TAWIRI Newsletter

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REGROW PROJECT

Detections of Wildlife Species Using Camera Traps and Machine Learning

Special Issue

IN THIS ISSUE

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Message From the Director General

Dear Colleagues

As we continue with our efforts to better understand and conserve our planet's wildlife, I am pleased to report that our inventory project using camera traps has been progressing well. Through the dedication and hard work of our research team, we have been able to deploy a large number of camera traps in key wildlife habitats across the Udzungwa Mountains and Mikumi National Parks.

These cameras have been capturing a wealth of valuable data on the species distribution, behavior, and demographic characteristics. So far, we have identified a wide variety of wildlife using the cameras, including large mammals such as elephants, buffalos, lions, leopards, as well as medium large mammals like duikers, bushbuck, honey badger, and squirrels. We have even captured footage of some elusive and rarely-seen species, like Abbot's duiker.

As we continue to collect and analyze this data, we will be able to gain a much better understanding of the ecology and conservation needs of these species. We hope that this project will help inform future conservation efforts and aid in the protection of wildlife and their habitats.

I would like to extend my sincere thanks to everyone involved in this project, including our research team, volunteers, and partners. Big thanks to the Ministry of Natural Resources and Tourism for the financial support via theResilient Natural Resource Management for Tourism and Growth (REGROW) project, and we value the World Bank's technical assistance before and during project implementation.

Your hard work and dedication are greatly appreciated, and I look forward to sharing more updates on our progress in the coming days.

Dr. Eblate Mjingo

Director General

Tanzania Wildlife Research Institute

Message From the Director of Research

Dear Wildlife Enthusiasts,

I am excited to share preliminary results from our recent camera trap-based survey. This survey has provided us with valuable data on the biodiversity of the area, for improving tourism and update various stakeholders.

By analyzing the data from the camera traps, we identified a wide range of wildlife species, including several rare and endangered species. This information is vital for developing sustainable tourism practices that highlight the unique wildlife in the area. Data collected can be used to design appropriate tourism circuits in protected areas.

In addition, these preliminary inventory results can be used to update stakeholders, including policy makers, land managers, and conservationists, about the status of wildlife populations and their habiats.

This information is critical for making informed decisions about wildlife conservation and management. Furthermore, the data from the camera traps can provide essential insights into illegal wildlife activities, such as poaching.

This information can be shared with law enforcement agencies to aid in the protection of wildlife. As a wildlife research organization, we are committed to sharing our findings with others and working collaboratively to ensure that our natural resources are protected and managed sustainably. We can create a better future for wildlife and people using the preliminary inventory results from our camera trap survey.

Thank you for your continued support of our work.

Sincerely,

Dr. Julius Keyyu

Director of Wildlife Research,

Tanzania Wildlife Research Institute

Message From the Project Focal Person

We are delighted to present the Second Special Issue of the TAWIRI newsletter, under the REGROW Research Project. In the REGROW project, we aim to provide reliable data and recommend feasible conservation approaches that are effective and efficient. Camera traps and Machine Learning can improve our technological approaches to wildlife research.

Camera traps are probably 31% more effective than other methods at detecting many species, whereas the use of Machine Learning increases the detection of species by approximately 91% more than other methods. As cameras are an "open" trap throughout the day and night, it is likely the most important factor that makes camera trapping a highly efficient method.

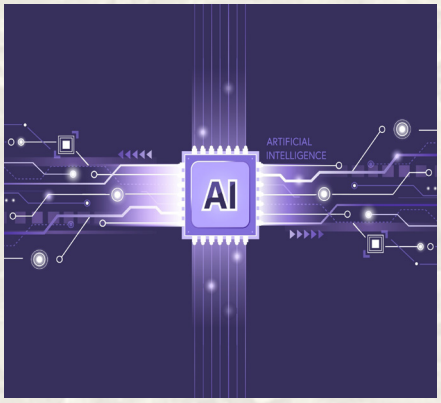
In this issue, we emphasize the use of these methods in species inventory and to overcome the challenges from other known approaches. However, challenges are inevitable in endeavoring the work.

We hope that mainstreaming camera trapping and machine learning technology in conservation plans will be a priory by conservation authorities.

Dr. Bukombe John Kija

TAWIRI-REGROW Focal Person

Tanzania Wildlife Research Institute



Backround Information

The Issue Behind the Story

Wildlife inventories play a crucial role in conservation efforts, providing valuable information about various species' population dynamics, distribution, and behavior. Traditional methods of wildlife inventories, such as direct observations and manual surveys, have limitations regarding accuracy and efficiency.

