ascobolus* was isolated from rhinoceros dung and named *Ascobolus nairobiensis* after Nairobi National Park where the first individual of this species in the
world was isolated. The second was another unknown organism belonging to the same genus *Ascobolus* isolated from waterbuck dung and named *Ascobolus tsavoensis* after Tsavo National Park where the first individual of this species in the world was isolated.

The discovery of these two species is a great contribution, first to the understanding of the biology of fungi and secondly to the conservation of biodiversity. There still remains more work to understand the habits and roles that these organisms play in the ecosystem.


MycoBank: MB564303

*A microscopic apothecioid fungi isolated, 250-400 micrometres (µm) height and 150-250 µm wide; pale brown to brown or white with a pale brownish base; top surface flat and dotted due to the dark pigmented spores inside the protruding spore sacs (asci). Asci 160-190 × 26-34 µm, each with 8 spores, cylindrical operculum 9.5-13.5 µm diameter, with a stalk 40-60 × 6.5-8 µm. Ascospores 21-26.5 × 12-14 µm, ellipsoidal to narrowly ellipsoid, at first hyaline, then pale violet, finally violet to brown. Gelatinous sheath thick, unilateral.*

**Fig. 12:** *Ascobolus nairobiensis* (KWS NNP014-2010)

*A:* Ascomata on dung

*B-C:* Details of ectal excipulum

*D:* Paraphyses

*E-F:* Asci with ascospores in different stages, note spore arrangement (white and blue arrow)

*G:* Free mature ascospores, note the ornamentation (arrows).

*H:* Apical part of asci, note the opercula (arrows)

*I:* Ascus apex with ascospores, note unilateral gelatinous sheath (arrow)

**Scale bars:** A = 1000 µm, B-C = 20 µm, D-F = 50 µm, G-I = 20 µm

MycoBank: MB564304

A microscopic apothecioid scattered or in groups, superficial on surface of dung 350-400 × 250-300 µm, smooth, whitish. Paraphyses filiform, 2-3 µm diameter, septate, hyaline, containing pale yellow vacuoles, branched at the base, tips not inflated, embedded in pale yellow or colourless mucus. Asci 200-250 × 45-55 µm, 8-spored, clavate-sacciform, with a dome-shaped apex, broad short stalk. Ascospores 26-34 × 15-18 µm, single-celled, ellipsoidal, at first hyaline, maroon or dark violet at maturity, thick coarsely warty, with a unilateral gelatinous sheath.

**Fig. 13: Ascobolus tsavoensis (KWSTE006B-2009).**

A, I: Ascomata on dung.
B: Squashed ascoma.
C: Details of ectal excipulum.
D: Mature Asci with ascospores.
E: Mature ascospores, note thick warts (red arrow).
F: Asci tips showing open (white arrow) and closed operculum (black arrow).
G: Immature ascus, note stipe (yellow arrow).
H: Paraphyses and ascospores.

**Scale bars:** A = 500 µm, B = 200 µm, C = 20 µm, D = 50 µm, E = 20 µm, F = 20 µm, G = 20 µm, H = 20 µm, I = 1000 µm.
Intelligence bugs on elephants

Ngoru Bernard¹³, Nzisa Martha¹⁴ and Gombe Alex¹⁵

Tsavo ecosystem covering about 48,319 km² mostly lowland savanna, hosts the largest contiguous protected area of 23,700 km². This represents 4% of the total land mass in Kenya and 50% of the total protected area.

This protected area is composed of Tsavo East-14,000 km², Tsavo West-7,000 km², Chyulu-700 km² and South kitui-2,000 km². The ecosystem also extends to Tanzania to include Mkomazi National Park. Group ranches, private ranches and human settlements constitute the rest of the ecosystem.

This ecosystem is the haven of elephants in Kenya with about 12,600 individuals as per the February 2011 aerial count. This constitutes 36% of total number of elephants in Kenya. These elephants are traditionally thought to traverse Kilimanjaro in Tanzania, Amboseli in Kajiado County and Shimba hills in Kwale County. They also make seasonal movements within the parks, adjacent community and private ranches. In the process of these movements, they cause insecurity to the residents through human deaths and injuries, and property damage. The elephants also face the danger of either being killed, injured, snared or even poisoned by the local community as they crisscross their farms.

