



Ministry of Tourism
and Wildlife



National Recovery and Action Plan for the Mountain Bongo (*Tragelaphus eurycerus isaaci*) in Kenya

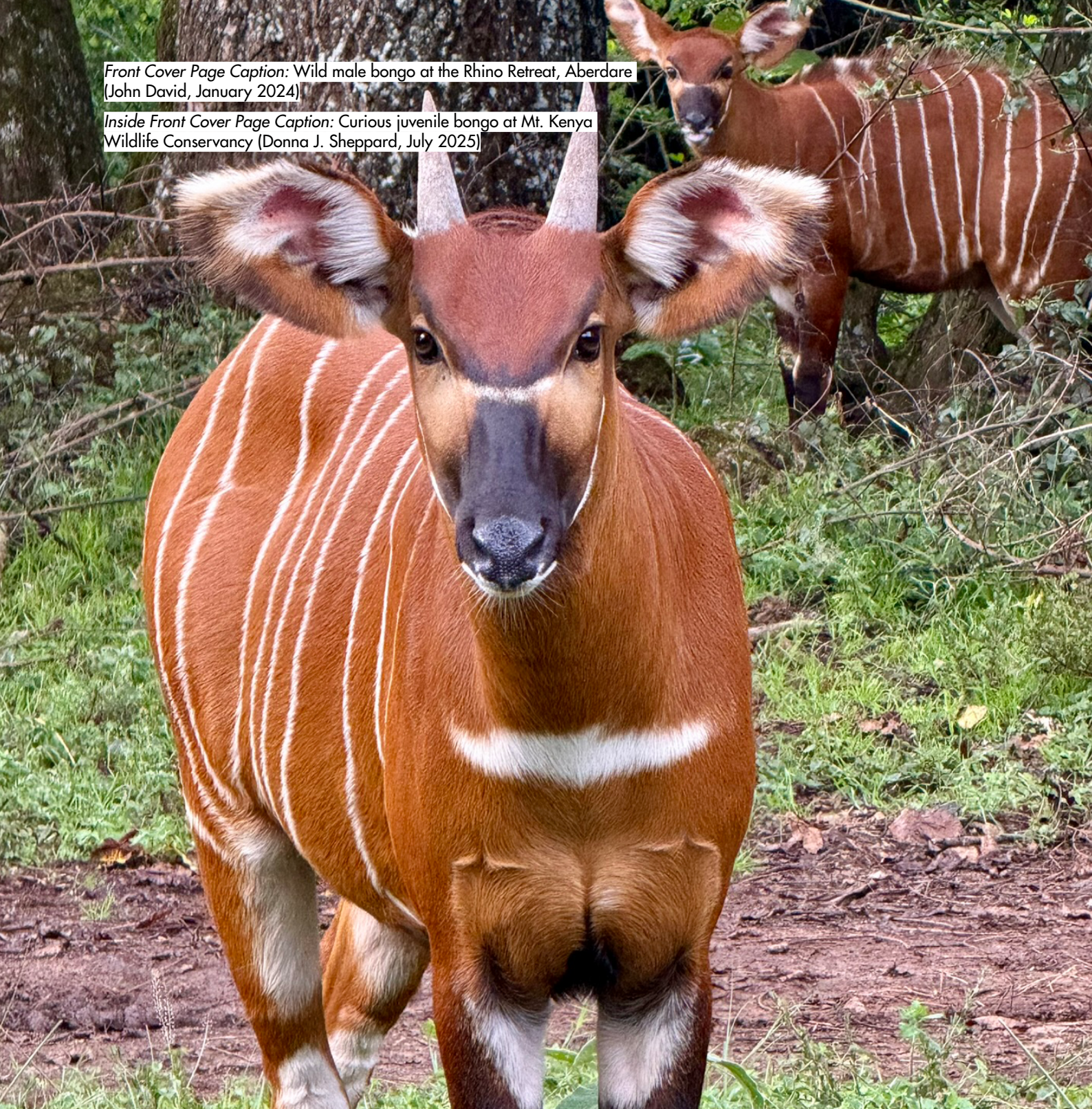
(2026-2030)

SECOND EDITION



Front Cover Page Caption: Wild male bongo at the Rhino Retreat, Aberdare
(John David, January 2024)

Inside Front Cover Page Caption: Curious juvenile bongo at Mt. Kenya
Wildlife Conservancy (Donna J. Sheppard, July 2025)



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SECOND EDITION

The development of the second edition of the National Recovery and Action Plan for the Mountain Bongo (*Tragelaphus eurycerus isaaci*) in Kenya (2026-2030) was led by Kenya Wildlife Service, National Bongo Taskforce with financial support from Rhino Ark, Wilder Institute/Calgary Zoo and Mount Kenya Wildlife Conservancy with Technical support from IUCN SSC Antelope Specialist Group, Chester Zoo and Manchester Metropolitan University

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Reviewed by IUCN SSC Antelope Specialist Group

Cover page photo credit: John David, January 2024, Rhino Retreat, Aberdare National Park

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Abbreviations

AI	Artificial Intelligence
AMSL	Above Mean Sea Level
AU	African Union
AZA	Association of Zoos & Aquariums
BOT	Board of Trustees
BSP	Bongo Surveillance Project (renamed Mountain Bongo Project)
BVD	Bovine Viral Diarrhea
CBD	Convention on Biological Diversity
CFA	Community Forest Association
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DeKUT	Dedan Kimathi University of Technology
DNA	Deoxyribonucleic acid
DVS	Directorate of Veterinary Services
EAC	East African Community
EA	European Association of Zoos and Aquaria
EEP	European Endangered Species Programmes
FMD	Foot and Mouth Disease
GPS	Global Positioning System
ILRI	International Livestock Research Institute
IUCN SSC	International Union for Conservation of Nature, Species Survival Commission
IUCN SSC ASG	IUCN SSC Antelope Specialist Group
IUCN SSC KeSSG	IUCN SSC Kenya National Species Specialist Group
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Forest Service
KSA	Kenya Space Agency
KTB	Kenya Tourism Board
KWS	Kenya Wildlife Service
LoRaWAN	Long Range Wide Area Network
M&E	Monitoring and Evaluation
MBRCT	Meru Bongo and Rhino Conservation Trust
MCF	Malignant Catarrhal Fever
MKWC	Mount Kenya Wildlife Conservancy

MMU	Manchester Metropolitan University
MoT&W	Ministry of Tourism and Wildlife
mtDNA	Mitochondrial DNA
MVP	Minimum Viable Population
NR	National Reserve
NBTF	National Bongo Taskforce
NEMA	National Environment Management Authority
NMK	National Museums of Kenya
NGAO	National Government Administration Officers
PPCP	Public Private Community Partnership
PPE	Personal Protective Equipment
RA	Rhino Ark Kenya Charitable Trust
RCMBCT	Ragati Chehe Mountain Bongo Conservation Trust
RSCF	Rare Species Conservatory Foundation
SD	Standard Deviation
SDG	Sustainable Development Goals
SNP	Single Nucleotide Polymorphism
SO	Strategic Objective
SW Mau	South Western Mau
TAG	Taxon Advisory Group
TB	Tuberculosis
TPF	Tourism Promotion Fund
UAS	Unmanned Aircraft System
UNESCO	United Nations Educational, Scientific and Cultural Organization
UoN	University of Nairobi
WCK	Wildlife Clubs of Kenya
WCMA	Wildlife Conservation and Management Act
WICZ	Wilder Institute Calgary Zoo
WRTI	Wildlife Research and Training Institute
ZIMS	Zoological Information Management System

Foreword



The second edition of Kenya's National Recovery and Action Plan for the Mountain Bongo (*Tragelaphus eurycerus isaaci*) for the period 2026-2030 reflects Kenya's unwavering commitment to conserving one of its most iconic and critically endangered antelope species, ensuring that future generations will continue to benefit from the ecological, cultural and natural heritage that the mountain bongo embodies.

This plan is the outcome of extensive collaboration among a diverse array of stakeholders, including government agencies, conservation organizations, research institutions, local communities, and international partners. Their collective efforts and shared vision have been pivotal in shaping a comprehensive approach that combines effective policy implementation led by the Government, scientific rigor, community participation, and adoption of innovative technologies to enhance species and habitat monitoring and recovery efforts of the species. Unfortunately, despite these concerted efforts the mountain bongo population in Kenya continues to decline, with less than 65 individuals in 2 small, fragmented populations in the wild in Aberdare National Park and Maasai Mau and 114 in breeding facilities.

We extend our sincere gratitude to all stakeholders and partners who continue to work alongside the Kenya Wildlife Service in safeguarding Kenya's iconic wildlife species and their habitats. We acknowledge, in particular, the Kenya Forest Service and Rhino Ark for their commitment to securing critical forest ecosystems that support the survival of the mountain bongo. We thank Mount Kenya Wildlife Conservancy for availing secure space and resources necessary to establish a mountain bongo breeding and reintroduction program. Of notable significance is the recent collaboration with local communities and the Meru County Government, which led to the establishment of the Meru Bongo Rhino Conservation Trust, supported by a generous donation of 17 mountain bongos by the Rare Species Conservatory Foundation, Florida, USA an occasion I had the honour of presiding over at JKIA on February 23, 2025.

We also recognize and appreciate the ongoing partnerships with the Wildlife Research and Training Institute (WRTI), Bongo Surveillance Program (BSP), Rhino Ark, Mount Kenya Trust, communities living adjacent to mountain bongo sites and other conservation stakeholders, whose joint efforts in monitoring mountain bongo populations and their forest habitats remain invaluable. Looking ahead, the integration of advanced technologies, including AI-enabled remote camera monitoring currently being piloted through a partnership with Chester Zoo will be instrumental in enhancing conservation outcomes. We therefore encourage more partners and stakeholders to join and support this important initiative.

Building on the lessons and achievements of the previous strategy (2019-2023), this second edition adopts a more integrated and adaptive framework, aiming to address the pressing threats facing the species which include poaching, habitat degradation, small and fragmented populations and disease risks. It sets clear targets, strategic objectives, and actionable activities aligned with Kenya's legal and policy commitments, including the Wildlife Conservation and Management Act, Cap 376 that is currently undergoing review to address the emerging conservation needs and the Sustainable Development Goals.

Our shared vision remains a future where mountain bongo populations thrive within healthy ecosystems, supported by empowered local communities and reinforced through robust scientific research and conservation practices.

This plan underscores the importance of habitat protection, population management, community engagement and technological innovation in achieving this vision.

I commend Kenya Wildlife Service, Kenya Forest Service, Wildlife Research and Training Institute, other relevant government agencies, conservation partners, stakeholders and community members whose dedication and active participation are vital in translating this plan into tangible results. Through coordinated efforts, continued innovation, and unwavering commitment, Kenya will ensure the survival and recovery of the mountain bongo, which is a critical component of our nation's rich biodiversity.

Let us move forward with resolve, collaboration, and hope, confident that together we can secure a sustainable future for the mountain bongo and the ecosystems they inhabit.



Hon. Rebecca Miano, EGH

Cabinet Secretary

Ministry of Tourism and Wildlife

Preface



The second edition of Kenya's National Recovery and Action Plan for the Mountain Bongo (*Tragelaphus eurycerus isaaci*) 2026-2030 is a strategic document, which underscores Kenya's steadfast dedication to the conservation of this critically endangered species and their habitats. The mountain bongo is not only a symbol of our rich biodiversity, but also an integral component of the mountain ecosystems that are essential for ecological stability and the well-being of local communities.

The conservation of the mountain bongo and its habitats faces numerous challenges, including poaching, habitat degradation, small and fragmented populations, disease threats, and environmental pressures. Addressing these threats requires a concerted and holistic approach that combines scientific research, community participation, innovative technologies and effective policy implementation.

This plan builds on the lessons and successes of previous efforts, setting clear targets and strategic actions to accelerate recovery and ensure the species' long-term survival through securing wild populations and their habitats, leveraging

on opportunities from *in situ* and *ex situ* programmes to establish breeding sanctuaries, and reintroduction of the species in suitable habitats in their historic range.

Our shared vision is a future where self-sustaining mountain bongo populations thrive within healthy, resilient ecosystems with 750 individuals by the year 2075, benefiting local communities, inspiring national pride and contributing to Kenya's broader conservation commitments. Achieving this vision demands unwavering support, collaboration and resource mobilization from all stakeholders.

Reversing the decline of the mountain bongo is no small task, especially given the species' critically low numbers in the wild, estimated at less than 65 individuals. These remaining individuals exist in small, fragmented populations, with the majority found in Aberdare National Park and a few isolated individuals in the Maasai Mau. It is worrying that there have been no recent sightings in previously known habitats such as the South West Mau, Mount Kenya (Ragati/Chehe), and Eburu forest ecosystems. However, the prospects offered by active breeding programmes both in country, through institutions like the Mount Kenya Wildlife Conservancy (MKWC) and the Meru Bongo & Rhino Conservation Trust (MBRCT) and internationally in accredited *ex situ* facilities across the USA and Europe provide renewed hope. Through collaborative efforts, we have a genuine opportunity to halt and ultimately reverse the decline of this iconic antelope.

I call upon all partners, government agencies, research institutions, local communities, and development partners to stand united in supporting the implementation of this plan. Together, through dedication and coordinated action, we can secure a sustainable future for the mountain bongo, safeguarding Kenya's natural heritage for generations to come. Let us commit ourselves to this vital cause, knowing that our collective efforts are instrumental in turning this vision into reality.

A blue ink signature of Silvia Museiya, written in a cursive style.

Silvia Museiya, CBS

Principal Secretary

State Department for Wildlife

Acknowledgements



Kenya Wildlife Service, wish to express sincere gratitude to the Cabinet Secretary, Ministry of Tourism and Wildlife, Hon. Rebecca Miano, for her unwavering policy support and guidance in the conservation agenda of our wildlife. Her leadership and commitment have been instrumental and formed the basis of development of this second edition of the National Recovery and Action Plan for the Mountain Bongo.

I extend my appreciation to the Principal Secretary, State Department for Wildlife, Ms. Sylvia Museiya, for her continued support and encouragement, which have been vital in steering Kenya's conservation efforts amidst a changing conservation landscape.

I thank the Kenya Wildlife Service Board of Trustees for their guidance, continued support and having confidence in the management and staff of Kenya Wildlife Service to deliver the conservation agenda and on recovery of endangered species of wildlife.

This plan was developed under the dedicated leadership of the Kenya Wildlife Service and the National Bongo Taskforce, with valuable technical support from the IUCN SSC Antelope Specialist Group, Rhino Ark Charitable Trust, Wilder Institute/Calgary Zoo, Mount Kenya Wildlife Conservancy, Chester Zoo and Manchester Metropolitan University. We are grateful for the financial support provided by Rhino Ark Charitable Trust, Wilder Institute/Calgary Zoo and Mount Kenya Wildlife Conservancy, whose contributions have been crucial in bringing this plan to fruition.

We express our gratitude to the Kenya Forest Service for providing the necessary space and habitats essential for the conservation of the mountain bongo. Their support in safeguarding these critical ecosystems is fundamental to the success of our collective efforts.

We thank the County Government of Narok for safeguarding and continued partnership with communities to secure Masai Mau communal forest which is a critical habitat for the mountain bongo.

I commend all stakeholders who participated actively in the consultative workshop, whose insights, expertise and commitment greatly enriched this process. I call upon all partners, government agencies, research institutions, local communities and development partners to join hands and support Kenya Wildlife Service in implementing the activities and programmes outlined in this plan.

Together, we can effectively address the threats facing the mountain bongo, reinforce our conservation actions and achieve our shared goal of species recovery.

Let us work collaboratively with dedication and purpose, confident that our collective efforts will secure a sustainable future for the mountain bongo and enrich Kenya's natural heritage for generations to come.



Prof. Erustus Kanga, PhD, CBS, EBS

Director General

Kenya Wildlife Service

Executive Summary

The second edition of the National Recovery and Action Plan for the Mountain Bongo (*Tragelaphus eurycerus isaaci*) in Kenya (2026-2030), builds upon the foundation laid by the first edition of the Action Plan (2019-2023). The overarching aim is to secure self-sustaining, genetically diverse populations of mountain bongo across their historic ranges, thereby contributing to the conservation of Kenya's mountain ecosystems and fulfilling national and international legal and policy commitments.

The plan aligns with Kenya's Constitution, Wildlife Conservation and Management Act, Cap 376 and various national policies including Vision 2030 the Wildlife Policy (2020) and the Sustainable Development Goals (SDG 15). It emphasizes participatory management, habitat protection and inter-agency collaboration, reinforcing Kenya's commitments to biodiversity conservation and ecosystem sustainability.

The long-term vision is to restore self-sustaining mountain bongo populations thriving within healthy forest ecosystems by 2075, recognised nationally and globally as a heritage species that benefits local communities. To realise this vision, the programme aims to achieve a national population of 750 mountain bongos in Kenya by 2075 through sustained conservation efforts.

Evaluation of the level of implementation of the first edition of the action plan (2019-2023) revealed significant gaps, with only 21.7% of the activities fully achieved. Major challenges include permitted activities, which negatively impact on the mountain bongo and its habitats, small and fragmented populations, poaching, habitat degradation, disease threats and infrastructure development in critical habitats that could impede population recovery. Monitoring and stakeholder coordination require strengthening, with a need for standardised monitoring and increased engagement at all levels.

Despite concerted efforts, the mountain bongo population continues to decline in the natural range with the Kenyan population estimated at 143-177 individuals with approximately 29-63 individuals in small fragmented populations in the wild and 114 in breeding facilities.

With so few animals remaining in the wild, the mountain bongo faces the risk of extinction. The population is limited to fragmented habitats, mainly in Aberdare National Park and the Mau Forest, with no recent records in other historical ranges. However, ongoing local and international breeding programmes offer a promising path toward recovery through coordinated conservation efforts.

This second edition of the action plan adopts a holistic approach, focusing on three primary goals: (1) enhancing wild population growth, (2) establishing breeding sanctuaries for rewilding, and (3) supporting reintroduction efforts into suitable habitats. The action plan is guided by six strategic objectives focused on (1) securing of mountain bongo populations and habitats, (2) *in situ* and *ex situ* conservation management programmes to enhance population recovery, (3) community involvement, (4) scientific research, (5) ecosystem management and (6) effective coordination.

The plan outlines 50 specific activities with clear timelines and responsible stakeholders, including the reinforcement of captive populations through genetic management and translocation, habitat restoration, policy harmonization, and community engagement. Technological innovations such as AI-assisted monitoring and remote sensing will be leveraged to improve surveillance and data management.

A critical component involves establishing breeding sanctuaries and reintroduction sites within former ranges, supported by local and international collaborations and community-based initiatives like the Meru Bongo and Rhino Conservation Trust (MBRCT). Recent successful translocations, including the repatriation of 17 mountain bongos from Florida to MBRCT exemplify progress toward these objectives.

Recognizing past shortcomings, the plan integrates a robust Monitoring and Evaluation framework with annual reviews to ensure adaptive management, timely progress assessment, and stakeholder accountability.

This strategic plan embodies Kenya's renewed commitment to the mountain bongo recovery efforts by providing SMART (Specific, Measurable, Achievable, Relevant and Time-bound) targets and activities with special emphasis on habitat conservation, population recovery, scientific research and stakeholder partnership. Through coordinated efforts, innovative technologies, and community participation, Kenya aims to restore and sustain mountain bongo populations, securing their place as a vital component of the country's rich biodiversity heritage.

1. Introduction

1.1 Legal Requirements

This action plan has been developed in accordance with national laws, policies and relevant wildlife-related Multilateral Environmental Agreements aimed at enhancing the protection, conservation and recovery of endangered species whose populations and habitats are under threat. In particular, Section 49 of the Wildlife Conservation and Management Act (WCMA), Cap 376, mandates Kenya Wildlife Service (KWS), in collaboration with relevant stakeholders, to develop and implement recovery plans for the conservation and management of all species listed in the Sixth Schedule, including rare, endangered and threatened species.

The WCMA guides that, when developing species-specific recovery action plans, it is critical to include site-specific management strategies designed to achieve the plan's overarching goal of ensuring the species' conservation and survival.

This action plan serves as a unifying platform and fosters synergy among stakeholders involved in mountain bongo conservation. It provides comprehensive background information on the mountain bongo, outlining the legal and policy framework, profiles threats to the species, outlines conservation efforts and stakeholder analysis that will be critical in supporting implementation of the action plan.

The plan articulates a clear vision and overall goal, and specific goals supported by six (6) strategic objectives with corresponding key targets, time-bound activities and programmes, key performance indicators and responsible actors. This action plan has a well-defined implementation structure, resource mobilization plan and a monitoring & evaluation framework to effectively monitor its implementation.

1.2 First Edition (1st Edition) of the National Recovery and Action Plan for the Mountain Bongo in Kenya (2019-2023)

To address the increasing challenges and threats facing the mountain bongo populations and their habitats, Kenya developed the 1st edition of the National Recovery and Action Plan for the Mountain Bongo in Kenya (2019-2023). The action plan was guided by a vision, a goal, 8 strategic objectives and 129 activities.



Vision: Free-ranging and genetically representative populations of mountain bongo, thriving across intact historic mountain ecosystem ranges, cherished by the Kenyan people and the global community.



Goal: To secure minimum population sizes for mountain bongo within their ranges in Kenya, to achieve a national population of 750 individuals over the next 50 years.

Strategic objectives:



Security: To secure wild populations



Human Activities: To manage legal activities, stop illegal human activities that destroy mountain bongo habitat to ensure sustainability



Small populations: To use novel technologies to address the vulnerability of small and isolated bongo populations



Communities: Optimise the participation of communities living adjacent to bongo habitat in bongo conservation



Policy harmonization: Policies and inter-agency collaboration that enhance conservation efforts for mountain bongos and their habitats.



Law enforcement and prosecution: To enhance law enforcement capacity and prosecution through engagement of relevant agencies



Species interaction: To minimize the negative impacts of other species on bongo



Disease: To optimize the assessment and management of disease risk to wild and captive bongos

1.2.1 Implementation Status of the First Edition of the National Recovery and Action Plan for the Mountain Bongo in Kenya (2019-2023)

Evaluation on implementation of the action plan established that 76 activities (59%) were not implemented with only 28 activities (21.7%) fully implemented while 25 activities (19.3%) were partially implemented.

Some strategic objectives and activities were outside the scope of the strategy e.g., SO 5 - policy harmonisation. There was no specific strategic objective focusing on breeding programmes which have been identified as being critical to recovery efforts through the reintroduction and the reinforcement of wild populations of mountain bongo, utilizing opportunities provided by both *in situ* and *ex situ* management programmes.

Managers should work collaboratively with scientists to identify research priorities, ensuring that studies are designed to directly address the specific needs of mountain bongo recovery rather than simply producing scientific output. There is a need for standardised monitoring and reporting across all bongo populations with central data management.

In the coordination framework, it was noted that the National Bongo Management Committee did not meet and the regional committees for Mountain (Mt. Kenya-Ragati/Chehe, MKWC, MBRCT programmes) and Central rift conservation Area (Mau/Londiani and Eburu) site committees also did not meet. The feeling was that the regional committees were creating another layer of decision-making that duplicates the work of the NBTF. Thus, it was felt that the regional committees might be redundant. However, they were retained with the regional KWS Senior Assistant Directors for the Mountain and Central Rift Conservation Areas required to convene the committees to meet as necessary. The National Bongo Taskforce (NBTF) only met 3 times in the life of the previous action plan. To keep implementation of the action plan on track, the NBTF should convene more frequently, with meetings held at least twice a year. Site specific projects and programmes met regularly and were more effective in the implementation of the action plan. It was noted that monitoring and evaluation of the action plan was not undertaken. There is a need to have an active secretariat to follow up on implementation of activities and facilitate M&E.

1.3 Action Plan Development Process

The second edition National Recovery and Action Plan for the Mountain Bongo (*Tragelaphus eurycerus isaaci*) in Kenya (2026-2030), was developed through a combination of approaches.

In February 2025, a technical team from the National Bongo Taskforce conducted a review of the implementation of the first edition of the action plan (2019–2023). The review aimed to assess the progress made in the species' recovery efforts, capture lessons learned, and identify gaps and priority areas for inclusion in the second edition.

Stakeholder mapping was undertaken at international, national and site specific levels which formed the basis for the stakeholder consultation workshop. This provided a forum for enhancing partnerships and collaboration among various stakeholders involved in mountain bongo conservation.

Review of relevant literature, implementation status of the 1st edition of the action, input from the stakeholders consultative workshop and field surveys reports on the species formed the basis of development of the 1st draft of the revised action plan. The draft was circulated to stakeholders for validation and IUCN SSC Antelope Specialist Group for technical validation.

Comments and input from the validation process were incorporated to produce the final version of the action plan which was then presented to KWS Management, KWS Board of Trustees and the Ministry of Tourism and Wildlife for approval and subsequent launch

1.4 Legal and Policy Framework

a. Constitution of Kenya 2010. The Constitution is the supreme law of the country.

Chapter 1: Article 2(6) states, 'Any treaty or convention ratified by Kenya shall form part of the law of Kenya under this Constitution'

Chapter 5 Section 2

- i. Article 69 (1) The State shall (d) encourage public participation in the management, protection and conservation of the environment; (e) protect genetic resources and biological diversity.
- ii. Article 69 (2) Every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources.

b. Sustainable Development Goals (SDGs). The SDGs are a set of 17 global goals adopted by the United Nations in 2015 as a universal call to, among others, protect the planet. SDG 15, Life on Land has targets that are relevant to the conservation and recovery of the mountain bongo and their habitats. They are:

- i. Target 15.2: Halt deforestation and restore degraded forests by 2020;
- ii. Target 15.4: Ensure by 2030 the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development;
- iii. Target 15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species;
- iv. Target 15.7: Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products.

c. Vision 2030. In 2008, Kenya launched Vision 2030, a blueprint policy document to transform Kenya into a newly industrializing middle-income country providing a high quality of life for all its citizens by 2030. Recognizing the importance of securing a clean, and sustainable environment, Vision 2030 identified key flagship environment projects, including "The Water Catchment Management Initiative". This calls for rehabilitating the five water towers of Kenya. These are the largest mountain forest ecosystems of Kenya and include Mount Kenya, Aberdare Range, Mau Forests Complex, Cherangani Hills and Mt. Elgon. They cover the main current and potential ranges for the bongo.

d. Wildlife Policy. In 2020, Kenya adopted a new Wildlife Policy which prescribes a broad range of principles, measures and actions to be pursued to achieve sustainable wildlife management in Kenya. Although most of the policy is relevant to the conservation and recovery of the bongo, there are a few sections that are directly related to this plan. In these sections, the Government is requested to:

- i. Develop mechanisms to guide and regulate captive breeding and artificial propagation of wildlife (4.3.5.6);
- ii. Strengthen skill training, technological capabilities and innovation to secure all wildlife species and their natural habitats in accordance with the law (4.6.3.1);
- iii. Enhance inter-agency collaboration in combating wildlife crime (4.6.3.2);
- iv. Enhance the capacity of local communities to combat wildlife crime and biopiracy (4.6.3.4);
- v. Enact dedicated laws for vulnerable and endangered wildlife species (4.10.3.1);
- vi. Develop mechanisms to regulate the donation/gifting and exchange of wildlife species between Kenya and other countries (4.10.3.5);
- vii. Develop a framework to regulate the establishment and management of captive wildlife facilities (4.10.5.6);
- viii. Strengthen capacity for wildlife veterinary services (4.11.5.2);
- ix. Develop and implement mechanisms for wildlife disease surveillance, epidemiology and management (4.11.5.3);
- x. Establish a national wildlife data and information sharing and integration platform (4.13.2.5); and,
- xi. Establish a framework for inter-agency cooperation and stakeholder engagement for effective management of wildlife in Kenya (5.2.4.4).

e. National Wildlife Strategy 2018-2030. Has four pillars which will be key in implementation of this action plan namely; Resilient Ecosystems; Engagement by all Kenyans; Evidence Based Decision Making; and Sustainability and Governance

f. National Landscape and Ecosystem Restoration Strategy (2023-2032). Although the Strategy is focused on restoration interventions, it also calls for actions that are relevant to the conservation and recovery of the bongo, in particular: Output 2.1, Activity 1.1.1: Develop / review and implement ecosystem restoration and management plans.

g. The Task Force on the Conservation of the Mau Forests Complex, 2009. The Task Force made several recommendations that are relevant to the conservation and recovery of the bongo. They are:

- i. The protection of biodiversity hotspots should be enhanced. They include the following areas: Transmara, South West Mau and Maasai Mau.
- ii. A biodiversity restoration action plan should be developed and implemented, in consultation with stakeholders and communities;
- iii. A strategic forest management plan for the Mau Forests Complex should be developed within a period of one year with input from all sectors and stakeholders.

h. The Task Force on Forest Resources Management and Logging Activities in Kenya, 2018.

The Task Force made several recommendations that are relevant to the conservation and recovery of the bongo. They are:

- i. The Cabinet Secretary should engage the relevant county governments to declare threatened community or private forests, in particular the Maasai Mau and Mt Kulal, as provisional forests.
- ii. Indigenous forest areas that host critically endangered species, such as the mountain bongo, should be properly demarcated and gazetted as nature reserves.
- iii. Each forest station should have a "Forest Conservation and Management Committee" which comprises the Forest Manager and representatives from the key conservation agencies and stakeholders, including the forest dependent communities and marginalised groups.

i. The County Governments Act, 2012.

- i. Section 110 (1) outlines requirements of development of a ten-year county GIS based database system spatial plan for each county to facilitate the development of a well-balanced system of settlements and ensure productive use of scarce land, water and other resources for economic, social, ecological and other functions across a county;
- ii. Section 102. The principles of planning and development facilitation in a county shall (d) protect and develop natural resources in a manner that aligns national and county governments policies

j. Forest Conservation and Management Act, Cap 385

An Act of Parliament to give effect to Article 69 of the Constitution with regard to forest resources; to provide for the development and sustainable management, including conservation and rational utilization of all forest resources for the socio-economic development of the country and for connected purposes. Of particular interest are the following sections:

- i. Section 39 which provides for the declaration of nature reserves for the preservation of biological diversity and threatened or endangered species;
- ii. Section 42 on the management of indigenous forests as habitat for wildlife in terrestrial forests and fisheries in mangrove forests;
- iii. Section 48 regarding the application for community participation, in particular with regard to CFA's proposals concerning methods of monitoring and protecting wildlife and plant populations and enforcing such protection.

02. Background

2.1 Overview

The mountain bongo (*Tragelaphus eurycerus isaaci*) is a critically endangered forest antelope endemic to the high-altitude montane forests of central Kenya. It is the largest and most social of all forest-dwelling antelopes, with adult males weighing up to 400 kg. Distinguished by its striking reddish-chestnut coat marked with 10–15 vertical white stripes, the mountain bongo also features distinctive white markings on the cheeks, forehead, and limbs.

Primarily a browser, the mountain bongo feeds on a variety of forest vegetation such as leaves, shoots, bark, and herbs, and may occasionally graze, particularly in managed or semi-wild settings. It plays a vital ecological role in seed dispersal and forest regeneration. Females form small herds, while males are largely solitary. They inhabit dense forest cover, are mainly crepuscular, and depend on mineral-rich salt licks to supplement their diet.

Mountain bongos are extremely sensitive to habitat loss, disease from domestic livestock, and past hunting pressure. With approximately 29-63 individuals believed to remain in the wild, the subspecies faces an extremely high risk of extinction. Conservation efforts include breeding under human care, habitat restoration, disease prevention, and reintroduction into protected forest sanctuaries such as the Mawingu Bongo Sanctuary.

2.2 Taxonomy

The mountain bongo (*Tragelaphus eurycerus isaaci*) is one of the two subspecies in which the bongo taxon (*Tragelaphus eurycerus*) is currently divided, the other being the nominate subspecies lowland bongo (*Tragelaphus eurycerus eurycerus*) (Kingdon, 1982; Elkan & Smith, 2013). The nominate subspecies covers any bongo population found outside of Kenya, and thus its range covers West Africa (Guinea, Sierra Leone, Liberia, Ivory Coast with anecdotes of presence in Togo) and Central Africa (Gabon, Central African Republic, Congo, DRC, South Sudan) and one population found in Eastern Africa (Uganda, in Semuliki National Park). The Kenyan population, and the now-extinct bongos on the Ugandan side of Mt Elgon pertain to the mountain subspecies, which is the focus of this action plan. While the taxonomy of bongo appears clearly defined, the existence of such a vast range in a single subspecies has been questioned by authors (Gippoliti et al., 2018). Further research into the distinctiveness of various populations would help better clarify the taxonomic status of the antelope.