Recent advancements in technology, specifically the use of camera traps, machine learning, and artificial intelligence (AI), have revolutionized the field of wildlife inventories. This Newslette Summarizes the potential of maximizing detections in wildlife inventories by integrating camera traps, Machine Lerning and AI, highlighting their benefits, challenges, and prospects.

The camera-trap based inventory conducted by TAWIRI aimed at evaluating the occurence and composition of large and medium-sized terrestrial mammals in the Udzungwa Mountains and Mikumi National Parks. The study was conducted to extend the work of several conservation agencies in the area aimed at understanding the distribution of large and medium-sized terrestrial mammals in the areas.

Benefits of Camera Traps

Camera traps have become an essential tool in wildlife inventory and monitoring due to their many bene- fits. Some of the major benefits of using camera traps include:

Non-intrusive monitoring: Camera traps allow wildlife to be monitored without direct human contact, reducing disturbance to animals and minimizing the risk of human-wildlife conflict.

Cost-effective: Camera traps are relatively inexpensive compared to traditional methods of wildlife monitoring, suchasdirect observation or radio telemetry.

Wide coverage: Camera traps can cover large areas of habitat and can be left in place for extended periods of time, allowing for long-term moni- toring of wildlife populations.

Accurate data collection: Camera traps provide accurate and reliable data on animal presence, behavior, and abundance, which can be used to inform conservation and management decisions.

Safety: Camera traps can also improve safe- ty for researchers and wildlife managers by reducing the need for direct human contact with potentially dangerous animals.

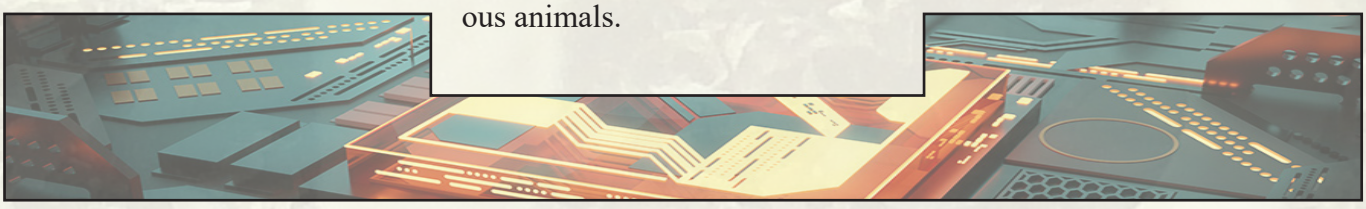
The Role of Machine Learning

Machine learning algorithms, has the potential to enhance the efficiency and accuracy of wildlife inventories by automating the process of image analysis. Traditional methods of analyzing camera trap data involve manual review and species identification.

This approach is time-consuming, subjective, and prone to human error. By contrast, AI algorithms can be trained to identify and classify species automatically based on large datasets of labeled images. This saves time and effort and reduces the subjectivity in species identification.

Tools Used

In this Newsletter we used Machine Lerning Technology to extract information from photographs obtained by camera traps to determine Wildlife Species existing in Udzungwa Mountains and Mikumi National Parks. We used the MegaDetector (Beery, Morris et al. 2019, Fennell, Beirne et al. 2022) and Wildlife Insight (Ahumada, Fegraus et al. 2020) tools in Machine Learning for data processing and species identification, respectively.