Since the establishment of Tsavo National Park in 1948, the adjacent areas have consistently undergone conversion from natural habitat to human use that includes settlement, farming and even intensive irrigation. These areas served as wildlife dispersal areas and to date wild animals particularly elephants have a propensity to get there, not only for forage and water resources but also for their ranging behaviour. This scenario, over the last two decades has continuously heightened the human-elephant conflict in the Tsavo ecosystem.

Strategies to control human-wildlife conflict include both remedial and preventive measures; that is problem animal control and management of wildlife respectively. In particular, the adoption of electric fencing in human-wildlife conflict hotspots has proven useful as a preventive measure. The oldest fence in the area, Ndii-Ndara fence was erected in 1995 and since then, several other fences have been constructed. Currently there are seven fences (Fig. 14: Bura-Maktau: 31km, Ndii-Ndara: 45km, Athi-Umbi: 71km, Bachuma-Dakota: 45km, Jipe-Rombo: 44km, Mtito-Mang’elele: 10km and Manyanga-Kaunguni: 18km) constructed in the Tsavo Area by Kenya Wildlife Service, local communities and conservation partners. The total distance covered by all fences is 264 km of 1,140 km total perimeter of the entire protected area.

Most of these fences have effectively deterred wildlife especially elephants from raiding crop farms. However, some fences have had challenges especially where wildlife movement patterns have been severely interfered with. The key challenges are breakage of the fences and “funneling effect”. The funneling effect leads to intensification of farm raids in areas where the fences end and hence more cases of human wildlife conflict.
In order to enhance the management of human-wildlife conflict, understanding wildlife movements particularly of elephants is imperative. Monitoring of movements has been made easy by new technology especially GSM/VHF. In Tsavo, a total of 13 elephants are currently being monitored using the GSM/VHF collars which are linked to satellites. These elephants were collared in two phases; a group of 4 in March 2011 and another group of 9 in March 2012. These collars send signals every hour which can be accessed through a computer to obtain spatial-temporal data on the animals. This project is part of the Kenya Wildlife Service (KWS) and International Fund for Animal Welfare (IFAW) elephant movement study project in Tsavo. The main goal is to effectively equip KWS to design intervention measures for human-elephant conflict as well as provide information for security operations in ensuring safety for the elephants.

The data generated is useful in mapping migratory routes, establishing length and width of the elephant corridors, and discerning migratory patterns with respect to forage and water as influenced by weather conditions. The data is also useful in determining time and distances of migrating elephants to and from farms and human settlements. Further, this data is also valuable in understanding the ecosystem, planning human settlement and land use especially in developing community wildlife sanctuaries in the region.

Four sampled elephants named Mackinon female, Mackinon male, Emusaya male and Sala male were collared between the 15th and 16th of March 2011. These samples have provided useful information on movement patterns (Fig.16). The Mackinon female has been utilizing both Tsavo east national park and part of the Taita ranches. Its range extends all the way from north of Aruba up to Kuranze area but most of the time it forages in Taita and Rukinga ranch. Mackinon male has spent almost 100% of its time foraging in the national park and its range extends from the northern areas of Satao camp to Dakota-Kulalu area.
Sala male has spent 100% of its time foraging in the Tsavo east national park and its range extends from the southern area of Emusaya to Sala gate though occasionally it has been in the Dakota-Dika area.

Emusaya male before its death in November 2011 spent time foraging in Emusaya area and occasionally in Galana ranch. Sala female whose collar only worked for two months had its range extending from Kulalu ranch to Sala gate. Data collection is still going on for the active collars.

The data collected from the Mackinon female indicates that the elephant migratory corridor connecting the Tsavo east national park and the ranches lies between the area of Maungu and Bachuma. Although the data shows that elephants might have been using the area east of Bachuma gate en-route to Dakota as their migratory corridor, the Bachuma-Dakota electric fence (Fig. 14) has blocked the route.

From 17th to 24th March 2012, another 9 elephants, adding up to a total of 13 elephants, were collared in different parts of Tsavo. Fig. 17 shows the distribution and movement patterns of the collared elephants in a period of 8 days.

**Fig. 16: Distribution of collared elephants from March 15th 2011 to February 2012**

**Fig. 17: Distribution of the collared elephants from 17th to 24th March 2012**

Within this period, the Kasigau male moved all the way from Kasigau ranch where it was collared, passing...
through the southern area of Kasigau community, Washimbu ranch, Musamiti ranch up to Rukinga and Taita ranches. From Taita ranch, the male moved to Kambanga and Dawida ranch and finally settled in Kuranze region.