2.3 Conservation Status

The nominal subspecies, the lowland bongo (*Tragelaphus eurycerus eurycerus*) is classified as **Near Threatened** (IUCN SSC Antelope Specialist Group, 2017), primarily due to its wide distribution and population estimates of up to 30,000 individuals. However, threats such as hunting, habitat loss, and disease remain significant concerns. The lack of comprehensive research warrants further investigation into the subspecies' conservation status.

In stark contrast, the **mountain bongo** (*Tragelaphus eurycerus isaaci*) is classified as **Critically Endangered** (IUCN SSC Antelope Specialist Group, 2016). Its dire conservation status is driven by a combination of factors. Mountain bongos inhabit montane forests and highland areas that have largely escaped the habitat loss due to agricultural clearance, resulting in fragmented distribution across isolated forest patches. These forest islands exist within a human-dominated matrix, which impedes gene flow and connectivity between the remnant populations of mountain bongo, with severe implications for population viability.

Fragmentation has compounded the impacts of historic and current threats, including disease such as rinderpest (Kingdon, 1982; Elkan & Smith, 2013) and hunting both for subsistence and sport. Sport hunting pressure was likely minimal due to the difficulty of locating bongos in dense forests, and significantly more hunting licenses were issued than animals actually harvested (M. Prettejohn, personal communication).

Historically, bongos were a common sight in Kenya's highland forests until the 1970s (Kingdon, 1982; Elkan & Smith, 2013). They were reclassified as **Endangered** in the 1990s and were believed to be extinct in the wild by the early 2000s. However, in 2008, the Bongo Surveillance Project captured the first images of remnant individuals, leading to their classification as **Critically Endangered**. Today, the situation remains precarious, with only two areas—Aberdare National Park and the Maasai Mau Forest—confirmed to host remnant breeding herds. Even under the most optimistic estimates, the total wild population is approximately 28-63 individuals, with the two subpopulations completely geographically isolated from one another.

Despite the current population status in the wild, there is cause for hope. Over 800 mountain bongos are currently held in zoos and managed collections worldwide. Kenya has benefited from these programmes in Mount Kenya Wildlife Conservancy and Mawingu Mountain Bongo Sanctuary which host a combined population of 114 individuals. These populations are a critical reservoir for reinforcing wild populations and potentially reintroducing the species into suitable areas of its former range.

2.4 Biology, Behaviour, and Ecology of the Bongo

2.4.1 Biology and Reproduction

The mountain bongo is a social antelope and the largest of the forest antelopes. Males can weigh up to 400 kg, whilst females can reach 350 kg. The bongo is characterised by a reddish chestnut coat with 10 - 15 white stripes covering the flanks. Other white markings cover the cheeks (2 – 3 round spots), a chevron on the forehead and stripes on the front of its limbs. These markings help to identify individual bongo (Gibbon *et al.*, 2015) and have been used to develop ID systems (Sandri *et al.*, 2023). Sexes differ in pelage colour: males become dark brown to black over three-quarters of their body, whereas females and the lowland subspecies do not show any darker pelage. Bongos are polygynous and sexually mature at around 2 years of age, though in the wild breeding may be influenced by environmental factors such as food availability. Breeding occurs throughout the year; however, in wild populations, parturition frequently peaks during or immediately following the rainy season. The gestation period averages 270 days (approximately 9 months) and usually culminates in the birth of a single calf, with twinning events documented only rarely. Females give birth in secluded, densely vegetated areas, with the calf concealed for several weeks with the mother returning periodically to feed and tend to the calf.

2.4.2 Behaviour

Female mountain bongos live in herds of up to 50 individuals, whereas males tend to be solitary; however, there have historically been anecdotes of herds of up to 100 individuals (Sheppard *et al.*, 2024). Although males are reported not to form harems or coerce females (Kingdon, 1982; Estes, 1992; Elkan & Smith, 2013), hunters and local trackers have observed that males often follow female herds and may restrict access by other males in the area (Sheppard *et al.*, 2024). Bongo are not known to form bachelor herds, a behaviour which complicates captive management. This difference in behavior, and likely ecology, between males and females is reflected in philopatry and survivorship: similar to other polygynous antelope species, males tend to leave the natal area, whereas females tend to be more philopatric (Sandri *et al.*, 2023).

2.4.3 Ecology

Mountain bongos are primarily browsers, feeding on a diverse range of vegetation, including leaves, shoots, bark, vines, herbs, shrubs, and occasionally fruits and grasses. Their diet reflects the seasonal availability of forest vegetation, with a preference for regenerating growth, areas recently disturbed by tree falls or human activity, and forest ecotones. Although primarily browsers, bongos do consume grasses (Elkan & Smith, 2013), and recent observations from breeding programmes in Kenya have confirmed this behavior in animals under human care (Fundi et al., 2022). Salt licks and mineral-rich soils also play an important role in their ecology, as they regularly visit these sites to supplement their intake of minerals—particularly sodium and potassium—which are limited in their browse diet (Hillman, 1986; Klaus et al., 1998; Klaus-Hügi et al., 2000). These locations are often focal points of bongo activity and may be critical for maintaining health and reproductive function.

Ecologically, mountain bongos are important seed dispersers and browsers, influencing forest structure and plant community dynamics. Their movements through dense forest undergrowth create trails used by other animals, and their foraging activity shapes patterns of plant regeneration. Mountain bongos are naturally shy and elusive, avoiding open areas and relying heavily on dense vegetation for cover. They are mostly crepuscular or nocturnal, being most active at dawn and dusk, although activity patterns may vary depending on human disturbance levels. Their home ranges may be influenced by habitat quality, food availability, and levels of human disturbance.

2.5 Historic Populations and Distribution

Mountain bongos (*Tragelaphus eurycerus isaaci*) historically inhabited many of Kenya's montane forests, including the Aberdare Mountains, Cherangani Hills, Chepalungu Forest, Mau Forest Complex (including Mt. Londiani and Eburu Forest), Mt. Kenya, and Mt. Elgon. Historic population sizes by ecosystem are difficult to predict with certainty. However, during the 1950s, when bongos were still commonly encountered, the Eastern Aberdare and the Mau Forest are thought to have comprised populations in the hundreds. Herd sizes were reportedly observed up to 50 individuals, particularly in the Aberdare and Mau ecosystems (Kingdon, 1983). Large herds of 20–30 individuals were common in Aberdare, Mau, and Mt. Kenya forests, interspersed with smaller groups of 4–7 individuals. In Eburu Forest, group sizes were smaller, with 4–6 individuals at most (Sheppard et al., 2024). Bongos were also recorded in Mt. Elgon until the 1910s on the Ugandan side and until the 1970s on the Kenyan side (Kingdon, 1982).

Bongos were not evenly distributed across these montane forests, but favoured specific habitats of secondary and mixed forests (Estes et al., 2008; Sandri, 2020). Historically, they co-occurred with giant forest hog (*Hylochoerus meinertzhageni*) and bushbuck (*Tragelaphus scriptus*), reportedly consuming similar foods, but accessing resources at different heights. Bongos are thought to have more limited diets and to spend longer periods feeding from a single source compared to bushbuck or giant forest hog (Sheppard et al., 2024). Preferred habitat characteristics also included proximity to salt licks or mineral-rich water sources, dense or disturbed forest, and areas dominated by mountain bamboo at elevations ranging from 2,150 to 3,300 amsl (Luke & Beentje, 2020). Historical accounts suggest that bongos were crepuscular and occupied relatively small home ranges of 1–12 km, often feeding on preferred browse species for several days in a single area and repeatedly following predictable trails. In many areas salt licks and mineral-rich water sources appeared essential for health, reproductive function, and herd distribution.

In the decades following the 1950s, local hunters reported that single-male, multi-female social structures remained intact, but group sizes gradually declined. In the 1960s and 1970s, observed group sizes dropped to between 10 and 20 individuals, with groups of fewer than 15 individuals being most common. Not only did group sizes reduce, but bongo populations steadily declined or disappeared from their former ranges (Sheppard et al., 2024). For example, bongos were last confirmed in the SW Mau in the 1970s; despite continuous camera trap monitoring since 2011, no sightings have been recorded (M. Prettejohn, personal communication, February 13, 2025). In the Aberdare, populations on the southeastern slopes declined and vanished during the 1980s and 1990s, largely due to live trapping for international export to zoos and captive breeding programmes (Sheppard et al., 2024). The last confirmed images from the northeastern Aberdare (Kanjuri) were captured in 2012 (M. Prettejohn, personal communication, February 13, 2025). The most recent confirmed sighting at Ragati Forest, Mt. Kenya, occurred in November 2019 via camera trap (P. Comport, personal communication, February 13, 2025), while the last confirmed camera trap sighting in Eburu Forest was in July 2020 (D.J. Sheppard, personal communication, June 27, 2025).

In Cherangani, the population in 1960 was estimated at 300 but declined steeply during the 1960s due to illegal hunting, expanded cattle grazing, and forest loss (Stanley Price, 1969). A field survey in 1968 recorded only one adult in the main forest block, although small family groups persisted in northern gallery forests. Contemporary surveys, including camera trapping, have found no evidence of bongos, though habitat suitability remains high (Kimitei, 2013). See Appendix 1 for more information on historic populations and distribution.



a. Aberdare National Park and Forest Reserve

Located in central Kenya ($36^{\circ}30'-36^{\circ}55'E$, $0^{\circ}05'-0^{\circ}45'S$), the Aberdare include two main peaks, Oldonyo Lesatima (4,001 m) and Kinangop (3,906 m), and are a key water source for surrounding towns and Nairobi (Lambrechts et al., 2003; Kenya Forest Service, 2010). Historically, bongos were concentrated along the eastern flanks, particularly in the northeastern and southeastern Aberdare (Maganjo, Thuti, North Mathioya), with a third population in the Salient. Eastern slopes were occupied year-round, while small seasonal populations occurred on western slopes below the moorland at Chania River and Gura Falls (Kariuki, 2021). Salt licks and mineral-rich areas influenced herd activity and social structure.

b. Mt. Kenya National Park and Reserve

Kenya's highest mountain (Batian, 5,199 m) historically supported bongos along southwestern slopes from Ragati to Embu. Herds in the Mbiruru Hills established home ranges around specific salt licks (Miano, 2021). In the 1950s, bongos were observed drinking at rivers near human camps in Embu (Smith, 2021). Hunting surveys in the 1960s confirmed their absence from Embu demonstrating that suitable habitat did not guarantee occupancy. Herd sizes of 20-30 were common, though smaller groups were also recorded.

c. Mau Forest Complex and Eburu Forest

The Mau Forest Complex ($>4,000\text{ km}^2$) historically harbored widespread bongo populations, especially in southwestern blocks (Bosta-Kabbilat, Emitik-Chemosit) (Olang & Kundu, 2011). By the 1970s, sightings of live individuals became rare, with presence mainly inferred from snared or deceased animals at salt licks (Sigira, 2022). Eburu Forest, once part of Mau, housed smaller populations (20–30 individuals in the 1960s–1970s), declining to fewer than 15 by the 1990s due to hunting and habitat fragmentation (Kariuki, 2021; Ngaruro, 2022; Smith, 2021).

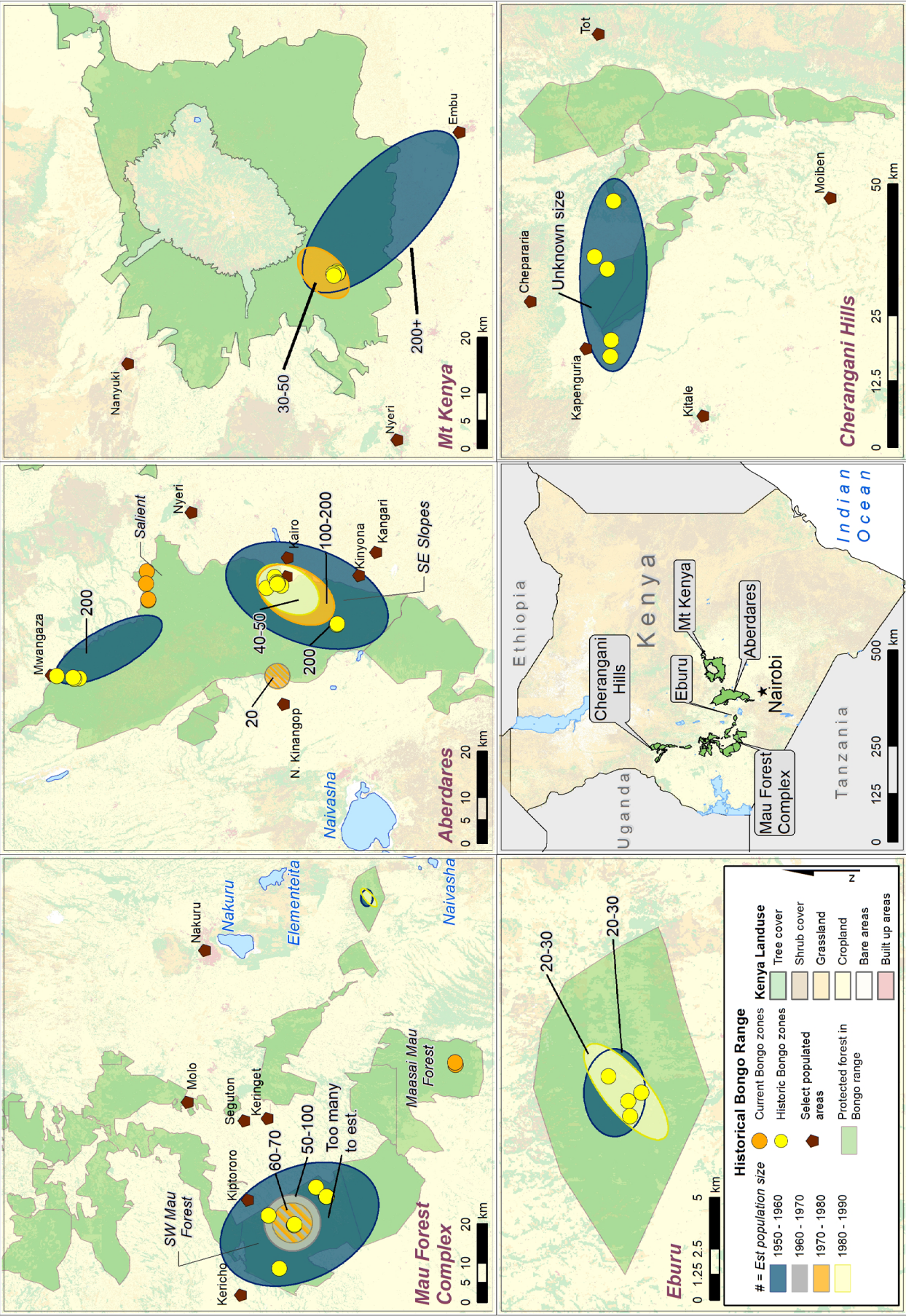
d. Cherangani Hills Forest

A collection of thirteen forest reserve blocks ($\sim 1,200\text{ km}^2$), the Cherangani Hills supported a significant bongo population in the mid-20th century (Akotsi & Gachanja, 2004; Chebii, 2016). Population declined from an estimated 300 in 1960 due to hunting, cattle grazing, and forest loss. Surveys in 1968 recorded only one adult in the main forest block; small family groups persisted in northern gallery forests. Recent surveys, including camera trapping, found no evidence of bongos, though habitat suitability remains high (Kimitei, 2013).

e. Mt. Elgon

Bongo were historically recorded on Mt. Elgon, persisting until the 1910s on the Ugandan side and the 1970s on the Kenyan side (Kingdon, 1982). This highlights the species' broader historical range in Kenya and adjacent regions, although populations were fragmented and local extirpations occurred before the late 20th century.

FIGURE 1: Historical mountain bongo ranges across Kenya (as reported by bongo hunters; Sheppard et al., 2024)



f. Current Population

In 2015, the Bongo Surveillance Project (BSP) estimated that the mountain bongo population had declined to around one hundred individuals (Shears, 2015). Population monitoring conducted using camera trap data collected by BSP between 2013 and 2018, and analyzed with a bespoke individual identification system (Sandri et al., 2023), found only two breeding populations: one in the Salient sector of the Aberdare and another in the Maasai Mau. The estimated population sizes were 23 (95% CI: 17–29) and 16 (95% CI: 12–20), respectively (Sandri et al., 2023), as shown in Figure 2. The Wildlife Research & Training Institute has been conducting monitoring in the Aberdare with camera traps and have derived an estimate of 46 individuals.

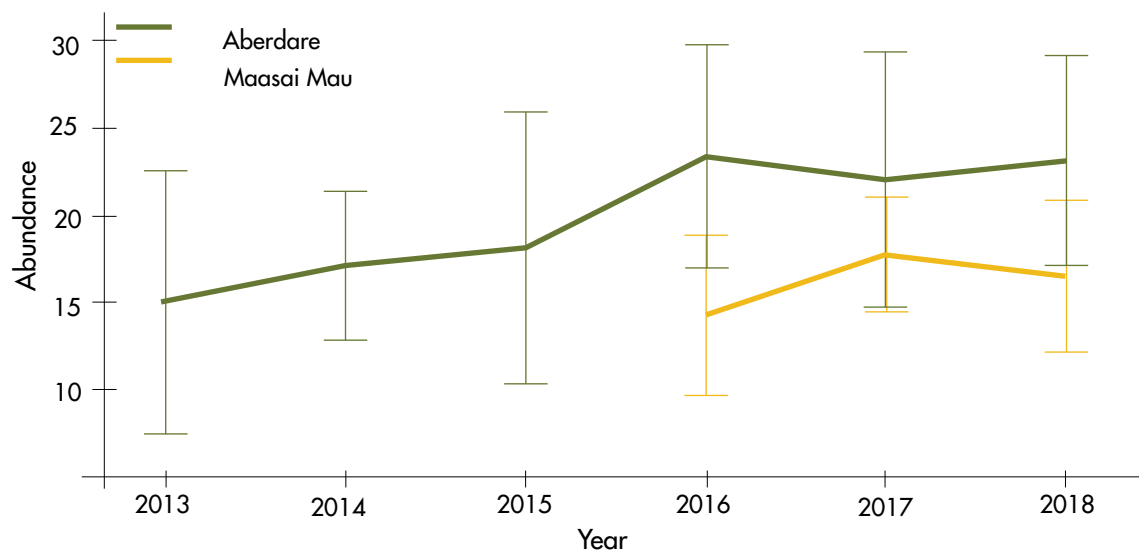
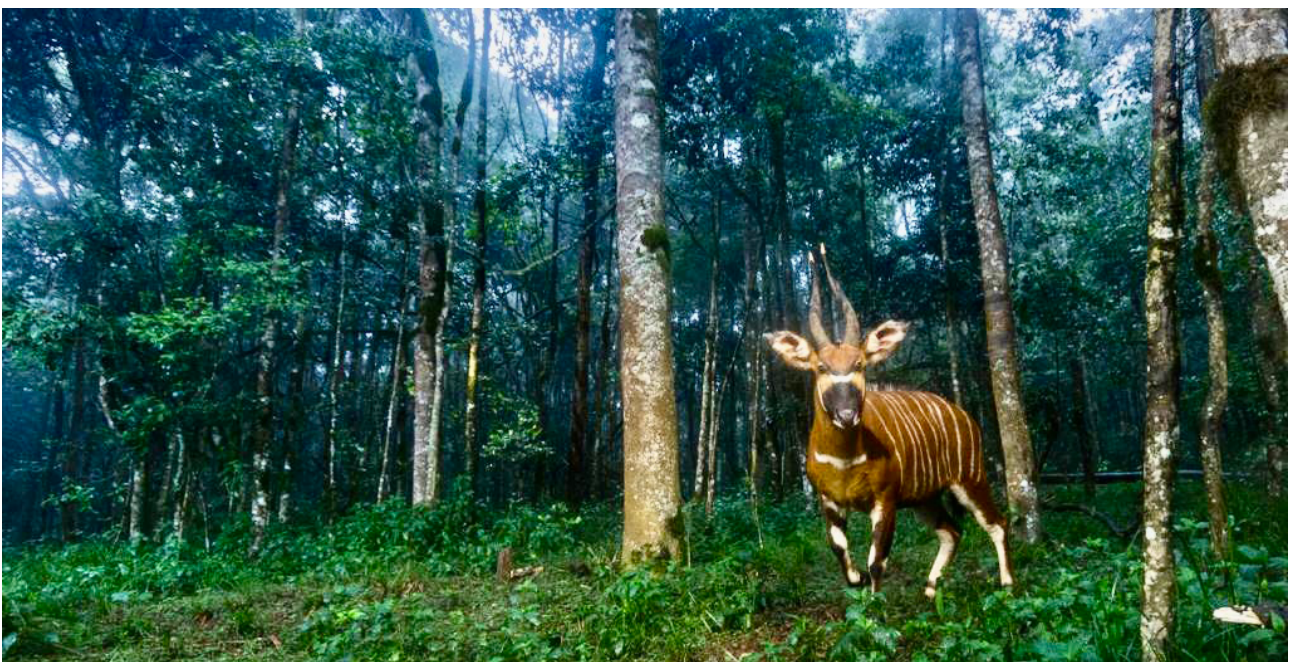


FIGURE 2: Population size estimates resulted from population monitoring of Aberdare (2013-2018) and Maasai Mau (2016-2018), from Sandri et. al., 2023



Caption: Wild female mountain bongo captured by Patrick Avery in 2023 by camera trap, in the Salient section of Aberdare National Park

As summarised in Table 1. It should be noted that, across the above reporting period, bongo population monitoring has occurred using two field methodologies. For BSP and Rhino Ark/Wild Calgry Zoo (RA/WICZ), continuous longtime studies have been the norm. In this system, a fleet of camera traps is established in an ecosystem in an “endless” fashion. Other studies (WRTI, MANMET) have had finite starting and ending points to their camera trap studies.

TABLE 1: Mountain bongo population estimates (February 2026)

Table 1(a): Wild mountain bongo population estimates (February 2026)

Site	Location	Current Population Estimate	Survey (method/year/source)	Comments
Aberdare	Salient	28-46	• Camera Traps/2013-2018/ Man Met, with BSP & KWS • Camera Traps/ 2022 & 2024/WRTI • Camera Traps/AI/2024/ CZ/MKWC • Camera Traps/2005-2026/ BSP	Refer to Sandri, Prettejohn et al., 2023
	SE Slopes	0	• Camera Traps/ Spoor/2017/Man Met	Putative spoor detected about 5 km from KFS Wanjerere station
	Northeastern - Kanjuiri	0	• Camera Traps/2012/BSP • Camera Traps/2016/Man Met	Last confirmed animal in 2012
Mt Kenya	Ragati/ Chehe	0	• Camera Traps/2018, 2022, 2023, 2024, 2025/ BSP, Rhino Ark, WICZ	Last confirmed animal August 2019
Eburu Forest Reserve		0	• Camera Traps, DNA/2016, 2018–2025/Man Met (2016), BSP, Rhino Ark, WICZ (2018-2025)	Last confirmed animal 1 July 2020 Sheppard DJ, Brichieri-Colombi TA, Stark DJ, Lambrechts C, Moehrensclager A and McPherson JM (2022) When Ecological Analysis Reveals Hidden Human Dimensions: Building on Long-Term Community Participation to Enable a Conservation Translocation of Mountain Bongo in Kenya. Front. Conserv. Sci. 2:788267.doi: 10.3389/fcosc.2021.788267
Mau Forests Complex	South west Mau / Transmara	0	• Camera Traps/BSP	Last confirmed animal in 1970s
	Maasai Mau	1-17	• Camera Traps/2013-2018/ BSP, Man Met (Sandri, Prettejohn et al., 2023)	Last confirmed animal from camera trap 22 December 2025 (O. Dyer, personal communication, Jan 29, 2026) Base population status incomplete and ongoing
Cherangani		0	• Camera Traps/2013/ Kimitei, MSc Thesis, University of Eldoret	Camera Traps/2013/Kimitei, MSc Thesis, University of Eldoret Refer to Sheppard DJ, Stark DJ, Muturi SW and Munene PH (2024) Benefits of traditional and local ecological knowledge for species recovery when scientific inference is limited. Front. Conserv. Sci. 5:1383611. doi: 10.3389/fcosc.2024.1383611
Mt Elgon	Uganda side	0	Camera Traps/2023/CZ	
Total		29-63		

Table 1 (b): Mountain bongo population estimates in breeding programmes in Kenya (February 2026)

Site	Location	Population Estimate
Mount Kenya	Mawingu sanctuary	25
	MKWC-Semi captive	75
	Marania/Muchene (MBRCT sanctuary)	14
Total		114

2.6 Mountain Bongo Genetic Status

The demographic history of the mountain bongo raises concerns about the genetic status of the remaining *in situ* populations. Some mountain bongo ranges are likely to have been isolated for many thousands of years, and the severe bottleneck since the 1970s means that the loss of genetic diversity and adaptive potential through genetic drift is inevitable. Inbreeding is also inevitable in small populations, and the associated inbreeding depression and possible inbreeding avoidance can have a pronounced effect on the fitness and reproductive potential of remnant populations.

Moreover, the current global *ex situ* population was founded by a small group of individuals ($N = 38$), all derived from the same population in the Aberdare. It is likely that at least some of these founders were related, and it is unlikely that the true level of inbreeding in current *ex situ* populations is accurately reflected in zoological studbooks, which typically assume that all founders are unrelated. This assumption was tested via simulations for the AZA and EAZA captive breeding programmes and results showed that founders were likely related (Sandri, 2020). With reintroductions into former ranges and the genetic rescue of remnant populations through reinforcement relying on the *ex situ* population, assessing the genetic relationships between and among *ex situ* and *in situ* populations, as well as determining levels of inbreeding within captive populations, is critical to the success of the mountain bongo recovery plans.

Several studies using different genetic markers have been undertaken on both *ex situ* and *in situ* populations of mountain bongo. The results of all these studies have shown strong evidence for genetic erosion and inbreeding, although with varying levels of effect. Faria et al. (2011) examined a 466 bp fragment of the mtDNA control region from faecal DNA collected in Mount Kenya, the Aberdare, Eburu, and Mau. The mtDNA control region is a non-coding section of the mitochondrial genome and is typically highly variable, making it an ideal marker for intraspecific population genetic studies. However, mtDNA is haploid and maternally inherited, representing a single locus, and is therefore typically less informative than studies of the nuclear genome, which use multiple polymorphic markers. Faria et al. (2011) found low levels of genetic diversity, with only two haplotypes detected across all four populations. One haplotype was present in all populations, while the second was found only in the Aberdare and Mount Kenya populations. O'Donoghue et al. (2017) and Cetkovská et al. (2024) both examined the same region of the mtDNA genome in ten *ex situ* animals. O'Donoghue et al. (2017) found no novel genetic variation in the captive population compared to the wild, although there was a higher frequency of the rarer wild haplotype in the captive population. Similarly, Cetkovská et al. (2024) found that the single haplotype detected in the captive population was underrepresented in the wild population.

Two studies have examined levels of genetic diversity and inbreeding using microsatellite markers in the EAZA captive population. Microsatellites are highly variable non-coding regions of the nuclear genome and are used as proxies for levels of genetic diversity and genetic signatures across the genome. Combe et al. (2018) developed 18 microsatellite markers and examined levels of genetic diversity in captive mountain bongo in the United Kingdom. Allelic richness was 3.8 ($SE \pm 0.3$), and expected heterozygosity was 0.47 ($SE \pm 0.04$), indicating moderate levels of genetic diversity in the 26 EAZA animals sampled. Contrary results on the genetic status of the *ex situ* EAZA population were reported by a more recent study by Cetkovská et al. (2024). Using a panel of ten microsatellite markers on ten individuals from the EAZA population, they found low levels of genetic diversity, with allelic diversity of 2.1 and an expected heterozygosity of 0.208, along with significant deviation from Hardy-Weinberg equilibrium. Inbreeding levels indicated very high inbreeding, with $F_{IS} = 0.260$ (95% CI: 0.059–0.441). F_{IS} is the proportion of variance in allele frequencies within a subpopulation due to non-random mating. Unlike pedigree-based inbreeding coefficients, it is not affected by assumptions about the relatedness of founders. A value of 0.260 is very high, exceeding that found in cases of parent-offspring reproduction or full-sibling mating.

Svengren et al. (2017) examined relatedness and genetic variation using a panel of single nucleotide polymorphism (SNP) markers in 97 mountain bongo samples—62 from the breeding sanctuary at the Mount Kenya Wildlife Conservancy (MKWC), and the remainder from *in situ* populations (Aberdare, $n = 22$; Mount Kenya, $n = 9$; Mau Forest, $n = 4$; and Eburu, $n = 2$), although it appears that only the results for the Aberdare population were reported. Unfortunately, the study does not provide details on the sample collection dates, but it is thought that the samples were collected several years prior to publication. Svengren et al. (2017) found high levels of relatedness in the MKWC, with most individuals related to the level of half-siblings, while most individuals in the Aberdare were unrelated. Expected

heterozygosity for the MKWC population was 0.40 (SD = 0.14), slightly lower than the Aberdare population at 0.45 (SD = 0.10). There were high levels of genetic differentiation between MKWC and the Aberdare population, with $F_{ST} = 0.028$ (95% CI: 0.016–0.042; $P < 0.0001$), despite the founders of MKWC originating from the Aberdare.

The results of previous genetic studies are complex, reflecting the use of different genetic markers, the populations sampled, the timing of sampling relative to population declines, and a lack of information on sample collection dates. However, the overall picture of the genetic status of both *in situ* and *ex situ* populations is consistent with their demographic histories and the founding of the *ex situ* population. Overall levels of genetic diversity are very low compared to other antelope species, with clear genetic differentiation between *in situ* and *ex situ* populations. More recent studies on the EAZA population highlight the importance of conserving the remaining, presumed novel genetic diversity in the remnant *in situ* populations particularly the Mau Forest population, which is not represented in the *ex situ* population or in the other remaining *in situ* population in the Aberdare. Levels of inbreeding appear to be very high, particularly in the *ex situ* populations, and current levels of inbreeding in *in situ* populations are likely not fully captured by previous studies. It is reasonable to assume that these populations also now exhibit significant inbreeding and would benefit from reinforcement.

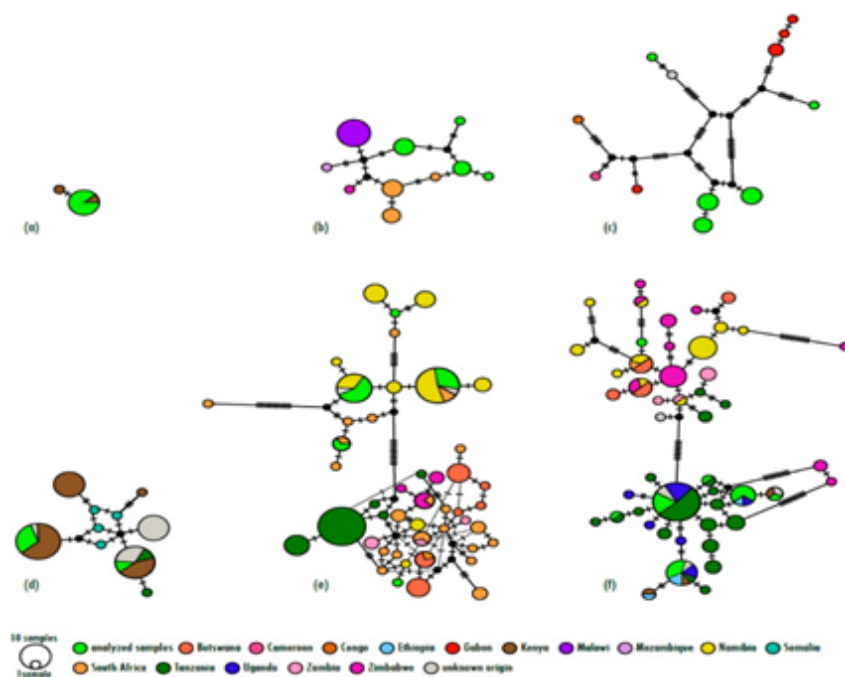


FIGURE 3: mtDNA haplotype networks

(a) the mountain bongo, (b) the nyala, (c) the sitatunga, (d) the lesser kudu, (e) the greater kudu, and (f) the common eland. Geographic origin is depicted through different colours and the size of the circles is proportional to the number of sequences of the given haplotype. Mutation steps are indicated through hatch marks and the length of lines is proportional to the number of mutation steps. Reproduced from Cetkovská et al. (2024).