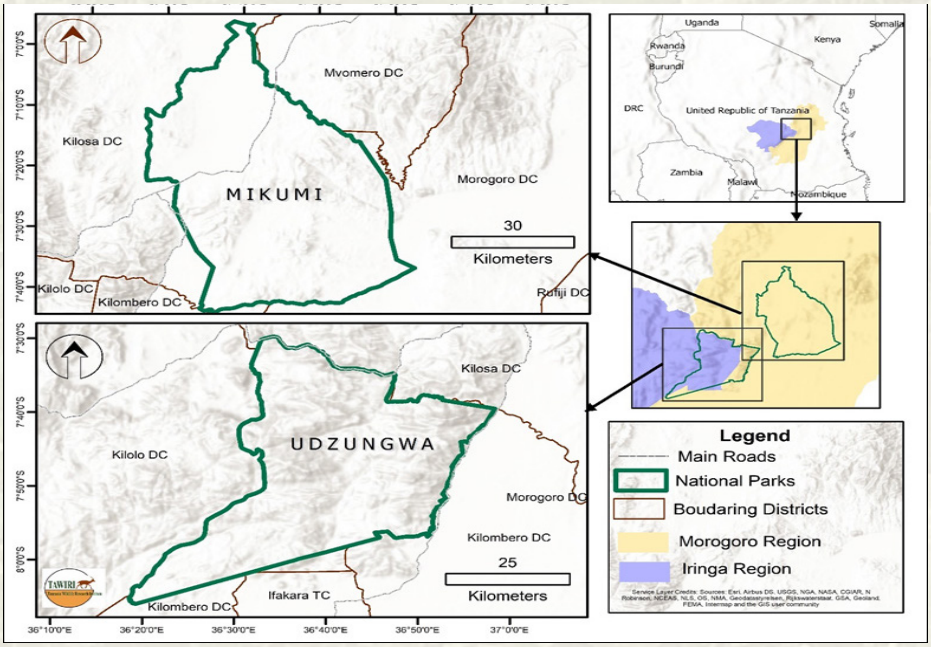
Surveyed Areas

This survey was conducted in the Mikumi National Park (MINAPA) and Udzungwa Mountains National Park (UMNP).

MINAPA covers an area of approximately 3,230 square kilometers and is a home to various wildlife, including elephants, giraffes, zebras, buffaloes, primates, and numerous species of birds and predators. The park is known for its diverse and abundant wildlife and stunning landscapes, including evergreen forests, savannas, woodlands, and wetlands.

On the other hand, UMNP is situated in the Morogoro and Iringa regions and covers an area of approximately 1,990 square kilometers. UMNP is known for its mountainous terrain, which includes a range of peaks that rise to 2,576 meters above sea level. The park is home to various wildlife, including elephants, buffaloes, and numerous species of primates, such as bush babies, galago, and colobus monkeys.

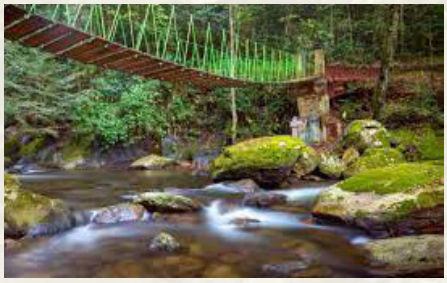
Cameras were placed at opportunistic locations that appeared promising for capturing photographs of terrestrial wildlife in the study area. It includes areas where indirect clues and evidence of animal activity are evident, such as game trails, tracks, and signs of wildlife. We analyzed all of the recorded images using Wildlife Insights Platform after separating images with blank and animals by using MegaDetector software.



Tourist Atraction in Udzungwa National Park

Water Falls

Swimming



Hiking

Tourist Atraction in Mikumi National Park

Game Drive

Walking Safaris

Night Game Drive

Species Distribution in Relation to Protected Area

In this study, we captured a total of 7,424 images and when we reviewed them, we identified two classes of animals (Mammalia and Aves). From the observed classes we found six orders of Mammalia, and three of Aves.

The total number of species that were identified from all images were 32, and most of them were from the order Cetartiodactyla which includes animals such as Bushbuck, Buffalo, Dikers, and others.

In the case of the number of species per location, UMNP had a total of 29 species while MNP had only 27.

A total of eight species were only found in the UMNP and not in the MINAPA, including Von der Decken's Hornbill, Caracal Species, Servaline Genet, Abbott's Duiker, Guereza, Sanje River Mangabey, Gambian Rat and Svynnerton's Bush Squirrel.

Similarly, a some of the species that were only found in the MINAPA and not in UMNP are Lion and Buffalo.