Since 20th March 2012, when the Njukini female was collared, it remained in the general area of Njukini within the Mbirikani/Kuku ranches. The Maktau female moved south-west up to the western border of Tsavo west and later moved to the north-eastern area of Jipe. The Sangayaya female spent its time in the southern area of Thabanguji where it was collared. However, it is evident that it moved up to Galana River probably to drink and wallow in the mud. The Jipe male remained in the vicinity of the lake where it was collared. This is probably because of the availability of water in Lake Jipe and the green pasture around the lake. The Kamboyo male equally remained in the southern area of Kamboyo.

The Ndiandaza male was collared around the southern Ndiandaza air strip from where it kept on moving further south up to Emusaya area joining Emusaya male. The ranges of Emusaya and Ndiandaza male have overlapped around the Emusaya region. The Ithumba male was collared south of Ithumba headquarters and it moved further south and settled in the northern area of Thabanguji. The Emusaya male spent time grazing in the southern area of Emusaya region.

The collaring has enhanced the management of elephants in the Tsavo ecosystem by providing near real-time locations of the collared elephants to security patrol teams and park managers on a daily basis. This information has informed the deployment of ranger patrols to address the security and human-elephant conflict. Meanwhile, research to find out the biophysical and anthropogenic factors affecting the distribution and movement patterns of Tsavo elephants is going on and will contribute to an enhanced understanding of the Tsavo elephant.

Kenya Wildlife Service takes lead in creating a road map on access and benefit sharing of biological resources in Kenya

*Kenya Wildlife Service, through a highly participatory process led the country in developing a strategy for bioprospecting within and outside protected areas. Through a series of workshops, expert discussions, and benchmarking missions in different countries of the world, the document which provides guidance for bioprospecting, access and benefit sharing was born. This strategy for bio-prospecting within and outside protected areas was launched on 1st November 2011 by the then Minister for Justice and Constitution Affairs, Hon Mutula Kilonzo. It is envisioned that the strategy will lead to realization of the country’s Vision 2030 on industrialization. The strategy seeks to tap the huge market of bio-prospecting to generate wealth and knowledge for the country.*

Bio-prospecting refers to access, research, discovery, development and the sharing of commercialized biodiversity products and derivatives through a fair and equitable manner between the provider and user.
Bio-prospecting is recognized as a potential avenue for wealth creation and income generation. It can be used as incentive for biodiversity conservation.

Kenya has potential to exploit her biodiversity ranging from microbes to higher plants and animals. The diverse landscape extending from marine to the peak of Mt. Kenya, presents a diversity of habitats such as marine, inland wetlands, fresh and salty water lakes, rivers, volcanoes, hot springs, savannahs, forests, mountains, caves, rangelands and dry lands which are containers for a rich biodiversity.

The valuable biological resources and associated derivatives together with traditional knowledge provide an opportunity for innovative development of products and processes. This bio-prospecting potential is very attractive to many world leading biotechnology companies especially in pharmaceutical and cosmetic industries. Examples include the use of buffalo (*Syncerus caffer*) for the development of vaccines for management of major livestock diseases, the bee venom (*Apis mellifera*) used for the production of analgesics and cancer management drugs, and tsetse repellent derived from Kenyan bushbuck (*Tragelaphus scriptus*). Similarly, Kenyan extremophilic microbes from the soda lakes are the major source of industrial products such as detergents. Finally, Grevy’s zebra (*Equus grevyi*) milk has been patented and commercially used as a biocide. These and many others reveal the potential of the country’s wildlife for bio-prospecting.

The bio-prospecting strategy is very crucial if positive gains are to be made. The strategy provides for the utilization of genetic resources through research and development (R & D). In situations of novel R & D discoveries, products and processes are commercialized. Before collection of any samples from the wild for the R & D, benefit sharing arrangements have to be agreed. Environmental Management and Co-ordination Act (EMCA) 1999 under its subsidiary Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit Sharing Regulations 2006 provides for access and benefit sharing arrangements which include prior informed consent (PIC) and material transfer agreements (MTA).

The main challenge addressed by the strategy is bio-piracy. Bio-piracy is the unethical access to biodiversity and associated knowledge without mutually agreed arrangements on access and benefit sharing. This practice has been widespread at all levels ranging from local, national and global level. Millions of specimens have been accessed from protected areas and deposited in local and international *ex situ* centres without prior permission of resource providers. It is now a requirement for anyone accessing biological resources and associated knowledge to have prior informed consent (PIC), mutually agreed terms (MAT), access permit and material transfer agreements (MTA).