03. Threats

3.1 Threats to the Mountain Bongo Populations and Habitats



Poaching/Hunting. Consumptive use of wildlife in bongo habitats, particularly through the use of snares, poses a severe threat to mountain bongo, even when they are not the targeted species. Due to current small population sizes, any offtake can have a significant impact on demography and long-term viability. The loss of a single reproductive-age female mountain bongo could take approximately three years to replace. In such small populations, the death of just one or two adult females can result in a significant decline in the population's reproductive potential. Moreover, the disturbance caused by hunting activities (particularly with dogs) can further pressure bongo herds, potentially forcing them into sub-optimal habitat and increasing stress levels.



Habitat degradation and land cover change (illegal human activities). Activities such as illegal logging, livestock grazing and charcoal production detrimentally impact bongo habitat. Such activities can reduce ecological carrying capacity and habitat suitability, and cause mountain bongo to move to either less secure or less suitable areas.



Permitted activities not compatible with bongo conservation (e.g., beekeeping and domestic livestock). Whilst permitted, specific activities in mountain bongo areas have the potential to negatively impact populations. Beekeeping often results in uncontrolled wildfires and livestock grazing increases the potential for disease transmission in addition to negatively impacting bongo habitat and increasing human disturbance.



Disease. The health of mountain bongos in breeding programmes is threatened by a range of infectious diseases, many of which are shared with domestic livestock or endemic to forest-edge ecosystems. Rinderpest was a significant threat to mountain bongo and one of the main drivers of population decline. Rinderpest was eradicated in Kenya in 2001 and currently does not pose a threat to populations. Current disease threats which can be severe are the following: **tick-borne diseases**, particularly *Theileria* especially in naive animals introduced into enzootic areas, where infections can be rapidly fatal if not anticipated and managed. **Parasitic infestations**—particularly gastrointestinal worms and liver flukes—are common in captive and semi-wild populations, leading to chronic weight loss, anemia, and lowered reproductive success if not routinely managed. **Bacterial diseases** of concern include **tuberculosis (TB)**, particularly *Mycobacterium bovis*, which poses a high risk due to potential spillover from cattle and humans. **Clostridial infections**, especially **enterotoxemia**, can cause sudden death in young or stressed animals, while **Salmonella** and **E. coli** may lead to septicemia and diarrhea outbreaks, particularly in calves. Viral diseases such as **malignant catarrhal fever (MCF)**—transmitted from sheep—and **bovine viral diarrhea (BVD)** represent serious risks that may suppress immunity and impact breeding success.

A bacterial disease that is important to be aware of would be **anthrax**, a soil-borne bacterial disease caused by *Bacillus anthracis*, which can be a potentially devastating threat to bongo populations. The spores can persist in soil for decades, especially in areas with a history of livestock outbreaks. Proactive strategies, including **vaccination in high-risk zones**, **strict carcass disposal protocols**, and **ongoing soil surveillance**, are essential to prevent the introduction or resurgence of this fatal disease within breeding populations.

Key disease and health considerations relevant to both *in situ* and *ex situ* programs are summarized in Table 2 at the end of the chapter.



Plant toxicity. Reports from the 1960s indicate that *Mimulopsis solmsii* could represent a threat to the mountain bongo. The plant, which is associated with bamboo habitat, is a potential food source for the mountain bongo. Reportedly, the plant, when it flowers approximately every seven years, becomes toxic and was responsible for significant deaths in mountain bongo populations in the Mau and Mount Kenya during the 1960s.



Predation. Predation particularly by spotted hyena and leopard poses a threat to mountain bongo populations. Typically, large healthy populations are not regulated by predation, but for small populations such as the current mountain bongo populations, predation pressure can have a significant impact on demography and population viability.



Infrastructure. Current plans are to construct a public highway, which will bisect the Aberdare and form a significant ecological barrier between the north and south of the Aberdare. The construction of the highway will have a significant impact on future plans for mountain bongo population expansion according to the targets set out in the strategy. The planned fenced rhino sanctuary in the Salient area has the potential if not sited correctly to impact on the mountain bongo population in this area and future population expansion. It is essential that there is harmonization between the management strategies and plans for the black rhinoceros and mountain bongo to ensure that the objectives are met for both species in the Aberdare.



Small Population Size. One of the biggest threats to current mountain bongo populations and their recovery is small population size and population fragmentation. It is well-documented that populations below the minimum viable population (MVP) size are highly susceptible to further declines and extinction due to random (stochastic) factors and allele effects, even in the absence of deterministic threats such as habitat loss and poaching.

Deriving realistic MVP estimates is species-specific and requires detailed life history data, along with information on how environmental variation affects mortality and population growth which is extremely difficult to derive from wild populations. An old rule of thumb, the 50/500 rule, states that populations should have at least 50 individuals to prevent inbreeding and 500 to avoid genetic drift (loss of adaptive potential). However, current species-specific MVP estimates suggest that populations in the thousands are necessary for long-term persistence (Traill et al. 2007).

In small populations, stochastic (random) factors can interact to further reduce population size and lead to extinction as highlighted in Table 3 at the end of the chapter. Given the current demographic status of the mountain bongo, it is fair to postulate that even in the absence of external threats (deterministic factors) current populations are below viable population size. In the current situation the reinforcement of populations is critical to the successful recovery of the mountain bongo.

All threats to the mountain bongo population are summarised in Table 4 at the end of the chapter. Table 4 shows threat scoring to analyse and compare the severity of different threats to wild mountain bongo populations and their habitat with respect to scope (extent), severity (impact), timing (current) and irreversibility. The scores give an overall threat on a scale of 1-3 as Low (1), Medium (2) and high (3).

TABLE 2: Disease and health considerations for *in situ* and *ex situ* programmes

#	Issues of concern	Consideration	Possible solutions and interventions
1	High vulnerability to parasitic, bacterial, and viral infections, especially in semi-captive settings.	Strengthening disease prevention and health surveillance	- Establish standardised veterinary protocols for routine health checks, vaccination, deworming and tick control across all breeding sites. - Implement active disease surveillance with regular fecal sampling, bloodwork and postmortem reviews. - Adoption of digital health tracking systems for real-time monitoring of individual animals and herd trends. - Develop and implement low-stress handling protocols with veterinary oversight. - Develop and implement a standardised disease and health monitoring dashboard across all the sites. - Align bongo veterinary priorities with national wildlife health strategies and biodiversity frameworks.
2	Small founder populations risk inbreeding and genetic disorders, reducing disease resistance.	Enhancing genetic health and diversity	- Maintain a national studbook in partnership with global <i>ex situ</i> bongo programmes. - Encourage gene flow through strategic transfers between breeding centers.
3	Lack of species-specific vaccines; reliance on livestock formulations with variable safety and efficacy.	Improving vaccine access and application	- Validate commonly used livestock vaccines for safety and efficacy in bongos through pilot studies. - Secure funding to develop or import wildlife-appropriate vaccines (e.g. for clostridial diseases, FMD).
4	Close contact with humans and livestock increases the risk of zoonotic disease transmission.	Reducing zoonotic and spillover risks	- Create and enforce buffer zones between bongo breeding areas and grazing lands. - Implement One Health outreach programmes to vaccinate local livestock and raise community awareness. - Introduce biosecurity protocols at breeding facilities, including footbaths, PPE and staff health screening.
5	Exposure to pesticides, herbicides, and contaminated water sources from surrounding farmland.	Addressing environmental and toxicological hazards	- Conduct annual water and soil quality testing at all bongo enclosures and adjacent areas. - Establish emergency detox protocols and training for staff in case of chemical exposure.

TABLE 3: Stochastic factors which can reduce population size

Factor	Effect
Inbreeding and inbreeding depression	- Inbreeding is inevitable in populations of small size and in the majority of species leads to a reduction in fitness due to inbreeding depression. - Inbreeding avoidance where reproductive rates decline in response to increasing inbreeding has been documented in a number of species.
Loss of genetic diversity	- Loss of genetic diversity is a function of a reduction of population size (bottleneck) where rare alleles (genes) are lost and the genetic composition of the pre and post bottleneck population differ. - Genetic drift which is the random sampling of alleles (genes) in a small population, leads to changes in the frequency of alleles. Drift results in the loss of genetic variation and the diversification of populations (in the absence of dispersal) over time. The magnitude of effect is directly proportional to population size and smaller populations lose genetic diversity at a faster rate than large populations. - Loss of genetic diversity often leads to a reduction in fitness and leads to a reduction in the adaptive potential of a population.
Environmental stochasticity	Environmental stochasticity refers to the unpredictable variation in environmental conditions over time and space. This variation can involve factors such as weather (e.g., drought), food availability, disease, and competition. Small populations are particularly vulnerable to environmental variability. For example, a disease outbreak in a large population is unlikely to eliminate all individuals, whereas the same disease could potentially wipe out an entire small population.

Demographic stochasticity	- Demographic stochasticity is the random variation in population size due to the probabilistic nature of births and deaths in a population. In a population the birth and death of each individual is discrete and probabilistic, in small populations these rates can differ from a normal distribution. It increases the risk of extinction in small populations. - Demographic stochasticity has a more pronounced influence on extinction and population growth in populations of very small size < 25 individuals. It is accepted that populations must be larger than 50 to 100 individuals to escape the immediate effects of demographic stochasticity. - In populations of approximately 150 individuals the effects of environmental stochasticity are approximately 10 times larger than demographic stochasticity.
Allee effect	The Allee effect is not strictly a stochastic factor but is still a function of population size and extinction risk. The Allee effect is the relationship between population density and fitness. Low density can influence cooperative anti-predator behaviour, communal rearing of young and the ability to find suitable mates.

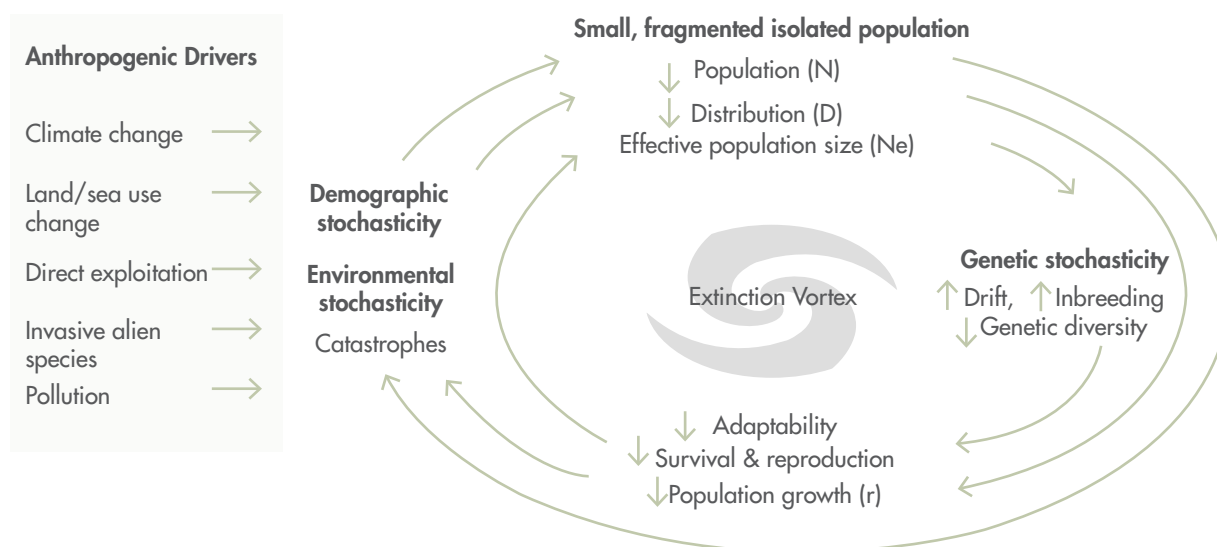


FIGURE 4: An extinction vortex.

A feedback cycle that results in a decline in population size due to stochastic factors associated with small population size, extinction is possible even in the absence of the factors which initially drove the population to small size. *Reproduced from Godwin et al. (2020)*

Table 4 shows threat scoring to analyse and compare the severity of different threats to wild mountain bongo populations and their habitat with respect to scope (extent), severity (impact), timing (happening now) and irreversibility. The scores give an overall threat on a scale of 1-3 as Low (1), Medium (2) and high (3).

TABLE 4: Threat assessment to mountain bongo by specific area

	Ecosystem	Area	Poaching/ Hunting	Habitat degradation and land cover change (illegal Human activities)	Permitted activities not compatible with bongo conservation (e.g. beekeeping and domestic livestock grazing)	Diseases	Plant toxicity	Predation	Infrastructure	Human settlement	Comments/ Remarks
1	Aberdare National Park/Forest Reserve	Salient	Low	Low	Low	Unknown	Unknown	High	Low	Low	
		Upper Honi	Low	Low	Low	Unknown	Unknown	Medium	Low	Low	
		Kanjuiri	Medium	Medium	High	Unknown	Unknown	Low	Low	Low	
		South Eastern Slopes	Medium	Medium	Medium	Unknown	Unknown	Low	High	Low	Disputed highway
2	Mount Kenya NR/Forest Reserve	Ragati/ Chehe	Low	Low	Medium	Unknown	Unknown	Low	Low	Low	
		Marania Sanctuary	Low	Low	Low	Unknown	Unknown	Low	Medium	Low	Existing dam
		MKWC Captive Bongos	Low	Low	Low	Medium	Unknown	Low	Low	Low	
		MKWC Mawingu Sanctuary	Low	Low	Low	Low	Unknown	Low	Medium	Low	Proposed dam
3	Eburu Forest reserve		High	Low	Medium	Unknown	Unknown	Medium	Low	Low	
4	Mau Forest Complex	South Western Mau / Transmara	High	High	High	Unknown	Unknown	Unknown	Medium	Low	Itare Dam
		Maasai Mau	High	High	High	Unknown	Unknown	Low	Low	High	Domestic livestock is found at the lower end of Maasai Mau
5	Cherangani		High	High	High	Unknown	Unknown	Unknown	Low	High	
6	Others- Londiani Forest Reserve/ Lembus Forest reserve, Mt Elgon, Chepalungu		High	High	High	Unknown	Unknown	Unknown	Low	High	

04. Stakeholder Analysis

To facilitate effective implementation of the action plan, support from relevant stakeholders at all levels will be critical. The stakeholder's consultative workshop on development of the second edition of the National Recovery and Action Plan for The Mountain Bongo identified relevant stakeholders in various categories as shown in Table 5 below;

TABLE 5: Mountain bongo stakeholder mapping

#	Category	Tier 1 - Directly mandated on conservation and research	Tier 2- Need to be engaged to support implementation	Tier 3 - Facilitative role
A	Government Agencies	• KWS • WRTI • NMK • KFS (HQs, Nyeri- Central Highlands and Nakuru –Mau Conservancies, Eastern Conservancies) • Directorate of Veterinary services	• National Government Administration Officers (NGAO) • Kenya Space Agency (KSA) • NEMA	• Ministry of Tourism & Wildlife (MoT&W) • Ministry Environment, Climate Change and Forestry • Wildlife Clubs of Kenya (WCK) • Tourism Promotion Fund (TPF) • KTB
B	County Governments	• Narok		• Nyeri, Meru, Laikipia, Nakuru, Bomet, Baringo Muranga / Kiambu , Nyandarua, Embu, Kirinyaga
C	Conservation Organisations/ programmes	• Rhino Ark / Wilder Institute Calgary Zoo • Bongo Surveillance Project • Mount Kenya Wildlife Conservancy • Mount Kenya Trust • Ragati Chehe Mountain Bongo Conservation Trust • Eburu Rafiki • Meru Bongo Rhino Conservation Trust • Loldia Eburu Project • CFA's (Muringato, Ndaragwa, Ragati, Chehe, Ontulili, Nanyuki, Marania/ Muchene, Ndoinet, Eburu • Other potential areas: Chepalungu, Londiani, Lembus, Mt. Elgon, Cherangani-Kiptaber, Kipkunwa, Irangi, Castle, Wanjerere, Zoti, Kiandongoro, Kimakia, Gatere, Hombe	• Chester Zoo • Rare Species Conservatory Foundation (RSCF) • European Association of Zoos and Aquaria (EEP) • AZA Antelope TAG • International Bongo Foundation	• Lewa Wildlife Conservancy • Mara Elephant Project • Dvur Kralove Zoo

#	Category	Tier 1 - Directly mandated on conservation and research	Tier 2- Need to be engaged to support implementation	Tier 3 - Facilitative role
D	Universities/ institutions of higher learning and research institutions	• WRTI • National Museums of Kenya	• ILRI • Masai Mara University • Manchester Metropolitan University • North Kenya Veterinary Services • KEFRI	• Universities and Colleges (Dedan Kimathi University of Technology, Chuka University • Karatina University • JKUAT, University of Nairobi, Liverpool John Moores University) • Mpala Research Centre • Florida International University/Tropical Conservation Institute • Other local universities
E	Local communities, private landowners and business operators	• Communities living adjacent to mountain bongo range, Private and community landowners	• Ecolodges, hotels and tour operators, Community-based organizations • Mount Kenya Safari Club • Ragati River Management Ltd • SGS Kenya	
F	Inter-Governmental Organizations		• CITES • IUCN SSC KNSSG • IUCN SSC ASG • UNESCO World Heritage Sites	• CBD • AU • EAC

05. Conservation and Management of the Wild Populations of Mountain Bongo and their Habitats

5.1 Conservation of the Remnant Wild Bongo Populations

Recent surveys reveal a worrying trend with only two known breeding populations of mountain bongo in the Aberdare and Maasai Mau, with neither of these populations likely exceeding 50 individuals according to recent estimates (Sandri et al. 2023). Enhanced monitoring of populations and habitats, along with a clear understanding of population dynamics is critical for guiding recovery efforts. Conservation of the remaining small *in situ* populations is essential for the long-term viability and adaptive potential of the mountain bongo.

Whilst the global captive population consists of over 800 individuals, genetic analyses indicate that the small remnant *in situ* population holds more genetic diversity than the captive populations (Faria et al., 2011; Svengren et al., 2017; Sandri 2020). Conserving this unique diversity in the wild population is vital (O'Donoghue et al., 2017; Cetkovská et al., 2024).

The conservation breeding program provides an opportunity for reinforcement of existing populations, and reintroduction into areas with suitable habitat where bongo have been extirpated. Consequently, the persistence of extant populations and the protection of remaining habitat are key to bongo conservation in the long term.

5.2 Monitoring Mountain Bongo Populations

Monitoring *in situ* mountain bongo populations is challenging and generally not possible through direct sightings. Therefore, indirect signs and remote sensing (particularly camera traps) provide the most effective means of monitoring bongos in the wild. There is a need to standardise monitoring and reporting among the different stakeholders across mountain bongo habitats. This is essential to track population trajectories, identify threats, and evaluate management interventions.

To improve monitoring, it will likely be necessary to expand efforts beyond known salt licks and implement systematic camera trapping over larger areas. Focusing only on salt licks, which are known to be utilised by bongos, risks missing individuals and groups and provides limited information on ranging behaviour, which is valuable for management and security. Furthermore, permanent, long-term camera trap monitoring is preferred over brief studies. The use of indirect signs (e.g., tracks, browse activity, resting sites; Estes et al., 2008) is useful both for identifying areas where bongos may be present and for guiding camera trapping efforts. Another improvement to long-term monitoring is found through GPS mapping of primary and secondary bongo signs recorded over months and years. Distribution mapping helps to determine bongo preferred habitat and change-over-time scenarios. Figure 5.2 illustrates cumulative bongo presence recorded in RA/WICZ camera traps between 2018 and 2021 and compares these records to historical BSP camera trap sightings from 2006 to 2016.

Capacity needs to be strengthened in bongo monitoring, standardisation, and reporting across different stakeholders. Expertise in recognising bongo indirect signs is limited, with few expert trackers available. However, the persistence of traditional ecological knowledge (Sheppard et al., 2024) should be embraced in developing tools to monitor the

species. Bongo tracks are often misidentified as those of waterbuck (*Kobus ellipsiprymnus*). While expert trackers can distinguish between them, the use of quantitative tools, such as the one designed in collaboration with MKWC (Sandri et al., 2023), could be implemented more widely in the field to aid accurate track identification.



FIGURE 5.1: Male mountain bongo caught in camera traps at Eburu Forest Reserve in 2019 (RA/WIRZ, 2019)

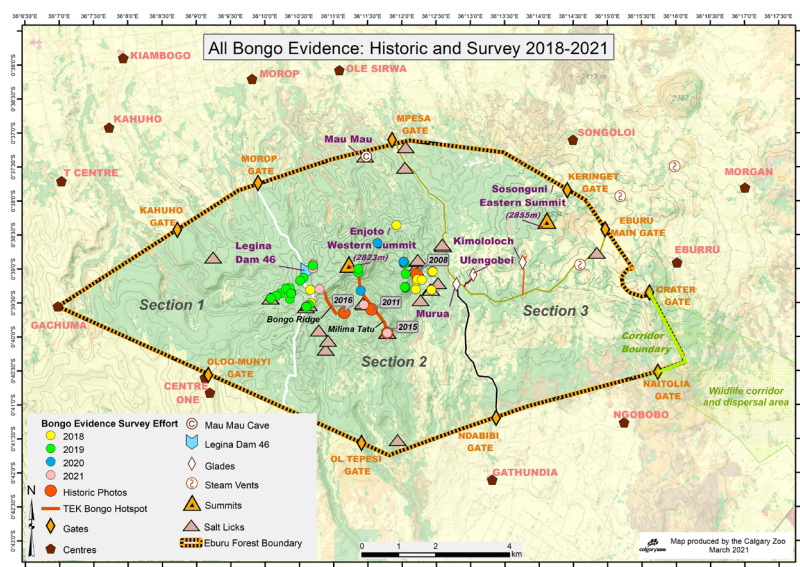


FIGURE 5.2: Cumulative primary bongo observations 2006-2021 (2008-2016 BSP [now MBP]; 2018-2021 RA/WICZ)

5.3 Monitoring Mountain Bongo habitat

Habitat monitoring should focus on assessing habitat suitability for reintroduction and reinforcement, detecting habitat change in mountain bongo areas (including the presence of invasive alien species), and evaluating human impacts. Rigorous monitoring will facilitate the early detection of threats to populations and increase the likelihood of successful translocations. Monitoring should be conducted periodically using standardised methods (including repeated surveys of the same vegetation plots) and consistent reporting. Several methods are available for forest monitoring, which should be reviewed, refined where necessary, and adopted as a standard approach by stakeholders involved in monitoring. As with population monitoring, there is also a need to strengthen stakeholder capacity.

Current monitoring efforts include the following: BSP, in collaboration with KWS and KFS, monitors habitat and illegal activities in parts of the Mau where bongos previously occurred, with regular patrols in South West Mau and the Trans Mara. Bongo have been continually monitored in Eburu Forest Reserve and Ragati/Chehe Forest, Mt. Kenya since 2018 and 2020 respectively with support from Rhino Ark in collaboration with Wilder Institute Calgary Zoo. Both Eburu and Ragati/Chehe Forest are considered potential reintroduction sites. The Wildlife Research & Training Institute also conducts monitoring in the Aberdare.

Standardised population and habitat monitoring will enable refinement of habitat suitability models to identify reintroduction areas at larger spatial scales. Previous studies have highlighted areas that may still provide suitable bongo habitat. Estes (2011) predicted suitable areas within the Aberdare and Mt. Kenya, while Sandri (2020) developed a model based on data points from breeding areas (the Salient in the Aberdare and Maasai Mau) and extended predictions to Mt. Kenya and Eburu (see Appendix 4).

5.4 Use of Technology in Monitoring Mountain Bongo Populations and Habitats

Camera traps are valuable for monitoring mountain bongo populations but generate large volumes of non-specific data, requiring significant effort to extract relevant information. Deployment and data retrieval are also labour-intensive. AI-based tools that automatically identify species in images offer potential to address these challenges.

Recent trials of AI-enhanced camera traps in the Salient of the Aberdare have shown promising results (Figure 5.7 and Figure 5.8) (Sandri, unpublished data).

Drones equipped with thermal imaging cameras provide another effective monitoring approach, as demonstrated in other forest systems (Whitworth et al., 2022). Similarly, Earth observation-based remote sensing has proven effective for tracking land cover change and forest degradation globally (Morrison et al., 2018). Collaboration among stakeholders, including the Kenya Space Agency, will facilitate remote monitoring of mountain bongo habitats, while captive populations offer opportunities to develop, test, and implement monitoring tools for wild populations (Sandri et al., 2023).

Integration of AI-enhanced camera traps, thermal drones, and satellite-based remote sensing into a coordinated, standardized monitoring protocol should be explored to improve detection accuracy, track population trends, and assess habitat quality across the species' range.



FIGURE 5.3: AI-enhanced camera traps in the Salient of the Aberdare (Chester Zoo & MKWC, 2025)



FIGURE 5.4: AI-enhanced camera traps in the Mawingu Mountain Bongo Sanctuary (Chester Zoo & MKWC, 2025)

06. Breeding and Reintroduction Programmes: Abroad and Local

6.1 Global Mountain Bongo Population

The international studbook has records of 3,613 animals from 1931 to present day. This global population has 38 identified founders, imported from Kenya (Aberdare National Park) between 1970 and 1978. The current global *ex situ* population of mountain bongo, as recorded in the Zoological Information Management System (ZIMS), is estimated as 812 animals across 139 institutions worldwide. This includes the Mount Kenya Wildlife Conservancy (MKWC) population, which hosts 100 animals; a European EEP population of 180 (58.122) animals across 47 institutions; and an American AZA population of 170 (63.106.1) animals in 37 institutions. Approximately 395 (142.192.61) animals are recorded at non-AZA US institutions with mainly private holders.

6.2 Mount Kenya Wildlife Conservancy Population

The Mount Kenya Wildlife Conservancy (MKWC) was granted a long-term user license by Kenya Forest Service for 776 acres in 2022 to be developed in phases with phase I which established the fenced Mawingu Mountain Bongo Sanctuary covering 25 acres. Located within the Mount Kenya Forest Reserve, this sanctuary consists of undisturbed forest within the mountain bongo's historical range. It provides the institution with an opportunity to both breed and rewild bongos in a secure and ecologically appropriate setting. The MKWC population descends entirely from the original Aberdare-sourced founders. A remnant group of 18 individuals from this founder population was later supplemented by 18 bongos imported from Association of Zoos and Aquariums (AZA) institutions in 2004. The current population of 100 bongos at MKWC consists of descendants from these two founding groups, forming a genetically traceable and managed lineage critical to ongoing breeding, reintroduction, and recovery efforts in Kenya.



Caption: MKWC bongo being released into the Mawingu Mountain Bongo Sanctuary

At MKWC, bongos are bred in natural forested enclosures in herds of approximately five adult females with one adult bull, determined by mean kinship to minimise inbreeding. Herd structures are designed to mimic the natural social behaviour of wild bongos. The animals are allowed to live in the forest enclosures to reacquire wild instincts, which are essential for survival.

Before transfer for release into the sanctuary, selected individuals undergo structured conditioning to accelerate acclimatization to wild environments. Selection is based on health, mean kinship, and behavioural readiness to ensure optimal survival potential. After release, bongos are closely monitored using AI camera traps, trail cameras, and human trackers to assess their adaptation, habitat use, and survival in a natural environment.

6.3 Meru Bongo and Rhino Conservation Trust (MBRCT)

The MBRCT project is an innovative public private community partnership program (PPCP) anchored in community-based conservation, involving the reintroduction of two critically endangered wildlife species (the mountain bongo and black rhinoceros) into a landscape conserved and managed by communities in a government forest. The project is envisioned as a broad partnership, incorporating National and Meru County governments, local communities and the private sector.

The County Government of Meru, Lewa Wildlife Conservancy, and Rare Species Conservatory Foundation, in support of the Kamulu and Ntimaka Community Forest Associations (CFAs) and in collaboration with the Kenya Wildlife Service and Kenya Forest Service, initiated the process to establish a black rhino and mountain bongo sanctuary in the Marania and Muchiene forest blocks of the Mt. Kenya ecosystem in April 2020. The Kenya Forest Service (KFS) granted a long-term user license for 101 hectares (250 acres) to establish holding and breeding facilities and to facilitate gradual reintroduction. The purpose of the project is to establish a founder population that contributes to species recovery efforts and gradually reintroduces animals to their former ranges, while benefiting local communities and aligning with priority actions identified in the current subspecies action plan.

Seventeen (17) mountain bongos (12 females and 5 males) were repatriated from the Rare Species Conservatory Foundation (RSCF), Florida, USA, on 23 February 2025. The individuals successfully completed the quarantine period and are now adapting well to their new environment.



Caption: MBRCT bongo arriving in Kenya on the 23rd of February 2025

6.4 EEP Population (Europe)

The EEP population of mountain bongo is currently made up of 183 (60.122.1) animals at 47 institutions. With 35 founders, 98% of the pedigree is known and has a genetic diversity value of 0.91 and mean inbreeding of 0.0861, the EEP population should be able to maintain a healthy population, maintaining its genetic diversity for many years. However, this relies on the assumption of unrelated founders, and as all animals were sourced from one population in the Aberdare National Park genetic studies are required to establish the actual genetic diversity. Initial genetic studies into the mountain bongo captive population have highlighted that genetic diversity is indeed significantly lower (O'Donoghue et al. 2017; Combe et al. 2018; Cetkovská et al. 2024), but as these studies only used low sample sizes, further studies are needed (however see section 2.5). The population reached a maximum of 231 in 2004, slowly decreasing to 176 animals in 2023.

With a plan to increase the EEP population to a target of 250, there has been a recent increase in breeding recommendations leading to the start of a return to growth in recent years. While all animals in zoos, and those at the Mount Kenya Wildlife Conservancy, can be traced to the animals caught and exported from the Aberdare National Park in the 1970's, the AZA and EEP population have been managed in isolation for at least 7 generations (based on T value of 6.6 yrs). With the MKWC herd being related to the AZA population following the 2004 transfer, the EEP population could provide an increase in genetic diversity to the MKWC stock

Due to the nature of mountain bongo management, with single breeding males typically housed with 3–4 females, the EEP currently has a surplus of males. Some bachelor groups exist and can serve as a useful pool for future breeding, but overall, these males are more difficult to place, and many are not used in the breeding program. These animals, in particular, could provide a valuable source of genetic diversity for other mountain bongo populations.

Based on criteria including age, mean kinship, founder representation, and relatedness, four bulls will be selected and transferred to MKWC as breeding stock, with the transfer planned for April 2026. Building on lessons from the previous transfer in 2004, additional steps will be taken to minimize the risk of tick-borne parasites (*Theileria*). Enhanced biosecurity measures will include housing the animals in new standalone facilities and more hands-on management to allow close monitoring and treatment. Female cows will be introduced to the selected bulls based on suitability.

6.5 AZA and US Private Ranch population

The AZA population is currently made up of 234 animals from 37 institutions, but a larger population of 395 animals is known to be kept by private holders in larger herds. Following the repatriation of 18 animals from the AZA to MKWC in 2004, a further 17 animals were imported from Rare Species Conservatory Foundation, Florida USA in February 2025 to MBRCT. These animals provide a further source of animals in Kenya for future conservation efforts, with the potential for further transfers when required.

6.6 Global Meta-population

A recommendation from the 2019-2023 plan proposed managing the global population as part of a meta-population, made up of the sub-populations but functionally acting as a single population. The advantages would be to show resilience to short-term demographic and genetic effects.

6.7 Best Practice Husbandry Management Guidelines in Worldwide Zoos

Mountain bongos in captivity are managed in a variety of systems, ranging from hands-on management of typically smaller herds in zoos, to more spacious safari or ranch models with larger herds, and to expansive boma-style fenced areas within their natural environment at MKWC. Each system has its benefits and constraints, and over the years a wealth of knowledge and experience has been gained.

Working with MKWC, information from best-practice husbandry guidelines from zoos can provide a useful framework for managing mountain bongos in any newly established breeding sanctuaries. This would encompass nutrition, demographic, genetic, and disease management. Staff exchanges between zoos and sanctuaries could offer valuable learning opportunities, while also giving keepers insight into different approaches to mountain bongo husbandry and in-situ conservation efforts.

07. National Mountain Bongo Recovery and Action Plan (2026-2030)



Vision: We envisage self-sustaining populations of mountain bongo thriving across healthy mountain forest ecosystems by the year 2075, benefiting local communities and embraced as a national and global heritage.



Goal: Achieve a national population of 750 individuals by 2075 by securing self-sustaining populations of mountain bongo within healthy forest ecosystems in Kenya.

To achieve the vision and the overall goal, working targets for population size in the mountain bongo historical range were suggested as shown in Table 6.