Frequently Detected Species


Bushbuck


Harvey's Duiker


Bushpig

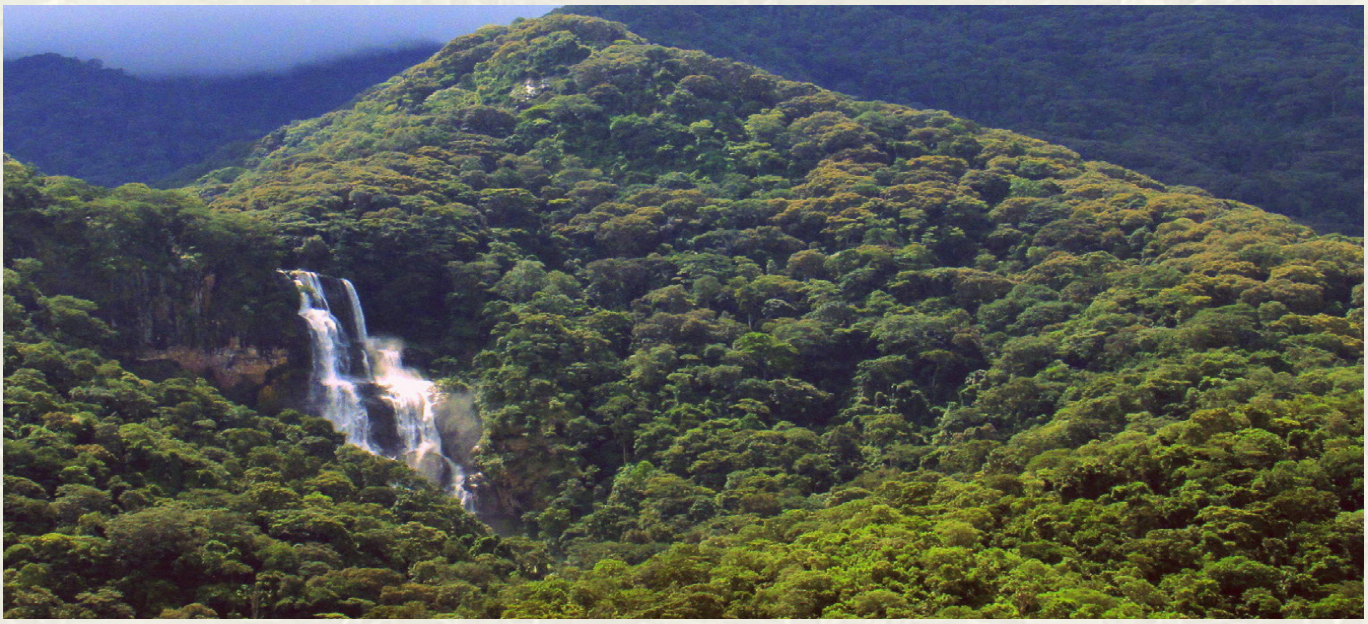

Common Warthog


Kudu


Baboon

Animal Observed	Mikumi NP	Udzungwa NP
Birds		
Von der Decken's Hornbill		√
Mourning Dove	√	
Eastern Crested Guineafowl	√	√
Carnivora		
African Civet	√	√
Bushy-tailed Mongoose	√	√
Caracal Species		√
Honey Badger	√	√
Leopard	√	√
Lion	√	
Spotted Hyaena	√	√
Herbivores/Ungulate		
Abbott's Duiker		√
African Buffalo	√	
African Elephant	√	√
Bushbuck	√	√
Bushpig	√	√
Common Duiker	√	
Common Warthog	√	√
Greater Kudu	√	√
Harvey's Duiker	√	√
Kirk's Dik-dik	√	√
Lesser Kudu	√	
Primates		
Blue Monkey	√	√
Guereza		√
Sanje River Mangabey		√
Vervet Monkey	√	√
Yellow Baboon	√	√
Rodentia		
Crested Porcupine	√	√
Gambian Rat		√
Svynnerton's Bush Squirrel		√
Omnivore		
Aardvark	√	√
Common Genet	√	√

Species Distribution in Relation to Elevation



The survey was conducted at elevations ranging from 400 to 1,830 meters above sea level. In general, most species were captured between 801 and 1,200 meters, while fewer were captured between 401 and 800 meters.

There are several factors that may explain these results, including species adaptation and seasonality factors, and the number of camera traps deployed at a particular elevation range.

To conclude the validity of the observed results, a detailed analysis of the acquired data is necessary.

Elevation Ranges	Total	Percent
400-600	55	0.74
601-800	210	2.83
801-1000	4407	59.36
1001-1200	2124	28.61
1201-1400	142	1.91
1801-2000	486	6.55
Total	**7424**	**100.00**

Variation of Duikers Species Count Based on Elevation

In this study, we identified a total of 32 species including three species of Duikers which are Abbott's Duiker (spadix), Common Duiker (grimmia), and Harvey's Duiker (harveyi).

Regarding the number of observations of the observed Duiker Species per species, Harvey's Duiker dominates, followed by Common Duiker.

In the case of Duiker's Species distribution with elevation, our study showed a clear distinction between the distribution of these three species during our survey period. Abbort's Duiker occupies only areas between 800 and 2,000 meters, while Common Duiker is only found from 800 to 1,000 meters.

As for Harvey's Duikers, our study shows they were seen from 400 meters to 2,000 meters and is most dominant between 800 and 1,200 meters and less between 400 and 600 meters.