The strategy provides structures and systems to effectively and efficiently manage and regulate bio-prospecting activities in Kenya. These are to be implemented through five strategic objectives as outlined:

1. Enhance institutional capacity and review of statutory and regulatory framework for effective bio-prospecting
2. Develop a central biodiversity database on all taxa and inventory including traditional knowledge associated with bio-prospecting
3. Develop a benefit sharing framework for biodiversity derived products and associated knowledge
4. Enhance information access and develop a communication system
5. Develop a financial and resource mobilization mechanism for bio-prospecting and implementation of the strategy
A race against time to save a critically endangered species

Ndeereh David

The black rhinoceros (*Diceros bicornis*) is critically endangered. Its population has declined by an estimated 97.6% since 1960 reaching a low of 2,410 globally in 1995 mainly as a result of poaching and loss of habitat. By the end of 2010, there were about 4,800 black rhinos in the wild.

There are four subspecies of the black rhinoceros namely *Diceros bicornis bicornis*, *Diceros bicornis longipes*, *Diceros bicornis michaeli* and *Diceros bicornis minor*. The subspecies *Diceros bicornis michaeli* also known as the eastern black rhinoceros has its current stronghold in Kenya which holds approximately 85% of the total wild population. Smaller but growing numbers of this subspecies also occur in northern Tanzania following an introduction from South Africa. Previously, the subspecies occurred in South Sudan, Ethiopia and Somalia through Kenya into northern-central Tanzania and Rwanda but has been extirpated in most of its former ranges. The Kenyan population estimated at 600 individuals is found in private sanctuaries, conservancies and protected areas.

It was a matter of great concern when death of black rhinos was reported in May 2010 at Pyramid Sanctuary within the Ol Jogi conservancy in Laikipia. The conservancy is a fenced area which consists of a fenced sanctuary and a ranch.

Concerted efforts were made to diagnose the problem and institute appropriate disease management strategies. By the time the disease outbreak was contained, nine rhinos had died from what was confirmed to be clostridial enterotoxaemia. Males and females as well as young and old animals were affected in different parts of the sanctuary. Incidentally, there were no mortalities recorded in the ranch.

Affected rhinos presented severe abdominal pain manifested by struggling and rolling on the ground, laboured breathing and death within 3-12 hours after signs of sickness were observed. Post-mortem examination revealed good body conditions with no obvious external lesions. The main gross lesions in all the rhinos that died were in the gastro-intestinal tract (GIT). The small and large intestines were diffusely congested, oedematous and filled with haemorrhagic fluid. The caecum in particular had large oedematus swellings. The mesenteric lymph nodes were enlarged and congested. A tentative diagnosis of clostridial enterotoxaemia, salmonellosis and toxicosis was made based on this picture.

Samples were collected at post mortem and submitted to referral laboratories for confirmatory diagnosis. Sections of the heart, lung, liver, spleen, kidney, small and large intestines, mesenteric lymph nodes and brain were preserved in 10% buffered formalin for histopathological analysis. Intestinal contents from sections of the GIT and tissue samples from the brain, liver and kidneys were also collected in cool boxes with ice packs for bacteriological culture and toxicological analysis. These samples were submitted to the University of Nairobi Veterinary School, the Government Chemist, Onderstepoort Veterinary Institute and IDEXX Laboratories in South Africa as well as the Central Veterinary Research Laboratory (CVRL) in the United Arab Emirates.

Toxicology samples tested negative for commonly used pesticides such as organophosphates, organochlorines,
carbamates and arsenic. Microscopically, the most characteristic lesion was severe necrotising-haemorrhagic enteritis. Numerous gram-positive rod-shaped bacterial colonies characteristic of clostridium species were occasionally seen in the intestinal mucosa. *Clostridium perfringens* type A was isolated from the stomach contents. *C. perfringens* type A was postulated as the aetiological agent.