TABLE 6: Working targets for population size

Region	Working Targets for Population Size	Region	Working Targets for Population Size in the long term (to be updated during action plan implementation)
Aberdare	300	Londiani	20
Mt.Kenya	250	Chepalungu	20
Mau	100	Cherangani	20
Eburu	20	Mt. Elgon	20
		Long term working population estimates	750

In setting these minimum population targets, contributors to the action plan:

1 Recognised

There is limited information on historic mountain bongo population sizes and structure in Kenya, and considerable uncertainty remains regarding current bongo numbers and status, particularly in West Mau, Eburu, and potentially Londiani. However, evidence of presence and population estimates exists for at least two areas: the Aberdare and Maasai Mau. Determining the ecological carrying capacity for a species in a given area is highly challenging and requires detailed monitoring to assess life-history characteristics of the population in conjunction with comprehensive information on the ecological factors that influence population performance. Consequently, estimating current and potential ecological carrying capacity is extremely difficult for all existing and potential mountain bongo habitats in the country. The

overall goal can be achieved through concerted efforts by stakeholders to manage the remaining wild mountain bongo populations and secure their habitats, as well as key parts of their former range, while leveraging opportunities provided by breeding sanctuaries, rewilding initiatives, and collaborations with ex situ breeding programs in Europe and the USA.

2 Accepted

That the predicted human population growth in Kenya is 2.3% p.a. (approximately 1 million people per year) and that there is a need for improved community livelihoods. Wide-scale human displacement from some areas is impossible. It is understood that the targets agreed are working targets and that the targets are below recommended thresholds for long-term demographic and genetic viability. In the short-term, the viability of some, if not all sub-populations, may depend on managing Kenyan stocks as an interconnected meta-population. Incorporating in-country and international captive populations into this meta-population could enhance overall viability. Furthermore, management must consider not only the numbers of animals but also their genetic qualities. These minimum population sizes may be reviewed as circumstances change.

Securing a sufficient number of animals in the wild is a key component of species recovery. However, determining what constitutes a “sufficient number” is a complex issue. For an elusive forest mammal like the mountain bongo, monitoring population size to assess whether targets have been reached presents an even greater challenge. Nonetheless numerical targets play an important role in sustaining momentum and evaluating progress within a recovery program. The physical, biological and ecological attributes of the species are key considerations in population restoration.

The following rules of thumb, taken from literature, were compiled to assist discussions of what might constitute achievable population size targets for bongo over the next 50 years a) for Kenya as a whole and b) in each bongo sub-population.

3 $N = > 50$ – Short-term Demographic Viability (e.g. Shaffer 1987)

Population targets are guided by established conservation genetics principles. While the traditional 50/500 rule (Franklin, 1980) provided an early benchmark for short-term genetic viability ($N \geq 50$) and longer-term evolutionary potential ($N \geq 500$), it is now widely regarded as a simplified and conservative guideline, with many authors recommending substantially larger effective and census population sizes (Reed et al., 2003). Contemporary approaches emphasise higher targets, often in the thousands, and the use of species-specific population viability analyses to ensure long-term demographic stability, genetic diversity, and resilience to environmental change (Flather et al., 2011). However, other authors have suggested that, given the difficulties of deriving species-specific population estimates, a long-term minimum viable population target of 5,000 individuals may be applied across taxa (Traill et al., 2010).

4 Functional Ecology and Sustainable Management

Other considerations may factor in setting target population sizes, such as the taxon’s function in the ecosystem. Maintaining this function across a taxon’s range (or former range) may require larger population sizes and densities than those required for population viability alone. There are several potential approaches to assessing where bongo should sit within this range, and a number of pieces of additional information which could usefully inform decisions. These include:

Historical population levels in Kenya: returning numbers to a size before the recent human induced bottleneck presents a useful starting point for discussion. However there is scant information on previous numbers other than a 1975 estimate by the Kingdon of 500 animals in the Aberdare. In addition, some sites such as Eburu have undergone extensive ecosystem changes in recent decades rendering historic levels impossible to achieve.

Potential population sizes of existing occupied sites and of those from which bongo have become recently extinct could provide a more realistic estimate of what may be possible in the short to medium term. Bongo Surveillance Project estimates of potential carrying capacity were as follows: Aberdare-600, Eburu-40, Mau-300, Mount Kenya-600. Additional recently vacated sites are considered to include: Cherangani (degraded), Londiani, Chepalungu, and Mount Elgon (disputed). No estimates of carrying capacity are available for these.

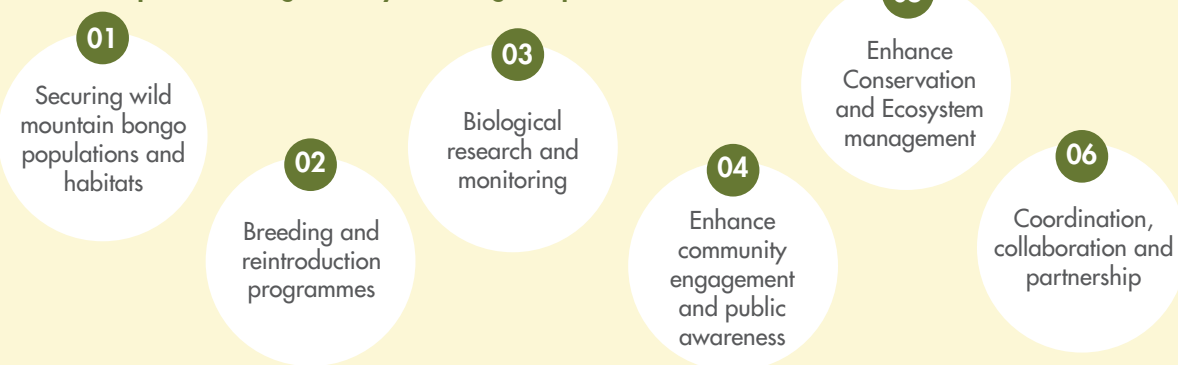
Theoretically possible growth rates: population models (Veasey, unpublished) suggest that if threats are removed and populations allowed to resume growth rates within the range observed in captive populations (7% per annum), bongo numbers could reach 3000 in 50 years. A population growth rate of 7% p.a. is in line with that observed in other antelope species.

5 Specific Goals

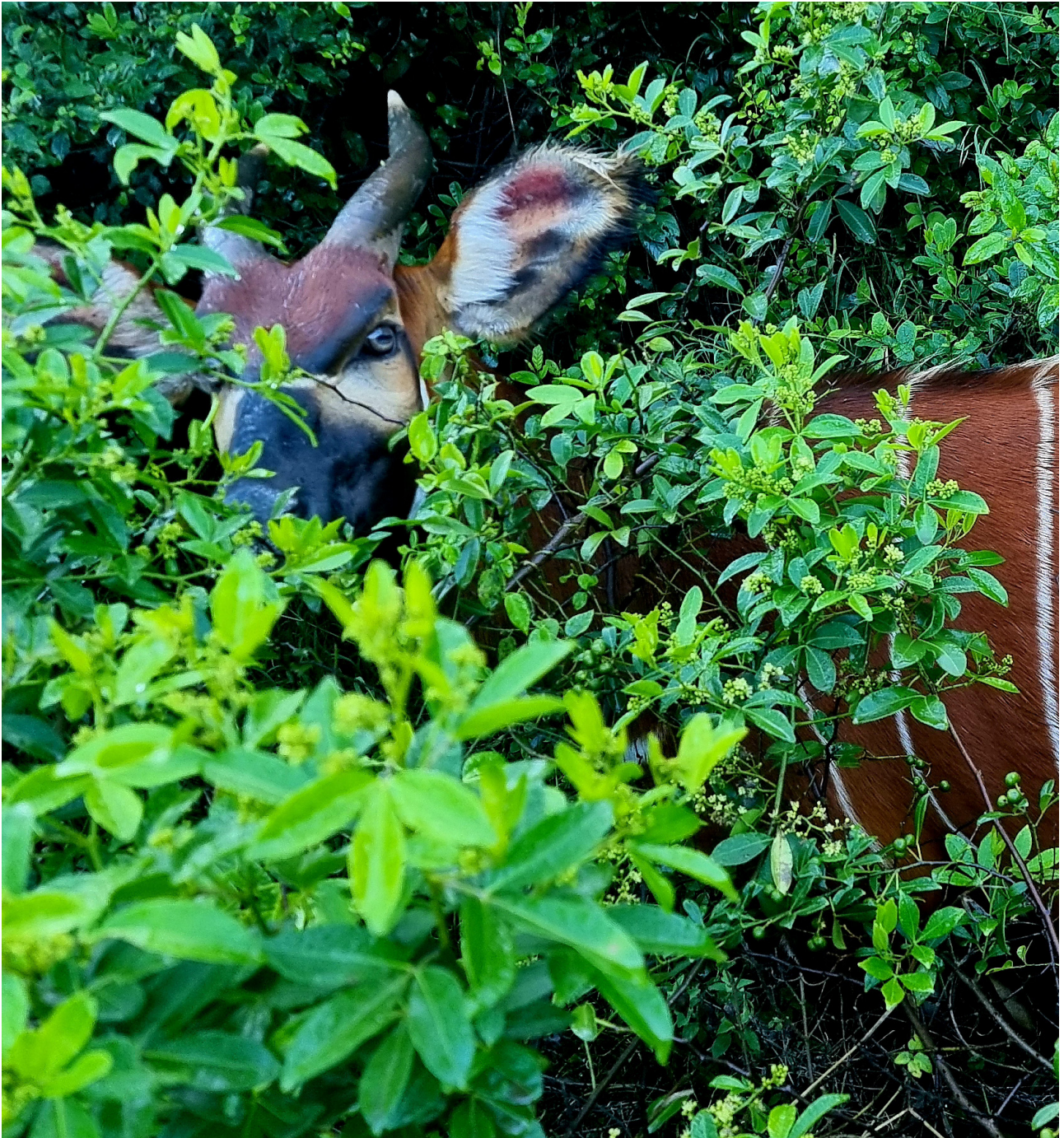
The action plan will focus on three specific goals over the next 5 years (2025 to 2030) focusing on the wild populations, breeding sanctuaries/reintroduction programmes and reintroduction programmes:

- 1. Wild Populations:** Secure and enhance growth in wild bongo populations within at least two ecosystems and explore opportunities for population reinforcement;
- 2. Breeding Sanctuaries and Reintroduction Programmes:** Establish increasing bongo populations in at least two breeding sanctuaries to provide animals for reintroduction / reinforcement;
- 3. Reintroduction Programmes:** Establish at least one forest release sites within suitable bongo habitat in former ranges to enable the re-introduction of pre-selected individuals.

The action plan will be guided by 6 strategic objectives:



The action plan delineates 23 clearly defined outcomes and target areas, encompassing 50 specific activities with established timelines and responsible actors as outlined in the logical framework in Table 7



Caption: A browsing sanctuary-bred bongo (MKWC, 2025)

TABLE 7: National mountain bongo recovery and action plan logical framework

OVERALL GOAL: Achieve a national population of 750 individuals by 2075 by securing self-sustaining populations of mountain bongo within healthy forest ecosystems in Kenya.

5-YEAR GOAL: Increase the national population by 50% by end of 2030

Strategic Objective	Target	Activities	Performance Indicators	Responsibility
Strategic Objective 1: Securing Wild Mountain Bongo Populations and Habitats	Target 1.1 Reduce illegal activities in all habitats with existing bongo populations	By the end of 2026, assess the extent of illegal activities in sites with wild bongo populations	Number of illegal activities documented in 2026 by joint security units pre-existing or established at each site	KFS, KWS, RA, MBP (BSP), MKWC, MBRCT, RCMBCT, WICZ, County Government of Narok, Mount Kenya Trust, respective CFAs
		By end of 2030, reduce illegal activities affecting all habitats with existing wild bongo populations by at least 90% compared to the above 2026 baseline	% reduction in illegal forest activity reports (vs. 2026 baseline)	KFS, KWS, RA, MBP (BSP), MKWC, MBRCT, RCMBCT, WICZ, County Government of Narok, Mount Kenya Trust, respective CFAs
		By 2030, establish and fully resource IPZs in all habitats with existing wild bongo populations	Number of IPZs operational by 2030 Number of trained rangers deployed % increase in patrol coverage (km ²) Number of joint operations conducted with partners	KFS, KWS, RA, MBP, RCMBCT, County Government of Narok, Mount Kenya Trust
		By end of 2030, reduce human activities (e.g. poaching) that could directly lead to wild bongo mortalities by at least 95% compared to 2026 baseline	% reduction in human activities (e.g. poaching) that could lead to bongo mortalities (vs 2026 baseline)	KFS, KWS, RA, MBP, MKWC, MBRCT, RCMBCT, WICZ, County Government of Narok, Mount Kenya Trust, respective CFAs
		By end of 2027, establish/ maintain intelligence network around / in all habitats within existing bongo populations and re-introduction sites	Number of intelligence units established and/or maintained	KWS, KFS, County Government of Narok
	Target 1.2 Review and streamline all surveillance technologies being used across ecosystems and stakeholders	By end of 2026, undertake a review of surveillance technologies being used by the various mountain bongo programs and stakeholders	Report on the surveillance technologies being used	Secretariat, Site programmes
		By end of 2027, pilot and deploy surveillance technologies in all habitats with existing wild bongo populations	Number of surveillance systems piloted/ deployed (e.g., AI cameras, LoRaWAN, GPS) Number of sites using technology-based monitoring systems	KFS, KWS, RA, BSP, MKWC, MBRCT, RCMBCT, WICZ, Mount Kenya Trust
	Target 1.3 Manage legal/ permitted forest activities and eliminate human-related negative species interactions	By 2026, document permitted activities with negative interaction with the mountain bongo and their habitats in specific sites with 2026 baseline	% reduction in number of negative interactions recorded per year (e.g., grazing and other permitted user rights)	Secretariat with information from site programmes, KWS, RA, BSP, MKWC, MBRCT, Ragati/Chehe Bongo Conservation Trust, County Government of Narok, Mount Kenya Trust, Eburu
		By 2027, identify and prioritise best approaches to manage permitted human activities in identified critical bongo habitats	Number and type of mitigation actions implemented	KFS, KWS, RA, BSP, MKWC, MBRCT, Ragati/Chehe Bongo Conservation Trust, County Government of Narok, Mount Kenya Trust, Eburu, CFAs
		By 2030, eliminate human related negative species interactions within 100% of IPZs	% reduction in the number of negative interactions recorded per year (e.g., grazing and other permitted user rights) using 2026 as the baseline	KFS, KWS, RA, BSP, MKWC, MBRCT, Ragati/Chehe Bongo Conservation Trust, County Government of Narok, Mount Kenya Trust, Eburu, CFAs

Strategic Objective	Target	Activities	Performance Indicators	Responsibility
	Target 1.4 Provide forensic evidence and prosecute cases with illegal activities negatively impacting bongos	By 2030, enhance prosecution of cases related to illegal activities affecting bongos	No of cases concluded	KWS
		Provide forensic evidence to enhance prosecution of bongo related poaching and bushmeat cases	No of cases with forensic evidence provided	KWS, WRTI
		By 2026, key mountain bongo sites have representation in Sub County and County Security Committees to enhance collaboration with NGAO	No of sites with representation to relevant security committees	KWS, Site management
		By 2028, key mountain bongo sites have representation in Court Users Committees (CUC's) to enhance collaboration with the judiciary	No of sites with representation to the local CUC's No. of engagement meetings with the judiciary	KWS, Site management
	Target 1.5 Ensure persistence and growth of current <i>in situ</i> populations	Assess demographic and genetic viability of each wild population (Aberdares, Masai Mau)	Wild population stable or increased compared to 2026 baseline	KWS, WRTI, NBTF
		Evaluate feasibility of releases to reinforce current wild populations		
Strategic Objective 2: Breeding, Reinforcement and Reintroduction Programmes	Target 2.1 Establish national guidelines and processes for best practices in management husbandry and disease control in breeding, reinforcement and reintroduction	By 2027, develop and implement national reinforcement and reintroduction guidelines aligned to the IUCN guidelines for reintroduction programmes	Reintroduction guidelines finalised and endorsed	KWS, WRTI, NBTF, IUCN
		By 2027, document desired genetic and demographic management, disease risk management and reinforcement/reintroduction strategies	Best practice document	NBTF, WRTI, IUCN, MMU, Chester zoo, genetic experts universities and research institutions
		By 2027, document key processes for establishment of bongo breeding, reinforcement and reintroduction programmes and adoption of best practice in management, husbandry and disease control	Process document and checklist and best practice procedures	KWS, WRTI, NBTF, IUCN, MKWC, MBRCT, Ragati/Chehe, Loldia/Eburu, Chester Zoo, Rhino Ark, Calgary zoo, RSCF
		Mountain bongo repatriation and reintroduction programmes within the action plan period 2026-2030 to be based on the national policy guidelines on introduction, reintroduction and donation of wildlife species	No of programmes approved in adherence to the guidelines	KWS, NBTF
	Target 2.2 Enable a growing mountain bongo population nationwide	By 2030, have a growing mountain bongo population (~ 5% pa) through intensive breeding, reinforcement and reintroduction programmes	% growth rate for each population Average national populations population growth rate	KWS, NBTF, MKWC, MBRCT, County Government of Narok, Ragati/Chehe, Loldia/Eburu, EAZA, AZA, RSCF
		By 2030, bongo breeding, reinforcement and reintroduction programmes established/sustained	MKWC and MBRCT programmes sustained/enhanced Assessments for new breeding and reintroduction and reintroduction programmes sites in suitable forest habitats undertaken and required capacity established to host a founder population of bongos	KWS, NBTF, MKWC, MBRCT, County Government of Narok, Ragati/Chehe, Loldia/Eburu, EAZA, AZA, RSCF
	Target 2.3 Prioritise mountain bongo reintroduction programmes in bongo-known historical bongo ranges	By 2027, identify and prioritise establishment of suitable sites for mountain bongo reintroduction in historical range	Ragati/ Chehe and Eburu reintroduction sites operationalised with a founder population of bongos	KWS, WRTI, NBTF, RA, Calgary zoo, BSP, Eburu, Loldia
			Assessments undertaken for other potential reintroduction sites as per the established criteria	KWS, WRTI, NBTF

Strategic Objective	Target	Activities	Performance Indicators	Responsibility
Strategic Objective 3: Biological Research and Monitoring	Target 3.1 Develop and deploy standardised protocols and surveillance technologies for the monitoring of wild bongo populations	By 2026, develop and deploy standardised wild population and habitat monitoring protocols	Monitoring protocols finalised Number of sites trained and using the standardised monitoring plan Monitoring reports	KWS, WRTI, IUCN, MMU, Chester zoo, NBTF, MKWC, MBRCT Ragati/Chehe, Loldia/Eburu projects
	Target 3.2 Establish a centralised database with harmonised status and bongo monitoring reports across all sites	By end of 2027, review and deploy appropriate monitoring and surveillance technologies across the mountain bongo habitats	Number of new monitoring technologies tested and validated Number of sites using suitable technologies Number of staff trained in new monitoring technologies	Rhino Ark, BSP, KWS, WRTI, MMU, MKWC, MBRCT, Chester zoo, NBTF, universities, research institutions
		By 2028, develop a centralised database with all the mountain bongo sites contributing data on mountain bongo populations and habitats	Database in place and being updated Number of sites providing data to update the centralised database	KWS, WRTI, NBTF, secretariat
		By 2028 derive site specific <i>in situ</i> mountain bongo population status base line reports including demographics and distribution for all areas then update annually	Site specific mountain bongo population status report including demographics and distribution Updated national wild mountain bongo population status report	KWS, WRTI, MMU, Chester zoo, NBTF, Rhino Ark, BSP, universities, research institutions
		Produce annual harmonised mountain bongo status reports	Standardised status report format developed Standardised reports from the existing programmes at MKWC, MBRCT, Aberdare, Masai Mau Ragati/Chehe and Eburu). Annual mount bongo status report	KWS, WRTI, NBTF, secretariat
		By end of 2027, review surveillance/monitoring technologies and deploy appropriate monitoring technologies across the mountain bongo habitats	Report on the effectiveness and adoption of the technologies by 2026 Enhanced mountain bongos populations and habitats at monitoring specific sites through use of appropriate technologies	KWS, WRTI, NBTF, Chester Zoo, Research institutions
	Target 3.3 Complete habitat mapping and feasibility studies for all potential mountain bongo reintroduction sites	By 2026, map critical bongo habitats covering the historical bongo range areas	% of historical range mapped Number of identified "hotspot" zones for conservation focus Habitat quality score (if defined) per mapped area	WRTI, MMU, Kenya Space Agency, Chester zoo, NBTF, universities, research institutions
		Conduct feasibility studies on potential mountain bongo reintroduction and reintroduction sites	Study report (s)	WRTI, MMU, Chester zoo, universities, research institutions

Strategic Objective	Target	Activities	Performance Indicators	Responsibility
	Target 3.4 Complete a management plan for the control of undesired plant species of concern (e.g. mimulopsis)	By 2028, map distribution of undesired plant species of concern (e.g. Mimulopsis) that might negatively affect bongos in critical areas (sanctuaries, extant wild populations)	% of critical areas mapped for undesired / dangerous plant species Inventory of undesired plant species for each site	WRTI, MMU, Chester zoo, Rhino Ark, universities, research institutions
		By 2030, develop and employ an undesired plant species management plan in identified priority sites	Number of sites implemented	KFS, KWS, Rhino Ark, BSP, MKWC, MBRCT, Specific site management
	Target 3.5	By 2027, develop site specific action plans profiling threats to mountain bongo populations and habitats and appropriate management measures	Sites being managed using site specific action plans	KFS, KWS, County government of Narok, Rhino Ark, BSP, Mount Kenya Trust, Ragati/ Chehe, Eburu
	Target 3.6 Complete Environmental and Social Impact assessments for all mountain bongo reintroduction programmes	By 2030, participate and provide input in ESIA processes involving proposals for construction of infrastructure in all forest habitats with bongo populations	No of sites where studies have been undertaken Presentation of study report and recommendations in appropriate forums No of forums attended No of presentation made % of recommended mitigations implemented Proposals on project alternatives agreed on and adopted	KFS, KWS, WRTI, County government of Narok, Rhino Ark, BSP, Mount Kenya Trust, Ragati/ Chehe, Eburu, CFA's, Universities, Research Institutions
		Petition development of infrastructure projects in critical mountain bongo habitats using appropriate procedures and channels	No of petitions Outcome of the petitions	Rhino Ark, BSP, Mount Kenya Trust, Ragati/ Chehe, Eburu, Research Institutions, CFA's
	Target 3.7 Complete a disease risk assessment and management plan for all breeding and reintroduction programmes	Carry out disease risk assessment for Mountain bongo breeding, reintroduction and reintroduction programmes and establish required capacity (or have access to required capacity) for disease surveillance, diagnosis and management by 2030 Develop capacity/ collaborate with identified facilities to undertake disease diagnosis, sample collection, testing, storage	No of sites where surveillance programmes have been undertaken Surveillance report and recommendations Site/ Programmes with onsite capacity Site/ Programmes with access to required capacity	KWS, WRTI, DVS, Authorised facilities and veterinarians KWS, WRTI, DVS, Authorised facilities and veterinarians
		Diagnose and treat all reported cases of sick bongos	No of cases attended Clinical intervention reports	KWS and authorised veterinarians
Strategic Objective 4: Community Engagement and Public Awareness	Target 4.1 Community engagement and participation strengthened in mountain bongo reintroduction programmes	By 2030, increase community participation in bongo conservation through appropriate site based engagement strategies	Type and number of community engagement strategies	Rhino Ark, BSP, MKWC, MBRCT, Ragati/ Chehe, Loldia Eburu, KWS, KFS, CFA's

Strategic Objective	Target	Activities	Performance Indicators	Responsibility
		By 2030, support at least one well thought out impact creating community led bio/enterprises in Bongo forest adjacent communities	Number of community-led conservation projects supported Number of new nature-based enterprises established % of adjacent communities benefiting from the supported projects	Rhino Ark, BSP, MKWC, MBRCT, Ragati/ Chehe, Loldia Eburu, KWS, KFS, CFA's
		By 2030, engage at least 10 community members/ groups through pro-conservation avenues (eg; community rangers, catering, tourism, maintenance works, community liaison, tree nurseries)	Number of livelihood initiatives Number of community members gainfully engaged	Rhino Ark, BSP, MKWC, MBRCT, Ragati/ Chehe, Loldia Eburu, KWS, KFS, CFA's
	Target 4.2 Mountain bongo education and awareness improved in forest-adjacent communities	By 2030, enhance education and awareness on mountain bongo conservation in bongo-adjacent communities and the general public	Number and types of platforms used Number of education/awareness sessions held for each site	Rhino Ark, BSP, MKWC, MBRCT, Ragati/ Chehe, Loldia Eburu, KWS, KFS, CFA's
		Conduct at least one awareness meeting annually with targeted messaging within bongo sites	Number of meetings	Rhino Ark, BSP, MKWC, MBRCT, Ragati/ Chehe, Loldia Eburu, KWS, KFS, CFA's
Strategic Objective 5: Conservation and Ecosystem Management	Target 5.1 Ecosystem management plans and PFMPs to contain critical bongo habitat zones	By 2027, develop/ review ecosystem management plans with habitat zonation covering all critical bongo habitats	Number of ecosystem plans updated/implemented Number of critical bongo habitats zoned Habitat suitability index applied in all sites	KFS, County government of Narok
		By 2030, manage critical bongo habitats in forests through well documented ecosystem management plans	Number of critical bongo habitats being managed through ecosystem plans % decrease in illegal activity within reserve boundaries Fire-risk assessments report	KFS, County government of Narok
		Review all PFMP upon their expiry to align them with the Ecosystem Management Plans	Updated PFMP	KFS, , County government of Narok
	Target 5.2 Design new nature reserves with bongo conservation enforced	By 2026, initiate the process of designating and operationalizing at least 2 new nature reserves with enforced protection measures for bongo conservation	Number of nature reserves designated	KFS, stakeholders
		By 2027, develop and adopt clear engagement structures between KFS, KWS, County Governments and stakeholders on establishment of mountain bongo programmes within the forest ecosystems	Clear engagement structures in place	KFS, KWS, County Governments, stakeholders
Strategic Objective 6: Coordination, Collaboration and Partnerships	Target 6.1 National regional and site specific bongo committees operationalised	By 2026, ensure that the National Bongo Task Force is functional and meeting as per schedule	Number of meetings held annually Minutes of meetings	KWS, NBTF, secretariat

Strategic Objective	Target	Activities	Performance Indicators	Responsibility
		By 2026, operationalize 2 regional committees for Mountain and Central rift areas and meeting as per schedule	Regional committees operationalised Minutes of the meetings	KWS Senior Assistant Directors for Mountain Conservation Area and Central Rift Conservation Area
		By 2026, formalize project site committees	Site committees recognised and included as part of the action plan Number of site committees with active programmes Minutes of the meetings	Site management
		By 2026, constitute and operationalize a secretariat to enhance coordination and implementation of the action plan	A functional secretariat established	KWS, NBTF
	Target 6.2 Ensure strong collaborations between all government, community, private and NGO stakeholders	By 2030, identify and foster collaborations and partnerships between KWS, KFS, County Governments, NGO's, CBO's to support mountain bongo conservation recovery programmes	No of collaborations and partnerships established	KWS, NBTF, Site projects
		By 2030, collaborations and partnerships established to mobilize resources and capacity to support implementation of the identified programmes and activities	Resources mobilized Priority programmes supported	NBTF, MKWC, MBRCT, Ragati/Chehe, Loldia/Eburu, specific project sites, EAZA, AZA, RSCF, IUCN, Chester zoo, MMU, project sites
	Target 6.3 Centralised monitoring and evaluation system established to competitively assess all mountain bongo reintroduction programmes	By 2026, develop and implement a standardised M&E framework	Framework develop and adopted	KWS, NBTF, Secretariat
		By 2026, develop a M&E tracking tool and score card	Tracking tool developed Progress scorecard and reports published (annual, midterm term, end term)	NBTF, Secretariat

To create an impact in the conservation and management of the Mountain Bongo in Kenya, the action plan identifies 3 priority areas as highlighted in Table 8;

TABLE 8: Priority high impact programmes and projects

#	Priority Programmes	Description	Timeframe	Source of funding
1	Enhanced monitoring and securing of wild population and their habitats in Aberdare and Masai Mau	Fencing and fence maintenance to secure critical mountain bongo habitats in mountain forests	2026-2030	Activity based budgets through partnerships and collaborations
		Establish security posts and deploy rangers and scouts		
		Adoption of appropriate mountain bongo populations and habitats monitoring technologies through site specific collaborative efforts among stakeholders	2026-2030	Activity based budgets through partnerships and collaborations
		Undertake surveys using standardised monitoring methods to establish baselines through site specific collaborative efforts among stakeholders		
2	Enhance the breeding sanctuaries, reintroduction and reintroduction programmes	Mount Kenya Wildlife Conservancy breeding program and Mawingu sanctuary	2026-2030	MKWC budgets
		Meru Bongo & Rhino Conservation Trust (MBRCT)	2026-2030	MKWC budgets
		Ragati/Chehe Mountain Bongo Conservation Trust	2026-2030	RA, Wilder Institute/ Calgary zoo budgets
		Lodia-Eburu/Eburu Forest	2026-2030	Safari collections budgets BSP, RA, Wilder Institute/ Calgary zoo budgets
3	Enhance coordination, collaboration and partnerships for effective implementation of the proposed programmes and activities	Effective NBTF, site committees and secretariat to support implementation of the identified programmes and activities	2026-2030	KWS, partners budgets
		Enhance community engagement and public awareness through targeted messaging in print, electronic media, documentaries, social media, websites	2026-2030	KWS, partners budgets

08. Action Plan Implementation

8.1 Coordination Framework

a. Policy and Management Support

The Kenya Wildlife Service (KWS) will serve as the lead agency coordinating all stakeholders in the implementation of the Conservation Action Plan for the Mountain Bongo.

Director General, KWS will provide guidance on major decisions in consultation with KWS Board of Trustees and the Ministry of Tourism and Wildlife on policy guidance

Implementation oversight will be provided by the KWS Senior Management, working in collaboration with the National Mountain Bongo Taskforce

b. Technical Support

The National Mountain Bongo Taskforce (NBTF) which is chaired by KWS with representation from WRTI and mountain bongo conservation and monitoring programmes and partners will provide technical and expert guidance on the best practices on conservation and management strategies for the Mountain Bongo. The membership to the NBTF is drawn from 11 national and local institutions & programmes, with representation from KWS, WRTI, KFS, MKWC, RA, Wilder Institute/Calgary Zoo, MBRCT, MKT, Ragati & Chehe Mountain Bongo Trust, BSP, Loldia Eburu. Five (5) international institutions have been co-opted to provide other areas of technical expertise to the taskforce. These include Chester zoo, RSCF, EAZA, MMU and IUCN. The committee will hold at least 2 meetings in a year, either in-person or virtually.

c. Site-Level Implementation

Two regional committees based on KWS conservation areas have been established to support coordination of stakeholders within the mountain bongo range. These are Mountain Conservation Area (Covering sites in Mount Kenya and Aberdare forests) and Central Rift Conservation Area (Covering sites in Eburu and the larger Mau forest complex ecosystem). The committee chaired by respective KWS Regional Senior Assistant Directors will meet at least twice annually.

To ensure effective implementation of identified activities, each of the projects and programmes will develop and implement site specific plans. The projects/ programmes will coordinate implementation of local-level actions and align with the national action plan.

d. Secretariat

A secretariat with membership drawn from KWS, WRTI with representation from non-governmental institution (s) with specific focus on mountain bongo conservation programmes will be established to provide the required support on the implementation of the action plan.

The secretariat with the guidance of the NBTf will provide required support to the regional committees and site specific programmes as well as provide support on the collection, consolidation, and dissemination of relevant data and information from across the Mountain Bongo’s programmes.