The difference in the number of observations of these three-duiker species may suggest different adaptation factors between them, but these differences are not conclusive

Harvey's Duiker

Abbott's Duiker

Species Distribution in Relation to Vegetation Cover Types

Vegetation cover plays a crucial role in shaping the distribution and abundance of wildlife species. For example, forested areas provide ideal habitats for species such as primates, squirrels, and many species of birds, while grasslands are more suitable for grazing herbivores.

Changes in vegetation cover can also have a significant impact on wildlife populations. Deforestation, for example, can lead to the loss of habitat for many species, as well as disrupt important ecological processes such as nutrient cycling and water regulation. Conversely, reforestation efforts can help to restore habitats and improve conditions for wildlife.

Overall, understanding the relationship between vegetation cover and wildlife distribution is important for conservation efforts and land management decisions. By protecting and preserving natural habitats, we can help to ensure the survival of many species and maintain healthy ecosystems.

A total of four vegetation types were considered in this study, including closed and open woodland, forests, and shrublands. The general character of closed woodland was areas with 15-70 % trees on the top layer and shrubs and grassland on the second layer, with almost all broadleaf trees remaining green all year.

The top layer of open woodland consists of trees 15 to 70% and the second layer consists of shrubs and grasses with an annual cycle of leaf-on and leaf-off periods. Forest areas were considered to have a canopy of trees of more than 70%, and broadleaf trees that stay green all year long.

Lastly, for shrubland, these were areas with woody perennial plants with persistent and woody stems and no defined main stem. These plants were less than 5 m tall, and the foliage was evergreen or deciduous.

Among all vegetation cover types, open woodland had the most species. In other studies, it has been found that this type of vegetation cover tends to have more wildlife species than other types of vegetation covers for several reasons, including Abundance of food (for example grasses, shrubs, and trees), Access to water, Shelter and hiding places, and Ecotones (commonly found near the edges of other types of vegetation, they offer a transitional habitat in which both adjacent vegetation types can thrive).

Row Labels	Mikumi	Udzungwa	Total
Closed woodland	1470	218	1688
Forest	1231	925	2156
Open Woodland	0	3207	3207
Shrubland	373		373
Total	**3074**	**4350**	**7424**


Blue Monkey


Buffalos

Species Endemism and Global Conservation Status

Species endemism refers to the phenomenon where a particular species of plant or animal is found exclusively within a specific geographic location or region, and nowhere else in the world.

The status of wildlife species can vary depending on factors such as their population size, distribution, and level of threat from human activities. The IUCN is a widely recognized organization that assesses the conservation status of wildlife species and publishes a Red List of Threatened Species.

The IUCN Red List categorizes species into nine categories based on their risk of extinction. These categories are: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD), and Not Evaluated (NE).

Species listed as threatened or endangered may receive greater protection under laws and regulations. They may be the focus of conservation efforts such as habitat restoration, captive breeding programs, and public education campaigns.


Abbott's Duiker (EN)

Endemic Species

Generally, we identified only one Endemic species in our survey, known as Sanje River Mangabey and, Scientifically, as Cercocebus sanjei. It is a species of Old-World monkey found in Tanzania, specifically in the Udzungwa Mountains. Unlike other mangabey species, Sanje River Mangabeys have a distinctive white crest on their forehead and a long tail.

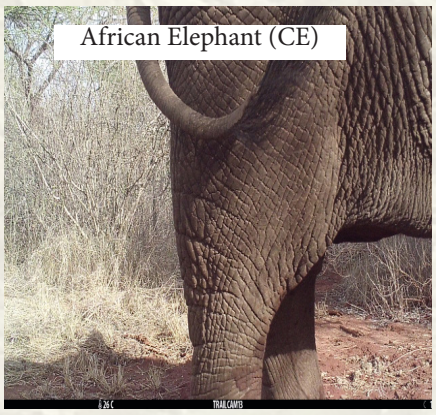
Sanje River Mangabeys are social animals that live in groups of up to 30 individuals, with a dominant male leading the group. These monkeys are diurnal and are most active during the day. They are omnivorous and feed on various fruits, leaves, flowers, insects, and small animals such as birds and lizards. Overall, Sanje River Mangabeys are intelligent, social, and adaptable animals that play an essential role in the ecosystem of their habitat.

Endangered and Criticaly Endangered Species

Two species in this study have been listed as Endangered by the IUCN, and one that has been listed as Critically Endangered by the IUCN. Abbot's Duiker and Sanje River Mangabey is the Endangered Species, while African Elephants are Critically Endangered.