**Fig. 18 & 19:** Gross pathological changes in a black rhino that died suddenly showing congestion and haemorrhages in the intestines

**Fig. 20:** Gross pathological changes in the caecum of a black rhino that died suddenly, showing oedematous swellings on the mucosa

*Clostridium perfringens* is responsible for different diseases such as gas gangrene, food poisoning and diarrhoea in humans as well as for enterotoxaemia and haemorrhagic gastroenteritis in many domestic and wild animals. The bacterium is ubiquitous in the environment and foods. It forms part of the normal gut flora in man and animals. Enterotoxaemia describes a disease caused by absorption of toxins produced by the growth of *C. perfringens* biotypes. There are five biotypes of the bacteria based on the differential production of these lethal toxins namely A, B, C, D and E. All types of *Clostridial perfringens* cause profound enterotoxaemia with sudden death as the principal manifestation. The disease is rarely reported in free ranging wildlife but is not uncommon in domestic animals that experience sudden change in diet. To our knowledge, this was the first reported case of clostridial enterotoxemia in free ranging wildlife in Kenya.

Being normal GIT flora, the factors that trigger the proliferation of *Clostridium* species leading to the development of the disease are not well understood. Nevertheless, it is presumed that some alteration in the normal GIT environment permits excessive multiplication of the bacteria which produce the toxins capable of causing intestinal damage and systemic effects such as shock. The sanctuary experienced a devastating drought in 2009 which drastically reduced
the populations of grazer species. It was estimated that over 600 Impalas and 400 buffaloes representing over 95% of each of these species died. The sanctuary later received above normal rainfall during the long rains of April 2010 leading to rapid overgrowth of foliage. It is presumed that these changes resulted in unusual amounts of green plants in the digestive system of the rhinos. These highly digestible plants with high amounts of proteins and carbohydrates and little fibre possibly together with other predisposing factors that were not identified played a role in changing the normal gut environment in the rhinos triggering the proliferation of *C. perfringens*.

After the death of the fifth rhino, to avert further losses, the remaining breeding females and one calf were moved from Pyramid Sanctuary to the ranch. This was aimed at reducing exposure of the animals to the yet unknown trigger factors leading to the mortalities. Two calves whose mothers had died were moved to a 1 hectare enclosed boma within Pyramid while two bulls were left on site.

All the 10 animals were covered with an intramuscular injection of the long acting antibiotic Duplocillin LA® consisting of 150,000 IU of Procaine penicillin and 150,000 IU of Benzathine penicillin per ml. Each rhino was also immunized with 5ml of the multivalent bacterin-toxoid ULTRABAC® 7 that contains killed standardized cultures of various *Clostridium* species for protection against different Clostridial infections. Two of the rhinos died soon after these interventions. It was presumed that the two were already affected by the time they were captured and treated and the stress of capture and relocation may have exacerbated the condition.

Vaccination is a common practice in disease management in domestic animals and humans but is rarely used in wildlife. Most vaccines are untested in wildlife and their delivery is beset by logistical, financial and animal welfare considerations. In this case, it was a race against time because the animals at Pyramid sanctuary were at risk of complete extirpation. The animals were thereafter monitored closely to assess response to the treatment. These management interventions successfully arrested further mortalities.
Species introduction: The case of Grevy’s zebra in Tsavo ecosystem

Nguru Bernard

Although Grevy’s zebra (Equus grevyi) are found mainly in Kenya and Ethiopia with 95% (2,375) of the global population being in Kenya, historically, Grevy’s zebras are not known to live south of the equator. The south-most population well known to many in Kenya is the Laikipia population which lives near the equator. However, in 1964, the first group of 22 Grevy’s zebra was translocated from Isiolo, in Samburu district to Aruba area in Tsavo East National Park. In 1977 another group of 30 individuals was translocated from the same place in Samburu to the north western side of Tsavo West National Park (Fig. 22). This is the only Grevy’s zebra population that occurs south of the equator and it is estimated to be 50 individuals.

Recent aerial censuses of large mammals in the Tsavo ecosystem counted several Grevy’s zebra. In 2008, 11 Grevy’s zebra were recorded with 9 individuals in Tsavo east south of Galana River, one individual north of Galana and one individual in Taita ranches. During the 2011 aerial censuses of large mammals, 47 Grevy’s zebra were recorded with 29 in the Tsavo east north of Galana, 3 south of Galana and 15 in Taita ranches (Fig. 22). Although in 1977 30 individuals were introduced in Tsavo West, none was sighted in this area during the two censuses.
In 2010, just before the aerial count, Alex Mwanzo, an MSc student at Kenyatta University, undertook a MSc study on the populations in Tsavo East & adjacent ranches titled ‘Distribution and Habitat association of Grevy’s zebra in south-eastern Kenya’. The study observed an interesting distribution almost similar to the 2011 aerial census. A total of 50 Grevy’s were counted with 95% of the sightings made outside the park in Taita Ranch, Rukinga and Kenya Meat Commission (KMC) Ranching Company land. Four groups were observed with 16 individuals in Taita ranch, 12 individuals in KMC ranch, 14 individuals in Tsavo East South of Galana River and 8 individuals in Rukinga ranch.