The secretariat shall keep track of the implementation of the action plan with the guidance of the NBTf in line with the established monitoring and evaluation framework

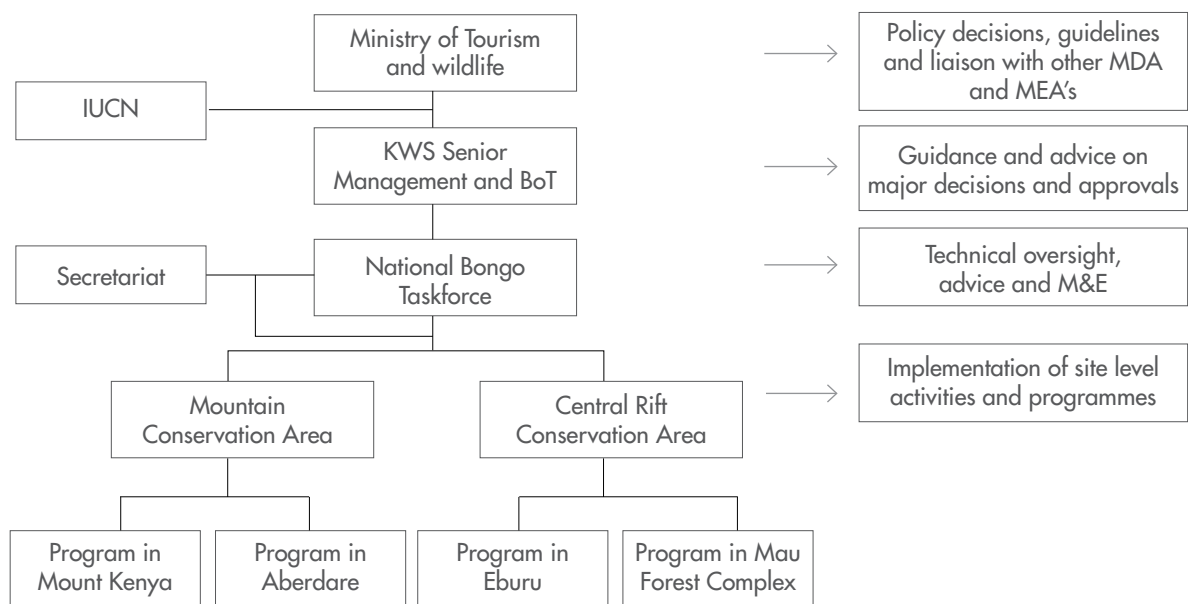


FIGURE 6: Coordination organogram of national recovery and action plan for the Mountain Bongo (*Tragelaphus eurycerus isaaci*) in Kenya (2026-2030)

8.2 Reporting

Reporting on implementation of the National Mountain Bongo Recovery and Action Plan will be undertaken as per institutional requirements, national and international reporting obligations. The will be undertaken through;

- Site specific reports
- National Bongo Task Force reports
- Research and monitoring reports and publications
- Annual status and trends reports
- Monitoring and evaluation reports.

8.3 Financial Plan

To facilitate implementation of the identified activities, financial resources amounting to Ksh.400 million in the next 5 years will be required. Some of the activities with major costs will be implemented as part of the already ongoing project activities such as Rhino Ark fencing programmes, site specific project budgets among others. The activity budget the estimates for each of the strategic objectives is shown in the Table below;

TABLE 9: Action plan implementation budget estimates

#	Strategic Objective	No Targets	No of activities	No of sites	Tentative budget (Ksh. 000')	Tentative budget (USD)
1	Securing wild mountain bongo populations and habitats	4	12	5	250,000	1,930,000
2	Breeding and reintroduction programmes	3	6	4	100,000	772,000
3	Biological research and monitoring	7	14	5	25,000	193,000
4	Enhance community engagement and public awareness	2	4	5	7,500	58,000
5	Enhance Conservation and Ecosystem management	3	6	5	7,500	58,000
6	Coordination, collaboration and partnership	4	8	Cross cutting	5,000	39,000

Resource mobilization to facilitate the implementation of identified activities and priority programmes will be undertaken through various approaches which include;

- Fundraising by the individual institution/ programmes/ projects
- Increase efficiency in use of existing resources either technical or financial and forums/ platforms for information dissemination
- Institutions to incorporate mountain bongo conservation activities in their budgeting processes
- Identify opportunities for collaborative and joint fundraising initiatives
- Identify and target specific partners to support implementation of identified activities
- Explore opportunities provided by students from universities and other institutions of higher learning to undertake research projects on identified priority programmes and activities

8.4 Monitoring and Evaluation

Evaluation of the level of implementation of the first edition of the national Recovery and Action Plan for the Mountain Bongo in Kenya (2019-2023) identified lack of an effective M&E plan to have resulted in low levels of implementation. From the lessons learnt, this action plan embeds a M&E plan with annual, mid-term and full-term reviews

M&E will be undertaken against the identified output/target/outcome areas and associated performance indicators as highlighted in the M&E framework below;

TABLE 10: Monitoring & evaluation framework

Strategic Objective	Output	Performance Indicators	Assumptions	Status (Annual/ Mid-term/ 5 year)
Strategic Objective 1: Securing Wild Mountain Bongo Populations and Habitats	By 2030, reduce illegal activities in all habitats with existing Bongo populations by at least 90% compared to 2026 baseline.	% reduction in illegal activity reports (vs. 2026 baseline)		
	By 2027, pilot and deploy surveillance technologies in all habitats with existing Bongo populations.	Number and type of surveillance systems piloted/ deployed		

Strategic Objective	Output	Performance Indicators	Assumptions	Status (Annual/ Mid-term/ 5 year)
		Number of sites using technology based monitoring		
	By 2026, document permitted activities with negative interaction with the mountain bongo and their habitats in specific sites with 2026 baseline	% reduction in number of negative interactions recorded per year (e.g., grazing and other permitted user rights)		
	Enhance prosecution of cases related illegal activities affecting bongos	No of cases concluded		
Strategic Objective 2: Breeding and Reintroduction	By 2027, document key processes for establishment of bongo recovery programmes	Process document and checklist		
	By 2030, grow mountain bongo populations through intensive <i>in situ</i> and <i>ex situ</i> programmes	% population growth		
	By 2027, identify and prioritise establishment of suitable sites for mountain bongo reintroduction in historical range	Number of sites identified		
		Number of sites operationalised with mountain bongo reintroduction		
Strategic Objective 3: Research and Monitoring	By 2026, develop and deploy a standardised population monitoring protocol and plan	Monitoring protocols finalised		
		Number of sites trained and using the standardised monitoring plan		
		Monitoring reports		
	By 2027, test and integrate appropriate monitoring technologies across the mountain bongo habitats	Number of new monitoring technologies tested and validated		
		Number of sites using new technologies		
		Number of staff trained in new monitoring technologies		
	By 2026, produce detailed habitat maps covering 100% of historical bongo zones	% of historical range mapped		
		Number of identified “hotspot” zones for conservation focus		
		Habitat quality score per mapped area		
	Conduct ecological studies on suitable bongo habitats	Study report(s)		
		Publication(s)		
	Document types and cases of negative species interactions within critical mountain bongo populations and habitats using 2026 baseline	Types and number of negative interactions recorded per year		

Strategic Objective	Output	Performance Indicators	Assumptions	Status (Annual/ Mid-term/ 5 year)
	By 2030, participate and provide input in ESIA processes involving proposals for construction of infrastructure in all forest habitats with bongo populations	No of forums attended		
	By 2030, ensure reported cases of sick mountain bongos are attended to and disease surveillance undertaken in existing bongo populations and potential reintroduction sites	No of presentation made		
		No of sites specific disease surveillance and disease management programmes		
Strategic Objective 4: Community Engagement and Public Awareness	By 2030, increase community participation in bongo conservation through appropriate site based engagement strategies	Type and number of community engagement strategies		
	By 2030, enhance education and awareness on mountain bongo conservation in bongo-adjacent communities and the general public	Number and types of platforms used		
		Number of education/ awareness sessions held for each site		
Strategic Objective 5: Conservation and Ecosystem Management	By 2030, manage critical bongo habitats in forests through well documented ecosystem management plans	Number of critical bongo habitats being managed through ecosystem plans		
	By 2026, enforced protection measures for mountain bongo populations and habitats within forest ecosystems	% decrease in illegal activity within reserve boundaries		
	By 2030, reduce human induced disturbance in critical mountain bongo habitats within forest ecosystems using 2026 baseline	% reduced in human induced disturbance in critical mountain bongo habitats within forest ecosystems		
Strategic Objective 6: Coordination, Collaboration and Partnerships	By 2026, ensure the implementation and coordination structure is operationalised	Committees established and meeting as per ToRs		
		Number of meetings held annually		
		Minutes of meetings		
	By 2030, identify and foster collaborations and partnerships to support mountain bongo conservation recovery programmes	No of collaborations and partnerships established		
		Resources mobilized		
	By 2030, track implementation of the activities and programmes identified in the action plan	Develop an M&E framework as part of the action plan		
		Progress scorecard reports		

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Appendices

Appendix 1: Historic Bongo Populations and Distribution

Tables, Figures & Text taken from:

Sheppard DJ, Stark DJ, Muturi SW and Munene PH (2024) *Benefits of traditional and local ecological knowledge for species recovery when scientific inference is limited*. *Front. Conserv. Sci.* 5:1383611. doi: 10.3389/fcsc.2024.1383611

Many critically endangered species persist in remnant populations so small that ecological information required to assist recovery, such as species-typical demographic parameters and habitat preferences, can be difficult to acquire based on science alone. Traditional ecological knowledge (TEK) can fill information gaps and provide additional understanding, though this expertise is not ever-lasting and often overlooked. We report on research focused on a species survival plan for mountain bongo (*Tragelaphus eurycerus isaaci*), a critically endangered antelope endemic to Kenya, persisting in the wild with fewer than 80 individuals in four separated montane forests. Extensive camera trapping, in preparation for a potential conservation translocation of captive-bred bongos into one or more forests, yielded limited results. With only five bongo events from 182,781 wildlife images analysed across a 21-month period in one study, results suggested that data were based on activities of just few individuals. Moreover, additional information critical to translocations, such as typical group size and sex ratios, could neither be observed nor obtained from the literature. This knowledge gap was largely resolved using expert interviews, and historical range and browse mapping, conducted with eight former Kenyan hunters, enriching understanding of behavioural characteristics rendering bongo particularly vulnerable to exploitation. Consistently similar responses from observations spanning a 50-year period (1950s to 1990s) across four ecosystems added certainty to responses. This study endorses a combination of data sources when dealing with remnant populations and specifically recommends making use of this documented mountain bongo TEK to inform decisions about potential bongo reintroductions in Kenya.

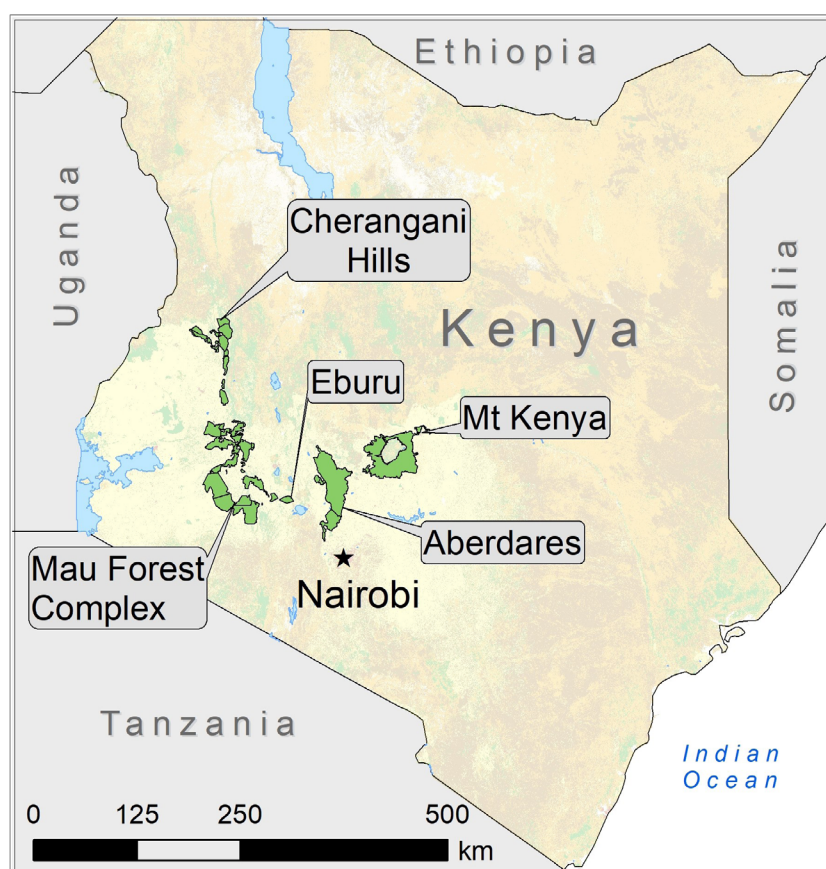
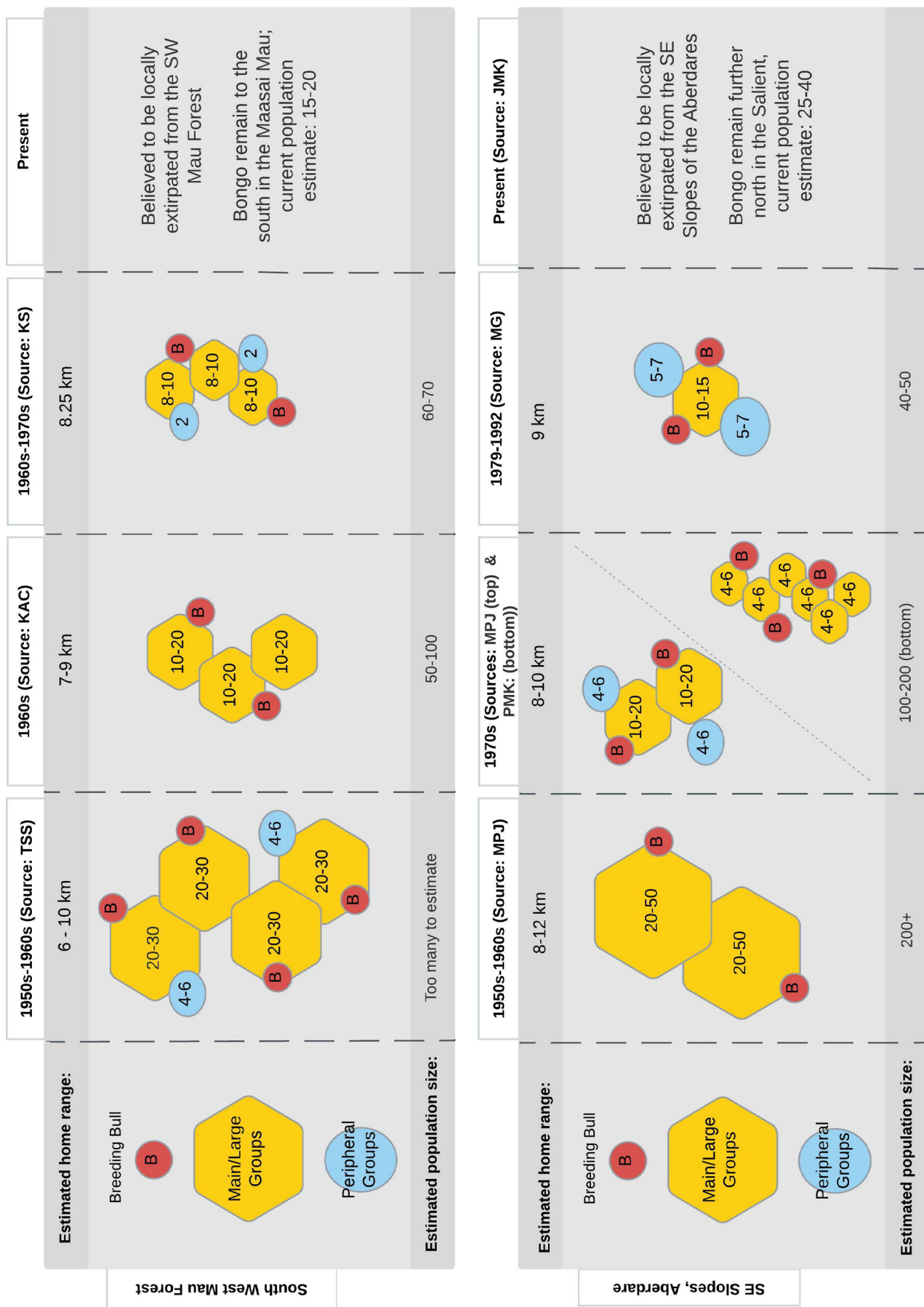


FIGURE 1: Mountain forests in Kenya where healthy mountain bongo populations were historically found as reported by former mountain bongo hunters

FIGURE 2: Mountain bongo home range, herd size changes, and population shifts over time as reported by for mer mountain bongo hunters



Changes in estimated home range (top row), bongo population size (bottom row), and typical herd size and composition (middle row) over time in the South Western Mau (upper panel) and the Southeastern slopes of the Aberdare (lower panel). The changes in the observed size of the main herds (yellow hexagons) and smaller peripheral groups (blue circles) are depicted by size and numbers within these shapes. The small red circles represent single breeding males observed on the periphery of the main herds, with overlapping shapes illustrating the spatial relation of these smaller groups and single males to the main herds.

Hunters reported that they would start tracking bongo at a naturally-occurring salt or mineral lick (7/8 hunters reported this), close to water sources (4/8 hunters reported this) within the mountain bamboo (*Oldeania alpina*) vegetation layer and follow the largest tracks (4/8 hunters reported this), assuming that these tracks were made by males. As trophy hunters only shot the largest males, the fact that male bongo had a habit of separating themselves from the rest of the herd made them prime hunting targets.

Reportedly, hunters would also seek out signs of giant forest hog (2/8 hunters reported this), or locate a favorite bongo browse species, such as the locally named 'setiot' or 'thunguya' (7/8 hunters reported this). Table 1 provides a list of species routinely named by hunters as important bongo browse and photos of those browse species are presented below in Figure 3.

TABLE 1. Bongo browse information given during hunter interviews. Browse descriptions were provided by the hunters interviewed, except for the descriptions that have an alternative source referenced. Number subscripts refer to the plant number in the browse figure. Names with an asterisks (*) are bongo browse species disputed by respondents of different forest ecosystems.

Local (Language)	English	Scientific	Description	Ecosystem	Hunter
Mũnyũgũnyũgũ (Kikuyu) ¹	None	Crassocephalum montuosum	Woody forest herb to 1.5m height; common in clearings & areas of abandoned cultivation (Gachathi, 2007)	Aberdare	MG
Mũtare (Kikuyu) ²	Blackberry	Rubus spp.	Scrambling shrub with edible fruits, scattered sharp prickles on the stems, compound leaves (Gachathi, 2007).	Mau, Eburu, Aberdare, Mt. Kenya	TSS
Nderema/ Mũrerema (Kikuyu) ³	Vine spinach	Basella alba	A twining herb, usually found near forests, also does climb fences, has whitish, very small flowers (Gachathi, 2007). A climber (SMN).	Aberdare	MG
				Eburu	SMN
Nguratiet (Ogiek) ⁴ Mũrangi (Kikuyu)	Mountain bamboo	Yushania alpina (M.Gachathi, pers. comm., April 14, 2022)	Bongo give birth July / Aug; females feed on fresh bamboo shoots for some days in a row, getting fat (KS). A hollow-stemmed, tree-like plant of the grass family growing to 16m height, flowers only once in its lifetime (Gachathi, 2007).	SW Mau	KS
Rũtho (Kikuyu) ⁵	None	Mimulopsis alpina	Long-stalked leaves along a scrambling, stout, woody herb (Gachathi, 2007).	Aberdare	MG

Local (Language)	English	Scientific	Description	Ecosystem	Hunter
Mũruya/ Mũrũngũ/ Mũruca (Kikuyu) ⁶	None	Piper capense	Shrub with a sweet scent; bongo eat the young shoots (SMN). A soft, woody shrub to 3m height, common in wet forests providing shade, swollen nodes on stem, heart-shaped aromatic leaves, tiny white spiked flowers (Gachathi, 2007).	Eburu	SMN
Setiot (Ogiek) ⁷ Thũngũya (Kikuyu)	None	Mimulopsis arborescens (M.Gachathi, pers. comm., April 14, 2022)	A tall shrub – the bongo rest here in the day, feed in the night. Lots of flowers, popular with bees. Bushbucks & buffaloes would eat on different levels (KAC).	SW Mau	KAC
			Favorite food source; available in both rainy & dry seasons (KS)	SW Mau	KS
			Very tall shrub; bongo hide / rest there during the day; feed there at night; plant with 7-year flowering cycle; when it dies back, you can see their horns poking above the bushes (TSS)	Mau, Eburu, Aberdare, Mt. Kenya	TSS
			A shrub; bongo & bushbuck both feed on this. Bushbuck feed & move on. Bongo stay for many days; they hide here. Found along stream-edges & within bamboo forest; flowers are popular with bees (PMK).	Aberdare	PMK
Turkwot (Ogiek) ⁸	Hunter's Spinach	Asystasia gangetica	Bitter; medicinal use for malaria treatment & stomach ache	SW Mau	KS
Mahũithia (Kikuyu)*	None	Kalanchoe densiflora	A shrub with a salty taste; only the bongo eats it (MM). A succulent herb with yellow flowers found in disturbed places close to water & in moist habitats (Gachathi, 2007).	Mt. Kenya	MM
Siratet (Ogiek)*	Basketgrass	Oplismenus hirtellus	A species of perennial herb, a climber in the true grasses family. They have a self-supporting growth form (EOL v3, 2018).	SW Mau	KS
Sosonet (Ogiek)	Polka Dot Plant spp.	Hypoestes spp.	A small herb with trumpet-shaped white flowers; flowering takes place every 10-12 years (Zocchi et al., 2020)	SW Mau	KS
	Moss, rotting bark & upturned roots		Bongo eat moss & rotten wood from fallen trees; you could see signs that they had gone up on their hind legs to reach the moss & rotting bark (MPJ)	Mau, Eburu, Aberdare & Mt. Kenya	MPJ & TSS

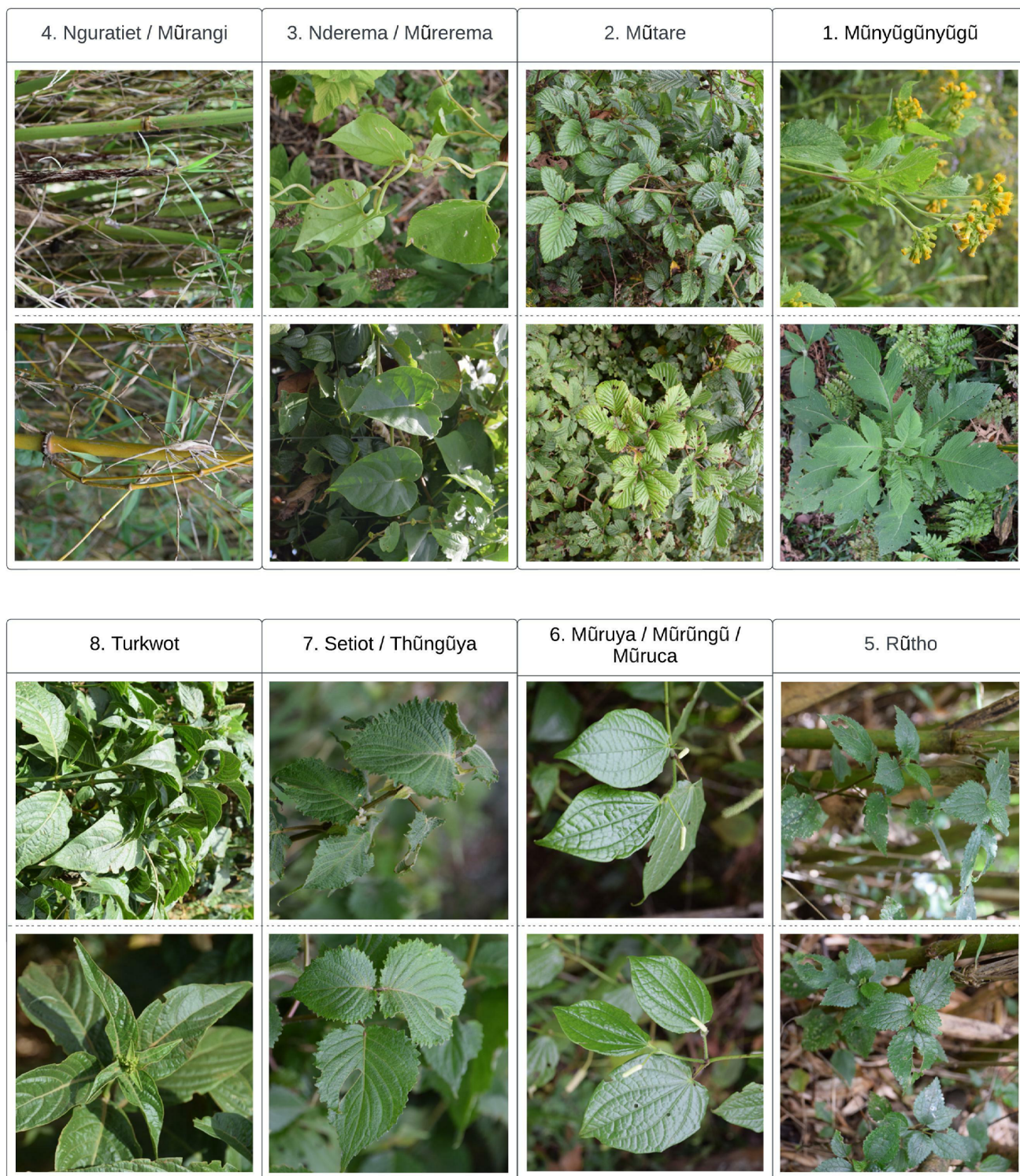


FIGURE 3: Photos of species routinely named by hunters as important bongo browse species.

Appendix 2: Identification, Monitoring and Body Scoring of Bongos

By: Tommaso Sandri, Fred Omengo, Bradley Cain, Martin Jones, Dave Mallon & Ed Harris

Protocol to aid in the conservation and Management of the Bongo:

- i. A bespoke ID-System for bongo identification
- ii. A quantitative method to identify bongo spoor in areas where waterbuck and bongo are sympatric
- iii. Camera trapping protocol for monitoring
- iv. The application of a pre-existing Body Condition Scoring (BCS) system to the captive bongo herd at MKWC

I. ID-system

The lack of an identification system is a major impediment to the long-term monitoring of any animal population of conservation concern (Legg & Nagy 2006). Here we describe a user based visual ID-system that requires little training, and is fast and transferable.

The ID system was initially developed on the captive herd at the Mount Kenya Wildlife Conservancy (MKWC). The system relies on individual features of bongo flanks (Figure 1). Of these, stripe pattern have been found previously to be important for individual identification (Gibbon et al. 2015).

The system was tested for its transferability amongst multiple observers through the analysis of inter- relator reliability (irr, Hallgren 2012) using K statistics (Fleiss 1971, Landis & Koch 1977), where the closer the value of K to 1 the higher the agreement amongst observers. 15 naïve observers, who are neither trained in the system nor bongo experts, are asked to ID 10 bongo flanks. The results show a substantial agreement (average K = 0.65) amongst the 15 observers, thus showing that the ID-system here presented is transferable, reliable and can become a useful tool for long-term monitoring (Figure 2).

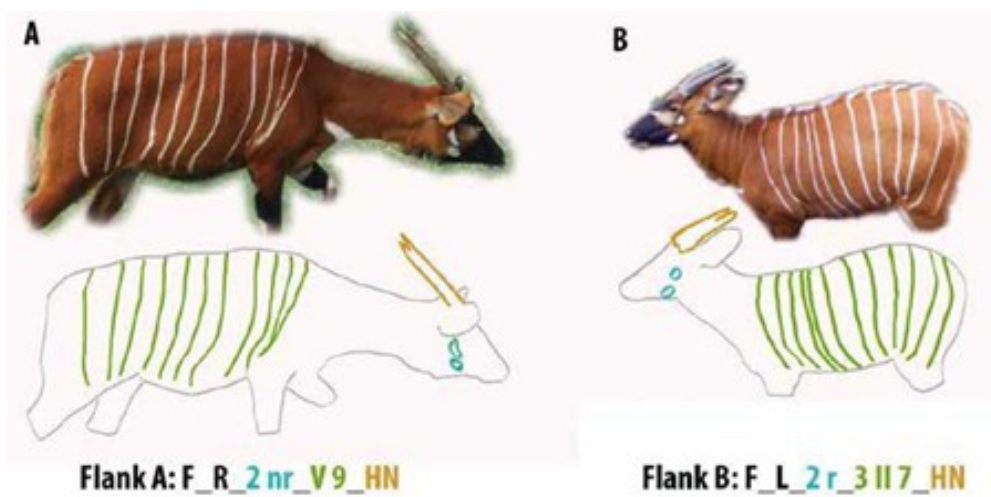


FIGURE 1: Example of our newly developed ID-system for bongo flanks



FIGURE 2: BSP picture taken in the Salient (ANP) with individuals with the ID system code assigned by BSP.

Flank A is coded as F (female), R (right flank), 2 nr (two facial spots, upper spot is not round), V (2 stripes converge), 9 (nine stripes with no peculiar feature), HN (horns appear normal). Flank B is coded as F (female), L (left flank) 2r (two facial spots, upper is round), 3 (three stripes with no peculiar feature), 11 (two stripes appear narrower than the others on the animal's flank), 7 (seven stripes with no peculiar feature), HN (horns appear normal).

II. Track identification method

The identification of bongo tracks is generally not problematic, however in areas where both bongo and the similarly sized waterbuck (*Kobus ellipsiprymnus*) are sympatric, misidentification can occur and waterbuck spoor can be wrongly identified as bongo (Faria et al. 2011). Misidentification of spoor can obviously have a significant impact on the reliability of any monitoring program.

In an attempt to increase monitoring reliability, we have developed a quantitative method for distinguishing between the spoor of the two species. Thanks to the access to MKWC captive herd, we measured 100 bongo tracks and 50 waterbuck tracks. We opportunistically sampled and measured tracks in enclosed areas within the conservancy where only one of the target species was present. Our sampling did not differentiate among age-classes or sexes. Our results show that the length to width ratio (LW) averages $1.2 (\pm 0.15)$ for bongo and $1.5 (\pm 0.13)$ for waterbuck (Figure 3). A 2-sample t test found the difference to be significant ($p < 0.0001$). Subsequently, we included LW in a logistic regression (Dreiseitl & Ohno-Machado 2002) as a predictor of the species. Results show an AUC, a measure of predictive reliability of the logistic regression, of 0.90 out of a maximum value of 1.

The incorporation of two simple measurements easily retrievable in the field should greatly increase the reliability of bongo monitoring through spoor.

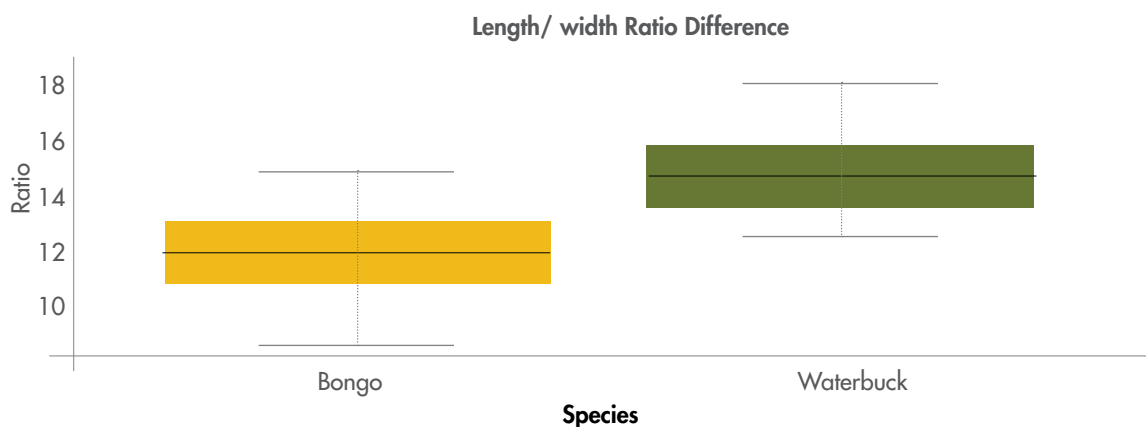


FIGURE 3: The plot shows the difference in length to width ration between bongo tracks and waterbuck tracks

III. Camera trap protocol

The method is adopted from (O' Connel *et al.* 2011) on using camera traps to collect data for the development of a Habitat Suitability Model (HSM) for bongos. The use of both presence and absence points is considered the most accurate (Guillera-Arroita *et al.* 2015) method. In order to retrieve both presence and absences we implemented a random sampling covering the available habitat in the area of interest (Hirzel & Guisan 2002).

Cameras are placed at 1 km from one another in a grid array. The devices are installed facing active game trails and tied on robust trees (to avoid interference from wind) and at a height of at least 1.5 m (to avoid disturbance from hyenas). Cameras are set to take 3 photographs per capture event during both day and night. Cameras are left in place for at least 10 nights.