Lion (VU)


Sanje River Mangabey (EN)


African Elephant (CE)

Global Species Status

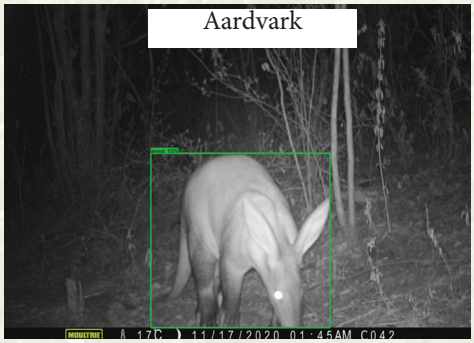
Least Concern

Near Threated

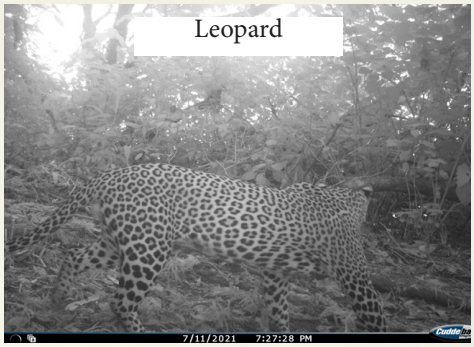
Vulnerable

Endangered

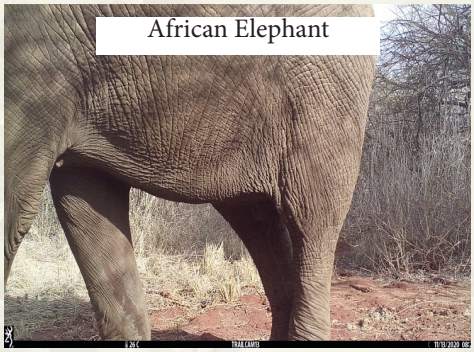
Critically Endangered


Aardvark


Buffalo


Leopard


Sanje River Mangabey


African Elephant

Animal Observed	IUCN Status
Birds	
Von der Decken's Hombill	Least Concerned
Mourning Dove	Least Concerned
Eastern Crested Guinea fowl	Least Concerned
Carnivores	
African Civet	Least Concerned
Bushy-tailed Mongoose	Least Concerned
Caracal Species	Least Concerned
Honey Badger	Least Concerned
Leopard	Vulnerable
Lion	Vulnerable
Spotted Hyaena	Least Concerned
Herbivores/Ungulate	
Abbott's Duiker	Endangered
African Buffalo	Near Threatened
African Elephant	Critically Endangered
Bushbuck	Least Concerned
Bushpig	Least Concerned
Common Duiker	Least Concerned
Common Warthog	Least Concerned
Greater Kudu	Least Concerned
Harvey's Duiker	Least Concerned
Kirk's Dik-dik	Least Concerned
Lesser Kudu	Near Threatened
Primates	
Blue Monkey	Least Concerned
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Vervet Monkey	Least Concerned
Yellow Baboon	Least Concerned
Rodentia	
Crested Porcupine	Least Concerned
Gambian Rat	Least Concerned
Svynnerton's Bush Squirrel	Least Concerned
Omnivore	
Aardvark	Least Concerned
Common Genet	Least Concerned
Servaline Genet	Least Concerned

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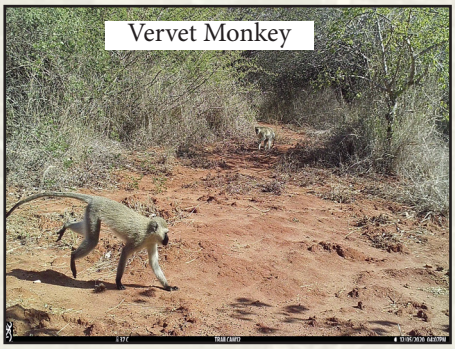
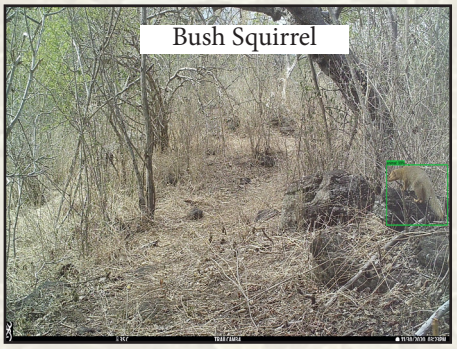
Observed Species Images

Observed Species Images





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