All the sighted animals looked healthy. However, one suspected hybrid with common zebra was observed. This is not unique to Tsavo as similar hybrids have been observed in Ol Pejeta conservancy. This study did not record any sighting of the species in Tsavo West although in a 2008 on-ground survey, sighting was made of one adult male in a herd of common zebras.

The main objective of introducing the Grevy’s zebra in the Tsavo ecosystem was to enhance their conservation and management. The species has undergone a significant decline in numbers from an estimated 15,000 individuals in the late 1970s to a present-day estimate of 2,500 individuals distributed north of the equator.

Introduction was expected to enhance not only their numbers but also their distribution. This translocation was intended to move the species from insecure community land by then in Samburu, due to rampant poaching in unprotected areas.

Incidentally, though introduced inside the park, most of them as the censuses indicate have dispersed outside the protected area into community land where bush meat, poaching, charcoal burning and competition with livestock for resources such as water and grass is a major threat to the species.

Since most Grevy’s zebra reside outside protected areas, it is imperative that local communities living within the area are involved actively in the management of the species. To achieve this, KWS hopes to engage them through education and awareness programs, research and monitoring activities, community policing and eco-tourism initiatives. This initiative is well-captured in the Grevy’s zebra conservation strategy. However, it is scientifically imperative to investigate habitat preferences for the Grevy’s zebra within the Tsavo ecosystem. This would further advise management options for maintaining population within the protected area.

Hybridization between the common zebra (Equus burchelli) and the Grevy’s zebra has been an issue of concern to the management. Quite often ‘hybridization’ involves the mating of a male Grevy’s zebra with a female common zebra to produce a morphologically superior animal than both parents. The question of why it is not the reverse may be explained by the differences in mating behavior and size differences between the two species where the Grevy’s zebra is larger than the Burchell’s zebra. The occurrence of this phenomenon in Tsavo is confirmed as several individuals...
have been spotted. This triggers off thoughts of Darwin’s ‘survival of the fittest’ perspective on the evolution of species. However, the viability of the offspring is a question of discussion. Further, how these hybrids associate with either of the two species is an issue of behavioural study. In view of their morphological superiority, they may dominate in groups of both species.

In view of the various censuses, population estimates in Tsavo ecosystem appear to have decreased from the introduced total of 52 to the highest estimate of 50 individuals. Although the censuses may not be definite, any other probable inference would be that there is no increase in numbers. It is in this context that the current Tsavo management plan considers the population as ecologically not viable. The plan proposes establishment and maintenance of a viable population firstly by undertaking a comprehensive population and genetics study, and secondly by establishment of a Grevy’s zebra site committee in Tsavo. These would provide management options to ensure continued survival of the Grevy’s zebras without compromising the ecological integrity of the Burchell’s zebra.
CONTRIBUTORS

1. Kasiki Samuel: Deputy Director, Biodiversity, Research & Monitoring Division
2. Mijele Dominic: Veterinary Officer, Masai Mara Research Station
3. Kiambi Sospeter: Assistant Research Scientist, Masai Mara Research Station
5. Gakuya Francis: Principal Scientist, Veterinary and Capture Services
6. Omondi Patrick: Principal Scientist, Species Conservation & Management
7. Ndeereh David: Senior Veterinary Officer, Veterinary and Capture Services
8. Musyoki Charles: Senior Scientist, Species Conservation & Management
9. Chege Monica: Assistant Research Scientist, Conventions & Research Authorization
11. Mungai Paul: Senior Technologist, Ecological Monitoring & Biodiversity Valuation
12. Njogu James: Principal Scientist, Conventions and Research Authorization
13. Ngoru Bernard: Senior Scientist, Tsavo Conservation Area
14. Nzisa Martha: Research Scientist, Tsavo Conservation Area
15. Gombe Alex: Research Assistant, Tsavo IFAW-KWS Project
16. Mukonyi Kavaka: Senior Scientist, Ecological Monitoring & Biodiversity Valuation
17. Mutungi Priscilla: Research Scientist, Ecological Monitoring & Biodiversity Valuation
18. Mbaka Raymond: Technologist, Ecological Monitoring & Biodiversity Valuation