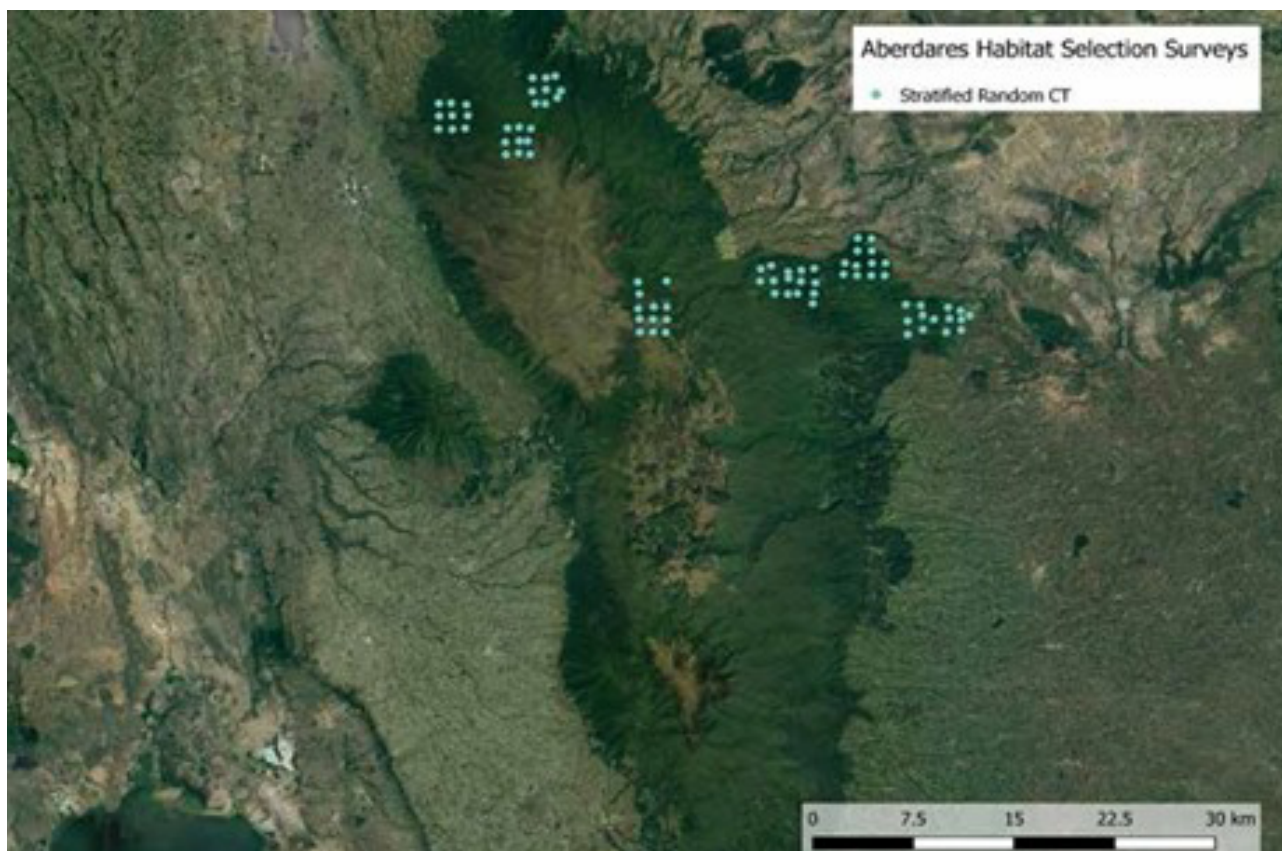


FIGURE 4: Map of bongo habitat selection survey sites in the Aberdare

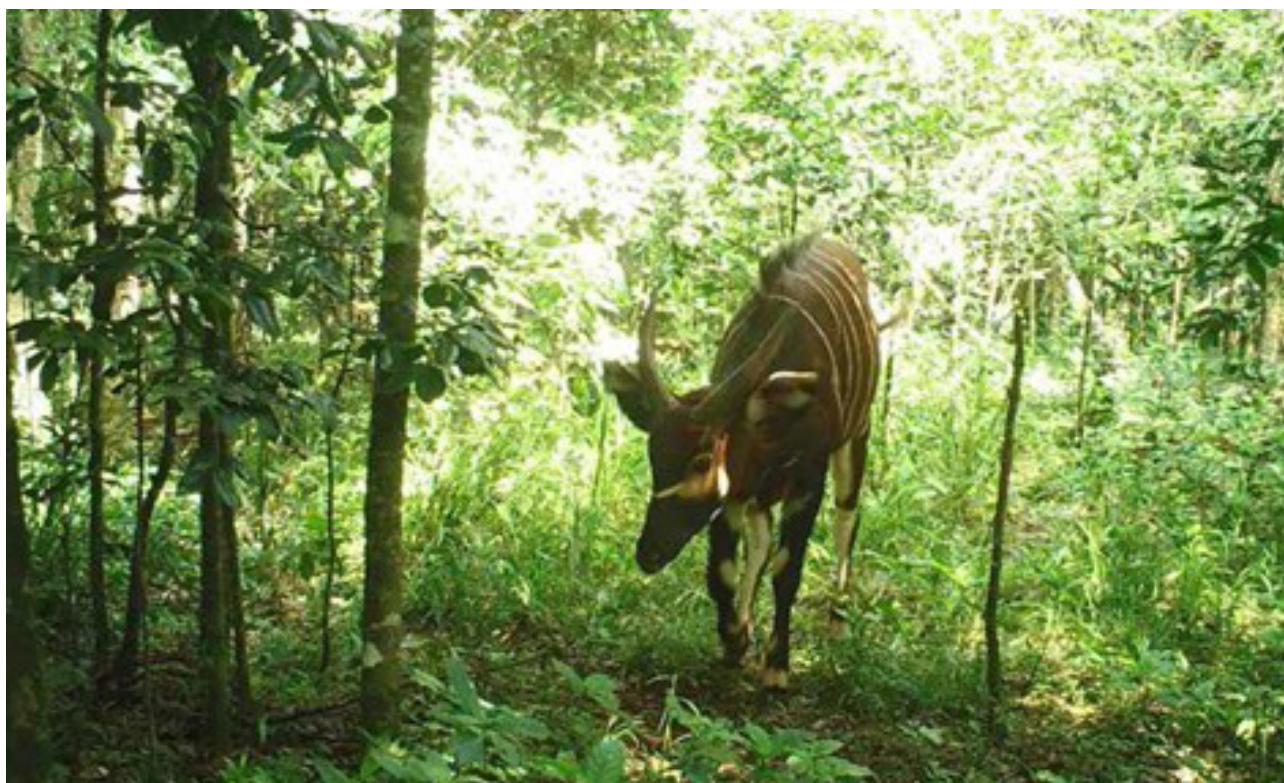


FIGURE 5: A young male at the Salient (ANP, August 2018)

IV. Body Condition Scoring System

Assessing and evaluating the condition of individuals is of primary interest for conservation actions (Stevenson & Woods 2006). Captive individuals can be assessed for their suitability for release or breeding purposes and they can then be monitored after release using a standardised body condition system.

The use of a standardised system allows multiple practitioners to objectively evaluate the body condition of an individual animal. A standard system for monitoring body condition can be used to assess the welfare of captive individuals, which is relevant for their reproductive output. In order to assess the status of the bongo herd at MKWC we implemented a system previously designed for captive mountain bongo by Disney (Disney Animal Programmes 2005, Figure 6). BCS scoring relies on visually estimating the amount of accumulated fat over various body parts (Wright et al. 2011).

The system was applied through photographic records of each individual rather than live encounter in order to test its applicability on pictures. This would allow the system to be remotely applied to individuals captured from camera traps. A mean body condition of 3.2 was obtained with the lowest score being 1 (found in one individual) and 4 (in 13 individuals) being the maximum (Figure 7 for examples). No individual was found to be obese (score 5). The scores appear comparable with results from a previous analysis in UK zoos (Wright et al. 2011).

Results from the captive herd were compared with wild individuals in the Salient area of the Aberdare NP. The wild individuals were scored using photographs retrieved from both MMU and BSP where the flank was clearly visible. The wild individuals mean BCS was 2.9 showing no significant difference to that of the captive MKWC population (Wilcoxon test: $P > 0.05$; Figure 8)

The application of an internationally recognised scoring system allows for the comparison of the MKWC herd with other institutions worldwide. Besides, the application of a standardised system will allow practitioners and managers to both evaluate individuals for their suitability for reintroduction and, when paired with a reliable ID-system, monitor individuals following the release.

Score	Emaciated	Thin	Good	Fat	Obese
Outline Depictions					
Neck & Shoulders	- Emaciated - Bone structure is easily visible - No fat	- Neck is thin - Decreased girth	- Neck is thick - Shoulders are flat	- Neck is thick - Fat deposits evident - Shoulders slightly rounded	- Fat is evident along neck - Bulging fat - Neck is thick - Neck blends into shoulder - Shoulders are rounded
Withers	- Emaciated - Bone structure is easily visible - No fat	- Thin - Bone structure is evident	- Withers has fat deposits - Decreasing visibility of bone structure	Fat deposits are evident	Fat deposits make withers appears flatter/ less discernable
Loin & Back	- Emaciated - Spinous processes are easily identifiable	- Spinous processes are not individually identifiable, but spine is still prominent - Transverse processes faintly discernible	Back is sloped to withers	- Fat deposits are present - Back appears flatter	- Wide back - Patchy fat - Back is flat
Tail head & Hips	Pelvic bones are very prominent	- Pelvis bones at the point of the hip are rounded, but still evident - Pelvis bones at rump may be slightly discernable	- Fat is present around tailhead - Pelvic bones are flat	Hips are rounded	Hips/thighs are very round
Ribs	- Emaciated - Rib spacing appears wide and depressed	Ribs still discernable, but fat is discernable by touch	Ribs are not visible, but discernable by touch	- Ribs are not visible - Fat deposits may be evident	Fat deposits may be present, easily evident

FIGURE 6: Bongo body condition scoring system (Disney Animal Programmes, 2005), figure from Wright et al. 2011.

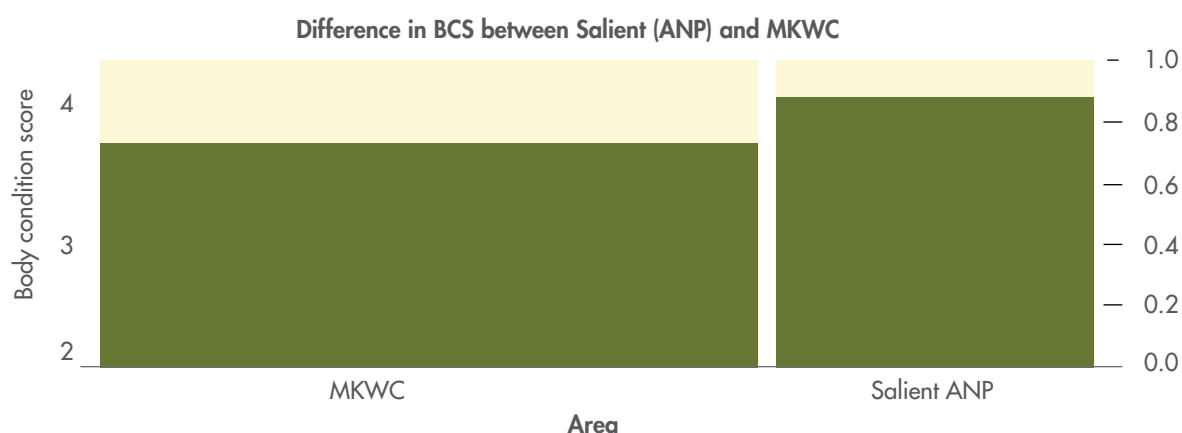


FIGURE 7: Body condition score in the Salient (ANP) and in captivity (MKWC)

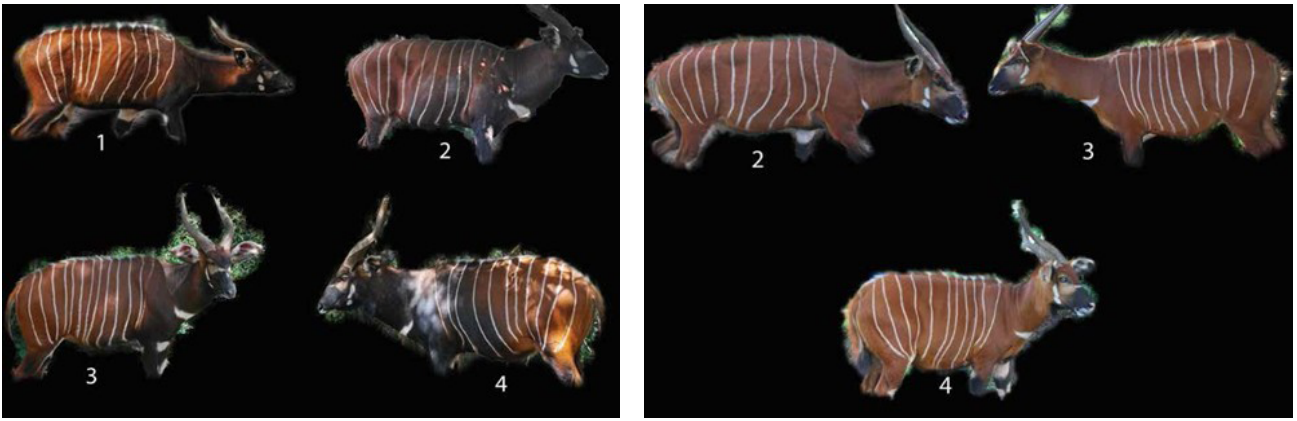


FIGURE 8: The image shows examples of bongo individuals from MKWC captive herd with relative body score assigned following the Disney scoring system.

Appendix 3: Report on Demographic Analyses on Mountain Bongo Population

By, Tommy Sandri*, Brad Cain, Martin Jones, Richard Preziosi, W. Ed Harris

Background

The mountain bongo (*Tragelaphus eurycerus isaaci*, hereafter bongo) is a critically endangered antelope endemic to Kenya (Elkan and Smith, 2013). Once widespread throughout multiple highland areas in central Kenya, from Cherangani hills to Mt. Elgon (Kingdon, 1982), a combination of habitat loss, disease and hunting resulted in the fragmentation and decline of wild populations (IUCN SSC Antelope Specialist Group, 2016). The current range is limited to only four mountain areas: Aberdare, Mau, Eburu and Mt. Kenya (Faria et al., 2011).

However, the situation of these populations remains hitherto uncertain. While thanks to the camera trap surveillance monitoring of BSP we have evidence of their persistence, information on their size and vital rates (e.g., survivorship) is still limited.

Here, thanks to our analysis of BSP footage we were able to retrieve vital information on the status of these populations for the period 2013 – 2018:

- Estimates for population size for each year, providing indication for the population trends
- Sex and age specific estimates for survivorship, which allows for population viability analyses.

This information, hitherto missing, is crucial for the effective management and protection of this endangered antelope, as population size allows for an immediate understanding on the situation of wild bongo in Kenya. When population size is combined with estimates of vital rates such as survivorship, the viability of these populations can be assessed.

Methods

ID System

We were given access by BSP to its extensive library of camera trap footage, resulting from their continuous effort in surveillance monitoring of the last known populations.

BSP camera traps are strategically located on salt licks, where multiple individuals can be captured (see Figure 1 for example footage).

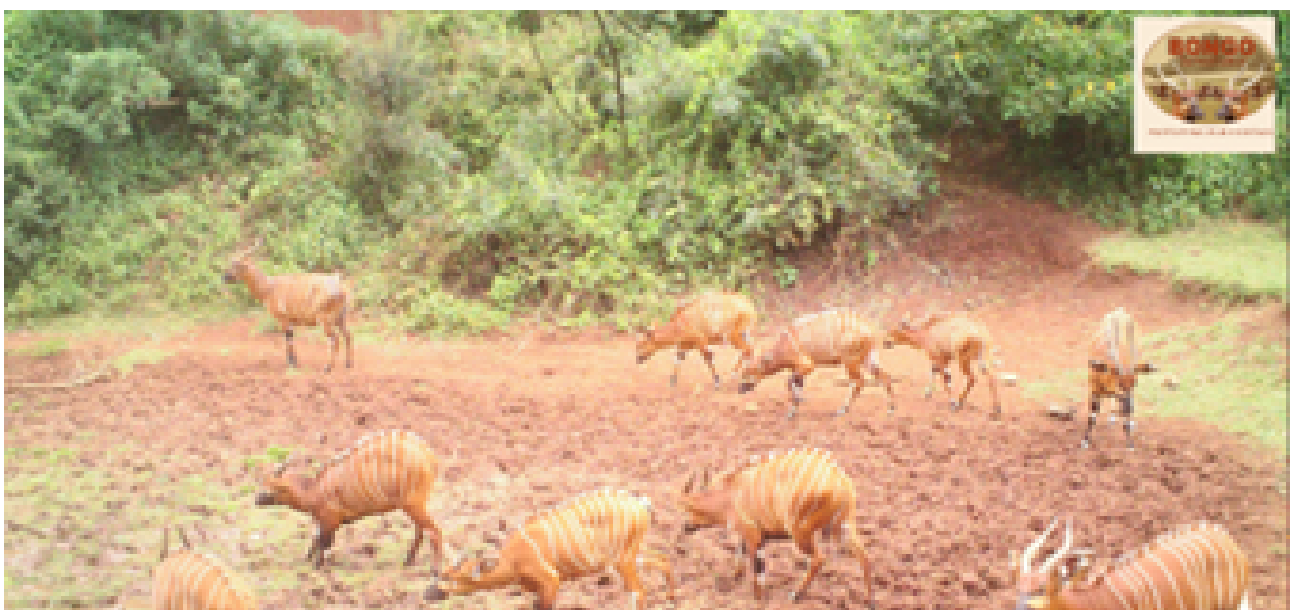


FIGURE 1: Example of capture from BSP camera traps. In this case from the Salient sector of the Aberdare National Park.

In order to extract the information retained in the footage, we developed an ID system to be implemented on BSP footage to identify individuals, Figure 2 shows an example of this, and additional information can be found in the bongo national strategy (KWS, 2019).

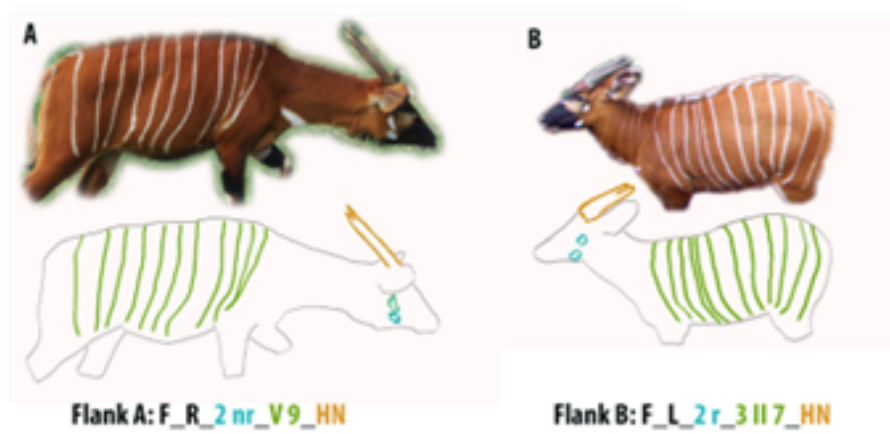


FIGURE 2: The image explains the ID-system developed for bongo

Flank A is coded as F (female), R (right flank), 2 nr (two facial spots, upper spot is not round), V (two stripes converge), 9 (nine stripes with no peculiar feature), HN (horns appear normal). Flank B is coded as F (female), L (left flank) 2r (two facial spots, upper is round), 3 (three stripes with no peculiar feature), II (two stripes appear narrower than the others on the portrayed flank), 7 (seven stripes with no peculiar feature), HN (horns appear normal).

BSP Footage

The footage collected by BSP between 2013 – 2018 was divided into 81 discrete surveys conducted in the four areas known to host bongo: Salient sector in the Aberdare (N surveys = 24), Mt Kenya (N=22), Maasai Mau (N=19), and Eburu (N=13). Each survey lasts three to four weeks with one to three cameras placed at salt licks known to be frequented by bongo through indirect signs such as dung and spoor. In the period 2013 – 2018 BSP monitored two salt licks in the Aberdare (in the Salient area of the mountain range) and one in the other areas. Figure 4 shows the location of BSP camera traps.

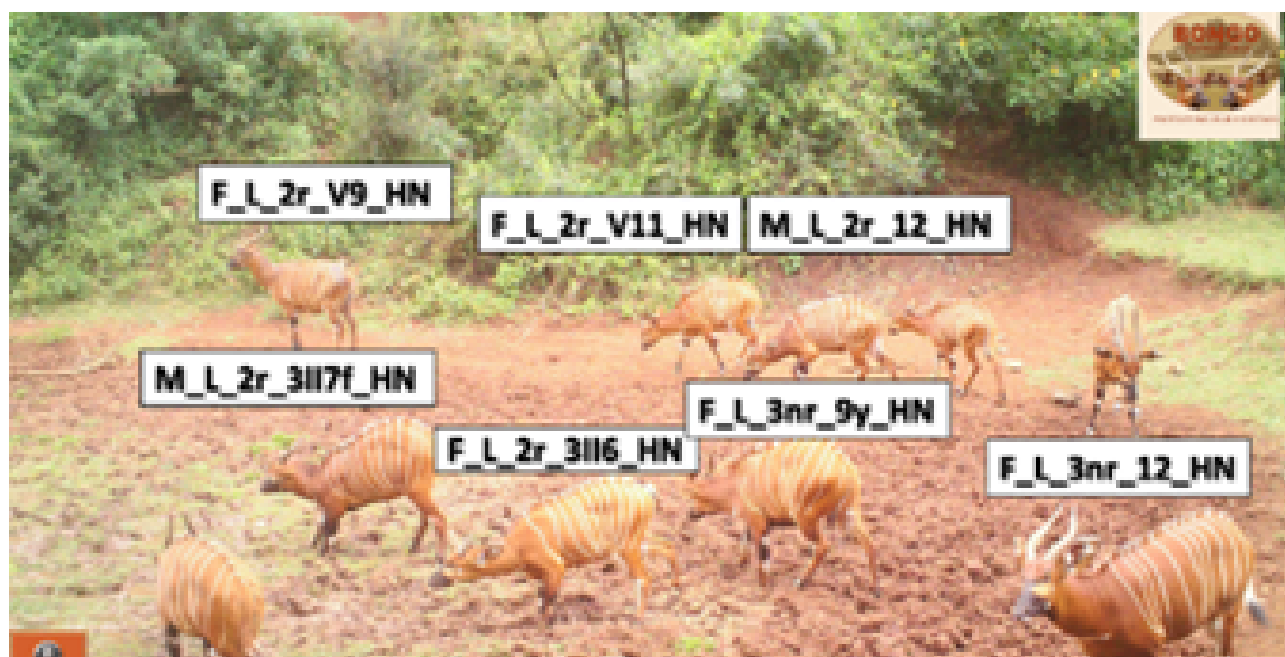


FIGURE 3: The ID system allows to identify individuals in BSP camera trap footage. Here the capture shown in Figure 1 includes identification codes following the ID system (shown in Figure 2).

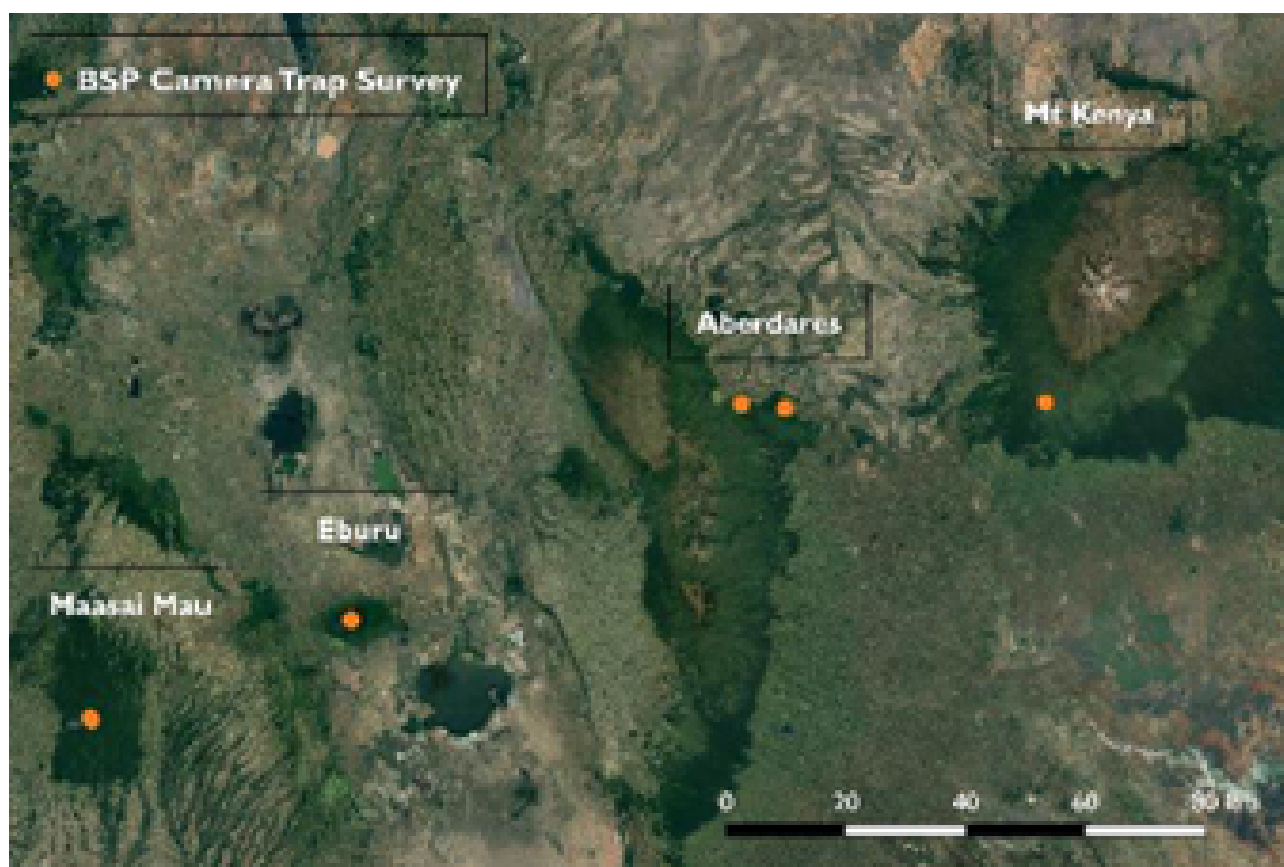


FIGURE 4: Locations surveyed by BSP

Mark – Recapture

The ID system was implemented on BSP footage, identifying individual flanks, as bongo are asymmetrically patterned, hence flanks rather than individuals are identifiable. See Figure 3 for an example of implemented ID system on BSP footage. Moreover, thanks to the appearance of bongos we were also able to age the individuals in two age classes (below or above 2 years of age) relying on horn development, a method also used with other antelopes (Owen-Smith 1993; Marshal 2017).

The identification of individuals in BSP footage allowed us to conduct Mark-Recapture analysis, which is a common tool in retrieving both size and vital rates in a population (Lebreton et al., 1992). The technique requires individuals to be unambiguously identified and a capture history is then compiled where for each capture session (in our case, BSP surveys) each individual is recorded as either captured or not. In our analysis, the first capture of an individual was considered its marking, and any following capture a re-capture. Table 1 provides an example of a capture history.

TABLE 1: Example of capture history to be analysed via Mark-Recapture

Individual	Survey 1	Survey 2	Survey 3
ID_1	1	1	0
ID_2	1	0	1
ID_3	1	1	1
ID_4	0	0	1
ID_5	0	0	1
ID_6	1	0	0
ID_7	0	1	0

The compiled capture history is then analysed through specific software, in our case MARK (White and Burnham, 1999) which allows for the implementation of multiple models allowing for differences in capture probability and survivorship among others. The model that best fits the capture history fed to the program provides the estimates for both size and vital rates.

A mark-recapture technique called “Robust Design” (Pollock, 1982) was adopted. This approach allowed for the estimation of population size in each year, thus providing additional information on the trend of the assessed populations. We assessed the trend of the population relying on the parameter λ (lambda) for yearly population growth, calculated as following: $\hat{N}(t) / \hat{N}(t - 1)$, where $\hat{N}$ is the population size estimate and t is the sampling period (Owen-Smith and Mason, 2005), in our case t refers to a year between 2013 – 2018.

While the estimate of size is a vital and hitherto missing information for bongo in the wild, individual survivorship allows a deeper understanding of the status of these populations. Therefore, estimates for survivorship were also retrieved through Mark-Recapture analysis. The estimates, dependent on sex and age group, were then implemented to assess the short-term viability of these populations, through Population Viability Analysis (PVA, Akçakaya and Sjøegren-Gulve, 2000) providing an insight into the risk of extinction faced by bongos in the Salient and in Maasai Mau. Therefore, a preliminary PVA was conducted in Vortex (Lacy and Pollak, 2020). The PVA was conducted relying on parameters retrieved in this analysis (age and sex dependent survivorship), and from a previous PVA (Princée, 2016) conducted on Lowland bongo (*Tragelaphus eurycerus eurycerus*).

Results

102 flanks in BSP footage spanning 2013 – 2018 were identified (Figure 5) with both Aberdare and Maasai Mau comprising individuals of both sexes and age classes (Table 2). Of these, eight were encountered only once (five were left flanks and three were right), and their capture histories were excluded from MR analysis due to the risk of misidentification (Morrison et al., 2011). As mentioned earlier I identified one flank in Eburu and in Mt Kenya surveys, hence no capture histories were compiled from these areas.

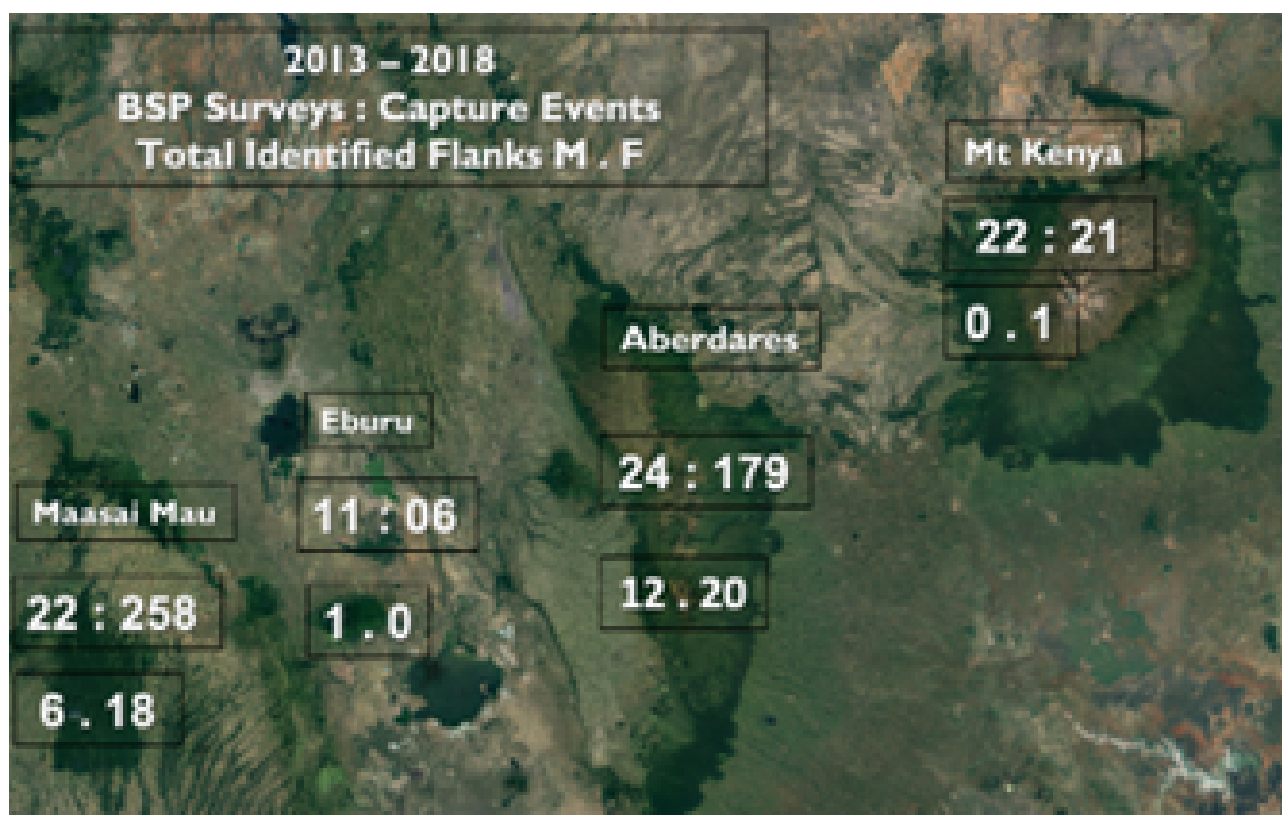


FIGURE 5: Number of left flanks (the majority of those captured) identified in each area.

Note the single flanks found in Mt. Kenya (1 female) and Eburu (1 male). Moreover, the map includes the number of surveys conducted in each area and the number of bongo capture events (defined as being independent captures at least 60 minutes apart).

Hence, Maasai Mau and the Aberdare were the only areas where multiple individuals were identified.

TABLE 2: Estimates resulting from the analysis of the capture histories in MARK.

Primary Period	Captured Flanks	New IDs young	Population Size $\hat{N}$ (C.I.)	Sex Ratio	λ
ABERDARE					
1	11:12	3:5	14.98 (7.46 - 22.5)	0,38	
2	12:17	2:3	17.1 (12.85 - 21.34)	0,64	1,14
3	12:13	0:0	18.1 (10.34 - 25.86)	0,54	1,06
4	17:21	6:5	23.3 (16.9 - 29.71)	0,65	1,29
5	18:15	6:2	21.93 (14.7 - 29.3)	0,38	0,94
6	18:22	2:2	23.11 (17.11 - 29.1)	0,42	1,05
MAASAI MAU					
1	8:5	3:0	8.74 (3.85 - 13.64)	-	
2	8:5	2:1	9.99 (4.18 - 15.81)	-	
3	13:9	4:5	14.27 (9.7 - 18.84)	0,44	
4	17:12	3:1	17.71 (14.45 - 20.97)	0,41	1,24
5	14:5	3:0	16.47 (12.16 - 20.78)	0,25	0,93

Primary period refers to the longer period in which multiple surveys were conducted by BSP (following Robust Design syntax). Captured flanks is the number of individual flanks identified in each period. The table also reports the number of newly identified animals marked as < 2 years of age. The Sex Ratio is based on the population size estimates for the period, and λ indicates population growth from one period to the next.

By having estimates of pop size for multiple years the trend of the pops was also assessed, see Figure 6, and values for population growth (λ) are shown in Table 2.

The latest (2018) population estimates for Salient and Maasai Mau are the following: 23.11 (C.I. 17.11 - 29.1) and 16.47 (12.16 - 20.78) respectively.

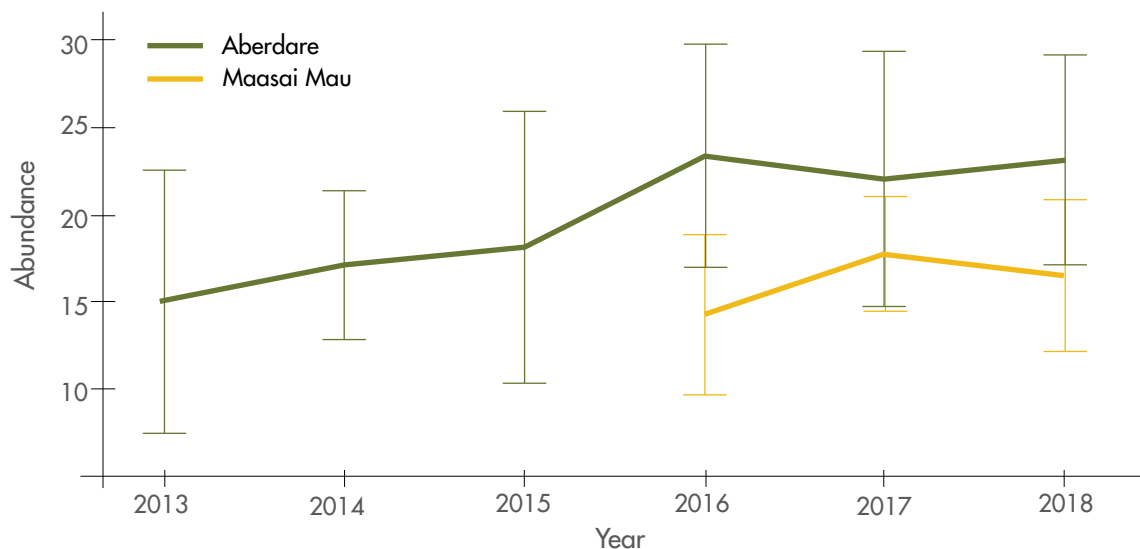


FIGURE 6: Plotting population size estimates against years allow for a clear visualization of the trend of the two assessed populations (Aberdare and Maasai Mau).

The gap in Maasai Mau prior to 2016 is due to the failure of capture histories of those years to comply with close population assumptions (i.e., the populations were not closed to death and immigration within the period as requested for the retrieval of confident estimates when implementing Robust Design).

Implications for Bongo Conservation

Although the Mountain bongo has long attracted the attention of the conservation community, the lack of basic information on this antelope demography was a limitation to a better understanding of its current status in the wild.

We now have rigorous estimates on 2 known populations on the wild, Maasai Mau and Aberdare (specifically the Salient). The finding that Maasai Mau hosts the second largest population should foster the advocacy for this forest to be protected from human encroachment (Nkako et al., 2005), although more analyses on the influence of human activities in this forest are required. Whereas, the finding that the most important area, to ours and BSP knowledge, lies in the Aberdare is no surprise. This area was always considered the stronghold of the mountain bongo (Kingdon, 1982). However, what is concerning is the restricted area where bongos are found, solely in the Salient. The area is well protected within the boundaries, and fence, of the Aberdare National Park.

The structure of Maasai Mau and Aberdare population was assessed for the first time through their sex-ratio. A skewed ratio in favour of females is typical of antelopes (Jarman, 1974). The sex ratio found in the Aberdare population is similar to that of other African antelopes where males are mostly solitary (Owen-Smith and Mason, 2005). However, considering the very small size of these populations, a skewed sex ratio may be problematic, as low number of males can lead to females failing to conceive in a season with an immediate impact on population dynamics (Milner-Gulland et al., 2003).

Moreover, although no assessment of social networks among individuals was attempted, it appears that both areas are home to single herds of females. Therefore, while the trends of the populations may appear positive, the fact that in practice these populations consist of a single herd each is a cause for concern.

Furthermore, the estimation of survivorship is not only of interest for the scientific community as it is one of the first time the survivorship of a forest ungulate has been retrieved, but it also allowed us to evaluate the viability of Maasai Mau and Salient populations. The results from our preliminary PVA show that both populations do not face an immediate risk of extinction (Figure 7). However, it also shows how population growth in both areas is likely not enough to achieve the objective stated in the National Strategy of 400 individuals in Mau and Aberdare in the next 50 years (KWS, 2019). Another note of concern derives from the assessment of population growth.

Both of the surveyed populations have grown throughout the period of interest (2013 – 2018, Figure 6). However, it is clear from our results that in both Maasai Mau and Salient bongo have not steadily grown, but alternated periods of growth to periods of decline. This pattern may result from stochasticity in birth rates and sex ratio, which likely affects small populations (Engen et al., 2003). An alternative possibility is that of a density-dependent pattern, where young survival is limited when the area or territory has reached its carrying capacity (Brook and Bradshaw, 2006). The latter hypothesis appears to be in agreement with the findings presented, as the period between 2016 and 2017 is the only period showing a decline in Aberdare, while the previous period (2015 – 2016) had the highest growth on record. When the possibility of the Salient area having reached its carrying capacity is included in the PVA, the goals of the National Strategy are even less likely (see Figure 7, B).

Conclusion

The combination of camera trapping on salt licks by BSP, our ID-system, and Mark-Recapture has allowed us to assess population size and survivorship of this critically endangered antelope, a task otherwise impossible to achieve in the forest of central Kenya. Moreover, we have provided some hitherto missing information on what are likely 2 of the last remnant populations of Mountain bongo in the wild.

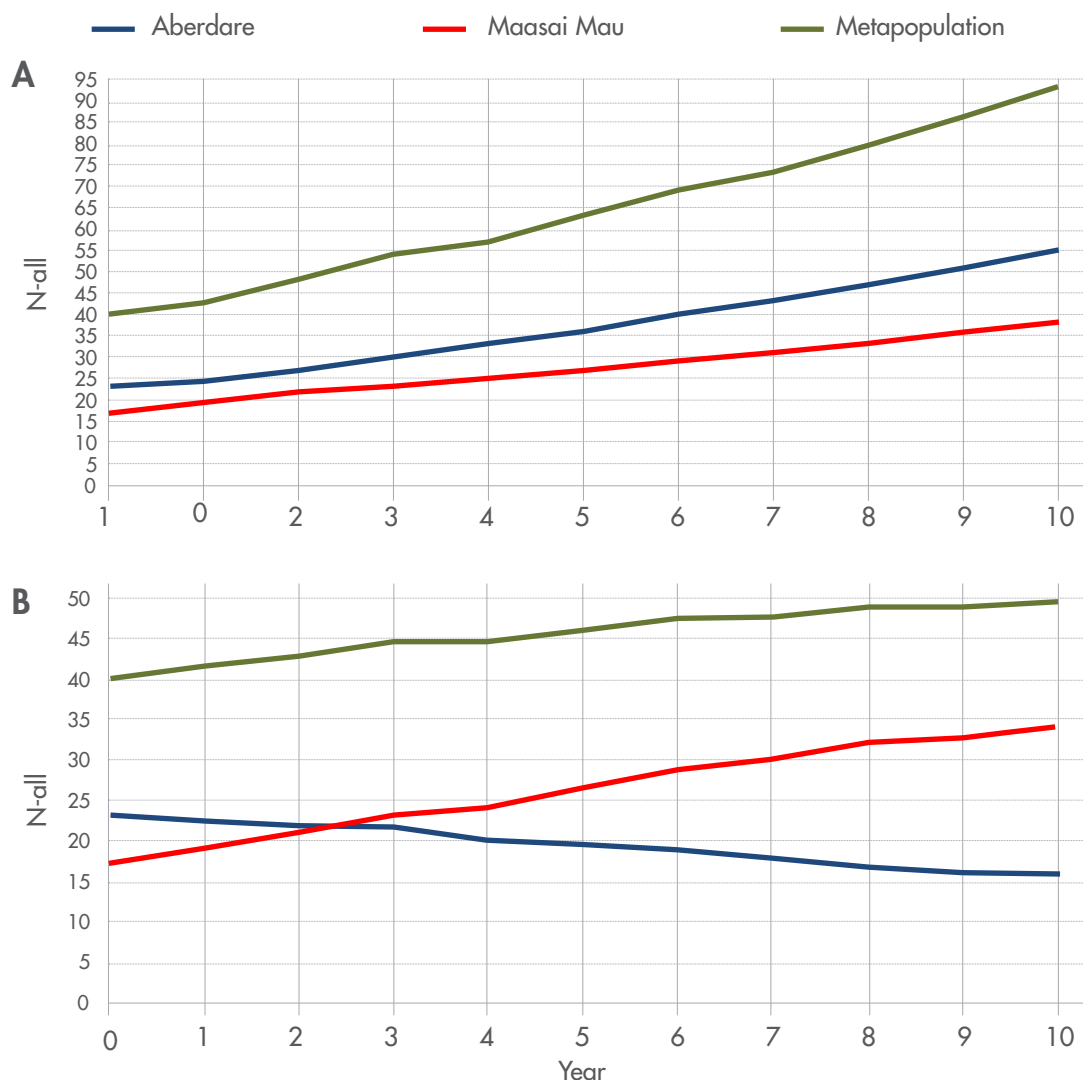


FIGURE 7: VORTEX outputs for two scenarios PVA (10 years with 500 iterations) which differ for their carrying capacity limit

a. Carrying capacity is set as 100 in both areas.

This scenario is used as an example of how the populations were to grow if no limits on carrying capacity were considered. In this scenario both populations continue to grow, with no risk of extinction predicted.

b. Carrying capacity is set as 30 in Aberdare and 50 in Maasai Mau.

This scenario considers an estimate of carrying capacity based on the analysis of population trends in both areas in the period analysed with BSP footage (2013 – 2018), where in the Aberdare the population always declines after reaching about 30 individuals. Hence, this value is used as the maximum carrying capacity of the area. The result is that Maasai Mau keeps expanding, becoming in time the largest population. Whereas the salient population remains in a more delicate situation, although with a 0.01 risks of going extinct in the next ten years.

Appendix 4: Report on Habitat Suitability Model Predictions for Mountain Bongo

Tommy Sandri*, Bradley Cain, Martin Jones, Richard Preziosi, W. Edwin Harris

Introduction

Distribution of mountain bongo (*Tragelaphus eurycerus isaaci*, hereafter bongo) is currently limited to four mountain areas in central Kenya: Aberdare, Mt. Kenya, Mau and Eburu (Faria et al., 2011). However, results of the demographic analysis conducted by Tommy Sandri as part of the PhD project, established that, only two of these areas host breeding herds of bongo. This novel information has precipitated the need to update current understanding of bongo distribution, as previous models (Estes et al., 2011) although optimal in execution and validity, did not have demographic information available. Moreover, the main objective of a distribution model is the prediction of areas that are suitable for a species not just to survive, but to allow population growth (Battin, 2004; Guisan et al., 2017). Therefore, I developed a new distribution model only relying on data collected in the areas where bongo herds are known to breed, thus excluding the possibility of counting areas marginal for this antelope.

Hence, the resulting model allows the prediction of likely suitable habitat not just for individual bongo, but for breeding populations. The model is implemented to predict suitable habitat in all four mountain areas, thus providing an insight into the situation of bongo habitat in central Kenya.

Methods

To develop a distribution model relying on the novel demographic information I focused on two of the four areas known to host bongo: Maasai Mau and the Salient in the Aberdare National Park. To allow for more precise predictions, both presence and absence locations were retrieved via a combination of two methods: Camera Trapping and Sign Surveys.

Camera Trapping

Camera traps were deployed using randomly generated grids arbitrarily placed in different areas in order to cover both the elevation gradient and the range of habitats that bongo could feasibly occupy within the study areas. The grids covered the entire range of vegetation present within the Aberdare, Figure 1, whereas, due to homogeneity in habitat, I conducted a single survey in Maasai Mau.

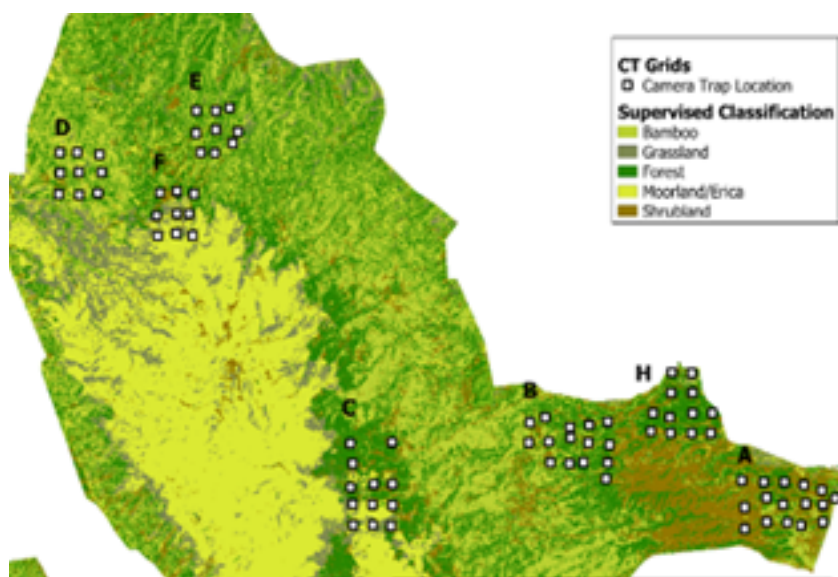


FIGURE 1: Camera Trap locations in grid surveys conducted in the Aberdare. The map shows a vegetation supervised classification (from Morrison, 2019) showing the entire range of vegetation present was included in the surveys.

Grid apices were 1x1 km apart in order to assume independence of captures. Surveys varied in space and time as described in Table 1.

Data were also collected using targeted location of known bongo presence resulting from surveys conducted in 2014 and 2016. These surveys were of a “deliberately biased” nature, a technique to offset the low probability of detection for rare and elusive species (Meek et al., 2014), and their duration was limited to 6 days in order to allow the coverage of multiple areas within the field-season.

TABLE 1: Details of surveys conducted between 2014 and 2018. Surveyed area is missing for deliberately biased (DB) surveys.

Survey (Year)	Area	CT N	Duration	Total Effort	Elevation Range	Area (Km2)
Grid A (2015)	Salient ANP	15	12	180	1970 - 2140	8.8
Grid B (2015)	Salient ANP	15	15	225	2390 - 2740	8.9
Grid C (2015)	Salient ANP	12	19	228	3150 - 3340	5.8
Grid D (2016)	North ANP	9	15	135	2280 - 3020	4
Grid E (2016)	North ANP	9	14	126	2700 - 3040	3.8
Grid F (2016)	North ANP	9	14	126	3220 - 3400	3.7
Grid G (2018)	Maasai Mau	12	13	156	2270 - 2460	2.7
Grid H (2018)	Salient ANP	12	25	300	2150 - 2300	6.8
South (2017)	South ANP	9	33	297	2700 - 2770	-
DB 1 (2014)	Salient ANP	12	6	72	~ 2400	-
DB 2 (2014)	Salient ANP	12	6	72	~ 2400	-
DB 3 (2014)	Salient ANP	11	6	66	~ 2300	-
DB 4 (2016)	Salient ANP	9	6	54	~ 2200	-

A third Camera trap survey was conducted in the southern area of the Aberdare in 2017 (Figure 2). This area is characterised by steep valleys with thick vegetation, mainly bamboo, therefore I excluded the use of random grids due to safety and logistical concerns. To survey this area I placed 9 cameras along four ridges, these are known by experienced trackers to be used by animals for roaming the area. This survey was conducted in collaboration with Bongo Surveillance Project (BSP), with the aim to assess the presence of bongo population in the area.

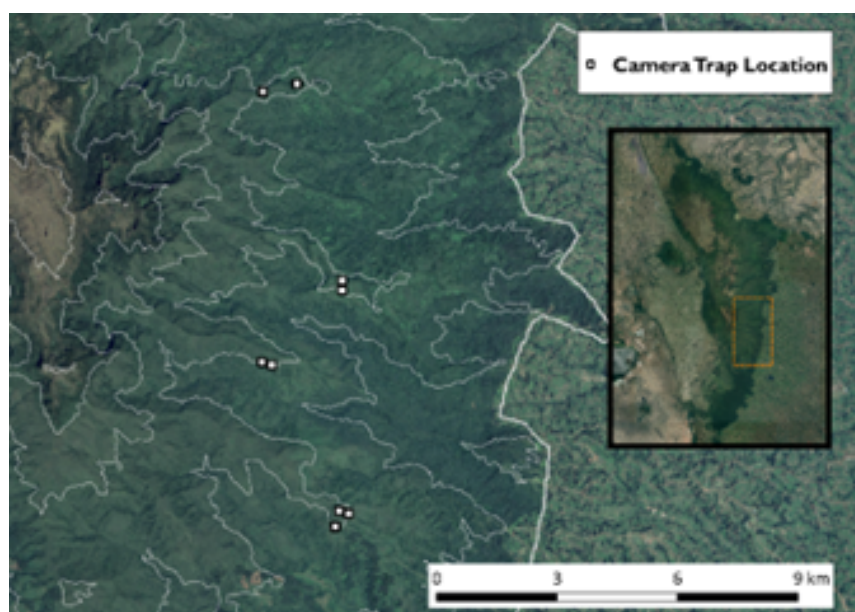


FIGURE 2: Location of surveys conducted in the Southern zone of the Aberdare. The inset shows the location within the Aberdare range.

Sign Surveys

Sign surveys were conducted using the recce approach (Walsh and White, 1999; Hausser et al., 2017) by walking along game trails. Signs typically used for antelope detection are dung piles and tracks (Estes et al., 2008; Bowkett et al., 2009). However, identification of antelopes from dung is difficult without the use of genetic tools (Bowkett et al., 2009). This is a particular issue for bongo, as dung is similar in appearance to that of the syntopic waterbuck (*Kobus ellipsiprymnus*), a similarly sized antelope, which is known to result in misidentification (Faria et al., 2011). Therefore, only bongo tracks were used to identify presence. These were identified using a quantitative method I developed relying on captive populations of bongo and waterbuck. The method discerns tracks of bongo from those of waterbuck relying on their aspect ratio (maximum length / maximum width). Recces were conducted in the Aberdare in 2017 and 2018 and Maasai Mau in 2018. In addition to recces, I also opportunistically recorded signs encountered during camera trap placement in both areas.

Satellite Imagery

In order to predict bongo habitat throughout the known range 30m resolution multi-spectral images from the Landsat 8 satellite were used.

The multiple wavelength of light in Landsat multi-spectral images can be combined to reflect specific characteristics on the ground, the so-called spectral indices (Wegmann et al., 2016). Because of the fine spatial scale (900m²), the focus was indices that could be sensitive to different vegetation structures. Therefore, 10 indices, retrieved from literature were arbitrarily selected.

In order to ground truth findings from satellite imagery analysis, at each camera trap location in the Aberdare I sampled vegetation characteristics in 22.4m circular plots: Stem Density, Basal Area, Mid Layer Density, Herbs Ground Cover.

Previous research has shown the importance of topography for bongo presence (Estes et al., 2011). Hence, I relied on a 30m resolution digital elevation model (DEM) to include in the analysis elevation and ruggedness (a measure of how different is the elevation of a location compared to its surroundings).

I conducted all spatial analysis in QGIS (QGIS Development Team, 2019) while I used R (R core team, 2019), for other spatial analysis, statistical analysis and data manipulation.

Model Development

To build a predictive distribution model, a machine learning method was adopted: Random Forest (Breiman, 2001), a powerful tool in the development of this type of models (Elith and Graham, 2009; Evans et al., 2011; Guillerá-Arroita et al., 2015).

Random Forest can handle many predictors, however a model with fewer variables is easier to interpret (Murphy et al., 2010). Thus, to find the best model for predicting bongo habitat I followed the parsimonious model selection approach described by Murphy (2010).

To conduct cross-validation of the model, data were divided into a train dataset (70% of locations) and a test dataset (remaining 30%). The train dataset is used for developing the model while the test for model validation. Data partition maintained the same representation of the two areas (Aberdare and Maasai Mau) as in the original dataset.

In order to assess the predictive ability of the resulting model, the area under the curve (AUC) of a Receiver – Operator Characteristics (ROC) was used (Fielding and Bell, 1997). Moreover, following Manel (2001) I also use Cohen's kappa (Cohen, 1960) for model validation, as AUC in case of rare species can be misleading. Cohen's kappa (hereafter kappa) measures the proportion of all possible cases of presence or absence that are predicted correctly by a model after accounting for chance. Both measures (AUC and kappa) range in values from 0 (predictive ability equal to chance) and 1 (perfect predictions).

The model would then be used to predict suitable habitat throughout the bongo known range.

Results

Camera Trapping

Camera trapping resulted in 17 bongo capture events in 13 camera trap locations, these are shown in Figure 4. Of these, eight cameras were part of the “deliberately biased” surveys, while the remaining were part of the 1x1km grids. All but one of the locations are in the Aberdare, as camera trapping in Maasai Mau resulted in a single capture.

The mean time a camera was operational until its first bongo capture was 8.2 days ($SE \pm 2.2$, $N = 13$). Therefore, in case of the shorter surveys, which lasted only 6 days, cameras that failed to detect a bongo were not counted as absence locations and their locations were excluded from the analysis. Moreover, two cameras were lost in two surveys (specifically Grid A and B, see Table 1), and their location was therefore excluded from the analysis.

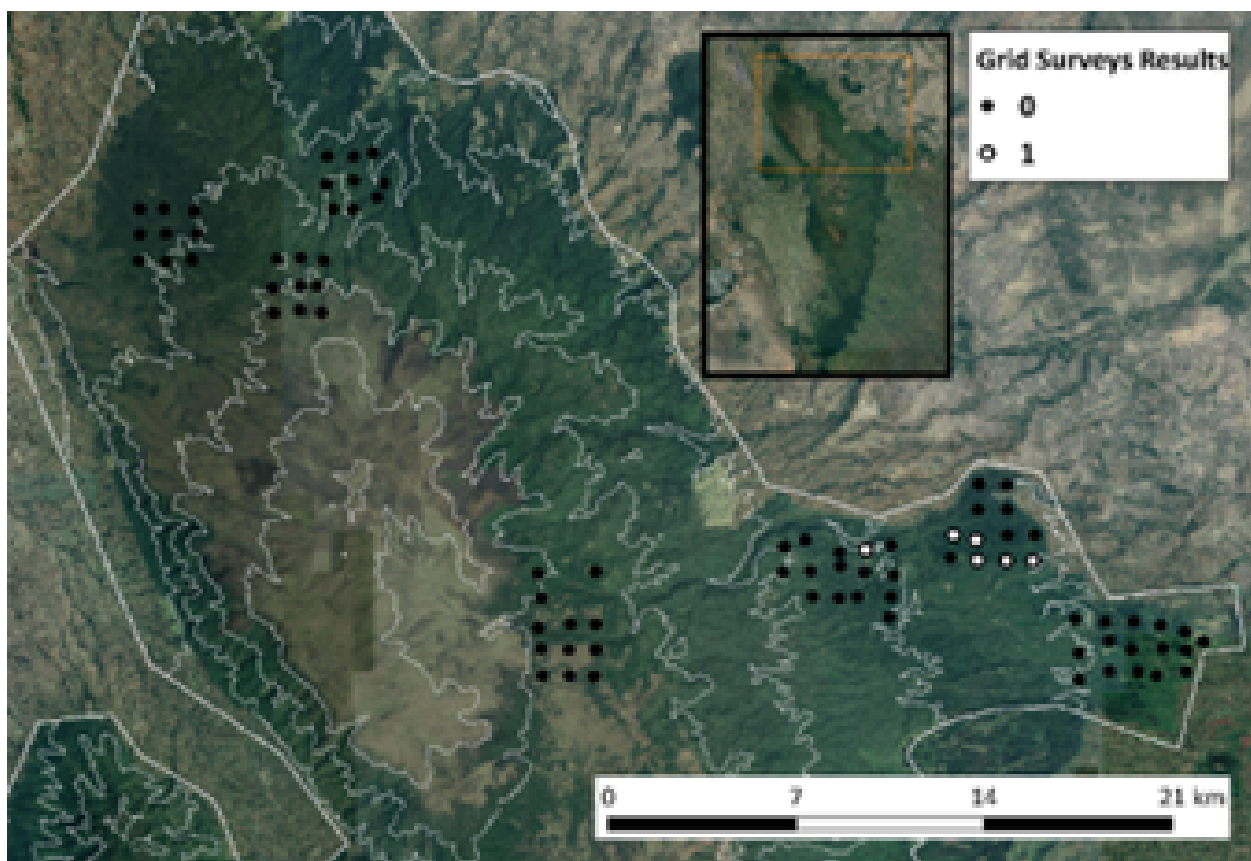


FIGURE 3: Results of the grid surveys in the Aberdare. The inset shows the location within the Aberdare range.

Sign Surveys

During the recce sign surveys, I recorded 104 tracks in Aberdare and Maasai Mau (Figure 4 and 5). Of these, 78 (43 in Maasai Mau, 35 in Aberdare) were kept for model development. Combining tracks and camera traps the presence locations used in the model development were 91. The remaining cameras ($n = 89$) constitute the absence points used in the analysis. My data are balanced with close to 1:1 representation of presence and absence locations. This helps avoiding imprecise predictions, a common issue in models with limited and unbalanced data (Evans et al., 2011).

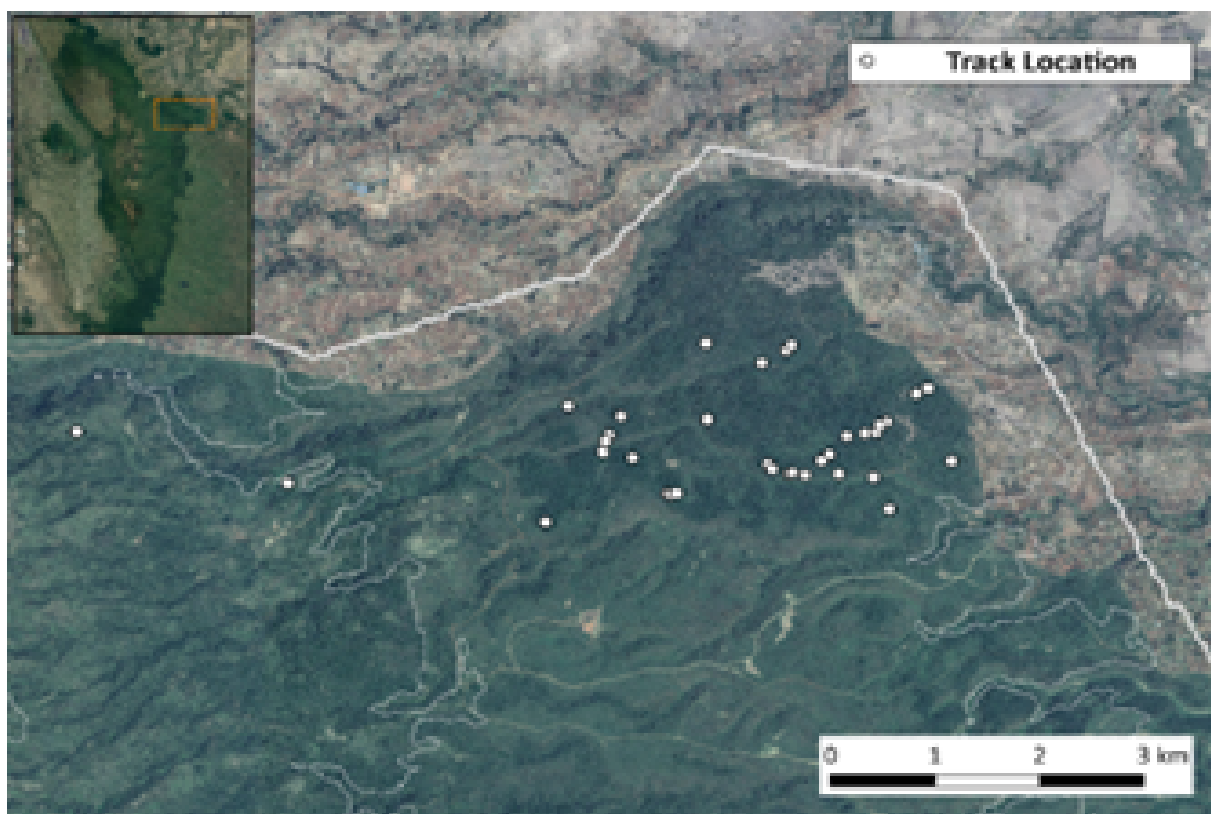


FIGURE 4: Tracks recorded in the Aberdare. The inset shows the location within the Aberdare range.

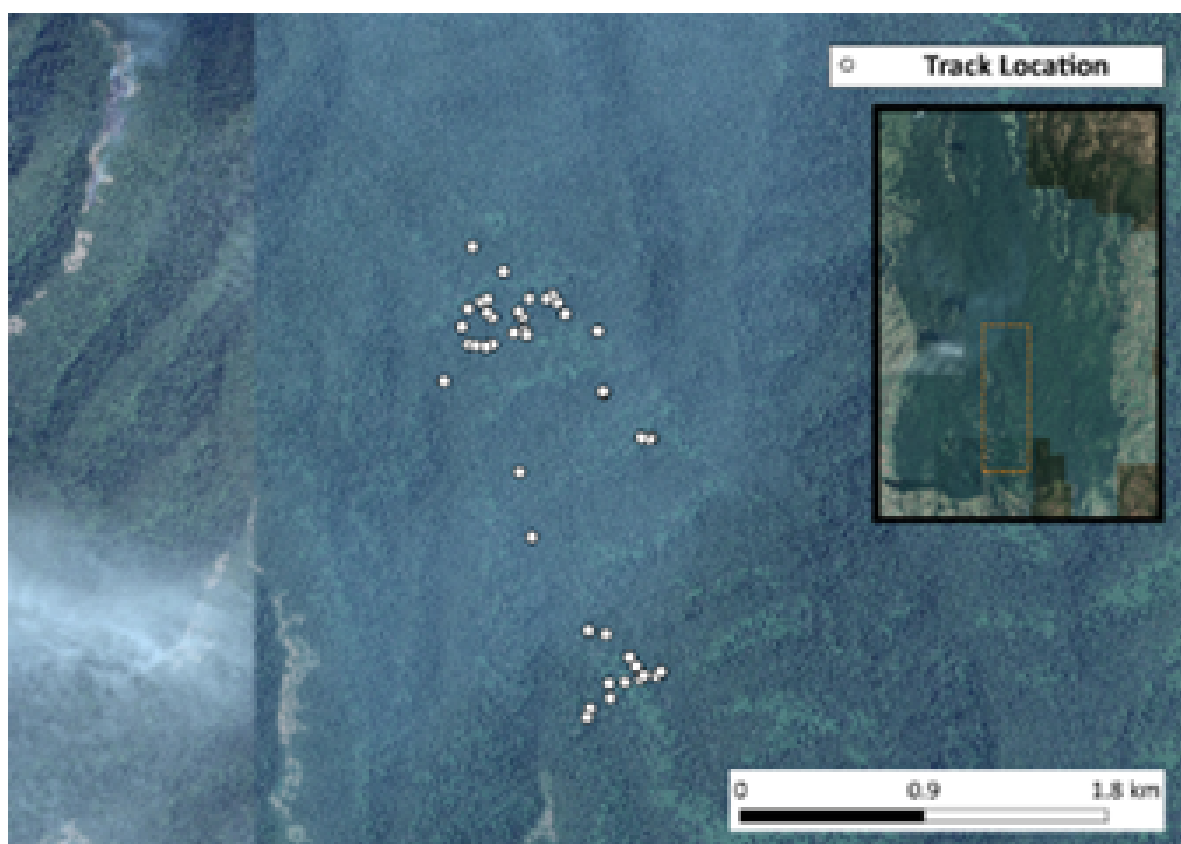


FIGURE 5: Tracks recorded in Maasai Mau. The inset shows the location within the Maasai Mau area.

Model Development

Parsimonious model selection (Murphy, 2010) resulted in a model containing five variables: elevation, ruggedness, and three vegetation indices MSR, RR and TCB: MSR is a good predictor of structured vegetation (Haboudane et al. 2004), and here correlates with stem density, while TCB relates to open ground (Baig et al., 2014) and here correlates negatively with forest indicative measures (i.e. stem density and basal area), and positively with mid layer density (i.e. shrubs).

The model has a correct classification rate of 82.8% for absences and 90.3% for presences. The selected model suggests vegetation is important in predicting bongo presence as well as topography, which is consistent with previous results (Estes et al. 2010, 2011). Elevation was found to be the most important predictor, and bongos seem occupy a specific altitudinal range (2000 – 2600 m).

Model predictive performance was good with an AUC of 0.92 and a kappa of 0.7, which is considered a substantial model performance (Landis and Koch, 1977; Manel et al. 2001).

In order to address the influence of different efforts among surveys (Table 1), I repeated the model building considering any late capture (beyond 15 days) as absences. The model developed using this other dataset retained the same predictors as the full dataset.

This model was used to predict bongo habitat throughout the four areas of interest (Maasai Mau, Aberdare, Mt Kenya and Eburu). The maps were computed using a moving window approach, where the result of a location is influenced by the surrounding area, this would allow the identification of suitable areas in relation to the surrounding ones.

Implications for Bongo Conservation

The model presented in this report differs from previous ones in having been developed relying solely on presence locations from areas where bongo herds are known to breed and, to some extent, growing: Maasai Mau and the Salient in Aberdare National Park.

Therefore, the predictions from this model not only show available habitat for bongo, but the habitat needed for breeding herds. The information is relevant to practitioners and conservationists as it allows for better and more accurate planning of reintroductions. However, maybe even more relevant, the predictions of this model may indicate areas yet to survey where habitat appears suitable, and these areas may be home to yet undiscovered bongo herds.

Figure 6 shows the prediction of suitable habitat in the Aberdare range. As expected, the Salient contains suitable habitat, which is where the resident herd resides. However, the map also highlights how limited the extent of suitable habitat is in this sector of the national park. Whereas in other sections of the range, in particular in the south (i.e. the Kikuyu escarpment) there appear to be extensive areas of likely suitable habitat. This southern forest appears promising in light of the recent finding of golden cat (*Caracal aurata*) in the area (Hatfield et al., 2019). This calls for further surveying of the area both for possible reintroduction candidate sites, and for possible bongo herds.

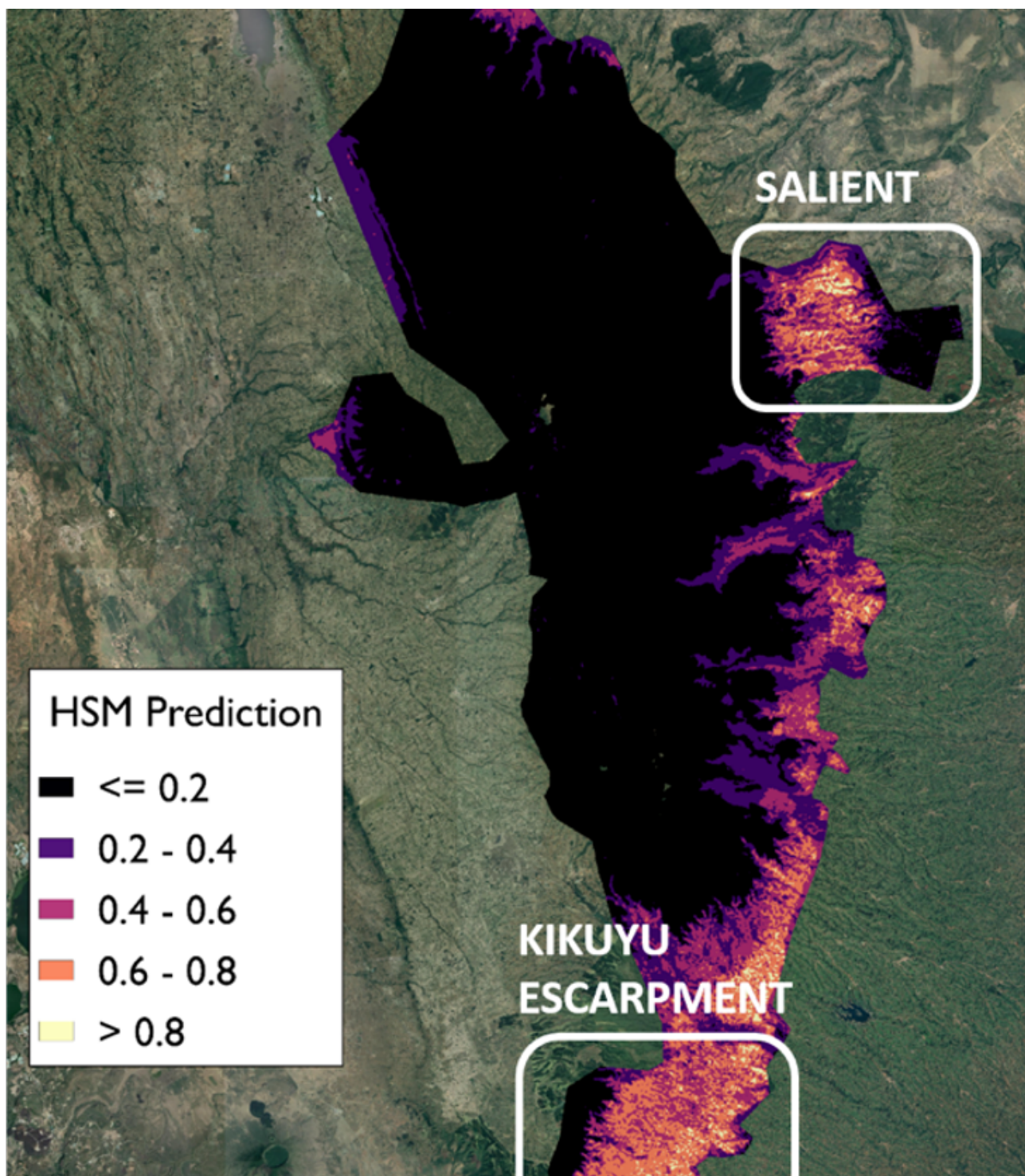


FIGURE 6: Habitat suitability pre-diction for the Aberdare, and location of the Salient and Kikuyu Escarpment in the Aberdare (Sandri, 2020).

Figure 7 shows the predicted habitat suitability in Maasai Mau. Here, it is clear that there is a larger extent of habitat compared to the Salient, with additional valleys to the one regularly surveyed by BSP showing promising habitat features for bongo presence.

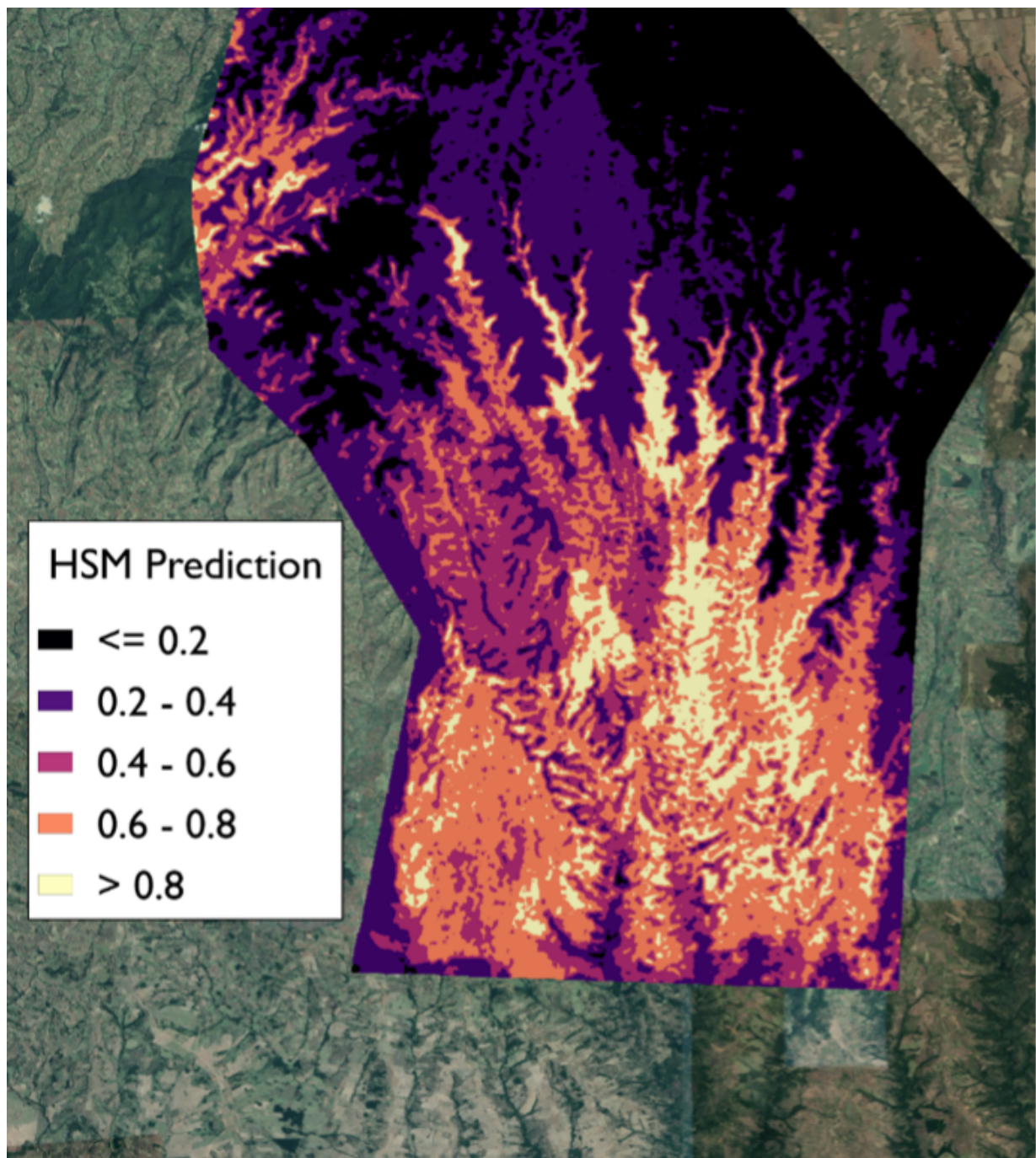


FIGURE 7: Habitat suitability prediction for the Maasai Mara (Sandri, 2020).

Figure 8 shows the prediction for Mt. Kenya. Mt. Kenya was once one of the main areas for mountain bongo presence (Kingdon, 1982). However, surveys by BSP have thus far failed to detect bongo herds. The only bongo regularly detected is a female in the vicinity of the Ragati conservancy. Nevertheless, this area, and others within both the national park and the forest reserve, appear to be suitable for bongo, at least from vegetation and topography. This confirms that Mt. Kenya hosts suitable habitat for bongo, indirectly confirming the relevance this area must have had in the past for this antelope. Moreover, Mt. Kenya is one of the main targets for current reintroduction initiatives, and the results here tend to validate the goodness of large parts of the area for bongo.

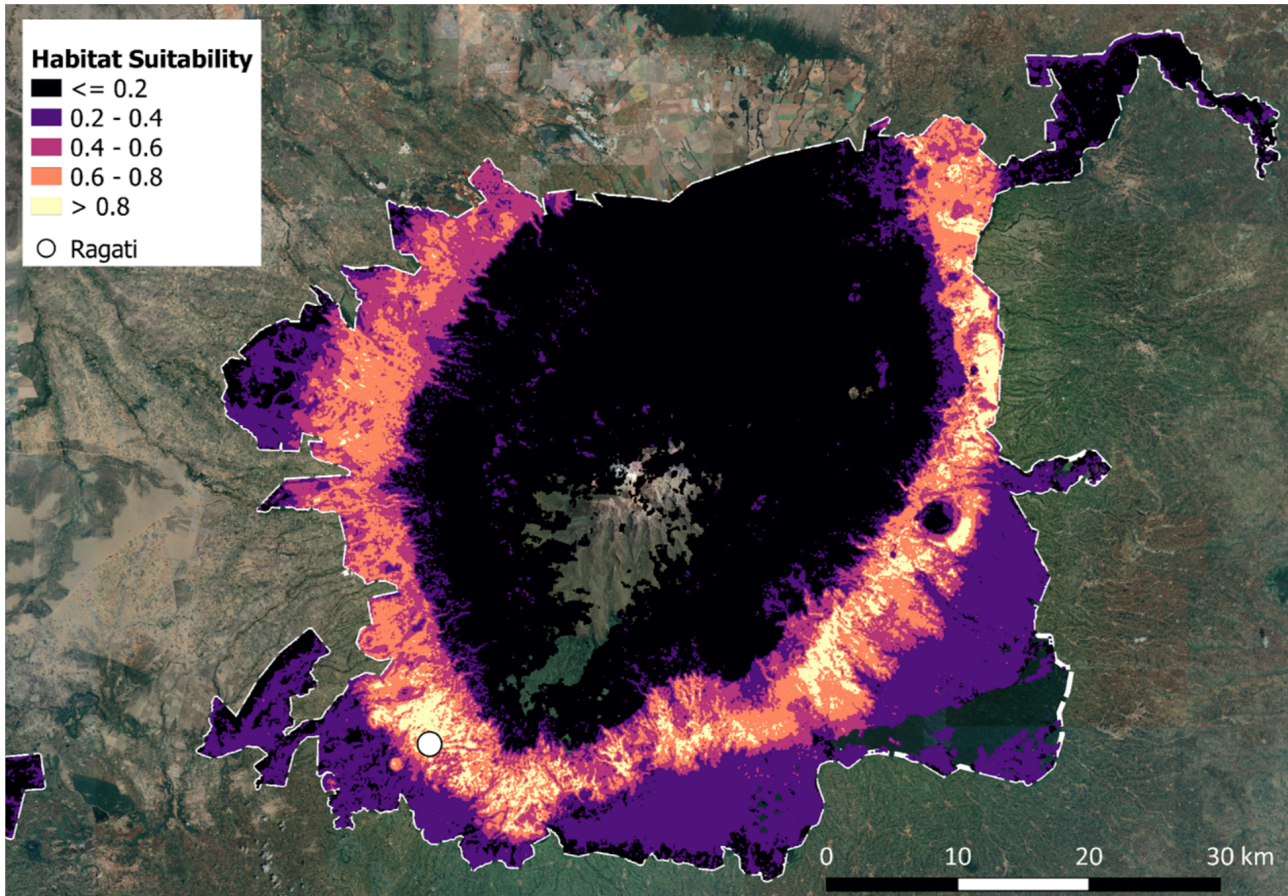


FIGURE 8: Habitat suitability prediction for Mt. Kenya National Forest, and location of the area surveyed by BSP (Sandri, 2020)

Figure 9 shows the predictions for Eburu. Of the four areas considered in this report, Eburu appears to be the one containing the least suitable habitat for bongo. The area is small, and only a fraction of it has optimal topography and vegetation for bongo.

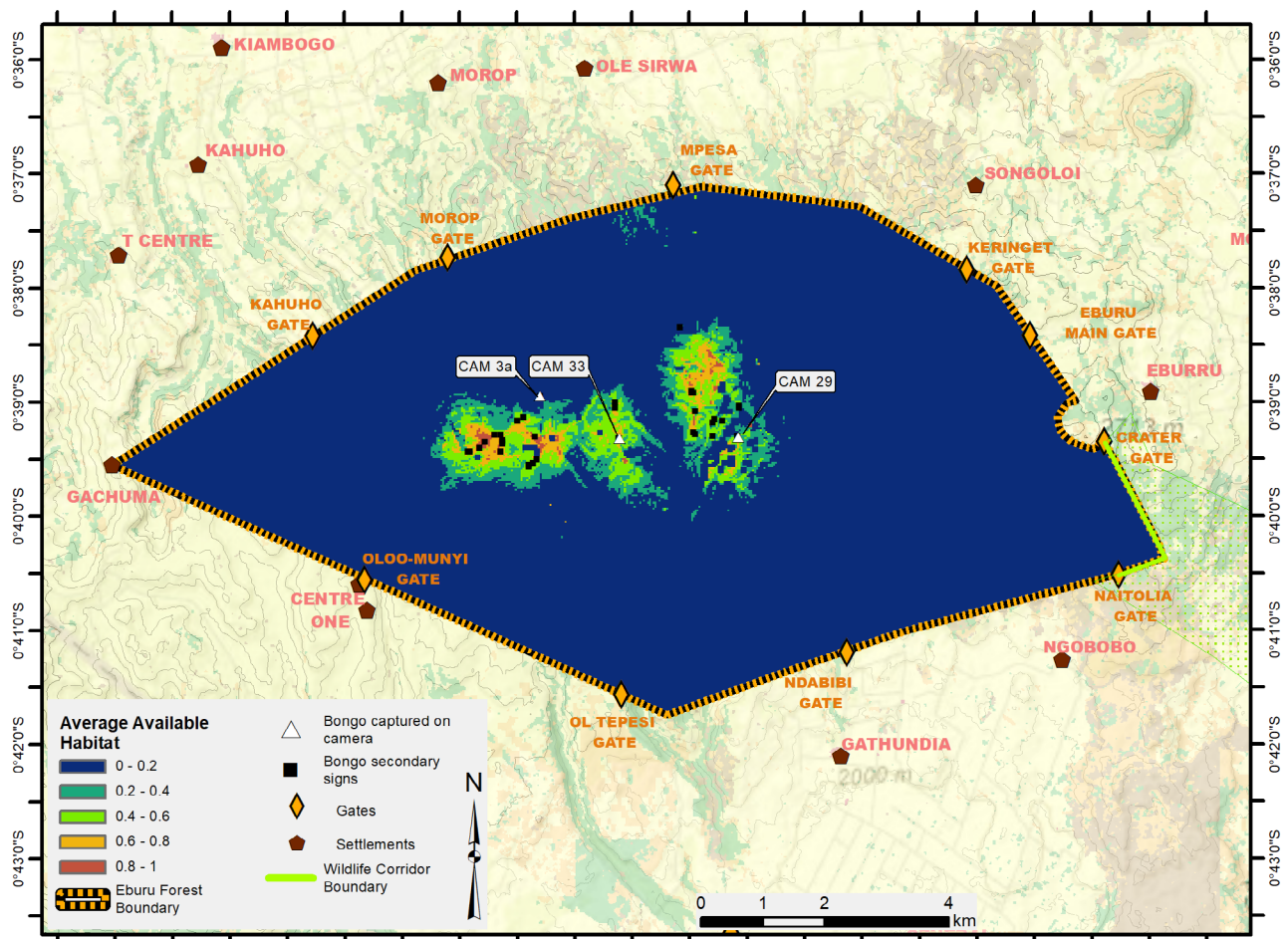


FIGURE 9: Habitat suitability prediction for Eburu Forest Reserve (Sheppard et al, 2022)

The main difference between predictions here presented and the previous model (Estes et al., 2011) is the role of ruggedness. Estes' model showed deep valleys as very important for bongo presence. Whereas my model shows the opposite, with gentler areas being preferred. This may well be an indication of the different data collected. Estes' included any sign of bongo throughout Mt. Kenya and Aberdare. This may have caused some locations occupied by bongo as a refuge (e.g., deep valleys) to be counted as suitable habitat. To further reinforce this point, some of the areas where Estes' found bongo presence seem devoid of bongo nowadays (i.e., the northern Aberdare). Therefore, while my dataset was smaller, and more spatially limited, it likely covers suitable habitat more than Estes', and hence provides a clearer indication of suitable habitat for bongo to not only survive, but breed.

However, one limitation of the predictions here presented is the lack of disturbance measures. Thus, the predictions show the quality of vegetation and topography for bongo, which is likely the most relevant feature in a location, but anthropic influence likely plays a role too, further analyses are needed to be able to fully accommodate for anthropic influence in bongo distribution.

Appendix 5: Mountain Bongo Fact Sheet

By, Jane Wathika, Mount Kenya Wildlife Conservancy

Theme	Description	
Taxonomy	Common names	Eastern Bongo, Kenyan Bongo, Ndongoro
	Scientific name	Tragelaphus eurycerus isaaci
	Conservation Status	Critically endangered. Less than 100 individuals in the wild
Appearance	Skin/Coat	Red chestnut with 10-15 vertical white torso stripes; Males are darker
	Horns	Both male and females have horns. The horn are spiral with one turn
Distribution & Habitat	Historical Range	Native to Kenya. Regionally Extinct in Uganda (Mt. Elgon). In Kenya, the mountain bongo is has its endemic populations in Mount Kenya (reintroduced in 2022), the Mau, Eburu Forests, and the Aberdare's
	Ex situ populations	There are approximately 415** bongos in zoos across USA and Europe
	Habitat	Mountain forests between 2000 to 3000 meters above sea level
	Gestation Period	270 days
Reproduction & Biology	Offspring per birth	1 young per birth; Twins are rare, and scarcely survive; Calves are usually left concealed in undergrowth to avoid detection by predators and mothers return to her calf to nurse at various intervals
	Weaning	At 6 months
	Age at Sexual Maturity	20-24 months
	Life span	19 years (Average)
	Mating season	Throughout the year
	Breeding lifetime	Females breed up to 16years of life; Females can mate within weeks after giving births
	Time of growth of horns	Male:6 months: Females: 1year
	Body Length	170-250cm
	Shoulder Height	110-130cm
	Tail Length	45-65cm
	Weight	Males: 240-400kg; Females 150-250Kg
	Foot size	Cloven hoofed; 75-100cm.
Behavior	Social interactions and Group sizes	Breeding groups of up to 24 individuals have been recorded composed of mothers and their young. Males tend to be solitary with loose coalitions among them
	Defense and Flight	Mothers can be extremely aggressive when they are with the young ones. To defend themselves, bongos attack swiftly with the horns held low and forward. When fleeing, they hold their horns against the back of their neck.
	Vocalizations	They have a wide range of vocalizations including grunts, snorts, 'clicking sounds' for bulls while questing to mate, or mothers calling out calves, bleat-like alarm calls etc. Each vocalization gives these animals signals for interaction or defense.
	Scent-marking	Male Bongos dig frequently in mud using their horns and afterward rub mud on trees, polishing their horns. During mating season, they soil their horns, leaving recognizable spoor on the forest ground.
	Daily activity	Most active at dusk and early morning
	Feeding habits and Diet	Predominantly browsers feeding on leaves, shoots, and occasionally graze on grass
	Senses	Acute sense of smell and hearing
	Sleep	They sleep in turns facing different directions allowing everyone to act as a sentry. Even during feeding, they take care, making careful pauses to listen to their surroundings

Appendix 6: Dietary Contribution, Relative Abundance for the Top Twenty Plant Foods Selected by Mountain Bongos during the Wet and Dry Seasons in Mount Kenya Wildlife Conservancy

By, Peter Fundi, Chuka University

Wet Season				Dry Season			
Food species	Dietary Contribution	Relative abundance	Electivity Index E*	Food species	Dietary Contribution	Relative abundance	Electivity Index E*
<i>Lantana trifolia</i> L.	2.01	0.21	0.81	<i>Trichocladus ellipticus</i> Eckl. & Zeyh.	11.91	2.09	0.78
<i>Microglossa pyrifolia</i> (Lam.) O. Kuntze	1.84	0.21	0.79	<i>Pennisetum clandestinum</i> Hochst. ex Chiov.	0.95	0.21	0.73
<i>Panicum monticola</i> Hook.f.	3.27	0.42	0.77	<i>Carex chlorosaccus</i> C.B. Clarke	0.81	0.21	0.68
<i>Glycine wightii</i> (Wight & Arn.) Verdc.	2.69	0.56	0.65	<i>Microglossa pyrifolia</i> (Lam.) O. Kuntze	0.8	0.21	0.68
<i>Rhus vulgaris</i> Meikle	3.93	1.05	0.57	<i>Rhamnus prinoides</i> L'Herit	8.36	2.3	0.67
<i>Stipa keniensis</i> (Pilg.) Freitag	19.15	7.09	0.45	<i>Toddalia asiatica</i> (L.) Lam.	12.4	4.8	0.56
<i>Senecio syringifolius</i> O. Hoffm.	3.31	1.25	0.44	<i>Clematis brachiata</i> Thunb.	0.34	0.14	0.54
<i>Grewia similis</i> K.Schum	3.92	1.67	0.39	<i>Mystroxydon aethiopicum</i> (Thumb.) Loes.	3.69	1.88	0.46
<i>Clematis brachiata</i> Thunb.	0.8	0.42	0.29	<i>Maytenus heterophylla</i> (Eckl. & Zeyh) Robson	3.55	1.88	0.44
<i>Cynodon dactylon</i> (L.) Pers.	1.06	0.56	0.29	<i>Dovyalis abyssinica</i> (A.Rich.) Warb.	2.61	1.67	0.36
<i>Solanum aculeastrum</i> Dunal	0.36	0.21	0.24	<i>Rhus vulgaris</i> Meikle	1.56	1.05	0.34
<i>Rhamnus prinoides</i> L'Herit	4.1	2.5	0.22	<i>Glycine wightii</i> (Wight & Arn.) Verdc.	0.63	0.42	0.34
<i>Ocimum lamiifolium</i> Benth	5.38	3.34	0.22	<i>Stipa keniensis</i> (Pilg.) Freitag	9.24	6.39	0.33
<i>Trichocladus ellipticus</i> Eckl. & Zeyh.	2.93	1.88	0.2	<i>Brachypodium flexum</i> Nees	7.07	5	0.32
<i>Olea europaea</i> L. spp <i>africana</i> (Mill.) P. Green.	10.77	8.34	0.11	<i>Panicum monticola</i> Hook.f.	0.93	0.7	0.29
<i>Maytenus heterophylla</i> (Eckl. & Zeyh) Robson	2.26	1.88	0.07	<i>Senecio deltoideus</i> Less.	0.19	0.14	0.29
<i>Dovyalis abyssinica</i> (A.Rich.) Warb.	2	1.67	0.07	<i>Rhus natalensis</i> Krauss	7.68	6.46	0.24
<i>Hibiscus lunarifolius</i> Wild	0.21	0.21	-0.05	<i>Grewia similis</i> K.Schum	1.36	1.67	0.05
<i>Thunbergia alata</i> Bojer ex Sims	0.24	0.28	-0.12	<i>Carissa edulis</i> (Forssk.) Vahl	0.79	1.05	0.01
<i>Zehneria scabra</i> Sond.	0.55	0.7	-0.15	<i>Olea europaea</i> L. <i>africana</i> (Mill.) P. Green.	5.75	8.34	0.04

Appendix 7: List of Stakeholders Workshop Participants 24-25 June 2025

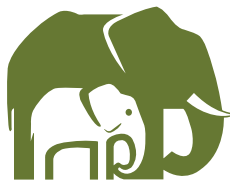
#	NAME	DESIGNATION	ORGANIZATION
1	Alice Bett	Senior Research Scientist	WRTI
2	Becky Summers	Administrator	RA/WICZ3
3	Benard Matu	Director-Natural resources	Laikipia County Government
4	Dr. Bradley Cain	Senior Lecturer	Manchester Metropolitan University
5	Brendan Hill	CEO	Ragati River Management
6	Charles Ruga	Chairman	CFA
7	Christian Lambrechts	Executive Director	Rhino Ark
8	Christine Winja	SPOA	KWS
9	Daisy Kui	County Forester	Narok County
10	Daniel Maritim	Chairman	CFA
11	Dominc Ogega	Forest Station Manager	KFS
12	Dr. Donna Sheppard	Bongo& Community Conservation Specialist	RA/Wilder Institute Calgary Zoo
13	Enock Ochieng	Patrols Manager	Mount Kenya Trust
14	Evans Kinoti	Inspector	KFS
15	Francis Mburugu	Forest Station Manager	KFS
16	Geofrey Wandeto	Chairman	CFA
17	George Abuto	Regional Forest Conservator	KFS
18	Gideon Kamweti	Chairman	CFA
19	Hugh Gibbon	Chairman	Eburu Rafiki
20	Jacob Chebet	Forest Station Manager	KFS
21	James Mwang'ombe	Principal Biodiversity Conservator	KFS
22	Jane Waitthaka	Research Scientist	MKWC
23	Jeff Waweru	Photographer/videographer	
24	John Kariuki	Chairman	CFA
25	John Karoki	Chairman	CFA
26	John Kinoti	Chairman	MBRCT
27	John Mbaabu	MBRCT Trustee	MBRCT
28	Dr. Kivara Luke	Private Veterinarian	Mt. Kenya Vet Services
29	Dr. Stuart Nixon	Senior Programmes Officer for Africa	Chester Zoo
30	Lawrence Mwebia	Trust Executive Officer	MBRCT
31	Lekishon Kenana	Deputy Director-Conservation Science Programmes	KWS
32	Linus Kariuki	Head-Species Conservation and Management	KWS
33	Lucy Muita	Senior Assistant Director- Mountain Conservation Area	KWS
34	Lydia Nyota	Chairperson	CFA
35	Dr. Malte Sommerlatte	CO-Founder	Ragati River Management
36	Martin Wagacha	Field Officer	Mt. Kenya ecosystem
37	Muturi Wachiuri	Conservation Program Associate	RA/WICZ
38	Dr. Nick Davis	EEP EAZA	Chester Zoo
39	Oli Drake	Conservation & Sustainability manager	The Safari Collection
40	Oscar Dyer	Director of operations	BSP
41	Patrick Kariuki	Chairman	CFA

#	NAME	DESIGNATION	ORGANIZATION
42	Patrick Mwangi	Field Officer	RA/WICS
43	Peter Munene	Education Outreach Officer	BSP/RA
44	Prof. David Mallon	Co Chair IUCN SSC ASG	IUCN, MMU
45	Prof. Paul Reillo	Founding Director and President	RSCF
46	Prof. Robert Chira	Senior Lecturer	UON
47	Raphael Muchembe	Chairman	CFA
48	Dr. Robert Aruho	Head of Conservancy	MKWC
49	Simon Gitau	Head-Enterprise Development & marketing	WRTI
50	Simon Muita	Species Officer	KWS
51	Steven Gachagua	Operations Manager	MKWC
52	Susie Weeks	Executive Director	MKT
53	Dr. Tommy Sandri	Bongo Project Africa Field Program Lead	Chester Zoo
54	Sofia Makena	Inspector	KFS
55	Viola Kemunto	GIS/RS Officer	KSA
56	Abdinoor Jirma	Warden	KWS
57	Peris Akinyi	Assistant Research Scientist	WRTI
58	Dr. Mukami Ruoro	Senior Veterinary Officer	KWS
59	Faith Murithi	CFA	CFA
60	Jaceth Mwendwa		
61	Samuel Nwiritu	CFA	CFA



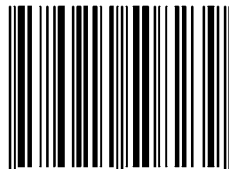


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